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LETTER OF TRANSMISSION

To His Honour W. D. Ross,

Lieutenant-Governor of the Province of Ontario.

Sir,—I have the honour to transmit to you herewith, for presentation to the Legislative Assembly of the Province of Ontario, the Thirty-eighth Annual Report of the Department over which I have the honour to preside.

I have the honour to be, Sir,

Your obedient servant,

Chas. McCrea.

Minister of Mines.

Department of Mines,
Toronto, 1929.

1 M

INTRODUCTORY LETTER

To The Honourable Chas. McCrea,
Minister of Mines.

Sir,—The undersigned has the honour to submit the Thirty-eighth Annual Report of the Department of Mines, issued in seven parts, as follows:—

Part 1

Introductory Letter, by Thos. W. Gibson.
Statistical Review, by W. R. Rogers and A. C. Young.
Classes for Prospectors, by E. M. Burwash.
Mines of Ontario in 1928, by D. G. Sinclair, R. H. Cleland, E. C. Keeley, G. S. Jarrett, A. R. Webster.
Mining Accidents in 1928, by T. F. Sutherland, G. E. Cole, D. C. Sinclair, J. G. McMillan, A. R. Webster.

Part 2

Geology of the Fort Hope Gold Area, District of Kenora (Patricia Portion), by E. M. Burwash.
Geology of the Area between Favourable Lake and Sandy Lake, District of Kenora, (Patricia Portion), by M. E. Hurst.

Maps:

No. 38*a*.—Favourable Lake to Sandy Lake Area, scale 2 miles to the inch.
No. 38*b*-1.—Fort Hope Area, scale 3 miles to the inch.
No. 38*b*-2.—Lake Nipigon to Albany River, scale 4 miles to the inch.

Part 3

The Sudbury Basin Area, by A. G. Burrows and H. C. Rickaby.
Map: No. 38*g*.—Sudbury Basin Area, scale 1½ miles to the inch.

Part 4

Investigations of Non-Metallic Mineral Resources of Ontario, 1928:
General Review of Non-Metallic Mineral Resources, 1928, by W. S. Dyer.
Semi-Commercial Tests on Northern Ontario Fire Clays, by W. S. Dyer and R. J. Montgomery.
Laboratory Tests on Northern Ontario Fire Clays, by R. J. Montgomery.
Ontario Ceramic Exhibit at Chicago, by W. S. Dyer.
A Survey of the Ceramic Industry in Ontario (Interim Report), by R. J. Montgomery.
Limestones of the Moose River and Albany River basins, by W. S. Dyer.
Lignite Coal from Blacksmith Rapids, Abitibi River, by R. E. Gilmore.
Sylvania Sandstone Deposit at Amherstburg, by W. S. Dyer.
Paleozioc Geology of the Albany River and Certain of Its Tributaries, by W. S. Dyer.

Part 5

Natural Gas in 1928, by R. B. Harkness.
Petroleum in 1928, by R. B. Harkness.

Part 6

Oba Area, District of Algoma, by J. E. Maynard.
Boston-Skead Gold-Copper Area, District of Timiskaming, by L. V. Bell.
Geology of the Sapawe Lake Area, with Notes on some Iron and Gold Deposits of Rainy River District, by J. E. Hawley.
Lead and Zinc Deposits, Dorion and McTavish Townships, District of Thunder Bay, by J. E. Hawley.

Maps:

No. 38*c*.—Oba area, scale 2 miles to the inch.
No. 38*d*.—Boston Creek area, scale 800 feet to the inch.
No. 38*e*.—Sapawe Lake area, scale ¾ mile to the inch.
No. 38*f*.—Dorion and McTavish Townships, scale 1 mile to the inch.

Part 7

Cartier-Stralak Area, District of Sudbury, by F. F. Osborne.
Ore Deposits near the North Shore of Lake Huron, by E. S. Moore.
Map No. 38*h*.—Cartier-Stralak area, scale 1 mile to the inch.

Only Part 1 is bound with the Sessional Papers of the Legislature. All parts are available on application to the Department.

Respectfully submitted,

Thos. W. Gibson,
Deputy Minister of Mines.

Department of Mines,
Toronto, 1929.

ONTARIO

PROVINCE OF ONTARIO

DEPARTMENT OF MINES

HON. CHAS MCCREA, *Minister of Mines.* THOS. W. GIBSON, *Deputy Minister.*

THIRTY-EIGHTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXVIII, PART I, 1929

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STATISTICAL REVIEW OF ONTARIO'S MINERAL INDUSTRY IN 1928

By W. R. Rogers and A. C. Young

Introduction

For the first time on record Ontario's mineral production has reached a value of one hundred million dollars. The total for 1928 was $100,083,122 as against $90,283,447 in 1927, the highest record heretofore. This increase of nearly ten million dollars represents a gain of 11 per cent.

As shown in Tables I and II, the mineral production is divided into four main groups: metallics worth $71,267,003; non-metallics, $7,822,641; structural materials, $14,815,814; and clay products, $6,177,664. Increases were noted in all groups, the greatest being 13.8 per cent for metallics.

The most important group, as may be noted above, is metallics, which represents 71 per cent of the total production. In this section the gold mining industry, which includes some silver, was the leading item, accounting for $32,688,818. The value for the nickel-copper industry, which also must be credited with all the platinum metals and a small quantity of gold and silver, was $32,494,723. While the gold dropped slightly more than one million dollars in value, and silver was down by two million ounces despite a more favourable price of the metal, the great increase in nickel-copper output was responsible for the highest metal record in the history of the Province.

Non-metallic minerals showed a very slight gain and may be described as unchanged, although a few of the more important items such as natural gas and salt showed some fluctuation.

Structural materials, due to increased output of cement and lime, and generally to a heavier demand for other materials of construction, showed a rise of more than one-half million dollars.

Clay products, which includes all branches of the ceramic industry using domestic clay as raw material, experienced a most prosperous year, the increase amounting to $324,629. Items showing the greatest advance were sewer pipe and structural tile.

The general prosperity of all sections of the mineral industry in 1928 as outlined above reflects improved business conditions in Ontario, and is an earnest of an era of future expansion.

One outstanding feature of the year was the tendency towards amalgamation or consolidation of companies, more particularly as regards non-metallics and structural materials: e.g., gypsum, lime, stone, sand and gravel. In the metallic field the International and Mond Nickel companies joined forces at the close of the year.

During the present century Ontario's mineral production has grown at a faster rate than that of Canada at large, and this applies more particularly to metals. The growth in millions of dollars is set forth in the comparative table which follows:

	Metals			Total Mineral Production		
	1928	1900	Ratio of Growth	1928	1900	Ratio of Growth
Canada	132.0	11.4	11.6 to 1	275.0	64.4	4.3 to 1
Ontario	71.3	2.6	27.4 to 1	100.0	9.3	10.7 to 1

TABLE I.—SUMMARY OF MINERAL STATISTICS OF ONTARIO FOR 1928

Product (tons of 2,000 lbs.)	Quantity	Value	Employees	Wages
METALLIC:		$		$
Gold....oz.	1,578,433	32,629,111	6,356	9,922,861
Silver.... "	7,171,304	4,156,431	1,035	1,540,840
Copper in matte exported (a)....tons	13,221	2,776,505	(b) 3,048	4,706,919
Nickel in matte exported (a).... "	18,856	6,788,315		
Copper, metallic and in concentrates, exported....lb.	40,164,606	5,993,644		
Nickel, metallic and contained in speiss exported.... "	49,216,004	12,609,197	(c) 797	1,298,778
Nickel oxide and salts.... "	12,688,111	2,921,395		
Platinum metals....oz.	23,539	1,309,923		
Bismuth....lb.	14,002	5,067		
Cobalt, metallic and in residues exported Cobalt oxide (metal content).... Cobalt in salts and unseparated oxides "	954,860	1,671,900	(d) 330	364,348
Lead, pig and in concentrates exported... "	6,814,757	402,289	490	438,011
Zinc in concentrates exported.... "	58,724	3,226		
Total....	....	71,267,003	12,736	18,271,757
NON-METALLIC:				
Actinolite....tons	70	875	8	1,468
Arsenic, white....lb.	4,097,226	178,149	(d)	(d)
Feldspar, crude and ground....tons	18,954	180,153	95	55,942
Graphite, crude and refined.... "	1,047	52,373	64	44,022
Gypsum.... "	85,811	553,271	248	289,292
Iron pyrites and sulphur.... "	(e) 4,974	54,100	....	....
Mica.... "	2,559	32,945	27	9,214
Mineral water....Imp. gals.	253,630	27,890	16	6,580
Natural gas....M. cu. ft.	7,632,740	4,535,312	1,209	1,497,999
Peat....tons	1,497	5,845	33	19,436
Petroleum, crude....bbls.	134,164	249,981	108	95,145
Quartzite and quartz....tons	194,503	308,608	105	95,165
Silica brick....M.	1,597	86,323	22	31,381
Salt....tons	279,841	1,377,629	299	337,214
Talc and soapstone.... "	14,925	179,187	45	44,858
Total....	....	7,822,641	2,279	2,527,716
STRUCTURAL MATERIALS:				
Cement, Portland....bbls.	3,911,795	5,520,897	838	1,108,254
Hydrated lime....tons	49,085	597,367	414	390,611
Quicklime....bush.	6,517,170	1,870,476		
Sand and gravel....tons	6,193,117	2,056,366	877	870,306
Sand-lime brick....M.	61,506	(f) 745,719	183	205,497
Stone: building, trap, granite, etc....tons	4,597,764	4,024,989	1,304	1,112,035
Total....	....	14,815,814	3,616	3,686,703
CLAY PRODUCTS:				
Brick, face....No.	110,172,272	2,267,268		
" common.... "	72,963,293	1,154,763		
" fancy and ornamental.... "	532,020	25,714	1,969	1.877,307
" sewer.... "	2,621,072	49,547		
Tile, drain.... "	20,275,694	572,577		
" structural.... "	....	1,035,119		
Sewer pipe, copings, flue-linings, etc.... "	....	974,157	239	271,062
Pottery....M.	....	98,519	32	37,253
Total....	....	6,177,664	2,240	2,185,622
GRAND TOTAL....	....	100,083,122	20,871	26,671,798

(a) Copper and nickel in matte valued at 15½ and 18 cents per pound, respectively.
(b) Employees and wages for nickel-copper mines and smelters.
(c) Employees and wages for nickel-copper refineries.
(d) Employees and wages for silver-cobalt smelters and refineries.
(e) Tonnage given is sulphur content.
(f) No deduction made for lime consumed in manufacturing.

TABLE II.—COMPARATIVE VALUE OF MINERAL PRODUCTION, 1924-1928

Product	1924	1925	1926	1927	1928
METALLIC:	$	$	$	$	$
Gold	25,669,303	30,206,432	30,950,753	33,627,040	32,629,111
Silver	7,233,078	6,964,325	5,781,706	5,230,402	4,156,431
Platinum metals	1,891,497	1,676,446	1,559,527	1,270,843	1,309,923
Cobalt (*a*)	1,662,526	2,328,517	1,136,014	1,764,534	1,671,900
Nickel (*b*)	11,309,326	15,946,673	14,374,163	15,262,171	22,318,907
Copper, metallic and in matte	3,825,294	4,739,124	4,828,964	4,946,533	8,770,149
Iron ore (*c*)	110	.....	.....	.....	.....
Pig iron (*d*)	91,862	.....	.....	.....	.....
Lead (pig)	419,405	601,704	580,730	528,729	402,289
Zinc	.....	13,685	.....	.....	3,226
Bismuth	27,913	18,566	6,440	1,003	5,067
Total	52,130,314	62,495,472	59,218,297	62,631,255	71,267,003
NON-METALLIC:					
Abrasives (*e*)	9,272	945	576	.....	.....
Actinolite	1,225	500	1,000	1,075	875
Arsenic, white	309,108	113,325	135,549	197,668	178,149
Asbestos	91,900	901	3,935	.....	.....
Feldspar, crude and ground	216,791	141,059	199,102	154,533	180,153
Fluorspar	1,343	200	.....	.....	.....
Graphite, crude and refined	72,842	134,213	158,994	109,613	52,373
Gypsum	467,097	491,833	496,059	500,688	553,271
Iron pyrites	44,542	8,799	4,912	6,077	54,100
Mica	172,252	82,661	59,085	75,183	32,945
Mineral water	13,133	25,452	27,277	12,811	27,890
Natural gas	4,076,014	4,083,341	4,415,918	4,331,780	4,535,312
Peat fuel	.....	8,394	.....	.....	5,845
Petroleum, crude	390,424	396,154	376,822	289,391	249,981
Phosphate of lime	.....	.....	.....	824	.....
Quartzite and quartz	(*f*) 221,452	(*f*) 359,691	339,304	266,204	308,608
Silica brick	.....	.....	56,441	(*g*) 28,549	86,323
Salt	1,337,311	1,466,450	1,388,672	1,510,777	1,377,629
Talc and soapstone	130,577	174,116	178,986	181,981	179,187
Total	7,555,283	7,488,034	7,842,632	7,638,605	7,822,641
STRUCTURAL MATERIALS:					
Cement, Portland	5,668,671	5,253,911	4,792,857	5,144,326	5,520,897
Lime, hydrated and quicklime	1,840,152	2,044,125	2,051,446	2,198,239	2,467,843
Sand and gravel	1,587,913	1,658,700	2,117,461	2,035,793	2,056,366
Sand-lime brick	512,361	677,103	461,376	(*h*) 721,485	(*h*) 745,719
Stone: building, trap, granite, etc.	2,789,368	2,817,335	3,258,168	4,060,709	4,024,989
Total	12,398,465	12,451,174	12,681,308	14,160,552	14,815,814
CLAY PRODUCTS:					
Brick, face	2,203,617	2,403,832	2,436,848	2,287,495	2,267,268
" common	944,892	733,793	768,734	1,063,724	1,154,763
" fancy and ornamental	88,857	21,728	20,047	25,016	25,714
" sewer	40,922	37,082	111,620	202,920	49,547
Tile, drain	373,980	360,710	340,403	521,957	572,577
" structural, roofing and floor	550,170	612,138	756,011	808,436	1,035,119
Sewer pipe, copings, flue-linings, etc.	851,327	893,443	835,206	852,187	974,157
Pottery	84,100	86,000	87,600	91,300	98,519
Total	5,137,865	5,148,626	5,356,469	5,853,035	6,177,664
GRAND TOTAL	**77,221,927**	**87,583,306**	**85,098,706**	**90,283,447**	**100,083,122**

(*a*) Cobalt oxide, metallic cobalt, and cobalt content of residues marketed.
(*b*) Nickel in matte, oxide and metallic nickel.
(*c*) Exports and shipments to points other than Ontario blast furnaces.
(*d*) Product from Ontario ore only. (*e*) Includes garnets and quartz pebbles.
(*f*) Includes value of silica brick.
(*g*) Not included in the total of non-metallics or grand total.
(*h*) No deduction made for lime consumed in manufacturing.

In Table III is given the aggregate value of the metals and metallic products from the time production began in Ontario down to the end of 1928. As regards pig iron it should be pointed out that since 1914 the statistics of annual production credit the Province only with the value of the product made from Ontario ore. This is but a small part of the total output, since the great bulk of the iron ore charged to the blast furnaces of the Province is "lake" ore from the mines of Minnesota and Wisconsin. In the production tables credit is taken only for the ore exported or shipped to points other than Ontario blast furnaces, since to include the value of the domestic ore converted into pig iron in Ontario furnaces would involve a duplication of this item.

TABLE III.—TOTAL MINERAL PRODUCTION OF ONTARIO

Year	Value of Mineral Production				
	Metallic	Non-Metallic	Structural Materials	Clay Products	Total
	$	$	$	$	$
Before 1891....	(a) 9,520,269		(a)		9,520,269
1891.....	388,715		4,316,958		4,705,673
1892.....	864,382		4,509,757		5,374,139
1893.....	614,762		5,505,991		6,120,753
1894.....	842,750		5,244,008		6,086,758
1895.....	616,055		4,554,083		5,170,138
1896.....	963,288		4,271,715		5,235,003
1897.....	1,038,089		(b) 4,480,452		(b) 5,518,541
1898.....	1,689,002		5,546,875		7,235,877
1899.....	2,055,592		6,361,081		8,416,673
1900.....	2,565,286		6,733,338		9,298,624
1901.....	5,016,734		6,814,352		11,831,086
1902.....	6,257,499		7,134,135		13,391,634
1903.....	5,242,575		7,628,018		12,870,593
1904.....	4,906,677		6,665,970		11,572,647
1905.....	10,201,010		7,653,286		17,854,296
1906.....	13,353,080		9,035,303		22,388,383
1907.....	14,550,835	3,020,537	3,876,275	3,571,726	25,019,373
1908.....	16,754,986	2,629,749	3,396,406	2,856,476	25,637,617
1909.....	22,928,496	2,825,751	4,028,206	3,198,922	32,981,375
1910.....	28,161,678	3,141,658	4,380,000	3,630,559	39,313,895
1911.....	29,102,867	3,674,926	4,935,609	4,263,395	41,976,797
1912.....	34,799,734	4,009,643	4,701,170	4,831,056	48,341,603
1913.....	37,507,935	4,296,450	5,866,775	5,561,151	53,232,311
1914.....	33,345,291	4,339,703	4,505,368	4,105,597	46,295,959
1915.....	44,109,769	4,655,250	3,609,371	1,871,379	54,245,679
1916.....	55,002,918	4,982,140	3,734,065	1,584,699	65,303,822
1917.....	56,831,857	7,702,942	4,962,284	2,596,749	72,093,832
1918.....	66,178,059	7,815,062	4,297,401	2,018,450	80,308,972
1919.....	41,590,759	6,308,182	7,208,413	3,776,562	58,883,916
1920.....	48,281,553	8,141,796	11,921,019	4,735,154	73,079,522
1921.....	28,777,581	6,636,217	13,967,386	5,183,125	54,564,309
1922.....	40,290,157	7,591,913	13,640,166	6,944,218	68,466,454
1923.....	44,076,660	8,511,786	13,139,757	6,269,140	71,997,343
1924.....	52,130,314	7,555,283	12,398,465	5,137,865	77,221,927
1925.....	62,495,472	7,488,034	12,451,174	5,148,626	87,583,306
1926.....	59,218,297	7,842,632	12,681,308	5,356,469	85,098,706
1927.....	62,631,255	7,638,605	14,160,552	5,853,035	90,283,447
1928.....	71,267,003	7,822,641	14,815,814	6,177,664	100,083,122
Total.....	1,016,169,151		498,435,223		1,514,604,374

(a) Prior to 1891, when the Ontario Bureau (now Department) of Mines was established it is estimated that metals to the value of $9,520,269 were produced. No estimate has been made of the output of non-metallics up to 1891.

(b) Estimated on basis of preceding year ($1,618,720 for stone, lime, and clay products).

The total production of metals in Ontario noted hereunder; gold moved up from third to first place in 1927:—

Metal or Product	Production to December 31, 1927	Production, 1928	Production to December 31, 1928
	$	$	$
Gold	249,069,826	32,629,111	281,698,937
Nickel, including nickel oxide	243,178,691	22,318,907	265,497,598
Silver	239,196,529	4,156,431	243,352,960
Copper (*a*)	82,595,047	8,770,149	91,365,196
Pig iron	84,775,556	.....	84,775,556
Cobalt (*b*)	19,474,559	1,671,900	21,146,459
Platinum metals	13,100,227	1,309,923	14,410,150
Iron ore (*c*)	9,463,516	.....	9,463,516
Lead	3,628,125	402,289	4,030,414
Molybdenite	209,735	.....	209,735
Zinc, in ore and concentrates	108,276	3,226	111,502
Bismuth	102,061	5,067	107,128
Total	944,902,148	71,267,003	1,016,169,151

(*a*) Includes small quantities of copper sulphate.
(*b*) Includes metal, oxide, salts, and cobalt contents of residues exported.
(*c*) Value of ore shipped out of the Province.

Gold

In the following table the value of the total gold output of the Province, exclusive of premium, is given, also that from Porcupine and Kirkland Lake, beginning in 1910 and 1913 respectively:—

TABLE IV.—TOTAL GOLD PRODUCTION IN ONTARIO

Year	Total Production	Porcupine		Kirkland Lake	
	$	$	Per Cent.	$	Per Cent.
1866-1891	(*a*) 190,258	.....	.....	.....	.....
1892-1909	(*b*) 2,509,492	.....	.....	.....	.....
1910	68,498	35,539	51.8	.....	.....
1911	42,637	15,437	36.2	.....	.....
1912	2,114,086	1,730,628	81.8	.....	.....
1913	4,558,518	4,294,113	94.1	65,260	1.2
1914	5,544,979	5,206,006	93.8	114,154	2.0
1915	8,501,391	7,462,111	88.6	551,069	6.5
1916	10,339,259	9,391,408	90.8	702,761	6.8
1917	8,698,735	8,229,744	94.5	404,346	4.6
1918	8,502,480	7,767,907	91.4	632,007	7.4
1919	10,451,709	9,942,803	95.1	486,809	4.7
1920	11,686,043	10,597,572	90.7	1,033,478	8.8
1921	14,692,357	13,103,526	89.5	1,524,851	10.4
1922	20,579,569	18,374,658	89.3	2,159,581	10.5
1923	20,136,287	17,313,115	85.9	2,719,939	13.5
1924	25,669,303	22,135,534	86.2	3,446,632	13.4
1925	30,206,432	24,733,120	81.8	5,385,256	17.8
1926	30,950,753	23,680,670	76.5	7,174,083	23.2
1927	33,627,040	23,851,857	70.9	9,674,114	28.7
1928	32,629,111	20,246,319	62.0	12,233,524	37.5
Total to end of 1928	281,698,937	228,111,067	80.9	48,307,864	17.2

The total production of gold from all sources in Ontario during 1928 was 1,578,433.29 fine ounces, valued at $32,629,111, as against 1,627,050.25 fine ounces worth $33,627,040 in 1927. For statistical purposes gold is evaluated at

the standard value, namely, $20.671834 per fine ounce. The decrease amounted to 48,616.96 fine ounces worth $997,929, or less than 3 per cent.

As will be seen in the table which follows, practically the total Ontario production is recovered by the auriferous quartz mines of Northern Ontario; 62.0 per cent. from Porcupine and 37.5 per cent. from the Kirkland Lake area. The balance or 0.5 per cent. of the total was mainly recovered in the refining of nickel-copper matte while a few hundred ounces were contained in copper ores or copper-lead-zinc concentrates exported from the Province for treatment. The total gold production from Ontario to the end of 1928 was $281,698,937, practically all of which was recovered during the present century. This output of gold which is expanding has a small influence on the production of silver. In 1928 the silver output was augmented by 482,850 fine ounces valued at $279,861, which was recovered mainly in crude gold bullion, and the nickel-copper refineries.

TABLE V.—ONTARIO'S GOLD PRODUCTION, 1928

Source	Ore Milled, tons	Bullion shipped				Total Value of Bullion (a)
		Gold content		Silver content		
		Fine ounces	Value $	Fine ounces	Value $	$
PORCUPINE						
Ankerite	66,606	13,986.03	289,117	1,458	843	289,960
Coniarum	52,005	10,634.49	219,834	1,220	700	220,534
Dome	548,000	188,626.41	3,899,254	27,348	15,797	3,915,051
Hollinger	1,778,470	515,232.91	10,650,809	95,996	55,426	10,706,235
March	32,627	6,459.58	133,531	599	348	133,879
McIntyre	524,695	201,842.22	4,172,449	50,634	29,359	4,201,808
United Mineral Lands (Paymaster)	94,050	8,835.75	182,651	1,078	620	183,271
Scottish-Ontario	255	326.50	6,750	77	45	6,795
Vipond	88,896	33,465.11	691,785	4,566	2,641	694,426
Blue Quartz	.....	6.72	139	2	1	140
Total	3,185,604	979,415.72	20,246,319	182,978	105,780	20,352,099
KIRKLAND LAKE						
Argonaut	5,219	1,563.54	32,321	188	109	32,430
Barry Hollinger	23,060	5,387.00	111,359	708	408	111,767
Canadian Associated Goldfields	10,619	851.44	17,601	176	99	17,700
Gold Hill	4,377	612.96	12,671	195	113	12,784
Kirkland Lake Gold	57,883	19,961.79	412,647	3,390	1,949	414,596
Lake Shore	279,661	196,532.92	4,062,696	19,557	11,269	4,073,965
Sylvanite	69,791	35,452.43	732,866	9,263	5,280	738,146
Teck-Hughes	317,213	238,887.56	4,938,244	18,453	10,552	4,948,896
Tough-Oakes Burnside	14,396	3,967.04	82,006	540	310	82,316
Wright-Hargreaves	256,331	88,580.07	1,831,113	12,778	7,397	1,838,510
Total	1,038,550	591,796.75	12,233,524	65,248	37,586	12,271,110
Miscellaneous	.....	3,173.83	65,609	.....	.....	65,609
Total for gold mines	4,224,154	1,574,386.30	32,545,452	248,226	143,366	32,688,818
Copper-lead-zinc ores (b)	.....	196.99	4,072	11,700	6,807	10,879
Nickel-copper refining	.....	3,850.00	79,587	222,924	129,688	209,275
GRAND TOTAL	.....	1,578,433.29	32,629,111	482,850	279,861	32,908,972

(a) In addition, $2,810.55 was received as premium on exchange.
(b) Ores and concentrates shipped by Amity and Treadwell-Yukon.

Several factors have a bearing on the decreased production of gold in Ontario during 1928. While the tonnage milled and grade of ore fell off at the Hollinger (the largest mine) the reduced production was balanced in part by increases at Kirkland Lake. The period also witnessed the cessation of mining activities at the Argonaut and Canadian Associated Goldfields, which produced small quantities of gold, but other properties such as the Coniaurum and March mines came into production during the year.

The total receipts of crude gold bullion, from all sources in Canada, at the Royal Mint, Ottawa, from its opening on January 2, 1908, to the end of 1927 was 9,574,183.34 crude ounces valued at $154,057,968.05.

Of the crude gold bullion received at the Royal Mint more than 90 per cent. comes from the Province of Ontario. There is considerable saving to the producers in shipping to Ottawa rather than to branches of the U.S. Mint at current exchange rates, not only in time saved, but also in express rates, insurance and prompt payment. The new arrangement made in December, 1925, for the refining of Ontario gold at the Royal Mint showed its effect in the receipts for 1926-7-8 as shown in the table below:

RECEIPTS OF CRUDE GOLD BULLION FROM ONTARIO MINES AT THE ROYAL MINT, OTTAWA, 1924 TO 1928

Year	Crude ounces	Precious Metals		
		Gold, fine oz.	Silver, fine oz.	Total Value $
1924	59,220	28,048	4,692	582,960
1925	139,130	105,888	19,130	2,201,974
1926	1,610,195	1,256,570	224,106	26,112,717
1927	1,721,111	1,338,192	229,657	27,793,399
1928	1,537,295	1,217,622	199,470	25,285,865

General conditions at Porcupine and Kirkland Lake are fairly well covered in the notes which follow dealing with individual properties.

PORCUPINE

Ankerite.—Development continued to the 600-foot level, mill operated at a daily rate of 182 tons, recovering on the average $4.35 per ton. Average number of men employed during the year was 142.

Canusa.—Formerly known as the Scottish-Ontario Syndicate. The test mill was remodelled and enlarged during the period. Underground work was continued on the 100-foot level. A small force of eight men were employed.

Coniaurum.—Working depth around 1,000-feet. A connection was made at the 500-foot level with the old Goldale workings. Mill constructed during the period has a capacity of 300 tons per day and commenced operating in July. Average number of men employed was 204.

Dome.—A new ore body to the north of the original deposits has been developed. Exploratory drifts in the igneous rock have encountered several ore depositions, which is of importance since the major portion of the ore milled at this property has been found in sedimentary rocks. The mill (amalgamation and cyanidation) handled 1,500 tons a day. Average grade of ore was $7.15 per ton and number of employees was 669.

Hollinger.—An extensive development campaign is now under way from the Schumacher shaft, which has already been connected on 12 levels to the old workings. The shareholders have ratified a proposal for the formation of an investment company for the handling of the large surplus of some thirteen million dollars. A disastrous underground fire in February curtailed output and resulted in the loss of 39 lives. During the year the mill averaged 4,982 tons per day from which extraction was $6.02 per ton. Total number on the payroll exclusive of salaried officials was 2,222.

March.—Depth of 600 feet attained with lateral development at this horizon now underway. Mill averaged 125 tons per day with a recovery of $4.13 per ton. A total of 79 workers were employed.

McIntyre.—The mill treated an average of 1,434 tons per day with a recovery of $7.95 per ton. With hoisting and transportation improvements now being completed at the older workings it will be possible to increase the daily mill tonnage. Underground development was actively prosecuted at the new No. 11 shaft and connections made by long drifts to the old workings. The total number of workers employed was 827.

Paymaster.—Underground development has been continued on the 600-foot level although the mill was closed in November. The average daily rate of milling was 273 tons from which $1.94 per ton was recovered. Average number of workers was 194. Work was continued at a depth of 600 feet to open an ore body already developed on the 300-foot level, and plans were made to continue on the 800-foot level.

Vipond.—Development was carried on as deep as the 1,000-foot level. A new ore body was opened up on the 700-foot level, and was also drifted on at the 600-foot and preparations made to develop the same ore body both above and below. In addition a long drive was being pressed toward the Krist property in which favourable ore deposition was expected. The mill averaged 263 tons a day, recovering $7.80 per ton. A total of 142 workers were employed.

Kirkland Lake

Barry-Hollinger.—Development continued on the 1,125-foot level also on the 1,250. This was later discontinued and a winze sunk to 1,375 feet. Mill operated at rate of 76 tons a day, with a recovery of $4.84 per ton.

Gold Hill.—Mill operated for 5 months during the period, at the rate of 25 tons per day and with values averaging $2.92 per ton. Exploratory work was continued on the 1,100-foot level.

Kirkland Lake Gold.—Depth of 3,250 feet attained. A new electric hoist has been installed. Mill treated an average of 158 tons per day, recoveries averaging $7.16 per ton.

Lake Shore.—Extra milling equipment installed in February, 1929, increases capacity of mill to 1,350 tons per day. Development is proceeding on the 1,600-foot level. A new shaft, 400 feet deep at the end of year, is being continued to 1,600 feet, and later will be driven to 3,000 feet. The average grade of ore milled ran $14.56 per ton. Employees numbered 557.

Sylvanite.—Ore being mined as deep as 1,000 feet. Development continued to the south on the 1,750-foot level. A new electric hoist, capable of a depth of 4,000 feet, has been installed. Mill operated throughout year at average capacity of 190 tons per day. Grade of ore was $10.58 per ton. There were 163 wage-earners employed.

Teck-Hughes.—Depth of 2,700 feet attained in main shaft. New shaft about 250 feet deep at end of year, and plans completed for development of property to 3,600 feet in depth. Ore now being milled is being drawn from above the 13th level. The mill averaged 866 tons of ore per day throughout the period, extraction being $15.60 per ton. Employees numbered 470.

Tough-Oakes Burnside.—The plant was closed down on November 28.

Wright-Hargreaves.—Development carried out to a depth of 2,000 feet, with considerable cross-cutting on several levels both north and south of the shaft. Mill operated steadily during the period, handling 700 tons per day on the average, and recoveries were $7.17 per ton. An average of 457 men were employed.

In 1925 Ontario passed the Yukon Territory in total value of gold produced and in 1926 the sister Province of British Columbia was overtaken also. Production from British Columbia began in 1858, from Ontario in 1866 and from the Yukon in 1885. Maximum output from British Columbia was $6,149,027 in 1913, from the Yukon $22,275,000 in 1900 and from Ontario $33,627,040 in 1927. Details as to relative standing are given below:—

Period	Ontario	British Columbia	Yukon Territory
	$	$	$
To end of 1925	184,492,033	195,695,376	181,242,977
1926	30,950,753	4,519,362	529,220
1927	33,627,040	3,784,889	639,483
1928	32,629,111	4,031,305	710,367
Total	281,698,937	208,030,932	183,122,047

The following figures summarize labour statistics as reported to the Dominion Bureau of Statistics and Ontario Department of Mines for the gold mining industry:—

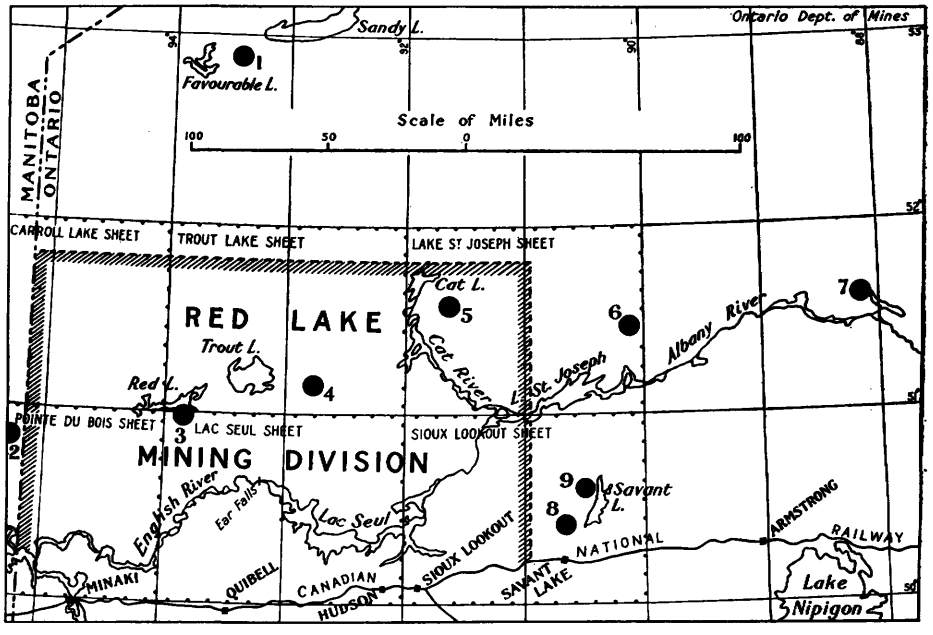
AVERAGE YEARLY WAGE, ONTARIO GOLD MINING, 1928

Locality	No. of Wage earners	Wages paid	Average Wage per annum
Porcupine	4,428	$6,968,877	$1,574
Kirkland Lake	1,928	2,953,985	1,532
*Non-producers	1,107	1,400,820	1,265
Total	7,463	11,323,682	4,371

*Operations were not on full time basis.

The average wage for accident cases, as reported by the Ontario Workmen's Compensation Board for the year 1927, shows that Class V, covering mining and explosives, was $29.09 per week. With the exception of rolling mill employees, this is the highest wage of any compensation class. Assuming a year of 50 weeks the above rating of $29.09 works out at $1,454.50 per annum.

Prospecting.—The year 1928 was noteworthy for exploration, particularly in Patricia district. Surface work and some diamond-drilling was done in 1928 on discoveries made in 1927 at Favourable lake in the northwestern part of Patricia. Assays from 16 holes put down by the Favourable Lake Mining and Exploration Company showed good values, chiefly in gold and silver. An east and west belt from Red Lake to Fort Hope on the Albany river, a distance of 250 miles, was prospected with the result that a new gold area, Pickle lake and Crow river, was brought to light. Careful examination of this area, and of other favourable rock formations in this wide stretch of country, will follow. The accompanying map indicates the relative position of the new fields. The dotted rectangles indicate map sheets on a scale of 4 miles to the inch, prepared from aerial photographs and issued by the Topographical Survey of Canada, Ottawa.



Key map of part of northwestern Ontario and eastern Manitoba showing relative position of mineral areas which have sprung into prominence during the past three years:

(1) Favourable lake (2) Central Manitoba (3) Red lake (4) Woman, Narrow, Confederation, Birch and Mink lakes (5) Shonia lake (6) Pickle lake and Crow river (7) Fort Hope (8) Kashaweogama lake (9) Neverfreeze lake.

Numbers 5, 6 and 8 were discovered during 1928.

Transportation by airplane is now so general that formerly remote and inaccessible localities are brought within close range. Sioux Lookout is headquarters for airplane travel in Patricia district. Aerial maps of this remarkably watered region have proved invaluable to the prospector and for airplane navigation. A storage dam is under erection at Ear Falls at the western end of Lac Seul, and it is expected that hydro-electric power will be developed at this point during 1929 to serve the needs of the Howey mine at Red Lake.

TABLE VI.—VALUE OF TOTAL PRODUCTION (GOLD AND SILVER) BY MINES OF THE KIRKLAND LAKE AREA

Year	Lake Shore	Teck-Hughes	Wright-Hargreaves	Tough-Oakes Burnside	Kirkland Lake	Sylvanite	Argonaut (a)	Barry-Hollinger	Canadian Associated	Ontario-Kirkland	Gold Hill	Total Value (b)
1913	.....	.....	$1,127	$66,632	.....	.....	.....	.....	.....	.....	.....	$67,759
1914	.....	.....	.....	117,644	.....	.....	$5,204	.....	.....	.....	.....	122,848
1915	.....	.....	.....	555,539	.....	.....	.....	.....	.....	.....	.....	555,539
1916	.....	.....	.....	711,625	.....	.....	.....	.....	.....	.....	.....	711,625
1917	.....	$66,722	.....	342,831	.....	.....	.....	.....	.....	.....	.....	409,553
1918	$416,414	80,570	.....	139,683	.....	.....	.....	(c) $10,114	.....	.....	.....	646,781
1919	263,354	169,590	.....	.....	$56,263	.....	2,631	.....	.....	.....	.....	491,838
1920	503,735	247,757	.....	.....	286,901	.....	26,863	.....	.....	.....	.....	1,065,256
1921	495,276	322,919	468,751	.....	242,417	.....	513	.....	.....	.....	.....	1,529,875
1922	471,341	596,495	762,753	107,481	224,396	.....	.....	.....	.....	$10,082	.....	2,172,458
1923	547,600	1,117,963	754,979	12,174	223,102	.....	72,512	.....	.....	.....	.....	2,728,331
1924	1,098,572	1,023,025	1,088,725	47,547	46,512	.....	152,072	.....	.....	.....	.....	3,456,453
1925	1,958,720	996,943	1,913,401	263,064	.....	.....	214,183	56,978	.....	.....	.....	5,403,289
1926	2,775,000	1,601,209	2,150,844	309,709	126,999	.....	112,189	86,263	.....	.....	.....	7,193,411
1927	3,375,053	2,781,962	2,151,916	153,215	473,673	$429,424	127,448	175,692	$34,595	.....	(d) $865	9,703,843
1928	4,073,965	4,948,896	1,838,510	82,316	414,596	738,146	32,430	111,767	17,700	.....	12,784	12,271,110
Total	15,979,030	13,954,051	11,131,006	2,909,460	2,094,859	1,167,570	777,245	440,814	52,295	10,082	13,649	48,530,059

(a) Exclusive of copper values.
(b) Exchange premiums received in addition to the above valuations were as follows: 1920, $110,424; 1921, $121,425; 1922, $19,590; 1923, $37,812; 1924, $24,028; 1925, $231 discount, and 1926, $595 discount; a net total of $312,453 for the seven years of which we have record.
(c) Patricia mine, afterwards called Barry-Hollinger.
(d) Samples shipped in 1923 and 1926 not heretofore reported.

TABLE VII.—VALUE OF TOTAL PRODUCTION (GOLD AND SILVER) BY MINES OF THE PORCUPINE AREA

Year	Hollinger	Dome	McIntyre	Vipond	Porcupine Crown and Northcrown	West Dome Lake	Ankerite	Night Hawk Peninsular	Schumacher (a)	Paymaster	Coniaurum	March	Rea and Newray
1910....	$31,194	$4,355	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1911....	6,000	4,277	.....	$5,160	.....	.....	.....	.....	.....	.....	.....	.....	.....
1912....	909,181	737,499	$77,657	16,259	.....	.....	.....	.....	.....	.....	.....	.....	.....
1913....	2,488,022	1,242,625	236,299	.....	Porcupine Crown. $326,803	.....	.....	.....	.....	.....	.....	.....	Rea $18,858
1914....	2,719,355	1,059,238	549,166	73,628	658,135	.....	.....	.....	.....	.....	.....	.....	Rea 125,255
1915....	4,206,015	1,530,287	750,812	246,053	602,436	$102,880	.....	.....	$48,236	.....	.....	.....	.....
1916....	5,073,401	2,153,820	1,218,073	176,686	578,322	16,814	.....	.....	225,301	.....	.....	.....	.....
1917....	4,261,938	1,480,174	1,710,204	209,738	377,904	44,434	.....	.....	198,605	.....	.....	.....	Newray 1,447
1918....	5,752,371	82,127	1,578,444	82,868	124,474	103,745	.....	.....	92,842	.....	.....	.....	Newray 1,516
1919....	6,722,266	1,290,301	1,978,014	.....	.....	23,910	.....	.....	.....	.....	.....	.....	.....
1920....	6,219,665	2,020,568	2,223,083	.....	Northcrown. 71,529	47,169	.....	.....	.....	.....	.....	.....	.....
1921....	9,051,276	2,290,264	1,827,761	.....	97,301 7,943	.....	.....	.....	.....	.....	.....	.....	.....
1922....	12,274,114	4,178,936	2,021,811	.....	.....	.....	.....	.....	.....	$2,800	.....	.....	.....
1923....	10,446,412	4,374,144	2,550,129	23,876	.....	.....	.....	.....	.....	.....	.....	.....	.....
1924....	13,433,063	4,307,624	3,604,874	596,803	.....	60,642	.....	$258,618	.....	.....	.....	.....	.....
1925....	15,749,109	4,365,923	3,721,499	565,379	.....	287,758	.....	196,947	.....	.....	.....	.....	.....
1926....	14,829,655	3,940,053	3,862,074	631,636	.....	220,758	$140,588	111,154	.....	63,551	.....	$11,055	.....
1927....	14,539,538	4,031,575	3,965,210	667,724	.....	(b)35,252	359,005	166	.....	135,025	.....	19,839	.....
1928....	10,706,235	3,915,051	4,201,808	694,426	.....	.....	289,960	.....	.....	183,271	220,540	133,879	.....
Total	139,418,810	43,008,841	36,076,918	3,990,236	2,871,847	943,362	789,553	566,885	564,984	384,647	220,540	164,773	147,076

(a) Purchased by the Hollinger in 1922. (b) Total value of bullion in 1927 was $87,919. Figures shown in above table allow for a deduction of $52,667 due to an erroneous return made in 1925.

TABLE VII.—VALUE OF TOTAL PRODUCTION (GOLD AND SILVER) BY MINES OF THE PORCUPINE AREA—*Continued*

Year	David-son	Preston and Clifton	Scottish Ontario	Porcupine Pet	Porphyry Hill	Gold Reef	Tommy Burns	De Santis	Hughes	Miscel-laneous	Total Value (*c*)
1910											$35,549
1911											15,437
1912											1,740,596
1913		Preston			$4,200						4,316,807
1914		Preston $15,212		$5,000							5,231,989
1915				5,551	2,036	$1,547					7,495,853
1916											9,442,417
1917						588	$289				8,285,321
1918	$15,579										7,833,966
1919	27,089										10,041,580
1920	11,246										10,690,561
1921											13,177,244
1922		Clifton 1,664									18,479,325
1923		Clifton 8,331								(*d*) $2,756	17,405,648
1924		Clifton 5,270									22,266,894
1925											24,886,615
1926								$146	$ 30		23,810,700
1927			$5,893							(*e*) 217,350	23,976,577
1928			6,795							(*f*) 65,609	20,352,099
Total	53,914	30,477	12,688	10,551	6,236	2,135	289	146	30	285,715	229,485,178

(*c*) A record of total exchange premiums received in addition to the above amounts shows the following: 1920, $1,265,664; 1921, $1,238,211; 1922, $189,022; 1923, $207,742; 1924, $172,721; 1925, $2,607 discount; 1926, nil; 1928, $2,810.55; or a net total of $3,073,564 for the seven years of which we have record. (*d*) Huddlestone and Cline. (*e*) Includes "highgrade" recovered from W. P. Wilson. (*f*) Highgrade and $140 from Blue Quartz.

TABLE VIII.—DIVIDENDS AND BONUSES PAID BY GOLD MINING COMPANIES TO DECEMBER 31, 1928

Name of Company	Date of Incorporation	Authorized Capital $ or shares	Capital Stock Issued $ or shares	Par value per share	Dividends and Bonuses paid to end of 1927, Amount	Dividends and Bonuses paid during 1928, Amount	Rate per cent., 1928 or per share	Total of Dividends and Bonuses paid to Dec. 31, 1928	Date when last Dividend or Bonus was paid
				$ c.					
Dome Mines, Ltd. (*a*)	Sept. 30, 1923	1,000,000	7,000,000	No par	11,452,506 75	953,334 00	1.00	12,405,840 75	Oct. 20, 1928
Hollinger Cons. Gold Mines, Ltd. (*b*)	May 25, 1916	25,000,000	24,600,000	5 00	42,732,400 00	5,412,000 00	22%	48,144,400 00	Dec. 31, 1928
Lake Shore Gold Mines, Ltd	Feb. 25, 1914	2,000,000	2,000,000	1 00	4,020,000 00	2,000,000 00	100%	6,020,000 00	Dec. 15, 1928
McIntyre-Porcupine Mines, Ltd	Mar. 16, 1911	4,000,000	3,990,000	5 00	6,803,408 00	798,000 00	5%	7,601,408 00	Dec. 1, 1928
Porcupine Crown Mines, Ltd	May 25, 1913	2,000,000	2,000,000	1 00	840,000 00	.....	.....	840,000 00	July 15, 1917
Rea Consolidated Gold Mines, Ltd	April 5, 1911	1,000,000	200,000	5 00	12,000 00	.....	.....	12,000 00	——— 1915
Schumacher Gold Mines, Ltd. (*c*)	Jan. 6, 1914	2,000,000	1,850,000	1 00	.....	.....	.....	.....	.....
Teck-Hughes Gold Mines, Ltd., The	Mar. 1, 1923	5,000,000	4,767,144	1 00	1,188,286 00	2,860,286 40	60%	4,048,572 40	Nov. 1, 1928
Tough-Oakes Gold Mines, Ltd	July 15, 1913	3,000,000	2,657,500	5 00	398,625 00	.....	.....	398,625 00	Dec. 27, 1916
Vipond Consolidated Mines, Ltd	July 17, 1922	2,500,000	2,250,000	1 00	67,500 00	.....	.....	67,500 00	Apr. 15, 1927
Wright-Hargreaves Mines, Ltd. (*d*)	June 16, 1916	5,550,000	5,550,000	No par	3,506,250 00	825,000 00	15c.	4,331,250 00	Nov. 1, 1928
Total	.....	.....	.....	.....	71,020,975 75	12,848,620 40	.....	83,869,596 15	.....

(*a*) On April 22, 1922, the capital of Dome Mines Co., Ltd. was reduced from $5,000,000 to $4,500,000 and $476,667 distributed to shareholders in addition to dividends paid to September 30, 1923. The new Company issued 1,000,000 N.P.V. shares at $7.00 per share.

(*b*) Hollinger Consolidated Gold Mines, Limited, is a consolidation of the Acme Gold Mines, Ltd.; Millerton Gold Mines, Ltd.; and Hollinger Gold Mines, Ltd. Dividends include $160,000 paid in 1915 by Acme, also $4,170,000 paid by Hollinger to May 25, 1916, the date of consolidation.

(*c*) The Schumacher mine was sold to the Hollinger in 1922 and a total of $1,591,000 or 86 per cent. of the assets distributed to shareholders, the final payment being made July 30, 1923.

(*d*) The authorized and issued capital was changed in May, 1927, from 2,750,000 shares of $1.00 par value to 5,550,000 shares of "no par" value.

TABLE IX.—DIVIDENDS AND BONUSES PAID BY GOLD MINING COMPANIES, 1912-1928

Year	Porcupine						Kirkland Lake				Total
	*Hollinger Consolidated	Porcupine Crown	†Dome Mines	Rea Consolidated	McIntyre	Vipond Consolidated	Tough-Oakes	Lake Shore	Wright-Hargreaves	Teck-Hughes	
1912	$270,000										$270,000 00
1913	1,170,000										1,170,000 00
1914	1,170,000	$240,000									1,410,000 00
1915	1,720,000	240,000	$400,000 00	$12,000			$132,875				2,344,875 00
1916	3,126,000	240,000	800,000 00				265,750				4,591,750 00
1917	738,000	120,000	300,000 00		$541,542 45						1,699,542 45
1918	1,230,000				543,042 45			$100,000			1,873,042 45
1919	1,722,000				364,028 30			100,000			2,186,028 30
1920	2,214,000		416,886 00		546,042 45			80,000			3,256,928 45
1921	3,198,000		478,947 75		546,042 45			120,000			4,342,990 20
1922	3,198,000		715,000 50		546,042 45			80,000	$412,500		4,951,542 95
1923	3,198,000		1,430,001 00		548,542 45			160,000	206,250		5,542,793 45
1924	3,198,000		1,906,668 00		774,125 00			380,000	206,250		6,465,043 00
1925	4,378,800		1,906,668 00		798,000 00			600,000	550,000		8,233,468 00
1926	5,805,600		1,906,668 00		798,000 00			1,000,000	893,750	$474,714 40	10,878,732 40
1927	6,396,000		1,191,667 50		798,000 00	$67,500		1,400,000	1,237,500	713,571 60	11,804,239 10
1928	5,412,000		953,334 00		798,000 00			2,000,000	825,000	2,860,286 40	12,848,620 40
Total	48,144,400	840,000	12,405,840 75	12,000	7,601,408 00	67,500	398,625	6,020,000	4,331,250	4,048,572 40	83,869,596 15

*Includes $160,000 paid by the Acme in 1915 before amalgamation with the Hollinger. †Exclusive of $476,667.00 repayment of capital in 1922.

Silver and Cobalt

Ontario's silver production, which first came into prominence in 1904, achieved its peak of production, namely 31,507,791 ounces in 1911. Since that year the output has gradually declined, and in 1928 dropped to the lowest level of any period during the past twenty-two years. This gradual decline is the natural result of mine depletion, although with a higher price for silver many lower grade ore deposits might be economically operated. The average price per ounce in 1928 on the New York market for silver of 999 fineness was 58.176 cents as against 56.370 cents in 1927.

While shipments from the Cobalt camp showed a general falling off there is a growing tendency for lessees to take hold of closed-down mines from which they take out enough ore to pay all expenses and return a fair profit. There are other encouraging features in the silver-mining situation. One is the successful development early in 1929 on the Cobalt Contact property. On the 300-foot level an important vein of cobalt ore has been discovered from which shipments are being made. Nipissing Mining Corporation and the O'Brien were the principal producers at Cobalt while at South Lorrain the Keeley, Frontier and Lorrain Trout Lake reported a smaller production than in 1927. The Castle-Trethewey and Miller Lake O'Brien in the Gowganda area were active throughout the period.

World conditions as regards silver prices indicate that present low prices of the metal will obtain for some time or at least until a slackening of output becomes apparent. This condition, however, was not observed at any time during 1928 and it was noticed that the figures of monthly production towards the end of the period were actually rising in most of the important silver-producing countries. The United States reported a rising production as did Peru, and the largest producer of all, namely, Mexico. At the same time stocks of silver in the Orient, both at Shanghai and in India, remained at a high level. As reported by Samuel Montagu and Co., silver stocks at Shanghai on November 24 were 132,959,000 fine ounces, and in India the reserves aggregated 362,519,000 fine ounces on November 2.

The output and shipments of silver are shown below. It should be pointed out that the figures given are based as nearly as possible on actual sales of bullion and silver contained in concentrates and residues exported, with the gross values as reported by the producers before deducting treatment and shipping charges. The figures for any one year do not agree with those in Tables X and XI:—

SILVER PRODUCTION, 1927-1928

Source	1927		1928	
	Fine Ounces	Value	Fine Ounces	Value
		$		$
Sales of bullion by the reduction companies, smelters and mines	7,984,001	4,490,657	5,883,583	3,419,624
Contained in concentrates and residues exported	849,828	479,537	816,571	469,753
Contained in crude gold bullion	272,023	154,449	248,226	137,366
Recovered by nickel-copper refineries	188,180	105,759	222,924	129,688
Total	9,294,032	5,230,402	7,171,304	4,156,431

TABLE X.—TOTAL SHIPMENTS FROM SILVER MINES, SMELTERS AND REFINERIES, 1904 TO 1928

Year	Bismuth		Copper(a)		Lead(a)		Nickel(b)		Cobalt(c)		Arsenic		Silver		Total Value
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Ounces	Value	
		$		$		$		$		$		$		$	$
1904	.....	.....	.....	.....	.....	.....	14	3,467	16	19,960	72	903	206,875	111,887	136,217
1905	.....	.....	.....	.....	.....	.....	75	10,000	118	100,000	549	2,693	2,451,356	1,360,503	1,473,196
1906	.....	.....	.....	.....	.....	.....	160	.....	321	80,704	1,440	15,858	5,401,766	3,667,551	3,764,113
1907	.....	.....	.....	.....	.....	.....	370	1,174	739	104,426	2,958	40,104	10,023,311	6,155,391	6,301,095
1908	.....	.....	.....	.....	.....	.....	612	.....	1,224	111,118	3,672	40,373	19,437,875	9,133,378	9,284,869
1909	.....	.....	.....	.....	.....	.....	766	.....	1,533	94,965	4,294	61,039	25,897,825	12,461,576	12,617,580
1910	.....	.....	.....	.....	.....	.....	504	.....	1,098	54,699	4,897	70,709	30,645,181	15,478,047	15,603,455
1911	.....	.....	.....	.....	.....	.....	392	.....	852	170,890	3,806	74,609	31,507,791	15,953,847	16,199,346
1912	.....	.....	.....	.....	.....	.....	429	14,220	934	314,381	4,166	80,546	30,243,859	17,408,935	17,818,082
1913	.....	.....	.....	.....	.....	.....	377	13,326	821	420,386	3,663	64,146	29,681,975	16,553,981	17,051,839
1914(d)	.....	.....	.....	.....	.....	.....	90	28,978	351	590,406	2,030	116,624	25,162,841	12,765,461	13,501,469
1915	.....	.....	.....	.....	.....	.....	35	28,353	206	383,261	2,490	148,379	24,746,534	12,135,816	12,695,809
1916	.....	.....	.....	.....	.....	.....	79	59,380	400	805,014	2,160	200,103	19,915,090	12,643,175	13,707,672
1917	.....	.....	53	28,840	.....	.....	155	125,071	337	1,138,190	2,592	608,483	19,401,893	16,121,013	18,021,597
1918	.....	.....	72	35,712	3	453	186	156,893	380	1,640,310	2,545	566,332	17,661,694	17,341,790	19,741,490
1919	.....	.....	110	40,976	12	1,296	276	188,418	298	1,019,479	2,834	485,360	11,214,317	12,738,994	14,474,523
1920	.....	.....	50	17,494	5	792	127	93,233	283	1,605,365	1,883	431,527	10,846,321	10,654,471	12,802,882
1921	.....	.....	103	34,504	3	270	10	7,665	126	616,235	1,491	233,763	8,261,931	5,564,594	6,457,031
1922	.....	.....	93	26,346	16	1,891	61	34,987	(f)776	1,333,676	2,059	299,940	10,711,127	7,658,802	9,355,642
1923(e)	9	48,139	56	16,214	26	3,738	42	19,321	380	1,803,872	2,579	582,794	10,377,846	6,677,367	9,151,445
1924	6	16,079	55	14,290	45	7,295	130	26,862	476	1,662,526	1,915	323,186	10,361,945	7,009,984	9,060,222
1925	10	18,578	77	17,007	31	1,888	290	116,347	558	2,328,517	1,078	113,325	9,614,881	6,700,129	9,295,791
1926	3	6,440	35	5,394	11	1,463	83	30,051	332	1,136,014	2,025	135,549	8,981,557	5,541,009	6,855,920
1927	1	1,003	20	2,940	3	312	100	52,829	440	1,764,534	2,481	197,668	8,883,829	4,970,194	6,989,480
1928	7	5,067	38	15,764	27	2,169	111	57,039	477	1,671,900	2,049	178,149	6,688,454	3,882,570	5,812,658
Total	36	95,306	762	255,481	182	21,567	5,474	1,067,614	13,476	20,970,828	61,728	5,072,162	388,278,074	240,690,465	268,173,423

(a) Copper and lead are recovered from certain silver ores and concentrates shipped to United States refineries.
(b) Nickel metal and metallic contents of all nickel compounds.
(c) Cobalt metal and metallic contents of all cobalt compounds, also in ores and speiss residues exported.
(d) Prior to 1914 an estimate based on assays was made of the nickel, cobalt and arsenic in the ores; later recoveries have been reported.
(e) Recoveries of bismuth from base bullion were not reported prior to 1923.
(f) Includes 460 tons of speiss residues worth $153,116.

The following table shows statistics based on the metal contents of shipments of ore and concentrates and should not be confused with the figures in the main table on page 2 and Table X immediately preceding. Silver shown as shipped in the following table is compiled for each mining area and is mainly the silver contents of ore or concentrates shipped to the reduction works at Cobalt or the silver smelters. Of necessity there is a lag and it does not follow that all the ores, etc., shipped have received treatment during the year by smelters, although in the aggregate these figures will agree closely with those for silver bullion sold, as given in the table on page 2 and also in Table X.

Since the discovery of silver at Cobalt in 1903 the silver contents of shipments from the camp and outlying silver areas, as reported by the operators, have been as follows:

TABLE XI.—SILVER SHIPMENTS BY CAMPS, 1904-1928

Year	Average price, cents per ounce (New York)	Silver Content in Troy Ounces					
		Total Ounces	Cobalt	Casey Township	South Lorrain	Gowganda	Montreal River and Maple Mountain
1904	57.221	206,875	206,875	.....	.....	.....	.....
1905	60.352	2,451,356	2,451,356	.....	.....	.....	.....
1906	66.791	5,401,766	5,401,766	.....	.....	.....	.....
1907	65.237	10,023,311	10,023,311	.....	.....	.....	.....
1908	52.864	19,437,875	19,424,251	500	13,124	.....	.....
1909	51.502	25,897,825	25,658,683	26,185	194,955	.....	18,002
1910	53.486	30,645,181	29,849,981	92,544	221,133	471,688	9,835
1911	53.340	31,507,791	29,989,893	114,789	933,912	468,687	510
1912	60.835	30,243,859	28,605,940	253,824	834,119	549,976	.....
1913	57.791	29,681,975	28,105,505	825,108	248,992	502,370	.....
1914	54.811	25,162,841	24,155,699	499,643	108,199	399,300	.....
1915	49.684	24,746,534	24,280,366	223,939	.....	242,229	.....
1916	65.661	19,915,090	19,008,517	445,900	77,280	383,393	.....
1917	81.417	19,401,893	18,327,258	.....	10,000	1,064,635	.....
1918	96.772	17,661,694	16,807,407	143,901	72,188	638,198	.....
1919	111.122	11,214,317	10,314,689	171,278	4,586	723,764	.....
1920	100.900	10,846,321	10,402,249	.....	8,253	433,352	(a)2,467
1921	62.654	8,261,931	7,673,535	1,101	328,886	258,292	117
1922	67.528	10,711,127	9,239,147	1,028	1,284,307	170,651	(b)15,994
1923	64.873	10,377,846	7,259,858	.....	2,955,646	160,761	1,581
1924	66.781	9,935,902	6,704,787	.....	2,633,058	598,057	.....
1925	69.065	10,707,235	6,252,115	.....	3,099,964	1,355,156	.....
1926	62.107	10,543,473	6,262,249	.....	3,044,584	1,236,640	.....
1927	56.370	8,543,513	4,482,543	.....	2,319,356	1,741,614	.....
1928	58.176	6,745,401	3,934,020	.....	1,133,952	1,677,429	.....
Total	.....	390,272,932	354,822,000	2,799,740	19,526,494	13,076,192	48,506

(a) Includes 885 ounces from Silver Islet, Lake Superior.
(b) Silver Islet, Lake Superior.

In addition to the silver content of ores, concentrates, residues, etc., producing mines are paid for the cobalt content provided the percentage is sufficiently high. Mine shippers in 1928 were paid $173,939 for 687,401 pounds of cobalt, and $3,328 for 44,475 pounds of copper.

From weekly statements, issued by the General Freight and Passenger Agent of the Temiskaming and Northern Ontario Railway, showing railway shipments of ore, concentrates, etc., from the Cobalt area the following information has been compiled: Total shipments, 3,484.83 tons, of which 2,207.48 were consigned to Deloro, 63.27 to United States smelters and refineries, and 1,214.08 tons to Europe.

The producers of silver are given in the following list:—

SILVER PRODUCERS IN 1928

Operator	Mine or Source	Location
Castle-Trethewey Mines, Ltd.	Castle-Trethewey	Gowganda
Cobalt Contact Mines, Ltd.	Cobalt Contact	Cobalt
Coniagas Mines, Ltd. (*a*)	Coniagas	Cobalt
Frontier (Lorrain) Mines, Ltd.	Lorrain Operating & Frontier Lorrain.	Silver Centre
Keeley Silver Mines, Ltd., The	Keeley	South Lorrain
Kerr Lake Mining Company, Ltd. (*b*).	Kerr Lake, ore dump shipments	Cobalt
La Rose Mines, Ltd.	La Rose	Cobalt
Lorrain Trout Lake Mines, Ltd.	Lorrain Trout Lake	Silver Centre
Lynch, C. D. (*c*)	Peterson Lake	Cobalt
Mining Corporation of Canada, Ltd.	Townsite City, Buffalo, Cobalt Lake.	Cobalt
Nipissing Mining Company, Ltd.	Nipissing	Cobalt
O'Brien, Ltd., M. J.	O'Brien	Cobalt
O'Brien, Ltd., M. J.	Miller Lake O'Brien	Gowganda
Sandoe & Moyle	Penn-Canadian	Cobalt

(*a*) Leased to E. H. Clemens.

(*b*) Leased to Arthur Brocklebank.

(*c*) Lessee of the following mines: Peterson Lake, Provincial, Beaver Lake, Hudson Bay, and Dominion Reduction.

Refineries.—The production of refined silver is carried on by two companies in Cobalt which operate reduction plants in conjunction with the mines and mills. The processes of extraction are hydro-metallurgical or wet methods, such as the cyanide process applied to silver-bearing ores. The Nipissing Mines, Limited, and the Cobalt Reduction Company (Mining Corporation), both operate such plants and in addition to high-grade silver bullion, they market flotation concentrates and residues. The refinery of the latter company has not been operated since 1926. The major part of the ore and concentrates shipped out of the Cobalt camp for treatment goes to the Deloro Smelting and Refining Company at Deloro. In the following table, data from reduction plants in the Cobalt area are not included:—

TABLE XII.—OPERATIONS OF ONTARIO SILVER-COBALT REFINERIES IN 1928

Products marketed	Sales	
	Quantity	Value
		$
Silver bullion.....fine oz.	4,067,922	2,358,000
Arsenic, white.....lb.	3,378,358	131,771
Cobalt products, including metals and metallic content of all oxides, mixed oxides and salts..... "	638,970	1,486,354
Nickel oxide, and salts (metal content)..... "	150,694	44,236
Base bullion (*a*)..... "	81,331	71,347
Speiss residues (*b*)..... "	593,606	135,425
Bismuth..... "	928	1,273
Total.....	.....	4,228,406

(*a*) Contains silver, lead, bismuth and antimony.

(*b*) Speiss residues contain silver, cobalt, nickel and arsenic.

TABLE XIII.—DIVIDENDS AND BONUSES PAID BY SILVER MINING COMPANIES TO DECEMBER 31, 1928

Name of Company	Date of Incorporation	Authorized Capital	Capital Stock Issued	Par value per share	Dividends and Bonuses paid to end of 1927	Dividends and Bonuses paid during 1928	Total Dividends and Bonuses paid to 31st Dec., 1928	Date when last Dividend was paid
		$	$	$ c.	$ c.	$ c.	$ c.	
Aladdin Cobalt Company, Limited	Aug. 23, 1912	500,000	500,000	5 00	75,000 00	.....	75,000 00	April 30, 1917
Beaver Consolidated Mines, Ltd	Mar. 1, 1907	2,000,000	2,000,000	1 00	710,000 00	.....	710,000 00	May 31, 1920
Buffalo Mines, Ltd., The (*a*)	April 27, 1906	500,000	500,000	50	2,787,000 00	.....	2,787,000 00	May 28, 1924
Casey Cobalt Silver Mining Co., Ltd	Dec. 19, 1906	100,000	100,000	1 00	203,249 33	.....	203,249 33	April 22, 1914
Castle-Trethewey Mines, Ltd. (*b*)	Jan. 20, 1922	2,000,000	2,000,000	1 00	18,027 00	.....	18,027 00	April 15, 1925
Cobalt Central Mines Co., Ltd	Dec. 13, 1905	5,000,000	5,000,000	1 00	192,845 00	.....	192,845 00	Aug. 25, 1909
Cobalt Comet Mines, Ltd. (*c*)	April 16, 1913	1,000,000	1,000,000	1 00	230,000 00	.....	230,000 00	April 1, 1915
Cobalt Silver Queen, Ltd	April 1, 1906	1,500,000	1,500,000	1 00	315,000 00	.....	315,000 00	Dec. 31, 1908
Coniagas Mines, Limited, The	Nov. 24, 1906	4,000,000	4,000,000	5 00	11,440,000 00	.....	11,440,000 00	May 1, 1924
Crown Reserve Mining Co., Ltd	Jan. 16, 1907	2,000,000	1,999,957	1 00	6,190,849 00	.....	6,190,849 00	Dec. 28, 1916
Foster Cobalt Mining Co., Ltd	Feb. 14, 1906	1,000,000	915,588	1 00	45,000 00	.....	45,000 00	Jan. 1, 1907
Hudson Bay Mines, Ltd	July 16, 1909	3,500,000	3,200,050	5 00	778,909 42	.....	778,909 42	Aug. 31, 1913
Keeley Silver Mines, Ltd	June 22, 1922	2,000,000	2,000,000	1 00	2,160,000 00	80,000 00	2,240,000 00	Mar. 15, 1928
Kerr Lake Mining Company, Ltd. (*d*)	Aug. 9, 1905	40,000	40,000	100 00	10,521,000 00	.....	10,521,000 00	Oct. 13, 1927
La Rose Mines, Ltd	May 31, 1908	1,500,000	1,500,000	1 00	6,600,546 84	.....	6,600,546 84	Mar. 24, 1923
Lorrain Trout Lake Mines, Ltd	Mar. 20, 1923	1,500,000	1,500,000	1 00	150,000 00	.....	150,000 00	July 15, 1925
McKinley-Darragh-Savage Mines of Cobalt, Ltd.	April 27, 1906	2,500,000	2,247,692	1 00	5,955,391 86	.....	5,955,391 86	Oct. 1, 1920
Mining Corporation of Canada, Ltd	Nov. 23, 1916	8,300,250	8,300,250	5 00	6,536,406 22	622,518 75	7,158,924 97	Dec. 20, 1928
City of Cobalt Mining Co., Ltd. (*e*)	Jan. 7, 1909	1,500,000	1,500,000	1 00	145,000 00	.....	145,000 00	April 15, 1920

TABLE XIII.—*Continued*

Name of Company	Date of Incorporation	Authorized Capital	Capital Stock Issued	Par value per share	Dividends and Bonuses paid to end of 1927	Dividends and Bonuses paid during 1928	Total Dividends and Bonuses paid to 31st Dec., 1928	Date when last Dividend or Bonus was paid
		$	$	$ c.	$ c.	$ c.	$ c.	
Cobalt Lake Mining Co., Ltd. (*e*)	Dec. 22, 1906	3,000,000	3,000,000	1 00	465,000 00	.....	465,000 00	May 29, 1914
Cobalt Townsite Mining Co., Ltd. (*e*)	May 8, 1906	100,000	45,011	1 00	1,042,259 61	.....	1,042,259 61	Nov. 11, 1914
Nipissing Mining Co., Ltd. (*f*)	Dec. 16, 1904	250,000	250,000	100 00	29,898,297 25	390,000 00	30,288,297 25	Dec. 31, 1928
Penn-Canadian Mines, Ltd. (*g*)	April 24, 1912	1,500,000	1,349,705	1 00	175,461 65	.....	175,461 65	Sept. 10, 1917
Peterson Lake Silver-Cobalt Mining Co., Ltd.	April 11, 1906	3,000,000	2,469,802	1 00	462,350 35	.....	462,350 35	Jan. 2, 1917
Right of Way Mines, Ltd	Sept. 11, 1909	2,000,000	1,685,500	1 00	252,825 00	.....	252,825 00	Mar. 17, 1917
Right of Way Mining Co., Ltd	July 13, 1906	500,000	499,518	1 00	324,643 93	.....	324,643 93	Oct. 1, 1909
Seneca-Superior Silver Mines, Ltd	Sept. 29, 1911	500,000	478,884	1 00	1,579,817 20	.....	1,579,817 20	Dec. 15, 1916
Temiskaming Mining Co., Ltd	Nov. 5, 1906	2,500,000	2,500,000	1 00	2,159,156 25	.....	2,159,156 25	Jan. 31, 1920
Temiskaming and Hudson Bay Mining Co., Ltd.	July 10, 1903	25,000	7,761	1 00	1,940,250 00	.....	1,940,250 00	Nov. 10, 1914
Trethewey Silver Cobalt Mines, Ltd	May 30, 1906 June 1, 1911	2,000,000	1,000,000	1 00	1,211,998 50	.....	1,211,998 50	Jan. 2, 1919
Wettlaufer Lorrain Silver Mines, Ltd	Nov. 30, 1908	1,500,000	1,416,590	1 00	637,465 50	.....	637,465 50	Sept. 22, 1913
Total (*h*)	.....	.....	.....	.....	95,203,749 91	1,092,518 75	96,296,268 66	.....

(*a*) In 1917 the capital stock of the company was reduced from $1,000,000 to $750,000, in 1918 from $750,000 to $500,000, and on December 21, 1919, from $500,000 to $150,000, by returning to shareholders amounts equal to the reduction in capital, leaving 300,000 shares issued of 50 cents each. The mine was sold to the Mining Corporation of Canada, and operated by it in 1920 and subsequently.
(*b*) 200,000 preferred shares par $1.00, redeemed April, 1925, and capital reduced from $2,200,000 to $2,000,000.
(*c*) Cash assets amounting to $50,000 paid on April 27, 1917.
(*d*) In addition a return of capital amounting to $600,000 was made on July 3, 1919, to stockholders of the Kerr Lake Mines, Ltd.
(*e*) Mining Corporation of Canada, Limited, now owns and operates the City of Cobalt, Cobalt Lake and Cobalt Townsite mines.
(*f*) Includes $16,288,297.25 paid in dividends by the Nipissing Mines Co. (the holding company) to the end of 1916.
(*g*) Paid out of capital $40,491.15 on September 10, 1917, and an equal amount on April 24, 1918.
(*h*) Does not include dividends by private companies such as M. J. O'Brien, Ltd.

Nickel, Copper and Platinum Metals

Nickel production in Ontario has grown from very small beginnings in 1887, followed by a long struggle for many years after that date, to be a most important industry and may now be credited with 85 per cent. of the world production of the metal. Production from New Caledonia, Ontario's chief competitor has been stationary for the past few years at about 4,000 tons per annum. Since the great war the problem has been to develop new industrial uses to provide an outlet for nickel which formerly was required for armament purposes. An aggressive educational campaign has been so successful within the past few years that whereas the nickel output for 1928 nearly equalled the wartime peak, the quantity marketed for armament use has been reduced from 60 to 3 per cent. The growth in output and industrial consumption of nickel, largely due to the spread of its uses both as fabricated articles and also in an ever-increasing number of alloys, has been responsible for the major part of the increase of profits during the past two years, and though this nickel market as yet is relatively small, the applicability of the metal to a wide range of new uses points to rapid expansion, particularly for steel rails, high pressure boiler linings, and automobile parts.

The new developments at depth on the Frood ore body mentioned below, which have proved an ore of very high copper content, adds to the interest since the demand for copper is practically unlimited. Two distinct types of ore bodies occur in the Sudbury basin, namely, "marginal" such as the Creighton, Garson and Levack mines, and "offset" such as the Worthington and Frood. The latter type has proved richer in platinum metals.

The most important feature during 1928 was the deep development work carried on at the Frood and Frood Extension mines by the International and Mond companies, respectively. According to the Report of the Ontario Nickel Commission, page 196, about 45 million tons of the upper portion of this deposit, estimated from drill cores, was reported as averaging 3.5 per cent. of combined metals, in the proportion of 2.05 of nickel and 1.45 of copper. The deep development work recently carried on, however, showed a much richer ore body at depth and large masses have been estimated to run from 4½ to 23 per cent. in copper and from 2 to 2.66 per cent in nickel. The precious metal content,including platinum metals, gold and silver, was also much richer than in the higher levels.

The Frood (International) and the Frood Extension (Mond) mines constitute one orebody. The International shaft is 3,050 feet deep and that of the Mond 3,350 feet. The International has levels opened up at depths of 1,200, 1,600, 2,400 and 2,800 feet; and the Mond at 1,400, 1,700,2,000, 2,400, 2,800 and 3,100 feet. The International shaft was started December 24, 1926, and completed on March 22, 1928, or a period of 15 months, sinking being at an average rate of 203 feet per month. Shaft dimensions are 28 feet by 15 feet outside timbers. The Mond shaft is about one-half mile away. Since the new year (1929) the orebody has been penetrated at the 2,800-foot level in the International and at the 2,800- and 3,100-foot levels in the Mond, the width of the ore where cut running from 143 to 185 feet. The ore has proved to be progressively richer at depth, especially as regards copper content. Lord Melchett, president of the Mond company, stated in December, 1928, that on the 3,100-foot level a considerable body of ore assayed over 20 per cent. copper, 2 per cent. nickel, and 0.64 ounces of precious metals per ton.

Lord Melchett states, and careful analysis appears to justify the assertion, that never in the history of mining have such high values been shown over such a large body of ore, and further, that there was no doubt that an ore body of

enormous size and of exceptionally high grade would be developed sufficient to make these merged companies one of the largest producers of copper in the world. In addition, the actual ore reserves at the other properties now being operated by the two companies are large.

In Table XIV, following, the course of the nickel industry during the past five years is presented. That this metal takes on added importance during times of war is indicated by the fact that while in 1913 the quantity of ore smelted was 823,403 tons, it rose in 1918 to 1,559,892 tons, fell to 314,120 tons in 1922 and through new peace-time markets found for nickel, rose again in 1923 to 1,140,160 tons. A steady expansion in the use of nickel for industrial purposes has been noted since 1923. The matte produced in 1928 exceeded that of 1918, the record year heretofore when the output was 87,184 tons from 1,559,892 tons of ore smelted. Nickel and copper contained in matte exported in 1928 were valued at 18 and 10.5 cents per pound, respectively:—

TABLE XIV.—NICKEL-COPPER MINING AND SMELTING, 1924-1928

Schedule	1924	1925	1926	1927	1928
Ore raised.....tons	1,411,980	1,264,748	1,322,050	1,305,917	1,457,910
Ore smelted..... "	1,307,694	1,258,849	1,309,782	1,350,214	1,476,704
Bessemer matte produced..... "	65,943	70,280	78,643	81,848	91,313
Nickel content..... "	34,638	36,596	39,038	39,623	43,393
Copper content..... "	18,490	19,636	24,159	25,969	29,704
Matte exported*..... "	26,565	32,397	34,908	33,541	39,310
Nickel content..... "	34,638	36,596	39,038	39,623	43,393
Copper content..... "	18,490	19,636	24,159	25,969	29,704
Matte refined in Canada..... "	36,613	38,567	33,489	39,253	67,866
Men employed.....No.	2,459	2,650	3,132	3,418	3,845
Wages paid.....$	2,859,600	3,487,051	4,359,066	4,919,445	6,005,697

*All matte was exported prior to 1918 when refining in Canada began at Port Colborne, Ontario. The British America Nickel Corporation commenced refining operations at Deschênes, Quebec, in 1920, and closed down finally in July, 1924.

Refineries.—During the year at Port Colborne, the International Nickel Company of Canada recovered electrolytic and refined nickel, nickel oxide, converter copper, platinum, palladium and other metals of the platinum group. The record for 1927 and 1928 is shown in the subjoined table:—

TABLE XV.—NICKEL-COPPER REFINING, 1927 AND 1928

Schedule	1927		1928	
	Quantity	Value	Quantity	Value
		$		$
Matte, treated.....tons	39,253	.....	67,866	.....
Nickel oxide, marketed.....lb.	8,478,963	2,037,458	12,445,951	2,877,739
Metallic nickel, recovered..... "	28,469,996	7,497,436	49,142,644	12,595,814
Blister copper, recovered..... "	22,656,720	2,805,454	41,609,160	5,937,153
Gold, recovered*.....ounces	4,866	99,908	3,850	79,586
Silver, recovered*..... "	188,180	105,759	222,924	129,688
Platinum metals, recovered*..... "	22,762	1,270,843	23,539	1,309,923
Employees.....No.	576	.....	797	.....
Wages paid.....$	.....	813,253	.....	1,298,778

*Includes recoveries by the Mond Nickel Company at Clydach in Wales.

Platinum metals are the most important by-products in the refining of nickel-copper matte. Details regarding precious metals recovered during a five-year period by nickel-copper refineries treating Ontario matte are noted in the table which follows:—

TABLE XVI.—PRECIOUS METALS RECOVERED, 1924-1928

	1924	1925	1926	1927	1928	
	Ounces	Ounces	Ounces	Ounces	Ounces	Value, $
Gold†	4,125	4,016	4,447	4,866	3,850	79,586
Silver	122,889	134,390	151,429	188,180	222,924	129,688
Platinum metals:						
Platinum	9,181	8,692	9,471	11,217	10,452	704,360
Palladium	8,923	7,856	9,790	11,247	11,389	489,728
Rhodium, Ruthenium, Osmium and Iridium	593	432	234	298	1,689	115,835
Total ounces	18,697	16,980	19,495	22,762	23,539	.....
Value $	1,891,497	1,675,706	1,559,527	1,270,843	.....	1,309,923

†Includes small recoveries of the rhodium group by the Mond Nickel Company.

Average prices obtained for platinum in 1927 were $67.40 and for palladium $43.00 per fine ounce. Prices of the rarer platinum metals fluctuate so widely that average prices are difficult to secure.

Dividends.—Prior to 1926 the Ontario Department of Mines did not receive full information in regard to dividends paid by nickel companies. Dividends paid were published for the first time in the last Annual Report:—

TABLE XVII.—TOTAL DIVIDENDS PAID BY NICKEL COMPANIES

Company	Period (inclusive)	Total to end of 1927	Paid in 1928	Total to end of 1928
Canadian Copper Company	1894–1901	$1,975,000	.....	$1,975,000
*International Nickel Co. preferred	1906–1928	11,764,518	$534,754.50	12,299,273
*International Nickel Co. common	1909–1928	61,480,596	4,331,098.25	65,811,694
Total	.....	$75,220,114	$4,865,852.75	$80,085,967
†Mond Nickel Company deferred	1906–1914	£264,043	.....	£264,043
†Mond Nickel Company preferred	1904–1928	2,118,859	£262,500	2,381,359
†Mond Nickel Company common	1905–1928	2,105,318	247,500	2,352,818
Total		£4,488,220	£510,000	£4,998,220
		or $21,842,334	$2,481,915	$24,324,249
Grand Total		$97,062,448	$7,347,768	$104,410,216

*Successors to the Canadian Copper Company. The International Nickel Company paid dividends on the common stock from 1909 to 1919, inclusive, and again from 1925 to 1928, inclusive. Common stock outstanding was $41,834,600, and preferred stock $8,912,600, or a total of $50,747,200 at the beginning of 1928. On December 19, 1928, the authorized capital stock of $62,000,000 of the New Jersey company was reduced by changing the par value of the shares from $25 to $1 each, and at the same time the name of the company was changed to "Nickel Holdings Corporation." On December 31, 1928, the authorized capital was further reduced to $993,425 fully issued or subscribed for stock consisting of $843,700 preferred stock and $149,725 common stock, par value in each case.

†Debenture interest paid by the Mond Company was £75,465 for the year 1928; and from 1912 to 1928, inclusive, totalled £1,120,833. The issued and paid-up capital of this company, as of December 31, 1928, was £1,250,000 ordinary; £1,750,000 cumulative preference, £2,000,000 non-cumulative preference, both of these 7 per cent.; £375,000 of 5 per cent. first mortgage debenture stock, and £1,033,974 of 5½ per cent. mortgage debenture stock; or a total of £6,408,974. All shares have a par value of £1 each.

Pig Iron, Steel, Ferro-Alloys, and Coke

As indicated in the table which follows, the production of pig iron and its products has risen sharply in Ontario during the past five years. Pig iron increased by more than 76 per cent. and steel by 77 per cent. No domestic ore has been charged to the blast furnaces since 1925, all production being derived from imported ore from the United States. The increase in ore charged was 48 per cent. The average price for the year of iron ore at lower lake ports was $4.40 per long ton.

One reason for the decline of steel production after the war was the slackening in railroad construction, and a factor in the improvement has been the resumption in the demand for rails and other steel products used by the railroads. The railways are the heaviest consumers of steel products in Canada, accounting for about one-third of the output. On the other hand building has been proceeding at an advancing rate, mining has been active, and the bountiful crops of 1928 and preceding years have created a brisk demand for agricultural machinery.

The prices used in evaluating the output of iron and steel were $22.50 per long ton for foundry iron, $22.75 for malleable, and $20.00 for basic, while steel billets were valued at $38.50 per long ton. The above quotations were applied to the output from both Hamilton and Sault Ste. Marie, as the values f.o.b. works. The average prices of foundry and malleable iron at Toronto, during 1928, were as follows: Foundry No. 1, $25.27; Foundry No. 2, $24.35, and Malleable, $25.27. Basic, which is practically all used in inter-plant manufacturing by the producing companies, was quoted at $20.00 per long ton at the works. Steel billets, of which only a small quantity are sold, e.g., to forging establishments, ranged from $33.50 to $45.00 per long ton at Montreal.

The iron and steel industry of the United States enjoyed a most prosperous year during 1928, and reached a new record of 50,000,000 tons of steel ingots, exceeding the previous high record, set in 1926, by 1,700,000 tons. The steady demands of the automotive and building industries continued through the autumn and early winter and some of the companies fell behind on orders already booked.

The following table gives particulars of the iron and steel-making industry of the Province for the last five years:—

TABLE XVIII.—IRON AND STEEL STATISTICS, 1924-1928

Schedule	1924	1925	1926	1927	1928
Ontario ore smelted.....short tons	8,231	6,830	.....	.....	.....
Foreign ore smelted..... "	836,233	732,356	948,154	1,019,971	1,242,937
Limestone for flux..... "	187,571	109,198	218,996	217,748	324,550
Coke..... "	438,323	262,344	503,871	487,825	736,746
Pig iron produced..... "	465,888	412,837	545,737	515,366	822,952
Value of pig iron produced.....$	9,484,139	8,048,992	9,805,300	9,663,108	15,468,110
Steel made.....short tons	499,986	529,327	534,732	635,173	885,414
Value of steel made.....$	14,196,029	18,904,520	16,710,365	18,695,950	30,436,098

As shown in Table XVIII foreign ore charged was 1,242,937 tons from which a total of 822,952 tons of pig iron were made having a value of $15,468,110. The output consisted of 484,792 tons of basic, 258,873 tons of foundry, and 79,287 tons of malleable, of which basic was valued at $20 per long ton.

IRON BLAST FURNACES IN OPERATION, 1928

Name of Company	Furnaces			Fuel used	Location
	No.	Daily capacity, long tons	Days operated		
Algoma Steel Corporation, Ltd.	4	1,600	365	Coke	Sault Ste. Marie
Steel Company of Canada, Ltd.	2	825	365	Coke	Hamilton
Canadian Furnace Co., Ltd.	1	300	223	Coke	Port Colborne

BLAST FURNACES IN ONTARIO FOR THE PRODUCTION OF PIG IRON

Company	Location	Furnaces		Remarks
		No.	Daily capacity gross tons	
Algoma Steel Corporation, Ltd.	Sault Ste. Marie	4	1,600	Active
Atikokan Iron Company	Port Arthur	1	175	Idle since 1911
Canadian Furnace Co., Ltd.	Port Colborne	1	300	Re-opened May 25, '28
Canadian Steel Corporation, Ltd.	Ojibway (near Windsor)	2	1,100	Under construction
Midland Iron and Steel Co., Ltd.	Midland	1	120	Idle since Feb., 1921
Parry Sound Iron Co., Ltd.	Parry Sound	1	90	Idle since Oct. 1, 1919
Standard Iron Co., Ltd.	Deseronto	1	60	Idle since June 9, 1919
Steel Company of Canada, Ltd.	Hamilton	2	825	Active

Note.—The first and last mentioned produce open-hearth steel as well as pig iron.

Steel and Ferro-Alloys.—Steel ingots to the amount of 778,071 long tons were made in Ontario by five companies. Of these 760,234 tons were basic open hearth for use in the manufacturing plants of the makers.

Direct steel castings derived by the open hearth basic, crucible, and electric process, totalled 12,477 long tons, of which 10,665 long tons were electric and the balance open hearth basic and converter.

Ferro-alloys were made by four companies and included ferro-manganese and ferro-silicon. The total output amounted to 45,233 long tons.

PIG IRON, STEEL AND FERRO-ALLOY PRODUCERS

Company	Location
Canadian Furnace Co., Ltd. (*a*)	Port Colborne
Steel Company of Canada, Ltd (*a*), (*b*)	Hamilton
Algoma Steel Corporation, Ltd. (*a*), (*b*)	Sault Ste. Marie
Dominion Foundries and Steel, Ltd. (*b*)	Hamilton
Wm. Kennedy & Sons, Ltd. (*b*)	Owen Sound
Canadian Carborundum Co., Ltd. (*c*)	Niagara Falls
Electro Metallurgical Co. of Canada, Ltd. (*c*)	Welland
Abrasive Company of Canada, Ltd. (*c*)	Hamilton
Canadian Electric Castings Co., Ltd. (*b*)	Orillia
Welland Steel Castings, Ltd. (*b*)	Welland
Carbon and Alloy Steel Co., Ltd. (*b*)	Welland
Union Carbide Co. of Canada, Ltd. (*c*)	Welland
London Rolling Mills Co., Ltd. (*b*)	London

(*a*) pig iron; (*b*) steel; (*c*) ferro-alloys.

Coke.—The Algoma Steel Corporation, at Sault Ste. Marie, and the Steel Company of Canada at Hamilton, produce coke in conjunction with their blast furnace operations, while the Hamilton By-Products Coke Ovens, Ltd., also at Hamilton, produces coke for domestic purposes, having commenced in January, 1924. On March 29, an announcement was made of the purchase of the Hamilton By-Products Coke Company and the United Gas Company of Hamilton by the Dominion Securities Corporation of Toronto. Previously a large share of the holdings of these two companies was controlled by United States capitalists. The control will now be in local hands, operating under the name of Hamilton By-Product Coke Ovens, Limited. The materials used and products consumed and sold by the coke plants in Ontario during 1928 are shown in the subjoined table:—

THE COKING INDUSTRY IN ONTARIO, 1928

Kind	Unit	Quantity	Value
			$
MATERIALS USED			
Bituminous coal, foreign	tons	1,583,835	7,563,053
Sulphuric acid, 66° Be	lb.	31,162,879	183,153
All other materials	.....	.....	32,171
Caustic soda	.....	.....	9,198
Total	.....	.....	7,787,575
PRODUCTS MADE			
Coke*	tons	1,132,614	7,645,257
Coke breeze	"	92,639	148,810
Gas sold and used	M. cubic ft.	12,105,121	2,555,677
Tar and tar products	Imp. gals.	11,394,510	731,093
Ammonium sulphate	lb.	32,208,749	636,882
Light oils	Imp. gals.	2,896,960	306,031
Total	.....	.....	12,023,750

Lead-Zinc

Except for a small recovery of lead in the smelting of silver-cobalt ores and also some lead contained in concentrates shipped from the Treadwell-Yukon copper-lead-zinc property in the Sudbury basin, the output as given in the main table was produced by the Kingdon Mining, Smelting and Manufacturing Company at Galetta. The total output in 1928 was 6,814,757 pounds valued at $402,289 as against 7,990,709 pounds worth $528,729 in 1927. This production was mainly in the form of pig lead, the lead from other sources amounting only to 232,367 pounds.

Zinc has again appeared as an item in the main table. Occasional shipments of zinc-concentrate have been made from the Galetta lead mine, the accumulations recovered in the treatment of an ore in which the principal mineral is galena. With the opening up of the Sudbury lead-zinc field, zinc should now become a regular item in the list of mineral products. In 1928 some 77 tons of concentrate were shipped, containing 71,052 pounds of zinc in addition to small amounts of gold and silver. A deduction of 160 pounds per ton of concentrate treated was allowed for losses in smelting. The net output was 58,724 pounds worth $3,226.

Copper concentrate also, to the extent of 715 tons containing 180,546 pounds of copper and important quantities of gold and silver, were exported to the United States for treatment. Ten pounds of copper per ton of material treated was allowed for smelter losses to be deducted from the above figure.

The Treadwell-Yukon mine was steadily developed during 1928. The present program consists of sinking three shafts to the 1,500-foot level connecting the tops by an electric railway to the mill. All marketable copper concentrate was shipped to Laurel Hill, L.I. The zinc shipments were made to Trail, B.C. and Kellogg, Idaho, for experimental purposes. Zinc concentrate will probably find a market in Europe.

The price of lead on the New York market during the year was 6.305 cents per pound and 6.131 cents at St. Louis. Zinc in 1928 averaged 6.027 cents at St. Louis.

Diamond-Drilling

As a prospecting tool the diamond-drill continues to gain in favour with the mining companies of Ontario. The following table gives data covering operations in Ontario during the past three years:

Year	Machines operated	Holes drilled	Core Extracted	
			Feet	or Miles
1926	71	1,986	385,932	70.8
1927	72	1,494	359,041	68.0
1928	85	1,901	485,304	91.9

During the year under review the areas where the drilling was done were: Porcupine, 190,915 feet; Sudbury, 163,327; Kirkland Lake and Boston Creek, 92,195. Red and Woman lakes, 16,041, Cobalt, 7,523; Savant Lake, 6,288; Michipicoten, 5,496; Timagami, 2,669; Gowganda and Elk Lake, 850 feet. A list of the operators is appended:—

DIAMOND-DRILL OPERATORS IN ONTARIO IN 1928

Name	Ontario Address	No. of drills active
Badeski, F	Timmins	9
Chisholm, D. D. (Kirkland Lake Diamond Drilling Co.)	Timmins	7
Dome Mines, Ltd	South Porcupine	2
O'Brien Mine	Cobalt	1
McIntyre Porcupine Mines, Ltd	Schumacher	3
Mitchell, W. J., (Diamond-Drill Company, Ltd)	Cobalt	5
Morissette, N	Haileybury	5
Ontario Diamond-Drilling Co., Ltd	Sudbury	10
Reed & Ryan	Timmins	11
Smith & Travers	Sudbury	15
Wright-Hargreaves Gold Mines, Ltd	Kirkland Lake	2
Sudbury Diamond-Drilling Co., Ltd	Sudbury	15
Total		85

NON-METALLIC MINERALS

During 1928 the value of the output of non-metallic minerals totalled $7,822,641 as against $7,638,605 in 1927, or an increase of 2.4 per cent. The main items, with values in order of importance were as follows, natural gas $4,535,312, salt $1,377,629, gypsum $553,271, quartz and quartzite $308,608, petroleum $249,981, feldspar $180,153, talc $179,187 and arsenic $178,149. Actinolite, graphite, iron pyrites, and sulphuric acid (i.e. sulphur content), mica, mineral water and silica brick were represented, as may be seen in Table 1 in the list of non-metallics, but were all under $100,000 each in value.

Actinolite

This mineral which is a variety of asbestos, has been mined in Hastings county in a small way since 1883. It is mainly exported to the United States where it is used as an ingredient in the manufacture of roofing material. In 1928 the output was 70 tons valued at $875 as against 86 tons worth $1,075 in 1927.

Arsenic

Arsenic in the native state is a metallic mineral but since it is produced in Ontario in the oxide form, called in the trade white arsenic, it has been customary to include it under the non-metallics. The whole production is recovered in the smelting of the silver-cobalt arsenides of northern Ontario, by the Deloro Smelting and Refining Company. Including the arsenic produced as insecticides and also contained in speiss residues exported to the United States for treatment, the production in 1928 was 4,097,226 pounds valued at $178,149 as against 4,961,178 worth $197,668 in the previous year.

Barite

This mineral has not appeared in the production table since the year 1923. Several deposits are known to exist, and one in the Porcupine gold area, Canada Nighthawk Mines, Limited, is equipped with milling facilities. The main difficulty, however, for domestic producers is the limited home market and the high duty to be met on entry into the United States markets.

Coal (Lignite)

A development which may be of far-reaching importance to the Province of Ontario was the preliminary examination and tests carried out on the deposits of lignite coal at Blacksmith rapids on the Abitibi river in Northern Ontario, by the Ontario Department of Mines. This deposit has long been known, but heretofore, no extensive tests beyond analyses have been made. During 1928 about 1,000 pounds was brought out and complete tests made at the Fuel Testing Laboratory of the Department of Mines, Ottawa. As a result the Ontario Department of Mines decided to carry out a plan of diamond-drilling to delimit the thickness of the seam and extent of the deposit, and this work was begun in the spring of 1929.

Feldspar

During 1928 eight producers shipped 18,954 tons valued at $180,153 as against 17,119 tons worth $154,533 in 1927. The major portion of Ontario's spar is exported in the crude state to the United States where it is used mainly in the pottery trade. Material for this industry is ground generally so that 91 per cent. will pass a 330-mesh screen.

A feature in the feldspar industry which is of interest to Canadian producers was the merger of a large number of producers and grinders of feldspar in the United States into a company called Consolidated Feldspar Corporation, formed for the purpose of consolidating feldspar properties to assure ample supplies of raw material with adequate milling facilities for grinding in each of the producing fields of the United States and Canada. The company is capitalized at $5,000,000. One Ontario producer, Feldspar Quarries, Ltd., has joined the merger. An immediate effect of this merger is that companies which formerly bought spar in Ontario, are now supplied by producers in the United States, with the result that some Ontario producers lost their market and were forced to close down their quarries early in 1929.

The grinding of feldspar in Ontario is all done by one company, namely, the Frontenac Floor and Wall Tile Company, in its plant, at Kingston. During 1928 about 2,700 tons were ground, the major portion of which found a market in Ontario for the manufacture of porcelain and enamelled steel articles, such as sanitary ware and cooking utensils, etc.

A market which offers future expansion in the consumption of spar is in the manufacture of certain cheaper grades of glass. Spar for this purpose is ground to 40-mesh, and is usually sold on the basis of combined alkali and alumina content. During 1928 at Oshawa, the Feldspar Glass Company, Ltd., carried on experiments, using electric furnaces. One furnace was destroyed by fire in December before commercial manufacture had been reached. The firm expects to make bottle glass, using feldspar mainly as raw material.

Graphite

The only producer in Ontario of this mineral was the Black Donald Graphite Company, Ltd., of Calabogie, from their property on lots 17, 18 and 19, concession III, Brougham township, in Renfrew county. The production during 1928 was lower than formerly, due in part to a disastrous fire in February, when the mill and power-generating plant were destroyed. No damage was reported in the mine workings.

During the year 106 tons were mined and 392 tons treated. Sales, which consisted of crude and refined graphite of various grades, totalled 1,047 tons, valued at $52,373, as against 1,795 tons worth $109,613 in 1927. About 85 per cent. of the Ontario production is exported. Unsold product on hand at the end of the year was 177 tons refined and 14 tons crude.

Gypsum

Only one company was in operation during 1928, namely, the Canada Gypsum and Alabastine, Limited. This new organization took over the Ontario Gypsum Company, Ltd., the Nova Scotia Coal and Gypsum Company, Ltd., and the Toronto Builders' Supplies, Ltd., in 1927. The new company operated its Ontario properties at Oneida (Lythmore) and Seneca (Caledonia), in 1928. There was a total production of 85,811 tons of gypsum of various grades valued at $553,271 as against 83,998 tons, worth $500,688, in 1927. The grades in 1928 were as follows: Crushed, 20,675 tons; fine-grained, 1,134 tons; calcined sold, 4,133 tons; and 59,869 tons consumed in manufactured products such as insulex, plaster board, gyproc, etc.

In March, 1928, a bond issue of $2,500,000 was offered the public in order to finance the purchase of the business and property of the Manitoba Gypsum Co., Winnipeg, and its subsidiary, the British Columbia Gypsum Co., Ltd. Port Mann, B.C. With the acquisition of the Manitoba and British Columbia properties, the company will control the sole production in Canada of gypsum

products, such as "Gyproc" wall board, partition and roof tiles, etc., as well as "Insulex" and "Alabastine," with up-to-date plants in Montreal, Que., Caledonia and Lythmore, Ont., Winnipeg, Man., and Port Mann, B.C., and will also be a large producer of plaster of paris, Keene's cement, lime, etc., at these and additional plants operated at Elora, Teeswater and Paris, Ont. Consolidated sales of all these Canadian companies totalled $4,175,342 for the year 1927. Export demand from Great Britain, New Zealand and other countries is growing and will be supplied from Montreal and British Columbia plants.

Iron Pyrites (Sulphur)

Shipments of iron pyrites (464 tons) in 1928 were all from the property of the Grasselli Chemical Company, Ltd., near Flower Station on the Canadian Pacific Railway north of Kingston. The entire output was exported to the United States. For statistical reasons, the figures in Table I show the sulphur content of the sulphuric acid produced at Coniston by the Mond Division of the International Nickel Company at the selling value of the acid, in addition to the estimated sulphur content of the iron pyrites at the value of the crude ore.

The total sulphur produced, and arrived at by this method, was 4,974 tons, valued at $54,100. The Coniston "contact" process plant supplies a large part of Ontario's requirements for sulphuric acid by treating sulphur dioxide gases recovered from nickel-copper smelting operations. A full write-up of this new industry appeared in Vol. XXXVI, Part I, page 26.

An iron pyrites property at Queensboro in Hastings county, which formerly produced ore, was under examination by the Nichols Chemical Co., Ltd., during the latter part of the year. Pumping equipment was installed so that the mine could be unwatered. No shipments of ore were reported.

Mica

During the period 2,559 tons of mica, principally scrap, valued at $32,945, were shipped from the mines, as against 1,284 tons worth $75,183 in 1927. The decrease in value indicates a considerable falling off in the shipment of the higher grades of thumb-trimmed mica. Only 30.77 tons were mined during 1928 by two operators while shipments were reported by 9 firms.

By grades the shipments were as follows:

Grade	Pounds	Value
		$
Thumb-trimmed	35,684	8,636
Splittings	140	84
Scrap	962,410	19,425
Ground	120,000	4,800
Total	5,118,234	32,945

Mica splittings were valued at 60 cents per pound. The thumb-trimmed, which in size varies from 1 inch by 1 inch to 5 inches by 8 inches, brought the following prices:

Size, inches	Cents per lb.	Size, inches	Cents per lb.
1 by 1	7–14	2 by 4	.50– .60
1 by 2	15–20	3 by 5	.80– $1.00
1 by 3	18–27	4 by 6	$1.25– 1.90
2 by 2	22	5 by 8	$2.00
2 by 3	28–55		

MICA SHIPPERS, 1928

Name of Owner or Producer	Location or Name of Mine	P.O. Address of Manager, etc.
Bennett, H. V.	Buyer of mica	Perth
Bio Mica Co., Ltd	Verona	324 Northcliffe Ave., Montreal
Kent Bros., and Estate of J. M. Stoness	Buyer of mica	Kingston
Lee, W. W.	" " "	Bedford Mills.
Martin, A. G.	" " "	236 Besserer St., Ottawa
McLaren, W. L.	4, 5, 6, VIII, N. Burgess tp.	Box 20, Perth
Smith, Damon	4, II, N. Burgess tp	Brockville, R.R. 3
Cross, W. C., Estate		Madoc

Mineral Waters

The companies producing mineral waters in 1928 were as follows:—

PRODUCERS OF MINERAL WATERS, 1928

Name of Owner, Firm, or Company	Location of Spring or Well	P.O. Address of Manager, etc.
*Belanger, A.	North Plantagenet tp	Papineauville, Que.
†Canada Dry Ginger Ale, Ltd.	Gloucester and Clarence tps.	6380 St. Urbain St., Montreal
Carlsbad, Ltd	Carlsbad Springs	Carlsbad Springs, Que.
Denault, F.	Lot 22, con. IV, Clarence tp.	Bourget.
Goderich Mineral Water Co.	Goderich	Goderich.
Gurd & Co., Ltd., Charles	Caledonia tp	1016 Bleury St., Montreal.
Sanitaris, Ltd	Lot 27, con. XII, Pakenham tp.	Arnprior.

*Sold spring in April, 1928 to A. Leroux, Papineauville, Que.
†Formerly Caledonia Springs Co., Ltd.

The following table records shipments since 1921 of mineral waters with valuation in bulk form at the works:—

Shipments	1921	1922	1923	1924	1925	1926	1927	1928
Imperial gallons	308,647	209,072	227,030	201,670	183,012	208,400	293,200	253,630
Value $	14,438	10,528	14,047	13,133	25,452	27,277	12,811	27,890

Natural Gas

Production of natural gas in Ontario in 1928 from 2,126 wells was 7,632,740 thousand cubic feet, with a retail value of $4,535,312, according to the report (Vol. XXXVIII, Part V) by R. B. Harkness, Natural Gas Commissioner. The selling price ranged from 35 cents to $1.20 per thousand cubic feet. Production in 1927 was 7,311,215 thousand cubic feet. For fuller details the special report above mentioned should be consulted. Labour statistics follow*:—

Schedule	No. Employees	Wages Paid
Gas producers and distributors	1,123	$1,399,388
Drilling contractors	86	98,611
Total	1,209	1,497,999

*Includes a few small operators, estimated.

Petroleum

A report on "Petroleum in 1928," by the Natural Gas Commissioner, appears in Vol. XXXVIII, Part V. Statistical tables, which are repeated here for convenience, are taken from the above-mentioned report.

CRUDE PETROLEUM PRODUCTION BY FIELDS, 1924-1928

Field	1924	1925*	1926	1927	1928
	Bbls.	Bbls.	Bbls.	Bbls.	Bbls.
Petrolia, and Enniskillen township..	60,916	53,166	55,485	60,172	60,547
Oil Springs	41,320	39,137	38,350	37,281	35,653
Moore township	4,483	8,195	2,438	2,014	2,148
Sarnia township	2,068	1,905	1,890	1,679	1,221
Plympton township	525	1,424	1,047	493	371
Bothwell	26,700	26,243	25,382	25,224	24,255
Dover, West } Tilbury	3,898	2,957	959	602	773
Tilbury East }	.....	.....	.....	60	735
Raleigh township	783	887	676	276	.....
Onondaga township	456	261	361	210	185
Mosa township	8,862	8,397	7,868	7,456	7,268
Thamesville	.....	289	2,376	4,139	1,006
Euphemia township	.....	39	.....	.....	.....
Dunwich township	1,351	1,001	139	.....	.....
Romney township	2,955	1,235	.....	.....	.....
Total production.....Bbls.	154,317	144,249	136,971	139,606	134,164
Value.....$	390,423	369,154	376,822	289,390	249,981
Average price per bbl.....$	2.51¼	2.56†	2.73	2.11	1.86

*Figures to July 1, 1925, supplied by the Supervisor of Petroleum Bounties at Petrolia.

†A bounty of 26¼ cents per barrel (35 Imperial gallons), or a total of $20,152, was paid in 1925 by the Federal Government under the "Petroleum Bounty Act" up to July 1, when the Act ceased to operate. This bounty was in addition to the values above quoted.

Refining of oil and the manufacture of oil refinery products were carried on during 1928 by four companies in Ontario, as follows:—

PETROLEUM REFINERIES, 1928

Company	Head Office	Plant	Days Operated
British American Oil Company, Ltd.	1312 Royal Bank Bldg., Toronto..	Toronto...	365
Canadian Oil Refineries, Ltd	Toronto	Petrolia...	360
Imperial Oil Refineries, Ltd	445 South Christina St., Sarnia....	Sarnia....	365
McColl Bros	114 Don Esplanade, Toronto.....	Toronto...	365

CRUDE PETROLEUM AND REFINERY STATISTICS, 1924-1928

Schedule	1924	1925	1926	1927	1928
Crude petroleum production:					
Imp. gals	5,401,102	5,024,770	4,693,999	4,886,199	4,695,714
*Selling value.....$	390,424	369,154	376,822	289,391	249,981
Canadian crude, distilled:					
Imp. gals	5,123,683	4,859,148	5,017,500	5,205,097	4,484,858
Value.....$	394,398	358,245	422,159	363,320	283,959
Per cent. of total	3.27	2.92	2.66	2.33	1.71

*The value includes bounty paid to producers up to July 1, 1925.

CRUDE PETROLEUM AND REFINERY STATISTICS, 1924-1928—*Continued*

Schedule	1924	1925	1926	1927	1928
Imported crude, distilled:					
Imp. gals.	151,381,481	161,895,295	183,347,749	218,200,977	257,929,514
Value $	11,575,058	13,056,823	16,940	15,900,079	17,617,756
Products:					
*Gasolene Imp. gals.	61,493,214	73,083,022	84,936,377	100,944,586	122,792,092
Value $	9,392,837	11,032,134	14,983,322	13,641,570	18,199,305
Illuminating oil Imp. gals.	28,816,322	18,677,629	8,088,787	23,712,369	21,304,385
Value $	3,055,188	2,222,569	1,266,577	2,828,872	2,650,877
Lubricating oil Imp. gals.	12,011,116	13,297,275	16,025,753	17,040,724	16,822,292
Value $	2,009,732	2,364,320	3,540,786	3,237,375	2,813,371
Engine distillate and naphtha Imp. gals.	.....	.....	53,869	4,045,416	3,062,787
Value $	.....	.....	10,774	510,960	445,526
Still gas M. cu. ft.	524,737	431,713	630,325	811,666	823,320
Value $	172,555	167,869	256,935	207,370	185,595
*Gas and fuel oil Imp. gals.	36,702,043	46,064,129	41,883,125	53,767,638	76,469,354
Value $	2,494,858	2,947,378	3,182,770	3,280,343	4,104,338
Paraffin wax and candles lb.	9,112,143	15,502,029	9,858,490	9,526,072	17,030,064
Value $	551,434	734,322	648,303	505,133	599,341
Tar and grease lb.	10,325,735	9,301,674	11,260,882	11,254,706	14,626,752
Value $	187,544	177,474	221,826	221,694	267,563
Acid oil Imp. gals.	1,350,450	1,858,176	711,970	768,171	†
Value $	61,748	85,761	35,823	46,634	†
Acid and petroleum coke tons	36,200	31,501	45,774	44,768	49,409
Value $	226,005	212,085	265,841	282,828	314,794
Asphalt Imp. gals.	.....	.....	.....	1,060,761	1,276,098
Value $	.....	.....	.....	58,919	65,003
Miscellaneous $	29,261	1,596	2,978	434,655	387,544
Total value of products $	18,181,162	19,945,508	24,182,575	25,256,353	30,033,257
Employees Ave. No.	1,603	2,165	2,241	1,871	1,853
Wages paid $	2,453,082	2,702,034	2,876,150	2,883,575	3,013,872
Capital invested $	.....	16,372,960	20,441,740	19,354,638	19,570,531

*The value includes bounty paid to producers up to July 1, 1925.
†Included in acid coke.

An examination of the table of imports will indicate a general increase in all products but paraffin waxes, candles and vaselines. In spite of the increase in the capacity of Ontario refineries and the addition of one large refinery, the importation of refined gasolene (irrespective of casing head or blending gasolene) has increased by two and one-half million gallons, and lubricating oils about one million gallons, or the output of a small refinery. Practically all of these imports are from the United States of America.

The following table shows the quantity and value (less freight, exchange and sales tax) of crude oil and its refined products imported into Ontario in the years 1927 and 1928. Nearly all of this came from the United States. The information is furnished by the Department of External Trade and Commerce, Ottawa, and forwarded by the Dominion Bureau of Statistics.

PETROLEUM AND REFINED PRODUCTS IMPORTED IN 1927 AND 1928

Imports	1927		1928	
	Imperial gallons	Value	Imperial gallons	Value
CRUDE PETROLEUM:				
Petroleum, 0.790 specific gravity or heavier, for refining	215,172,375	$9,882,693	260,328,023	$11,588,107
REFINED PETROLEUM:				
For use in concentrating ores	2,994	$1,792	4,877	$2,890
Gasoline lighter than 0.725 specific gravity (casing-head gasolene)	41,989,202	3,941,055	51,505,215	5,668,996
Gasolene between 0.770 and 0.725 specific gravity	6,860,050	705,403	9,312,836	1,064,398
Kerosene and illuminating oils	2,182,990	177,485	1,863,101	162,494
Gas oils, 0.790 specific gravity or heavier, imported by refiners	6,844	780	40,787	4,088
Lubricating and other oils	5,417,889	1,630,337	6,306,623	1,951,565
Fuel oil, 0.8235 specific gravity or heavier	8,308,386	537,578	9,029,113	586,014
Total	64,768,355	$6,994,430	78,062,552	$9,440,445
PETROLEUM PRODUCTS:				
Axle grease ..... lb.	2,463,158	$121,329	2,604,351	$118,581
Vaseline, toilet and medicinal petroleum	.....	130,612	.....	121,687
Paraffin wax ..... lb.	2,237,412	101,302	1,342,590	71,047
Paraffin wax candles ..... lb.	250,557	53,407	213,560	47,778
Other petroleum products ..... gals.	1,056,956	177,089	1,735,097	309,136
Total	.....	$583,739	.....	$668,229
Total value	.....	$17,460,862	.....	$21,696,781

Total net value of petroleum and refined products imported in 1928	$21,696,781
Duty paid on the above, calculated on existing tariff schedule	682,297
Sales tax at 3 per cent	650,903
Freight, approximately	9,988,168
Total value delivered in Ontario	$33,018,149

Quartzite, Quartz and Silica Brick

During 1928, there was a decided increase in the production of quartzite and quartz, the figures being 194,503 tons valued at $308,608 as against 159,150 tons worth $266,204 in 1927. Some quartz is also recovered as a by-product in the quarrying of feldspar, but during 1928 no sales were reported.

The largest producer is the Dominion Mines and Quarries, Limited, which operated its Killarney quarry on the north shore of Lake Huron. The East Neebish quarry, operated in former years by this company, was idle during the period. Manitoulin Quartzite, Limited, continued development work at its Sheguiandah quarry on Manitoulin island but reported no shipments. The works already completed include a dock 1,000 feet long to reach deep water. Buildings such as offices and blacksmith shop were erected, and plant railways laid. The quarry face is roughly 100 feet high by 200 feet wide and has been uncovered of overburden for three or four hundred yards. The Mond Nickel Company again reported production, all of which was crushed to 1½ inch size and consumed at the Coniston smelter, as a flux.

Wright and Company of Sault Ste. Marie were producers, part of their output going to supply raw material required in silica brick manufacture by

the Algoma Steel Corporation for consumption in their own plants. During 1928 there were 1,596,819 silica brick made having a value of $86,323.

Heretofore, the value of silica brick has been included in the total mineral production of Ontario after deducting the value of crude quartz entering into the product. But this method was confusing inasmuch as the true value of silica brick in the main table had to be shown at a lower figure. With a view to including silica brick along with industries such as the manufacture of refractories and cement products, it was decided to eliminate its value from the main table. This was done for the year 1927. It now appears more satisfactory to include the silica brick in the main table at its true value for the reason that otherwise the statistics of manufacturing industries are incomplete. For this report, the crude quartz consumed in the manufacture of silica brick is included under quartz with its proper f.o.b. selling value. In addition silica brick at its true value is also shown and included in the total. The duplication involved is very small.

A list of the producers follows:—

QUARTZITE, QUARTZ AND SILICA BRICK PRODUCERS, 1928

Name of Owner, Firm or Company	P.O. Address of Operator	Location of Quarry
Algoma Steel Corporation, Ltd.	Sault Ste. Marie	*
Booth, Edmund	Gordon Bay	Conger tp.
Dominion Mines and Quarries, Ltd.	Toronto, Canada Life Bldg.	East Neebish and Killarney.
Mond Nickel Company	Coniston	Neelon tp.
Rayner, G. W.	Toronto, 151 Roxboro St.E.	Deroche tp.
Wright and Company	Sault Ste. Marie	Deroche tp., Mile 19, A.C.Ry.

*Producers of silica brick. Quartz supplied by Wright and Company.

Salt

Revised figures for salt production by Ontario salt companies during 1928 give a total of 279,841 tons having a selling value of $1,377,629 as against 254,180 tons valued at $1,510,777 in the previous year. During the period eight companies operated nine establishments and employed on the average 299 workers, of whom 36 were females, with a payroll amounting to $337,214. The salt industry is centred in Bruce, Huron, Lambton and Essex counties, in the southwestern part of the Province, which is underlain by salt beds. Salt brine is pumped from wells, evaporated and graded. Included with the total output is the salt equivalent of brine used in chemical plants at Sandwich and Amherstburg, on the Detroit river, for the manufacture of bleaching powder, liquid chlorine, muriatic acid, caustic soda and soda ash. The chlorine plant of the Canadian Salt Company at Sandwich was damaged by fire in March, 1928.

Canadian Industries, Limited, a subsidiary of Imperial Chemical Industries, Limited, of London, England, purchased the Canadian Salt Company, Limited, on Nov. 11, indicating that the heavy chemical industry of Canada is rapidly growing. The output of liquid chlorine, bleaching powder, caustic soda and other alkali chemicals by the Canadian Salt Company has lately developed to a extent where it has become more important than the basic production of salt. The Windsor plant will be dismantled and production centred at Sandwich where the salt beds are thicker.

The several grades and total tonnages of salt, with value exclusive of packages, marketed for the past five years are tabulated as follows:—

SALT STATISTICS, 1924-1928

Schedule	1924	1925	1926	1927	1928
Land.....tons	4,612	5,125	3,965	4,599	3,621
Coarse..... "	28,496	33,197	31,192	25,216	26,730
Fine..... "	42,555	43,286	47,202	47,185	51,055
Table and Dairy..... "	41,134	46,602	50,461	53,477	56,214
Pressed Blocks..... "	3,572	4,605	6,505	7,709	7,083
Brine (salt equivalent)..... "	83,059	93,500	113,020	115,995	135,138
Total sold or used..... "	203,428	226,470	252,345	254,180	279,841
Value of products sold or used.$	1,337,311	1,466,450	1,388,672	1,510,777	1,377,629
Employees.....No.	*439	*467	*466	290	299
Wages.....$	482,263	555,729	614,790	322,549	337,214

*Employees of Sandwich salt and chemical works are included.

Companies producing brine or salt in 1928 were as follows:

OPERATING SALT COMPANIES, 1928

Name of Owner, Firm or Company	Location of Wells or Works	P.O. Address of Manager, etc.
Brunner, Mond Canada, Limited.....	Amherstburg*.....	Amherstburg.
Canadian Salt Company, Limited, The	Windsor..... / Sandwich*.....	Sandwich.
Dominion Salt Company, Limited, The	Sarnia.....	Sarnia.
Exeter Salt Works, Company, Limited.	Exeter.....	Exeter.
Goderich Salt Co., Limited.....	Goderich.....	Goderich.
Kincardine Salt Co., Ltd.....	Kincardine.....	Kincardine.
Western Canada Flour Mills Co., Ltd.	Goderich.....	Goderich.
Western Salt Company, Limited.....	Courtright.....	Courtright.

*Chemical works using salt brine as raw material.

Talc and Soapstone

Production was slightly lower in 1928 as compared with 1927, due mainly to the fact that no soapstone output was reported during the period. Two talc mines and mills were operated in 1928, namely, those of the Asbestos Pulp Company and Geo. H. Gillespie Company, both at Madoc in Hastings county. During the period 15,634 tons were mined and 15,915 tons milled. Ground talc is marketed in various grades as follows: Low at $9.00 per ton and medium at $12.50, while high grade brings as much as $18.00 per ton. The market is steady and is found mainly in Canada and the United States.

Following are statistics of talc and soapstone for the past five years:—

TALC AND SOAPSTONE STATISTICS, 1924-1928

Schedule	1924	1925	1926	1927	1928
Soapstone shipped.....tons	.....	64	110	135	.....
Ground talc shipped..... "	10,718	13,614	14,772	15,003	14,925
Total value shipments.....$	130,577	174,116	178,986	181,981	179,187
Employees, mine and mill.....No.	40	51	50	61	45
Wages paid.....$	37,075	47,971	47,083	51,834	44,858

STRUCTURAL MATERIALS AND CLAY PRODUCTS

General Remarks

The value of Canadian construction contracts awarded for 1928, reported by *McLean Building Review* was $472,032,600 as compared with $418,951,600 in 1927. Ontario contracts in 1928 amounted to $188,351,700. Building costs have been stable for the past three years and material prices are considerably below the peak of 1920. It is expected that prices will remain stabilized at or near the present levels and, while there may be some fluctuations in the cost of building materials, no important reductions in building costs appear likely for some time, particularly in view of higher wage schedules.

VALUE OF ONTARIO CONSTRUCTION CONTRACTS, 1924-1928

Classification	1924	1925	1926	1927	1928
Residential	$43,090,000	$47,529,600	$52,084,100	$57,580,800	$64,628,600
Business	27,706,000	32,579,800	38,808,200	81,328,100	58,700,200
Industrial	7,017,000	3,754,700	21,126,900	11,922,500	25,109,800
Engineering	58,228,000	37,381,000	29,910,200	45,327,600	39,913,100
Total	$136,041,000	$121,248,100	$141,929,400	$196,159,000	$188,351,700

Building permits in sixty-three Canadian cities in 1928 were valued at $219,105,715. Of this total thirty Ontario cities accounted for $104,777,566 or 47.8 per cent., as noted in the following table abstracted from *Annual Review of Building Permits in Canada in 1928*, issued by the Dominion Bureau of Statistics, Department of Trade and Commerce, Ottawa.

BUILDING PERMITS IN ONTARIO, 1920-1928

Year	30 Ontario Cities, Value	Prices Index No. (*a*)	Toronto Metropolitan Area (*b*) Value	Wages Index No. (*c*)
1920	$58,636,365	214.9 (*d*)	$30,049,413	180.9 (*d*)
1921	59,315,845	183.2	31,979,346	170.5
1922	81,396,259	162.2	36,405,625	162.5
1923	74,673,080	167.0	39,530,877	166.4
1924	57,330,141	159.1	29,636,428	169.1
1925	59,888,867	153.7	32,408,636	170.4
1926	65,373,757	149.2	31,588,124	172.1
1927	79,883,344	147.7	37,316,511	179.3
1928	104,777,566	149.3	59,817,568	185.6

(*a*) Applies to average weighted index numbers for Canadian wholesale prices of building materials on the basis of 1913=100, as compiled by Dominion Bureau of Statistics.
(*b*) Includes York and East York municipalities.
(*c*) Average index number of wages in Canadian building trades as compiled by the Federal Department of Labour on the basis of 1913=100.
(*d*) Peak year.

Cement

During 1928 the plants in operation were those of the Canada Cement Company, Limited, located at Belleville, Port Colborne, Lakefield; and that of the St. Marys Cement Company, Limited, at St. Marys. The Lakefield plant, the latest addition to Canada Cement Company's chain, was completely rebuilt and put in operation late in 1927. It is the largest plant in Canada with a daily capacity of 3,000 barrels. Cement statistics for the last pre-war year and subsequently are given in the following table:—

PORTLAND CEMENT STATISTICS, 1913-1928

Year	No. of Operating Plants	Average No. Employees	Wages	Stock on hand Dec. 31st bbls.	Sales		Average Price per bbl. (350 lb.)
					Barrels	Value	
			$			$	$
1913.....	13	1,382	955,729	450,213	3,802,321	4,105,455	1 08
1914.....	11	987	653,351	846,562	2,665,650	2,931,190	1 10
1915.....	7	692	425,170	755,799	2,302,242	2,534,537	1 10
1916.....	7	659	428,774	380,458	2,143,949	2,242,433	1 05
1917.....	6	589	538,355	567,261	2,063,231	2,934,271	1 42
1918.....	4	425	423,580	473,184	1,226,244	1,910,839	1 56
1919.....	5	647	722,029	278,188	2,022,575	3,659,720	1 81
1920.....	5	859	1,283,359	248,142	2,035,594	4,377,814	2 15
1921.....	5	883	1,228,460	174,686	2,723,072	6,425,266	2 37
1922.....	4	768	990,997	396,911	3,104,386	6,235,370	2 01
1923.....	4	852	1,084,711	452,378	3,296,428	5,855,590	1 77
1924.....	4	757	992,808	352,851	3,564,499	5,668,671	1 59
1925.....	4	700	921,643	339,541	3,462,358	5,253,911	1 52
1926.....	3	764	997,089	457,161	3,398,860	4,792,857	1 41
1927.....	4	931	1,129,546	264,241	3,751,786	5,144,326	1 37
1928.....	4	838	1,108,254	529,913	3,911,795	5,520,897	1 41

In the annual statement of the Canada Cement Company, Limited, for the fiscal year ending November 30, 1928, mention is made of the generally prosperous business conditions that prevailed throughout Canada during 1928 as responsible for a better demand for cement; also that concrete roads were steadily gaining in favour, offering an increased market for cement. Canada now has some 2,000 miles of concrete roads, while the United States has nearly 100,000 miles, or a ratio of 1 to 50 which is not commensurate with the population ratio of about 1 to 12.

In February, 1928, an official announcement was made concerning the purchase of the National Cement Company of Montreal for $2,435,000 by Alfred Rogers, President of the Elias Rogers Coal Company. This plant, which is now privately owned and will operate independently of any other company, is a factor in supplying the needs of Eastern Ontario.

Cement Products.—In recent years the industry of cement products manufacture in Ontario has assumed considerable importance. Since 1924 no data have been included in the tables of mineral production since the raw materials entering into the manufacture of these products have all been accounted for. But readers have pointed out that, being so closely allied to the building industry, statistics of cement products should be included so that complete information covering all structural materials might be available under one cover. The following table gives the record of materials used and products made by cement products manufacturers during the past 3 years in Ontario. Monolithic construction is not included. Statistics for the years 1924-5 appear in Volume XXXVII, Part 1.

PRODUCTION OF CEMENT PRODUCTS IN ONTARIO, 1926-1928*

	1926		1927		1928	
	Quantity	Cost at Works	Quantity	Cost at Works	Quantity	Cost at Works
MATERIALS USED		$		$		$
Portland cement.....bbls.	139,201	301,617	151,383	320,316	195,105	401,648
Quicklime.....bu.	655	307	143	76	641	305
Sand.....cu. yds.	48,581	94,503	39,193	64,214	42,499	66,176
Gravel..... "	83,307	121,050	65,525	112,584	66,572	110,545
Crushed stone..... "	6,752	14,570	5,888	10,691	20,693	65,243
Cinders.....tons	.....	.....	6,695	3,474	.....	22,818
Boxes, crates, lumber, etc.....	.....	7,562	.....	10,257	.....	18,806
Other materials.....	.....	28,158	.....	62,488	.....	51,100
Total.....	.....	567,767	.....	584,100	.....	736,641
PRODUCTS MADE						
Cement brick.....M.	1,678	53,112	226,588	79,863	2,597	39,947
Hollow building blocks, etc....	.....	826,938	.....	684,884	.....	779,462
Drain pipe.....	.....	134,722	.....	204,016	.....	124,088
Sewer and culvert pipe.....	.....	319,162	.....	340,215	.....	746,438
Artificial stone.....	.....	161,871	.....	153,562	.....	379,202
Cement posts, poles, etc.....	.....	26,341	.....	47,730	.....	9,319
Cinder blocks (cincrete)....M.	.....	.....	.....	69,145	950	190,158
Other products.....	.....	61,241	.....	105,635	.....	173,103
	.....	1,583,437	.....	1,685,050	.....	2,441,717

*Supplied by Dominion Bureau of Statistics, Ottawa.

The cement products industry is comprised of a number of small operations principally, although a few of them are fairly extensive and have substantial plants. Many of them, however, are organized for temporary operations to fill a local demand that may have arisen. As a result the number of plants fluctuates from year to year as may be seen in the accompanying table. On the other hand, wages paid and value of products made have steadily increased indicating that the well-organized establishments have a steady and expanding business.

PRINCIPAL STATISTICS OF CEMENT PRODUCTS INDUSTRY, 1924-1928*

	1924	1925	1926	1927	1928
Plants.....No.	92	148	133	109	105
Wage-earners (average).....No.	306	507	474	481	590
Wages paid.....$	268,385	411,836	439,487	468,371	617,503
Cost of fuel.....$	21,710	30,751	33,391	29,257	39,669
Capital invested.....$	1,348,246	2,068,497	2,168,758	1,888,102	2,501,018
Value products at works.....$	1,001,036	1,499,938	1,583,437	1,685,050	2,441,717

*Supplied by Dominion Bureau of Statistics, Ottawa.

Lime

Some 25 lime-kilns operated by 19 companies and individuals were in active operation in Ontario in 1928; the number has not varied greatly during the past ten years. The industry, while reduced in number of plants as compared with early years, has developed until annual production is 4½ times that of 1913. The production of hydrated lime has been developed in recent years, and a

number of plants are now equipped to manufacture this product which finds its market principally in the building trades. Quicklime is more widely used in the production of chemicals. Consumption percentages in the several industries in 1927 were as follows: Chemical works 64.4, building trades, 10.8, dealers 7.2, sugar refineries 3.5, pulp and paper 3.8, and the balance or 10.3 per cent. by glass works, tanneries, metallurgical operations and other consumers.

The lime-burning industry in Ontario gave steady employment during the year to 414 men who received $390,611 in wages. The largest item in manufacturing costs is that of fuel which includes coal, wood, natural gas, gasolene and kerosene. Statistics for the past five years follow:—

LIME STATISTICS, 1924-1928

Year	Lime Marketed or Used						Fuel Costs	Employees	Wages
	Hydrated			Quicklime					
		Value			Value				
	Tons	Total	Per Ton	Bush (70 lbs.)	Total	Per Bush.			
		$	$		$	c.	$		$
1924..	35,989	438,607	12 19	4,391,050	1,401,545	31.9	394,195	396	402,295
1925..	41,610	477,585	11 47	5,115,882	1,566,540	30.6	375,220	409	436,867
1926..	39,217	457,978	11 68	5,402,261	1,593,468	29.5	396,128	414	397,988
1927..	44,749	540,687	12 08	5,668,087	1,657,552	29.2	386,284	451	458,001
1928..	49,085	597,367	12 17	6,517,170	1,870,476	28.7	388,152	414	390,611

Below are given the names of producers and the location of plants operated in 1928:—

LIME PRODUCERS, 1928

Name of Owner or Company	Location of Kilns	Head Office Address
American Cyanamid Co.....(†)	Niagara Falls.....	Niagara Falls.
Beachville White Lime Co., Ltd.....	Beachville.....	Beachville.
Biederman, Albert G.....	Wilberforce tp.....	Golden Lake.
Brunner Mond Canada, Limited.....(†)	Anderdon tp., near Amherstburg.....	Toronto, Bank of Commerce Building.
Canada Gypsum and Alabastine, Ltd. (*)	Elora and Teeswater.....	Paris.
Canada Lime Co.....	Coboconk and Sand Point.	Toronto, 465 Bay St.
Cameron, W. M.....	Carleton Place.....	Carleton Place.
Chatham Lime Works.....	Owen Sound.....	Owen Sound.
Christie, Henderson & Co., Limited....	Hespeler (*), Puslinch, Kelso, Galt.....	Toronto, 201 Crown Office Building.
Dominion Sugar Company.....(†)	Chatham and Wallaceburg	Chatham.
Dominion Rock Products, Ltd.....	Eganville.....	Montreal, 1017 New Birks Bldg.
Gallagher Lime and Stone Co., Ltd.....	Barton tp.....	Hamilton.
Harvey E., Limited.....	Rockwood.....	Guelph.
Jamieson Lime Co.....	Renfrew.....	Renfrew.
Robertson & Co., Ltd., D.....	Nassagaweya tp.....	Toronto, 26 Queen St. E.
Shane Lime Co.....	Grattan tp.....	Eganville.
Standard White Lime Co., Limited.....	Beachville, Guelph (*), St. Marys and Rockwood.	Guelph, 15 Douglas St.
Toronto Brick Co., Ltd.....	Coboconk.....	Toronto, 897 Bay St.
Toronto Lime Co., Ltd.....	Dolly Varden.....	Toronto, 26 Queen St. E.
Weppler, Henry.....	Glenelg tp.....	Priceville, R.R. No. 2.

*Hydrated lime plants.
†Product from high calcium limestone is used in manufacture of chemicals and sugar.

Sand-Lime Brick

In 1928 the output of sand-lime brick was 61,506 M worth $745,719 as against 61,380 M valued at $721,485 in the previous year. These figures include the value of the lime consumed in manufacturing. The figure for value as shown in Tables I and II is the total selling value without any deduction, since the small duplication in value will in part compensate for sand produced by many part time operators from whom no reports are received.

The following table shows statistics for the past five years, also the comparative average values of common clay brick:—

SAND-LIME BRICK STATISTICS, 1924-1928

Year	No. of operating plants	No. of wage-earners	Wages	Sales				Average value per M. of common clay brick
				M.	Total selling value	Average value per M.	Value with lime cost deducted	
1924	10	186	195,116	54,410	$603,275	$11.09	$512,361	$16.94
1925	8	202	213,556	66,506	820,893	12.34	677,103	15.28
1926	8	178	171,747	46,869	555,847	11.86	461,376	15.18
1927	7	199	224,535	61,380	721,485	11.75	600,750	15.83
1928	7	183	205,497	61,506	745,719	12.12	624,228	15.83

All the active plants in 1928 were located in Toronto or vicinity. The lits follows:—

SAND-LIME BRICK PRODUCERS, 1928

Name of Company	Address	Location of Plant
Canada Sand-Lime Pressed Brick Co., Ltd.	28 Symes Rd., Toronto	Toronto.
Harbour Brick Co	Fleet St. at Bathurst, Toronto.	Toronto.
Hinde Bros	134 Northlands Ave., Toronto.	Toronto.
Leaside Brick and Sand Co., Ltd	York Bldg., Toronto	Toronto.
*Shepard, Jas. G., and Co., Ltd	Wellington, Ont	Wellington.
Toronto Brick Co., Ltd	897 Bay St., Toronto	Toronto.
Wilcox Lake Brick Co., Ltd	Richmond Hill, Ont	Wilcox Lake.
York Sandstone Brick Co., Ltd	447 Victoria Park Ave. Toronto	Toronto.

*Plant not operated in 1927 or 1928.

Sand and Gravel

Although figures for sand and gravel production as given in Table I cover the output of the more important operators, it should be pointed out that because of the seasonal nature of the operations and lack of information many small operators of isolated pits have of necessity been omitted. In addition to individuals and companies reporting pit operations, several operators were licensed to dredge some of the shoals and shore lines of the Great Lakes and Rivers.

In compilation of provincial statistics of sand and gravel the material consumed by the railway companies in the Province has never been included for the reason that it is produced by the railways from their own pits and used by them as ballast, no sales having taken place. In the reports of the Dominion Bureau of Statistics, this railway ballast is included as production, and this fact should be kept in mind in making any comparisons.

The output of sand and gravel during 1927 and 1928 was as follows:

Origin	1927		1928	
	Tons	Value	Tons	Value
Private pit operators	2,274,515	$966,178	2,193,250	$973,760
Dredged from Great Lakes and Rivers	1,488,271	799,825	1,566,540	580,201
Department of Northern Development	777,125	57,565	805,073	71,562
Department of Highways	640,000	200,000	740,961	164,655
Miscellaneous counties and townships	201,858	12,225	887,293	266,188
Total	5,381,769	$2,035,793	6,193,117	$2,056,366

The consumption of sand and gravel in 1927 and 1928 has been divided as follows:—

Consumption	1927		1928	
	Tons	Value	Tons	Value
Moulding Sand	131,161	$77,576	41,604	$44,306
Building Sand	967,995	416,036	1,121,570	417,847
Other Sands	5,218	6,833	12,496	12,718
*Railway Ballast	186,587	20,756	.....	.....
Concrete and Road Building	3,456,968	1,215,807	4,346,405	1,181,963
†Crushed and washed	633,840	298,785	671,042	399,532
Total	5,381,769	$2,035,793	6,193,117	$2,056,366

*Supplied to railways by sand and gravel producers. Sand and gravel produced for ballast by the railways from their own pits has not been included.

†This material is used principally in building and construction work.

Licensed Operations.—There were 29 boats operating in the Province during the season of 1928 engaged in removing sand and gravel under Ontario License. Of these, 19 operated in Crown waters exclusively and 10 operated in Crown waters and on privately owned properties. Each boat operating in Crown waters pays a license fee of $100.00 for each area. The fee to operate on private properties is $10.00. The rate of royalty ranges from 3 6/10 cents to 20 cents per cubic yard. This is based on the grade of material and the location of the deposits. The license fees amounted to $5,405.00, and total removals were 921,123.3 cubic yards upon which $125,966.13 royalty was collected.

No royalties were collected on 44,417 cubic yards delivered to 16 municipalities, and 239,281 cubic yards removed from privately owned properties. The various grades of material are used for concrete, stucco, plaster, road building and filling.

These operations were in St. Clair river, St. Lawrence river, Lake Ontario, Thames river, Lake Erie, Midland bay, Lake Huron, St. Marys river and Lake Superior.

A list of sand and gravel producers follows; only those having an output of 1,000 cubic yards or over in 1928 are listed:—

SAND AND GRAVEL OPERATORS, 1928

Name or Company	Material G=Gravel S=Sand	Location of Deposits	Address
Adair, Dolson	S. and G.	Caledon tp., lot 24, con. V	Caledon, R.R. 2.
Adelaide, Township of	S. and G.	Adelaide tp., lot 3, con. V	Arkona, R.R. 1.
Armstrong Supply Co., Ltd.	G.	York St., Hamilton	Hamilton.
Ashton, Thos	S.	Victoria Park Ave	Toronto, 1354 Queen St. East.
Austin, H. B	G.	Erin tp., lot 16, con. X	Erin, Box 48.
Barton, Township of	S. and G.	Barton tp	Clerk, Court House, Hamilton.
Bateman, Cecil	S. and G.	Grey tp	Ethel.
Bayham, Township of	S. and G.	Bayham tp	Road Supt., Straffordville
Beattie, A			Gadshill.
Bellyou, N. E	S. and G.	Murray tp., lot 6, con. 1	Trenton, R.R. 4.
Benson & Patterson	S. and G.	Stamford	Stamford.
Bentinck, Township of	S. and G.	Bentinck tp	Clerk, Hanover, R.R. 3.
Beverley, Township of	S. and G.	Beverley tp	Clerk, Rockton, Box 65.
Blizard, Mrs. R. E	S. and G.	London tp., lot 11, con. III	London, R.R. 6.
Boyd Bros	S. and G.	Osgoode tp., con. I	Osgoode.
Brantford, City	S. and G.	Webster St., Brantford	Brantford.
Breen, M	S. and G.		London, R.R. 6.
Breen, Thos	S. and G.	McGarry, tp	Cheminis.
Bruce, County of	S. and G.	Bruce county	Walkerton, Box 201.
Burrows, John	S. and G.	Widdifield tp	North Bay, 447 Klock Ave.
Campbellford, Town of	S. and G.	Within town limits	Campbellford.
C.N.R. Pit	S. and G.	Pickering tp	
Carroll Bros	S.	Humberstone tp., lots 1, 3, 4,5	490 Ellicott Sq., Buffalo, N.Y.
Cartwright, Township of	S. and G.	Cartwright tp	Supt., Burketon, R.R. 1.
Chambers, S. B	S. and G.	Adelaide tp., lot 1, Con. III	Watford, R.R. 5.
Collis, Edward	S. and G.		Henfryn.
Conlin, Herbert L	S. and G.	Scarborough tp	156 Front St. E., Toronto
Crosby, Wm	S. and G.	Blenheim tp., con. II	Princeton.
Cudmore, Mrs. Alice	S.	Usborne tp., lots 29, 30, con. IV	Hensall, R.R. 1.
Cudmore, Mrs. Bertha	S. and G.	Howard tp., lot 12	Thamesville, R.R. 6.
Cuthbert, C. E			Curries, Ont.
Dereham, Township of	S. and G.	Dereham, lot 22, con. VI	Mt. Elgin, R.R. 1.
Dibblee, W. H	S. and G.	E. Zorra tp., lot 17,con. XIII.	Woodstock, R.R. 7.
Dominion Concrete Co., Ltd.	S. and G.	Oxford tp., Seymour pit	Kemptville.
Donald, W. A	S. and G.	Dereham tp., lot 22, con. VII.	Ingersoll, R.R. 1.
Dorchester N., Township of.	S. and G	Dorchester N. tp	Dorchester Station.
Dowler Bros	S.		Billings Bridge.
Dumfries, Township of	S. and G.	Dumfries tp	Clerk and treasurer, New Dundee.
Durham Stone & Sand Co	S. and G.	Durham	Toronto, 402 Harbour Commission Bldg.
Eason, J	S. and G.		Georgetown.
Eix, Milton			Elmira, R.R. 1.
Empire Limestone Co	S.	Humberstone tp	Buffalo, N.Y., 19 Hudson St.
Enniskillen, Township of	S. and G.	Enniskillen tp	Road Supt., Petrolia, R.R. 1.
Essex, County of	S. and G.		Clerk, Sandwich.
Farr, Herbert	S. and G.		Woodbridge.
Ferguson, R. W	S.	Leeds tp	Brockville, 72 Pearl St.
File, Secord	S.	Brantford	Brantford, 43 Port St.
Flamboro W., Township of	S. and G.		Road Supt., Dundas R.R. 2.
Foster, R. R	S.	Nepean and Gloucester tps.	Ottawa, 278 Echo Drive.
Fraser, S. A	S. and G.	Arnprior, 1/3 mile E	Arnprior, R.R. 1.
Fraser Brace Engineering Co., Ltd	S. and G.	Dunlop tp., N. ½ lot 4, con. II	Montreal, P.Q.

SAND AND GRAVEL OPERATORS, 1928—*Continued*

Name or Company	Material G = Gravel S = Sand	Location of Deposits	Address
Fuller Gravel, Ltd	S. and G.	Fuller, Huntingdon tp	Toronto, 402 Harbour Commission Bldg.
Garafraxa E., Township of	S. and G.		Clerk, Orton.
Gear, H	G.		Erin.
Giffen, J	S. and G.	Erin tp	Georgetown.
Goodreau, Chas	S. and G.	Chatham tp., lot 24	Thamesville, R.R. 6.
Gosfield S., Township of	S. and G.		Road Supt., Ruthven, R.R. 2.
Gosfield N., Township of	S. and G.		Clerk, Cottam.
Gregory, Milton	S. and G.	Osborne tp., S.E.B. lot 6	Kirkton.
Halliburton, J., & Sons	S.	Guelph tp., lots 2 and 3, Div. C	Guelph, 101 Strange St.
Harbour Brick Co., Ltd	S.	Lake Ontario	Toronto, Fleet and Bathurst Sts.
Harwich, Township of	S. and G.	Harwich tp., various pits	Blenheim.
Higgs, Thos	S. and G.	London tp,, lot 21, con. I	London, R.R. 7.
Hill, John D	S. and G.	E. Zorra tp., lot 9, con. XII	Woodstock.
Hinde Bros	S. and G.		Toronto, 134 Northlands Ave.
Hoffman, J	S. and G.	Kitchener, Pine St	Kitchener, Pine St.
Hogg, Robt	S. and G.	Turnberry tp., lot 20, con. VII	Wingham, R.R. 1.
Hopkins, R. J	S. and G.	Westminster tp., Manor Park	London, 226 High St.
Horne, Geo	S. and G.	W. Wawanosh tp., lot 13, con. IV	Dungannon.
Huron, County of	S. and G.	Huron county, various pits	Goderich.
Hydro-Electric Power Commission of Ontario	S. and G.	Various pits	Toronto, 190 University Avenue.
Jacobs, John			Brodhagen.
Jugo Concrete Products Co.	S.	Toronto tp	Summerville.
Kent, County of	S. and G.	Raleigh, Oxford, Harwich, and Romney tps	Chatham.
Kettle, Robt	S. and G.		Petrolia.
Keyes, Sylvester W	S. and G.	East Oxford tp	Woodstock, R.R. 8.
Kilbourne & Son	S.	Westminster tp., Wharncliffe Rd.	London, 145½ Wharncliffe Rd.
Kingston Penitentiary	S. and G.	Portsmouth	Portsmouth.
Kingston Sand & Gravel Co.	S.	Kingston tp., lots 33-34, Con. V	Kingston, 183 William St
Kyle, Thos	S.	Hay tp., lot 15, con. VII	Hensall, R.R. 2.
Lambton, County of	S. and G.	Enniskillen tp., lots 7-9, con. XIII	Sarnia, 383 Christina St.
Lang, Ralph	S. and G.		Caledonia.
Le Viness, S	S	Stamford tp	Niagara Falls, R.R. 3.
Lovelace, Edwin J	S.	Pelham tp., lots 6,7, con. VIII., IX	St. Catharines, 1 York St.
Lowe, G. G	S.	Cumberland tp., lot 22, con. IV	Leonard, R.R. 1.
Maple Sand, Gravel & Brick Co., Ltd	S. and G.	Vaughan tp	Toronto, 454 King St. W.
McColl Bros	S.	Aldborough tp., lot 3, con VI.	Rodney, R.R. 1.
McQuillin, Wm	S. and G.	W. Wawanosh tp., lot 17, con. XIV	Lucknow.
Mersea, Township of	S. and G.		Road Supt., Blytheswood, R.R. 1.
Middlesex, County of	S. and G.	Various pits	London.
Middleton, Township of	S. and G.		Road Supt., Courtland, R.R. 4.
Monck, Township of	S. and G.		Clerk and treasurer, Beaumaris.
Moore, John	S. and G.	E. Williams tp., lot 8, Con. II.	Ailsa Craig, R.R. 1.
Nagle, Jos	S. and G.	Hibbert and McKillop tps	Dublin.
Newton, J	S. and G.		Limehouse.

SAND AND GRAVEL OPERATORS, 1928—*Continued*

Name or Company	Material G=Gravel S=Sand	Location of Deposits	Address
Northumberland and Durham, United counties of	S. and G.	Various pits	Cobourg.
Ollman Bros	S. and G.	Hamilton	Hamilton, 111 Macklin St.
Onondaga, Township of	S. and G.		Supt., Middlesport.
Ontario Sand Co	S. and G.	Vaughan tp	Maple.
Orford, Township of	S. and G.		Road Supt., Muirkirk.
Oxford, County of	S. and G.	Various pits	Woodstock, 510 King St.
Paris, Corp. of	S. and G.	Paris	Paris, Grand River St.
Park, Mrs. John S	S. and G.	Biddulph tp., lot 30, con. II.	Lucan.
Peel, Township of	S. and G.	Various pits	Alma, R.R. 2.
Pelham, Township of	S. and G.		Fenwick, R.R. 1.
Peterborough, City of	G.	Cor. Rogers and Wilson Sts., Peterborough.	Peterborough, 133 Simcoe St.
Ponsford Estate, A. E	S. and G.	Yarmouth tp., lot 1, con. VII.	St. Thomas, 605 Talbot St.
Quick, Chas. R	S. and G.	London, Manor Park	London, 101 Briscoe St.
Quigleys	S.	Saltfleet tp., Bartonville	Bartonville, R.R. 1.
Rae, Alexander	S. and G.		Listowel, R.R. 2.
Ratcliffe, Ltd., E. B	G.	Barton tp., lot 1, con. III.	Bartonville.
Rath, James	S. and G.	Middlesex, lot 4, con. A. & B.	Putnam, Box 33.
Regan & Blackburn	S.	Mount Dennis	Toronto, 1550 Dufferin St.
Sand & Supplies, Ltd	S.	N. Dumfries tp	Toronto, 54 University Ave.
Sanderson Bros	S.	Hullett tp., lot 18, con. XII.	Blyth.
Sandwich W., Township of	S. and G.		Clerk, Loiselleville.
Sargeant Co., Ltd	S. and G.	Barrie	Barrie, Box 88.
Sarnia, Township of	S. and G.		Sarnia, R.R. 3.
Saunders, Duncan	S. and G.	Elma tp	Atwood, R.R. 1.
Seine River Inspection Co.	S. and G.		Minneapolis, 1100 Builders' Ex. Bldg.
Seebach, Ed	S. and G.	Ellice tp., lot 8, con. IV	Sebringville, R.R. 1.
Sherman & Hubbell	S. and G.	Camden tp., lot 17, con. "B."	Thamesville, R.R. 5.
Smythe, Ltd., C.	S.	Etobicoke tp	Toronto, 11 King St. W.
Stevens, J. H	S.	Saltfleet tp	Stoney Creek, Box 211.
Stover, Elmer	S. and G.	Middleton tp., lot 16, con. III.	Tillsonburg, R.R. 4.
Sutherland, H. A	S. and G.	W. Zorra tp., lot 6, con. II.	Embro, R.R. 4.
Tack, Henry J	S.	London tp	London P.O., Sub. 1.
Toronto Gore, Township	S. and G.		Clerk, Malton, R.R. 1.
Urquhart, Alex		Fullarton tp	Fullarton.
Vanalstine, C	S. and G.		Trenton.
Wallace, Township of	S. and G.		Clerk, Gowanstown.
Walsh, Matthew	S. and G.	W. Nissouri tp., lot 31, con. III	Thorndale, R.R. 3.
Walsingham N., Twp. of	S. and G.		Clerk and treasurer, Langton.
Waterford Sand & Gravel Co., Ltd	S. and G.	Waterford	402 Harbour Bldg., Toronto.
Watson, Wm	S. and G.		Mitchell.
Wellington, County of	S. and G.		Guelph.
Wilcox, Harvey	S.	Stamford tp., lots 4, 17	Niagara Falls, 985 Bridge St.
Wilks, Geo	S.	Woodstock	Woodstock, 26 Railway St.
Windsor Sand & Gravel Co.	S. and G.	S. Gosfield tp., Essex County	Walkerville.
Winthrop, Robt	S. and G.	Nepean tp	Britannia Heights
Workman, J. J	S. and G.	Blenheim tp., con. VII	Drumbo, R.R. 1.
Wright & Co	S.	Deroche, Mile 5, A. C. Ry.	960 Green St., Sault Ste. Marie.
Yarmouth, Township of	S. and G.	Yarmouth tp., lot 3, con. IV.	St. Thomas.
York Sand and Brick Co.	S. and G.		East Toronto.
York Sand & Gravel Co., Ltd	S.	E. Toronto	Toronto, 1319 Bloor St. W.
Zavitz, Edgar M	S. and G.	Lobo tp., lot 6, con. VIII	Ilderton, R.R. 2.

Stone

The production of stone, limestone, sandstone, trap and granite during 1928 was 4,597,764 tons worth $4,024,989 as against 4,254,960 tons valued at $4,060,709 during the previous year. The number of employees was 1,304 during the period, while wages paid amounted to $1,112,035.

The following table shows the valuation of the several kinds of stone used or marketed during the past five years:—

VALUE OF STONE PRODUCTION, 1924-1928

Year	Limestone	Sandstone	Trap	Granite	Total
	$	$	$	$	$
1924	2,551,291	30,038	133,743	74,296	2,789,368
1925	2,530,623	44,562	154,107	88,043	2,817,335
1926	2,908,520	41,892	212,613	95,143	3,258,168
1927	3,716,419	50,192	205,480	88,618	4,060,709
1928	3,440,858	53,903	456,351	73,877	4,024,989

Separate statistics have been compiled covering special grades of stone, e.g., poultry grit, calcite and feldspar for stucco dash, and coloured stones to be used in the fine state for the surfacing of artificial stone products. During 1928 a total of 6,617 tons valued at $46,736 were produced as against 5,477 tons worth $42,845 in 1927. For compilation purposes this miscellaneous group is included with limestone.

A list of limestone operators follows:

LIMESTONE, 1928

Name of Company	Location of Quarry	Address
Barton, Municipality of	Barton tp	Hamilton, Court House.
Beachville White Lime Co., Ltd.	Beachville	Beachville.
Billy, Chas. V	Lombardy and Meath	Montreal, 510 Oxford Ave.
Bourgie, J. B	Russell tp	Embrun.
Brundige and Quinton	Kitley tp	Jasper.
Brulé & Sons, E. D	Hogsback, Gloucester tp.	Billings Bridge.
Brunner Mond, Canada, Ltd	Anderdon tp	Amherstburg.
Canada Cement Co., Ltd	Thurlow tp	Montreal, Station B, Box 290.
*Canada Crushed Stone Corp'n, Ltd	W. Flamboro tp	Hamilton, 72 Sun Life Bldg.
Carleton, County of	Gloucester tp	Ottawa, Court House.
Cartmell, John	Thorold	Thorold.
Cloutier & Grenon	Casselman	Casselman.
Cook, J. S	Amabel tp	Wiarton.
Dibblee Construction Co., Ltd	Various places	Montreal, 758 Victoria Sq.
Doan Contracting Co., Ltd	N. of Brechin	Toronto, 384 Sorauren Ave.
Dufferin Construction Co., Ltd	Various localities	Fleet St. at Bathurst, Toronto.
Dundas, Stormont and Glengarry, United Counties of	Finch	Cornwall.
Edgar Irvine Co., Ltd	Near Pembroke	Alexandria.
Foster, R. R	Merivale Rd	Ottawa, 278 Echo Dr.
Gordon Crushed Stone Co., Ltd	Haldimand co	Toronto, Confederation Life Bldg.
Grenville Crushed Rock Co., Ltd.	Oxford tp	Oxford Mills.
†Hagersville Quarries, Ltd	Walpole tp	St. Thomas, 4 Flora St.
Harvey, W. H. and Son		Deseronto.
Henniger, M. G	Goulbourn tp	Smiths Falls.
Highways Department, Ontario	Various townships	Toronto, Parliament Bldgs.
Humberstone, Tp. of	Humberstone tp	Humberstone, R.R. 1
Keeling, James	Owen Sound	Owen Sound, 16th St. E.
Kingdon Mining Smelting&Mfg.Co.	Galetta	Montreal, 314 Beaver Hall Hill.

*Canada Crushed Stone Co., Ltd., comprises in addition the following companies: Hagerville Contracting Co., Ltd., Queenston Quarries, Ltd., and Wentworth Quarries, Ltd.

†Owned by Dufferin Construction Co., Ltd.

LIMESTONE, 1928—*Continued*

Name of Company	Location of Quarry	Address
Kingston Penitentiary	Portsmouth	Portsmouth.
†Kirkfield Crushed Stone, Ltd	Kirkfield	Toronto, 136 Confederation Life Bldg.
Langton, Thos	Medonte tp	Coldwater.
Langton, Thos	Medonte tp., lots 19, 20, con. XIII	Coldwater.
Longford Crushed Stone Co		Longford Mills.
Law Construction Company, Ltd	Bertie tp	Toronto, 625 Confederation Life Bldg.
Lincoln, County of	Grimsby and Gainsborough tps	St. Catharines.
Longford Quarry Company, Ltd., The	Rama tp	Orillia, 6 Peter St.
‡McKay Co., Ltd., Alex	Owen Sound	Toronto, 2 Browns Ave.
McLean, H. C		Cornwall, 115 Adolphus St.
McGinnis & O'Connor		Kingston.
McQuigge, J.R	Ramsay tp., con. IX	
Middleton, J. N	Ancaster	Ancaster.
Milligan, F		Iroquois.
Oliver-Rogers Stone Company, Ltd.	Owen Sound	Owen Sound, 841 4th Ave. E.
Ontario Stone Corporation, Ltd	North Orillia tp	Toronto, 611 Excelsior Life Bldg.
Ontario Reformatory	Guelph	Guelph.
Ottawa and Gloucester Const. Co., Ltd		Ottawa.
Pembroke, Municipality of	Markus quarry	Pembroke.
Perkins, Geo. A	West Hill	Owen Sound.
Pirson, John	Grantham tp	Stevensville.
Queenston Quarries, Ltd	St. Davids	Hamilton, 72 Sun Life Bldg.
Ritchie Cut Stone Co., Ltd	Shelburne	Hamilton, 191 Grant Ave.
Robertson & Co., Ltd., D	Nassagaweya tp	Toronto, 26 Queen E.
Robillard & Son, H	Gloucester tp	Ottawa, 195 Nicholas St.
Roddy, J. M	Kingston	Kingston, 293 Division St.
Routly, H. T	Callander Rd., Georgetown, and Kincardine	Toronto, 9 Richmond St. E.
Standard White Lime Company, Ltd.	Beachville	Guelph, 15 Douglas St.
Walker Bros	Stamford tp	Thorold, Box 786.
Welland Ship Canal	Lincoln and Welland cos	St. Catharines.
Wentworth, County of	Barton and Binbrook tps	Hamilton, Court House.
Wilford & Co., Ltd., F. R	Matilda and Kitley tps	Lindsay.
Windmill Point Crushed Stone Co., Limited.	Bertie tp	Toronto, 625 Confederation Life Bldg.

†Owned by Dufferin Construction Co., Ltd.

‡Operated by M. C. Lapierre, 1994 Ninth St. E., Owen Sound.

The following operated quarries for sandstone, trap and granite in 1928:—

SANDSTONE

Name of Company	Location of Quarry	Address
Logan, Hugh	Esquesing tp	Glen Williams.
Robertson & Company, Ltd., D	Nassagaweya tp	Toronto, 26 Queen St. E.
Rogers & Hurst	Glen Williams	Toronto, 1189 Queen St. W.
Thompson, F	Esquesing tp	Terra Cotta.

TRAP

Dominion Trap Rock Co., Ltd	Bruce Mines	Montreal, 921 New Birks Bldg.
Fort William, City of	Rifle Range	Fort William.
Mond Nickel Company, Ltd	Coniston	Coniston.
Ontario Rock Company, Ltd	Belmont and Methuen tps.	Toronto, Crown Office Bldg.
Quinn Stone and Ore Co., Ltd	Mission Indian Reserve	Fort William.

GRANITE

Brown, R. & Son	Leeds tp	Ottawa, 376 Spark St.
Campbell and Gzowski		Toronto.
Farmer and Sons, Geo	Meath tp	Ottawa, 45 Bertrand St.
Gordon, D. J., Granite Co	Gananoque	Toronto, 239 Confederation Life Bldg.
Hydro-Electric Power Commission	Muskoka	Toronto, 190 University Ave.
Horne, Wm	Butler	Winnipeg, Man., Suite M., Ashford Blk.
McKee, James	Escott tp	Lansdowne, R.R. No. 3
Pembroke, Town of		Pembroke.
Peninsula Granite Quarries, Ltd	Peninsula	Peninsula.
Routly, H. T	Ferris tp	Toronto, 9 Richmond St. E.

MISCELLANEOUS

Bio-Mica Co., Ltd	Verona	Montreal, 324 Northcliffe Ave.
Bollender Bros	Haliburton	Haliburton.
Crystallite Stone Products	Hastings co	Hamilton.
Cooper, A	Neebing tp	Fort William.
Kingdon Mining, Smelting and Manufacturing Co., Ltd	Galetta	Montreal, 314 Beaver Hall Hill.
Winnipeg Roofing Co., Ltd	Silver Mountain	St. Boniface, Man., 264 Berry St.

Clay Products

The production of clay products of all classes, including sewer pipe, showed a gain of almost $325,000 in 1928. With the exception of the years 1922 and 1923 when prices were abnormal the production for 1928 was the greatest on record. The statistics for 1928 reflect the activity observed in building and construction throughout the Province in general (already mentioned in the introductory remarks under "Structural Materials and Clay Products"), and more particularly in the large cities where the building industry has consumed large quantities of brick.

The following table shows in detail the quantities and values of the several kinds of clay products made and sold in Ontario:—

CLAY PRODUCTS MARKETED, 1928

Kind	Number or Quantity	Value
Brick—Soft, mud process {Face	16,326,685	$317,800
Brick—Soft, mud process {Common	45,793,177	727,323
Stiff-mud (wire cut) process {Face	64,663,604	1,367,859
Stiff-mud (wire cut) process {Common	23,710,580	383,687
Dry-press {Face	29,181,983	581,609
Dry-press {Common	3,459,536	43,753
Fancy or ornamental brick (including special shapes, embossed and enamelled brick)	532,020	25,714
Sewer	2,621,072	49,547
Tile, structural: Hollow blocks (including fireproofing and load-bearing tile) tons	112,887	983,005
Roofing tile no.	72,930	6,435
Floor tile (quarries) sq. feet	171,020	45,679
Tile, drain no.	20,275,694	572,577
Sewer pipe (including copings, flue linings, etc.) tons	.....	974,157
Pottery from domestic clay no.	.....	*98,519
Total Value	.....	6,177,664

*Includes $400 worth of other products.

During the period a gain was again noted in the output of common brick. Pressed brick along with fancy and ornamental shapes, tile and so forth, showed a slight gain as compared with 1927. Pottery was up slightly in value and the same applies to sewer pipe.

The value of clay products marketed for the last pre-war year (1913) and for the past five years is given below:—

VALUE OF CLAY PRODUCTS SOLD OR USED, 1913 and 1924-28

Year	Brick		Pottery	Drain Tile	Sewer Pipe	Total
	Common	Pressed Fancy, Building Tile, etc.				
	$	$	$	$	$	$
1913	3,283,894	1,162,860	52,875	292,767	600,297	5,392,693
1924	944,892	2,883,566	84,100	373,980	851,327	5,137,865
1925	733,693	3,074,780	86,000	360,710	893,443	5,148,626
1926	768,734	3,324,526	87,600	340,403	835,206	5,356,469
1927	1,063,724	3,323,867	91,300	521,957	852,187	5,853,035
1928	1,154,763	3,377,648	*98,519	572,577	974,157	*6,177,664

*Includes $400 worth of other products.

Following is a list of 122 companies and individuals operating in 1928:—

BRICK AND TILE PLANTS, 1928

Name or Company	Address	Product
Alvinston Brick & Tile Co., Ltd	Alvinston, Box 26	Brick and tile.
Barnhardt, W. H	Stratford	Brick and tile.
Bartonville Pressed Brick Co., Ltd	Hamilton, 620 Lister Block	Brick.
Batchelor, Samuel	Proton Station	Brick and tile.
Booth Brick & Lumber Company	New Toronto	Brick.
Brampton Pressed Brick Co., Ltd	Brampton	Brick and tile.
Broadwell & Son, B	Kingsville, Box 137	Brick and tile.
Butwell, Richard	Toronto, 107 Lake Shore Rd., Humber Bay	Brick.
Caledon Shale Brick Co., Ltd	Toronto, 600 Bay St	Brick.
Campbell, Neil F	West Lorne, R.R. No. 1	Brick and tile.
Canadian Fireclay Products	Toronto, 60½ Adelaide St. East	Tile.
Canadian Pressed Brick Co., Ltd	Hamilton, 63 Ottawa St. S.	Brick.
*Chapman, John	Napanee, R.R. No. 3	Brick and tile.
Chapman Brick Co., Ltd	Toronto, 104½ Dawes Rd.	Brick.
Cooksville Company, Ltd	Toronto, 26 Queen St. E.	Brick and blocks.
Cooper, W. H	Hamilton, 312 Clyde Block	Brick.
Cornhill Sons, Ltd., James	Chatham, Grand Ave	Brick.
Curtin, Frank	Lindsay, R.R. No. 4	Brick.
Curtis Bros	Peterborough, Box 809	Brick and tile.
Dalton, M	Dresden	Tile.
DeLaplante & Co., J. E	Dawes Road, Coleman P.O.	Brick.
Deller & Son, Albert	Brownsville	Tile.
Deller Bros	Norwich, R.R. No. 2	Brick, blocks and tile.
Deller, Wm. H	Thorndale, R.R. No. 4	Tile.
Dochart Brick, Tile & Terra Cotta Works, The	Arnprior	Brick and tile.
Dolan, John	Watford, R.R. No. 2	Tile.
Dominion Sewer Pipe & Clay Products Industries, Ltd	Swansea, Toronto 3	Brick and tile.
Donaldson and Son, S. E	Harriston, R.R. No. 4	Tile.
†Donaldson, T. G	Greenock, R.R. No. 1	Brick and tile.†

*Same as Napanee Brick and Tile Works.
†Same as Moscow Brick and Tile Works.

BRICK AND TILE PLANTS, 1928—*Continued*

Name of Company	Address	Product
Don Valley Brick Works, Ltd., The	Toronto, 114 Federal Bldg.	Brick and blocks.
Douglas & Douglas	Wilkesport	Tile.
Dunn, David	New Liskeard	Brick.
Elliott, Chas	Bluevale	Brick and tile.
Elliott, Jas., Jr	Sault Ste. Marie	Brick.
Elliott, Wm	Glenannan	Brick and tile.
Frid Bros	Hamilton, Dundas Rd. and Macklin St	Brick.
Gammage, C. R.	Dresden	Tile.
Gardiner, Wm	Blenheim	Brick and tile.
Godfrey & Co., Thos	Carleton Place	Brick.
Grimsby Brick & Tile Co	Grimsby	Brick and tile.
Hallatt & Son, H	Comber	Brick and tile.
Hallatt Clay Products, Ltd	Chatham, 4 Richards Block	Tile.
Halton Brick Co., Ltd	Toronto, 28 Symes Rd	Brick.
Hamilton Pressed Brick Co., Ltd	Hamilton, Kensington Ave. South	Brick.
Hill, Aaron	Essex	Brick and tile.
Hill, A. W	Coatsworth, R.R. No. 1	Tile.
Hircock Bros	Bowmanville	Brick.
Hitch, D. A	Ridgetown, Box 236	Brick and tile.
Hitch, Thos	St. Thomas, Box 254	Brick, blocks and tile.
Hodder, Jos. H	Dutton	Tile.
Houston Co., Ltd., The	Tweed	Brick.
Howlett & Sons, Fred	Petrolia, Box 3	Brick, blocks and tile.
Huntsville Brick & Tile Works	Huntsville, Box 308	Brick and tile.
Interprovincial Brick Co., Ltd	Toronto, 30 Toronto St	Brick.
Jackson, W. B	Brantford, 290 Rawdon St.	Brick and tile.
Jamieson Lime Co	Renfrew	Brick and tile.
Janes, D. A	Mt. Brydges	Brick and tile.
Jasperson, B	Kingsville	Brick and tile.
Jervis, W. J	Dorchester, R.R. No. 3	Brick and tile.
*Johnson, James, Sr	Pembroke	Brick.
Koebel Bros	St. Clements, Box 54	Brick and tile.
Kruse Bros	Seaforth, R.R. No. 3	Tile.
Labey & Son, Geo. A	Foxboro	Tile.
Lindsay, Earl	Wallaceburg, R.R. No. 2	Tile.
Martin, Thos. E	Thamesville, R.R. No. 4	Tile.
McCoomb, Chester	Denfield, R.R. No. 2	Brick and tile.
McCormick Bros	Watford, R.R. No. 5	Tile.
McEachran, M., & Sons	Highgate	Brick and tile.
McIvor Bros	Cobourg, Box 636	Brick.
McMahon, Robert	Kerwood, R.R. No. 2	Tile.
Middleton, Chas	Wyoming	Tile.
Milton Pressed Brick, Ltd	Milton	Brick.
Miner, M. F	Kingsville	Brick and tile.
Morley-Walker Brick Co	Toronto, 114 Greenwood Ave	Brick.
Napanee Brick and Tile Works	*See* Chapman, John	
National Fire Proofing Co. of Canada, Ltd.	Toronto, 601 Dominion Bank Bldg	Blocks and tile.
Ollman Bros	Hamilton, 111 Macklin St.	Brick.
Ontario Denison Tile Co., Ltd	Windsor, 24 Wyandotte St.	Brick, blocks and tile.
Ontario Government (Department of Prov. Secretary)	Toronto (Mimico plant)	Brick, blocks and tile.
O'Reilly, T. E	Ottawa, 320 Bay St	Brick.
Ottawa Brick Mfg. Co., Ltd., The	Ottawa, 53 Queen St	Brick and tile.
Ott Brick & Tile Mfg. Co., The	Kitchener, 33 King St. E.	Brick and tile.
Owen Sound Brick Co., Ltd., The	Owen Sound	Brick.
Parks, H. W	Dresden, R.R. No. 2	Tile.
Paxton, Fred R	St. Catharines, 242 Queenston St	Brick.
Pembroke Brick Co., The	Pembroke	Brick.
Phillips & Son, Thos	Lucknow, R.R. No. 2	Brick and tile.
Phinn Bros	London, 238 Briscoe St	Brick, blocks and tile.

*Idle, 1928, sold from stock.

BRICK AND TILE PLANTS, 1928—*Continued*

Name or Company	Address	Product
Phippen & Field	Toronto, 150 Dawes Rd...	Brick.
Piggot & Co., Geo	Toronto, 72 Guestville Ave.	Brick.
**Piper, Murphy and Piper	Fort William, 509 Victoria Ave	Brick.
Port Rowan Brick & Tile Co	Port Rowan	Brick, blocks and tile.
Price & Cumming	Toronto, 58 Wellington St. East	Brick.
Price & Smith	Toronto, 458 Greenwood Ave	Brick.
Richardson & Son, J	Kerwood	Brick and tile.
Russell Brick Company	Toronto, 40 Blake St	Brick.
†Sadler, Frederick L	Dublin	Brick and tile.
Smith, Alex. & Son	Dutton, R.R. No. 2	Brick and tile.
Snelgrove, Andrew	Beaverton	Brick and tile.
Sproat, William M	Seaforth, R.R. No. 4	Tile.
Standard Brick Company, Ltd	Toronto, 500 Greenwood Ave	Brick.
Staples Brick and Tile Co	Staples	Tile.
Steele, Edwin	Vankleek Hill	Brick.
Streetsville Brick Co., Ltd., The	Toronto, 26 Queen St. E.	Brick.
Stroh, M. C	Conestogo	Brick and tile.
Sun Brick Co., Ltd	Toronto, 1104 Bay St	Tile and blocks.
Superior Brick & Tile Co., Ltd	Fort William	Brick and tile.
Sutherland, W. A	Parkhill, Box 293	Brick and tile.
Tope, Richard, Estate of	Hamilton, 171 Queen St. S.	Brick.
Toronto Brick Company, Ltd	Toronto, 60 Victoria St.	Brick.
Voakes & Son, D	Ruscombe, Box 20	Tile.
Wagstaff, Albert H	Toronto, 348 Greenwood Ave	Brick.
Wagstaff, Charles	Lindsay, R.R. No. 4	Brick and tile.
Waite, John E	Forester Falls	Tile.
Wallace & Son, R	North Bay, 66 First Ave.E.	Brick.
Wein, Aaron	Crediton	Brick and tile.
Winch, Stuart A	Paisley	Tile.
Windsor Brick & Tile Co	Windsor, Exchange Bldg.	Brick, blocks and tile.
Wright & Sons, Geo	Comber, Box 46	Tile.
Woodslee Brick & Tile Co	Woodslee	Brick and tile.

**Same as Fort William Brick Co.

†Same as Dublin Brick and Tile Works.

SEWER PIPE AND POTTERY WORKS, 1928

Name of Company	Location of Plant and P.O. Address of Manager, etc.
SEWER PIPE	
*Dominion Sewer Pipe and Clay Industries, Ltd	Swansea and Aldershot.
*Hamilton & Toronto Sewer Pipe Co., Ltd	Hamilton.
*Ontario Sewer Pipe & Clay Products, Ltd	Mimico.
POTTERY	
†Campbell Sons, R	Hamilton, Locke St.
Davis & Son, John	Toronto, 601 Merton St.
Foster Pottery Company	Hamilton, Main St. West.
†Smith Potteries, The	Oshawa, Box 111.

*These companies were absorbed early in 1929 by the National Sewer Pipe Company, Limited, with executive offices in the Metropolitan Building, Toronto.

†Imported clay used.

Mining Company Incorporations

A summary of mining companies incorporated and licensed in Ontario for the last pre-war year and subsequently is given hereunder:

ONTARIO MINING COMPANIES INCORPORATED AND LICENSED, 1913-1928

Year	Incorporated			Extra-Provincial Companies Licensed	
	No.	Nominal Capital	"No Par" Shares	No.	Capital for use in Ontario
		$			$
1913	119	78,000,000	.....	12	21,735,000
1914	80	39,030,000	.....	13	5,445,000
1915	59	42,005,000	.....	2	10,200,000
1916	83	109,079,500	.....	8	7,011,650
1917	100	117,183,000	.....	7	7,202,000
1918	59	49,800,000	.....	7	15,000,000
1919	149	223,600,000	.....	10	9,554,197
1920	119	146,094,000	.....	12	9,435,000
1921	67	105,715,000	.....	6	1,030,000
1922	91	181,040,000	.....	6	830,500
1923	88	179,295,500	.....	6	1,775,000
1924	85	156,485,000	.....	2	200,000
1925	70	107,400,000	9,010,000	3	162,510
1926	145	165,655,750	22,386,500	6	4,850,000
1927	199	344,145,000	40,034,000	10	3,260,000
1928	211	495,575,000	30,778,400	17	7,208,500

Of the 211 companies incorporated in 1928, 183 had specified capital and 33 were companies without nominal or par value, while 5 companies had shares of both kinds. The corresponding figures for 1927 were 199, 174, 30 and 5.

MINING COMPANIES WITH SPECIFIED CAPITAL INCORPORATED IN ONTARIO IN 1928

Name of Company	Head Office	Date of Incorporation	Capital $
Acme Kirkland Gold Mining Co., Ltd.	Toronto	May 3	1,000,000
Acme Securities, Ltd.	Toronto	Nov. 27	400,000
Alert Cobalt Mines, Ltd.	Haileybury	Mar. 12	1,500,000
Americanadian Mining and Exploration Co., Ltd.	Windsor	Apr. 10	2,000,000
Anglo-Sudbury Mines, Ltd.	Toronto	Feb. 13	600,000
Animikie Mines, Ltd.	Port Arthur	Apr. 2	2,000,000
Aurion Mining Corp., Ltd.	Toronto	Jan. 21	150,000
*Bancroft Mica Co., Ltd.	Bancroft	Mar. 31	50,000
Bellevue Silver Lead Mines, Ltd.	Toronto	Jan. 19	3,000,000
Bey Mines, Ltd., The	Toronto	Dec. 15	5,000,000
Bidarctic Hurricana Gold Mines, Ltd.	Cobalt	June 9	3,000,000
Bingham Mines, Ltd.	Toronto	Aug. 23	3,000,000
Bobjo Mines, Ltd.	Toronto	Sept. 26	5,000,000
Brent Red Lake Mining Co., Ltd.	Toronto	Feb. 8	40,000
Buffalo-Northern Mines, Ltd.	Bridgeburg	Mar. 30	1,000,000
Buffalo Red Lake Mines, Ltd.	Toronto	Feb. 4	4,000,000
Canadian Mining Associates, Ltd.	Hamilton	June 5	40,000
Canadian York & Lancaster Gold Mines, Limited.	Toronto	Feb. 10	3,000,000
Canoro Gold Copper Mines, Ltd.	Toronto	Nov. 29	5,000,000
Canusa Mining & Exploration Co., Ltd.	Toronto	Feb. 16	3,000,000
Carlson Gold Mining Syndicate, Ltd., The	Kapuskasing	June 11	50,000
Central Canada Mines, Ltd.	Fort William	Feb. 8	3,000,000
Centre Boischatel Copper Co., Ltd.	Toronto	July 20	3,000,000
Chelmsford Basin Mines, Ltd.	Toronto	Mar. 27	40,000
Cheltonia Kirkland Gold Mines, Ltd.	Toronto	Mar. 28	4,000,000

*No par shares issued in addition. See list of "No Par" Companies.

MINING COMPANIES WITH SPECIFIED CAPITAL INCORPORATED IN ONTARIO IN 1928—*Continued*

Name of Company	Head Office	Date of Incorporation	Capital $
Chippewa-Kirkland Mines, Ltd.	Toronto	Nov. 17	2,000,000
Clarence Gold Mines, Ltd.	Toronto	Jan. 16	2,000,000
Clearwater Lake Mining Co., Ltd.	Toronto	Jan. 19	50,000
Cleveland-Ontario Mines, Ltd.	Mine Centre	Oct. 16	50,000
Cobalt-Kittson Mines, Ltd., The	Latchford	Sept. 22	5,000,000
Clydach Gold Mines, Ltd.	St. Catharines	Mar. 19	3,000,000
*Coldwater Crushed Stone, Ltd.	Coldwater	Oct. 30	100,000
Conlac Mines, Ltd.	Toronto	Jan. 23	3,000,000
Copper Zinc Mines of Sudbury, Ltd.	Toronto	Mar. 21	3,500,000
Coulson Consolidated Gold Mines, Ltd.	Toronto	Mar. 27	3,000,000
Creighton-Fairbank Mines, Ltd.	Toronto	Mar. 1	5,000,000
Crystal-Kirkland Mines, Ltd.	Toronto	June 22	3,000,000
Darling-Kamiskotia Mines, Ltd.	Toronto	Jan. 21	3,500,000
Decewsville Crushed Stone Co., Ltd.	Hamilton	May 5	100,000
Denison Copper Mines, Ltd.	Toronto	June 14	4,000,000
De Santis Gold Mining Co., Ltd., The	Timmins	May 21	4,000,000
Devonian Oil and Minerals, Ltd.	Toronto	Apr. 19	1,000,000
Dominion Mining & Smelting Corp., Ltd.	Toronto	July 27	1,500,000
Doyle Mines, Ltd., The	Cornwall	Nov. 10	100,000
Duggan Rouyn Mines, Ltd.	Toronto	Dec. 18	5,000,000
Dyer-Mills Mining Co., Ltd.	Toronto	Nov. 22	3,000,000
Eagle Lake Soapstone Mines, Ltd.	Fort Erie	Nov. 16	500,000
East Bay Mines of Red Lake, Ltd.	Toronto	Feb. 22	3,000,000
East Main Gold Mines, Ltd.	Toronto	Oct. 26	4,000,000
East Sudbury Deep Mines, Ltd.	Toronto	Feb. 28	3,000,000
Eby-Kirkland Gold Mines, Ltd.	Niagara Falls	Mar. 20	2,000,000
Elstone Kirkland Mines, Ltd.	Toronto	Jan. 23	4,000,000
Enterprise Prospecting and Development Co., Ltd.	Kitchener	Jan. 14	500,000
Erving Mines, Ltd.	Windsor	Mar. 17	100,000
Fairbanks Lake Mining Co., Ltd.	Toronto	Nov. 6	300,000
Falconbridge Nickel Mines, Ltd.	Toronto	Aug. 28	5,000,000
Favourable Lake Mining and Exploration Company, Limited	Toronto	May 18	1,000,000
Favourable Patricia Exploration, Ltd.	Toronto	July 7	100,000
General Calcium Corp., Ltd.	Toronto	May 18	300,000
Gold Centre Porcupine Mines, Ltd.	Toronto	Mar. 8	3,000,000
Goldie Lake Mining and Development Company, Limited	Haileybury	Sept. 26	3,000,000
Great-Western Mining & Exploration Company, Limited	Toronto	May 1	5,000,000
Grenadier Gold Mines, Ltd.	Toronto	Nov. 13	4,000,000
Hamilton Porcupine Gold Mines, Ltd.	Hamilton	June 15	5,000,000
Henry Bros. Mines, Ltd.	St. Catharines	Feb. 7	5,000,000
Innerkip Quarries, Ltd.	Toronto	Sept. 28	500,000
Island Lake Gold Mines, Ltd., The	New Liskeard	Sept. 17	3,000,000
Johnston Brook Gold Mines, Ltd.	Toronto	Oct. 15	1,000,000
Kamiskotia Basin Mines, Ltd.	Timmins	Mar. 30	3,000,000
Kamiskotia Central Mines, Ltd.	Toronto	Jan. 26	3,000,000
Kenora Prospectors & Miners, Limited	Kenora	Feb. 14	40,000
Key Lake Mining Co., Ltd.	Rodney	Nov. 27	3,500,000
Kipper Tashota Gold Mining Co., Ltd.	Toronto	Aug. 1	3,000,000
Kirkland Cobalt Mines, Ltd.	Toronto	Jan. 12	3,000,000
Kirkland Consolidated Gold Mines, Ltd.	Toronto	May 29	7,000,000
Kirkland Hearst Mines, Ltd.	Toronto	Nov. 19	3,000,000
Kirkland Sullivan Gold Mines, Ltd.	Kirkland Lake	July 19	4,000,000
Kirkland Victoria Gold Mines, Ltd.	Toronto	May 5	4,000,000
Kitchener-Rouyn Mines, Ltd.	Kitchener	May 21	3,000,000
Kozak Mines, Ltd.	Toronto	Mar. 19	3,000,000
Labyrinth Lake Mining Co., Ltd.	Toronto	Feb. 15	500,000
Larado Gold Mines, Ltd.	Toronto	June 13	4,000,000
La Roche Mines, Ltd.	Toronto	Mar. 15	3,000,000
Lyndoch Mines, Ltd.	Toronto	Feb. 13	1,500,000

*No par shares issued in addition. See list of "No Par" companies.

MINING COMPANIES WITH SPECIFIED CAPITAL INCORPORATED IN ONTARIO IN 1928—*Continued*

Name of Company	Head Office	Date of Incorporation	Capital $
McKinley Mines Securities Co., Ltd	Cobalt	Feb. 3	1,000,000
McVittie-Graham Mines, Ltd	Sudbury	Jan. 27	5,500,000
Malrobic Mines, Ltd	Toronto	Apr. 24	3,000,000
Mammoth Metals, Ltd	Sault Ste. Marie	Mar. 3	5,000,000
Marbano Mines, Ltd	Cochrane	Apr. 11	4,000,000
Marion Sapawe Lake Gold Mines, Ltd	Toronto	June 6	3,000,000
Matabanick Kirkland Gold Mines, Ltd	North Bay	Sept. 5	3,000,000
Mayday Mines, Ltd	Toronto	June 5	3,000,000
Mayflower Gold Mines, Ltd	Fort William	May 15	3,500,000
Metalline Explorers, Ltd	Toronto	June 8	1,000,000
Midnorth Mines, Ltd	Toronto	Jan. 9	60,000
Miller Lake Mines, Ltd	Toronto	Jan. 23	1,000,000
Mindoka Mines, Ltd	Toronto	Oct. 6	3,000,000
Mining Prospects, Ltd	Toronto	Feb. 3	350,000
Mint-Gold Mines, Ltd	Toronto	Nov. 16	5,000,000
Mitchell Mines, Ltd	Toronto	April 4	100,000
Moffatt-Hall Mines, Ltd	Kirkland Lake	Aug. 27	5,000,000
Montbec Mines, Ltd	Toronto	Oct. 3	3,000,000
Nacada Gold Mining Co., Ltd	Haileybury	Feb. 14	2,500,000
Narlak Gold Mines, Ltd	Toronto	June 21	3,500,000
*National Sewer Pipe Co., Ltd	Aldershot	July 19	1,000,000
Newfoundland Lead Zinc Mines, Ltd	Toronto	Feb. 22	6,000,000
Newfoundland Millertown Mines, Ltd	Toronto	Feb. 24	5,000,000
Newfoundland Red Indian Lake Mines, Ltd	Toronto	Feb. 22	6,000,000
Niagara-Kirkland Gold Mines, Ltd	Niagara Falls	Dec. 12	3,000,000
North Hastings Mines, Ltd	Windsor	Feb. 11	25,000
Northern Copper Corporation, Ltd	Haileybury	Nov. 17	1,000,000
Northern Prospectors, Limited	New Liskeard	Sept. 1	150,000
Obaska Mines, Ltd	Toronto	Oct. 5	3,000,000
Pandora Gold, Limited	New Liskeard	Mar. 29	3,000,000
Patricia Dent Gold Mines, Ltd	Toronto	Nov. 1	5,000,000
Patterson La Salle Copper Mines, Ltd	Toronto	Apr. 28	2,000,000
Peninsula Granite Quarries, Ltd	Peninsula	July 14	40,000
Perry-Kirkland Mines, Ltd	Toronto	Apr. 13	3,000,000
Pioneer Prospectors Consolidated Mines, Limited	Toronto	Nov. 8	3,000,000
Pipestone Red Lake Gold Mines, Ltd	Toronto	Mar. 2	4,000,000
Polaris Gold Mines of Canada, Ltd	Toronto	Jan. 5	5,000,000
Pon-Dokis Mines, Ltd	Toronto	May 4	5,000,000
Porcupine Basin Mines, Ltd	Toronto	Mar. 20	300,000
Porcupine Holtyrex Mines, Ltd	Toronto	Feb. 11	5,000,000
Porcupine Paradise Gold Mining Co., Ltd	Toronto	Apr. 2	50,000
Porcupine United Gold Mines, Ltd	Toronto	Oct. 5	1,000,000
Premier Woman Lake Gold Mines, Ltd	Sarnia	May 17	3,000,000
Pritchard Kirkland Gold Mines, Ltd	Toronto	Jan. 14	3,000,000
Prospectors' Financing Co., Ltd	London	Mar. 17	500,000
Ramona Gold Mines, Ltd	Toronto	Sept. 4	3,500,000
Red Lake Bay Mines, Ltd	Toronto	Jan. 3	4,000,000
Ribago Sudbury Mines, Ltd	Haileybury	July 11	5,000,000
Rich Rock Gold Mines, Ltd	Toronto	May 30	4,000,000
Ridgeway Gold Mines, Ltd	Toronto	Oct. 5	3,000,000
Ridout-Cunningham Mines, Ltd	Chapleau	Sept. 18	5,000,000
*Ritchie Cut Stone Co., Ltd., The	Hamilton	Sept. 17	250,000
Roandale Mines, Ltd	Toronto	Mar. 10	1,000,000
Ronnoco Gold Mines, Ltd	Connaught	Feb. 24	3,000,000
Roydon Mining Corp., Ltd	Toronto	Jan. 18	6,000,000
Salmo Consolidated Mines, Ltd	Toronto	Mar. 30	3,000,000
Sandy Lake Mines, Ltd	Toronto	June 15	40,000
Scadding Mines, Ltd	Toronto	Sept. 25	2,000,000
Second Standard Royalties, Ltd	Toronto	Dec. 20	8,000,000
Seine River Mines, Ltd	Sarnia	Dec. 29	1,500,000
Serpent Basin Mines, Ltd	Toronto	Jan. 11	5,000,000
Severn Mines, Ltd	Toronto	May 23	3,000,000

*No par shares issued in addition. See list of "No Par" Companies.

MINING COMPANIES WITH SPECIFIED CAPITAL INCORPORATED IN ONTARIO IN 1928—*Continued*

Name of Company	Head Office	Date of Incorporation	Capital $
Shaft Island Gold Mines, Ltd.	Toronto	Mar. 19	3,000,000
Sherlett Lake Mining Co., Ltd.	Toronto	Feb. 16	2,000,000
Simpson Gold Mines, Ltd.	Toronto	May 22	3,000,000
Smith Cobalt Mines, Ltd.	Cobalt	Oct. 10	4,000,000
Stralak Mines, Ltd.	Toronto	Sept. 15	3,000,000
Sturgeon Lake Gold Mines, Ltd.	Toronto	July 12	5,000,000
Sudbury Blezard Mines, Ltd.	Hamilton	Feb. 8	5,000,000
Sudbury Central Mines, Ltd.	Toronto	Jan. 18	4,000,000
Sudbury Dowling Mines, Ltd.	Toronto	May 31	5,000,000
Sudbury Elbow Mines, Ltd.	Toronto	Apr. 13	2,500,000
Sudbury Fairbank Mines, Ltd.	Toronto	Jan. 21	3,000,000
Sudbury Lode Mines, Ltd.	Toronto	Mar. 24	5,000,000
Sudbury Nickel & Copper Co., Ltd.	Toronto	June 5	5,000,000
Sudbury Northern Mines, Ltd.	Toronto	Apr. 23	5,000,000
Sudbury Offsets, Ltd.	Toronto	July 6	5,000,000
Sudbury Ores, Ltd.	Sudbury	Feb. 11	1,000,000
Sudbury-Stralak Mines, Ltd.	Toronto	Oct. 25	3,000,000
Sudbury Treasure Trove Mines, Ltd.	Toronto	Mar. 19	3,000,000
Sudbury Vermillion Mines, Ltd.	Sudbury	Jan. 21	100,000
Sudbury-Walker Mines, Ltd.	Hamilton	Feb. 25	600,000
Sunrise Gold Mines, Ltd.	Toronto	Mar. 23	3,500,000
Swastika Kirkland Mines, Ltd.	Toronto	Aug. 16	2,500,000
Thompson Malartic Mines, Ltd.	Toronto	Mar. 6	3,000,000
Thunder Bay Silver Mines, Ltd.	Fort William	May 21	250,000
Tor-Branto Exploration, Ltd.	Toronto	Nov. 16	100,000
Toronto Kirkland Mines, Ltd.	Toronto	Feb. 14	4,000,000
Toronto Red Lake Mines, Ltd.	Toronto	Jan. 26	3,000,000
*Trail Oil Service, Ltd.	Islington	Jan. 21	500,000
Tremont Mines, Ltd.	Toronto	Mar. 31	3,000,000
Trinity Copper Mines, Ltd.	Toronto	Oct. 15	2,000,000
Ventura-Kirkland Mines, Ltd.	Toronto	Sept. 25	3,000,000
Wendigo Mines, Ltd.	Toronto	Mar. 31	3,000,000
Wessell-Kirkland Gold Mines, Ltd.	Toronto	Jan. 25	3,000,000
White Lake Mines, Ltd.	Toronto	Feb. 10	2,000,000
Whitrich Exploration & Development Co., Limited.	Toronto	Mar. 7	50,000
Winnie Lake Mining Co., Ltd.	Kirkland Lake	Sept. 6	3,000,000
Wright-Carroll Gold Mines, Ltd.	Toronto	Jan. 13	5,000,000
Total (183 companies)			$495,575,000

*No par shares issued in addition. See list of "No Par" companies.

MINING COMPANIES INCORPORATED IN ONTARIO IN 1928 HAVING SHARES WITHOUT NOMINAL OR PAR VALUE

Name of Company	Head Office	Date of Incorporation	No. of Shares
Armour Kirkland Mining Co., Ltd.	Ottawa	May 11	4,000
*Bancroft Mica Co., Ltd.	Bancroft	Mar. 31	200,000
Billieboy Gold Syndicate, Ltd.	Toronto	Nov. 20	40,000
Canada Potteries, Ltd.	Hamilton	May 19	10,000
Confederation Mining Co.	Toronto	Jan. 6	40,000
*Coldwater Crushed Stone, Ltd.	Coldwater	Oct. 30	12,000
Decca Chemical Mining Syndicate, Ltd.	Ottawa	Sept. 5	400
Drummond Woman Lake Mines, Ltd.	Toronto	Aug. 15	4,000,000
Gold Rock Mining Syndicate, Ltd.	Ottawa	June 7	4,000
Little Current Oil Co., Ltd.	Toronto	July 26	100,000
M. & M. Exploration, Ltd.	Kirkland Lake	July 7	12,000
Manitowaning Oil Co., Ltd.	Toronto	May 15	500,000
McVittie Investments, Ltd.	Toronto	Dec. 3	140,000

*Also see list with specified capital. Five companies having both capital and "No Par" shares are included in both lists.

MINING COMPANIES INCORPORATED IN ONTARIO IN 1928 HAVING SHARES WITHOUT NOMINAL OR PAR VALUE—*Continued*

Name of Company	Head Office	Date of Incorporation	No. of Shares
McVittie-Kirkland Mines, Ltd.	Toronto	Nov. 21	5,000,000
Milbar Mining Co., Ltd.	Ottawa	July 19	2,000
Montoro Mines, Ltd.	Toronto	Sept. 28	4,000,000
*National Sewer Pipe Co., Ltd.	Aldershot	July 19	100,000
New Goudreau Gold Mines, Ltd.	Toronto	Aug. 3	1,000,000
Ottawa Kamiskotia Mining Co., Ltd., The	Ottawa	April 16	5,000,000
Pennzoil Co., Ltd., The	Toronto	Dec. 21	10,000
Red Mammoth Gold, Ltd.	Toronto	Mar. 17	150
*Ritchie Cut Stone Co., Ltd., The	Hamilton	Sept./17	12,000
Ross Lake Gold Mines, Ltd.	Toronto	June 7	100,000
Ryan-Kirkland Gold Mines, Ltd.	Toronto	June 11	40 000
Scott-Kirkland Gold Mines, Ltd.	Arnprior	April 28	5,000,000
Shawinigan Exploration & Finance, Ltd.	Montreal	April 4	1,000
Smith Explorations, Ltd.	Sudbury	Feb. 8	1,000
Speculators Mining & Development Co., Limited	Toronto	June 8	300,000
Sudbury Basin Mines, Ltd.	Toronto	Jan. 19	2,000,000
Sudbury Shedden Mines, Ltd.	Sudbury	Sept. 20	50,000
Timmins Red Lake Mines, Ltd.	Timmins	July 3	3,000,000
*Trail Oil Service, Ltd.	Islington	Jan. 21	100,000
Windsor-Kamiskotia Mining and Development Syndicate, Limited	Windsor	Nov. 21	100,000
Total (33 companies)			30,778,400

*Also see list with specified capital. Five companies having both capital and "No Par" shares are included in both lists.

Under the provisions of the Ontario Companies Act, companies of extra-provincial incorporation are required to take out a license in Ontario and stipulate the amount of capital used in connection with mining enterprises where the land is situate within the Province.

EXTRA-PROVINCIAL AND MORTMAIN MINING COMPANIES LICENSED IN 1928 BY ORDER-IN-COUNCIL

Name of Company	Place of Incorporation	Date of License (O.C.)	Capital for use in Ontario
Acheson Graphite Corporation	New York State	Oct. 30	$100,000
Aerocrete Montreal, Ltd.	Quebec	Mar. 19	40,000
Alladin Mining Co., Ltd.	**	July 10	50,000
Capital Rouyn Gold Mines	**	Oct. 30	50,000
Denison Tile Co., Ltd.	**	Sept. 24	100,000
Dumont Mines, Ltd.	Canada*	Sept. 14	5,000,000
Gem Lake Mines, Ltd.	**	Mar. 7	50,000
Lake Duprat Mines, Ltd.	Canada*	Feb. 16	40,000
Lake Geneva Mining Co., Ltd.	Quebec	Aug. 31	500,000
E. J. Longyear Development Co., Inc.	Alabama	Jan. 11	1,500
Longyear Process, Inc.	Delaware	May 23	40,000
Mines of Canada, Limited	**	Sept. 24	50,000
Porcupine Deloro Mines, Ltd.	Quebec	Jan. 24	100,000
Precious Metals Corporation, Ltd.	Canada*	Apr. 12	40,000
Stillwell Mathe Mines, Ltd.	**	Jan. 26	7,000
Sudbury Rand Mines, Ltd.	**	July 10	1,000,000
Sullivan Rouyn Copper Syndicate, Ltd.	Quebec	May 23	40,000
Total (17 companies)			$7,208,500

*Incorporations under *The Companies Act*, Revised Statutes of Canada, 1906, Part I of Chapter 79. Where incorporation is outside of Ontario the State or Province is noted.

**License issued pursuant to the provisions of the Mortmain and Charitable Uses Act, Province of Ontario.

Mining Revenue and Expenditures

The revenue of the Department of Mines for the fiscal year ending October 31, 1928, is given in detail hereunder:—

ORDINARY:			
MAIN OFFICE			
Sand and Gravel—			
Royalties	$127,416.72		
Licenses	5,305.00		
		$132,721.72	
Casual Fees		833.50	
Sale of Record Books—Unwrought Metal Sales Act		23.00	
Boring Permits		500.00	
Gas Leases		3,750.00	
Refunds		110.65	
			$137,938.87
BRANCHES			
Inspection—Cable Testing Fees		$1,642.00	
Assessment—Taxes			
Acreage	$81,451.99		
Profit	356,033.83		
Gas	12,704.26		
		$450,190.08	
Chemical and Assay—Fees		3,991.31	
Mine Rentals—			
Mining Leases	$7,450.04		
Licenses of Occupation	2,692.30		
Miners—			
Licenses	$107,303.48		
Permits	2,280.00		
Fees—Recording	147,359.97		
Miscellaneous	7,424.26		
Maps—Sales	1,898.00		
		$276,408.05	
Draughtsman, North Bay—Fees		1,658.74	
Natural Gas Commissioner—Permits		833.84	
Temiskaming Testing Laboratories—Fees		17,145.66	
Sulphur Fumes Arbitrator—Damages collected		4,498.49	
			$756,368.17
			$894,307.04
CAPITAL:			
Mining Recorders—Mining Land Sales			73,936.80
Total Revenue			$968,243.84

Expenditures of the Department were $331,975.45 ordinary and $1,071.59 capital or a total of $333,047.04.

MINING LANDS SOLD AND LEASED IN YEAR ENDING OCTOBER 31, 1928*

District	Sales			Leases			Total		
	No.	Acres	Amount	No.	Acres	Amount	No.	Acres	Amount
			$ c.			$ c.			$ c.
Timiskaming	349	13,697.31	35,207.34	75	2,761.73	1,299.93	424	16,459.04	36,507.27
Cochrane	166	6,835.91	17,445.64	....	.....	.....	166	6,835.91	17,445.64
ThunderBay	20	704.50	1,761.25	2	59.00	59.00	22	763.50	1,820.25
Sudbury	36	1,399.31	4,123.51	22	819.05	117.03	58	2,218.36	4,240.54
Algoma	34	1,325.03	3,348.23	....	.....	.....	34	1,325.03	3,348.23
Kenora	37	1,483.65	3,983.17	....	.....	.....	37	1,483.65	3,983.17
Rainy River	10	392.85	1,054.51	....	.....	.....	10	392.85	1,054.51
Nipissing	....	.....	.....	1	20.43	2.04	1	20.43	2.04
Elsewhere	38	2,350.00	756.25	....	.....	.....	38	2,350.00	756.25
Total	690	28,188.56	67,679.90	100	3,660.21	1,478.00	790	31,848.77	69,157.90

*These figures do not agree with corresponding items of the revenue statement preceding which records collections of moneys actually received during the fiscal year.

SUMMARY OF BUSINESS TRANSACTED IN THE SEVERAL MINING DIVISIONS DURING THE CALENDAR YEAR, 1928

Schedule	Sudbury	Porcupine	Larder Lake	Sault Ste. Marie	Port Arthur	Kowkash	Timiskaming and Coleman	Gowganda	Montreal River	Kenora	Red Lake	Total
1. Letters received	7,215	3,478	7,307	1,592	3,568	694	2,104	435	666	1,238	2,712	31,009
2. Letters written	6,675	3,584	7,157	687	2,910	737	1,861	483	657	1,221	2,273	28,245
3. Miners' Licenses issued	2,156	333	503	335	596	120	466	.....	44	311	395	5,259
4. Miners' Licenses renew'd	1,742	1,140	1,263	431	710	183	1,099	92	130	195	474	7,459
5. Mining Applications recorded*	6,424	611	1,781	702	1,269	368	499	40	156	520	1,100	13,470
6. Mining Applications cancelled	540	153	907	420	101	64	272	186	237	91	691	3,662
7. Agreements, Transfers, etc., recorded	4,184	1,106	1,742	352	887	265	186	29	89	146	875	9,861
8. Receipts for Miners' Licenses, Permits, Recording Fees, etc. $	79,248 00	16,196 50	27,047 74	10,467 75	19,584 10	5,064 75	12,208 75	1,261 50	2,535 00	6,578 70	18,287 10	198,479 89
9. Receipts as Purchase Money or Rental $	14,124 82	9,322 62	40,355 75	5,336 68	2,236 00	110 00	6,511 54	531 62	1,777 37	317 50	1,029 12	81,653 02
10. Claims of which surveyors' plans were filed	87	112	228	116	36	3	28	15	8	18	407	1,058
11. Disputes entered	46	.....	6	3	6	.....	.....	.....	.....	.....	11	72
12. Disputed cases decided by Recorders	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1
13. Appeals to Mining Court	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
14. Extensions of time granted	1,586	406	1,017	199	435	7	70	48	196	112	1,476	5,552
15. Certificates of Record granted	880	78	349	51	39	3	67	14	17	9	10	1,517
16. Certificates of Performance of Work granted	531	82	374	59	24	3	72	14	30	11	12	1,212
17. Claims for which papers were forwarded to the Department for issue of title	175	85	338	52	26	3	79	14	19	2	12	805
18. Forest Reserve Permits issued	66	36	2	32	6	16	22	29	.....	.....	.....	209
19. Substitute Miners' Licenses issued	44	13	28	3	9	5	24	1	4	8	17	156
20. Abstracts issued	6,397	2,103	1,202	314	1,081	344	222	77	309	256	3,321	15,628

*There were 1,576 claims recorded at Toronto, making a total of 15,046 for the entire province as compared with 15,554 in 1927.

MINING CLAIMS RECORDED IN THE SEVERAL MINING DIVISIONS, 1907-1928

Mining Division	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Timiskaming	7,860	1,650	1,343	1,021	922	516	1,326	215	222	156	269	184	244	329	159	328	971	735	634	438	875	499
Coleman*	291	270	150	40	*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sudbury	456	254	1,859	1,131	2,309	776	483	237	233	464	262	168	673	267	319	701	436	559	546	1,367	3,351	6,424
S.S. Marie	291	100	.....	818	119	137	127	23	92	44	135	199	90	90	216	541	498	284	451	395	735	702
Port Arthur	317	370	475	207	183	180	182	353	641	172	180	66	171	108	120	296	222	300	494	1,278	982	1,269
Kenora	.....	73	102	95	89	91	.....	25	23	45	32	48	31	25	53	168	150	77	229	935	140	520
Parry Sound	102	56	.....	26	15	5	.....	2	.....	10	25	12	39	33	†	.....	.....	.....	.....	.....	.....	.....
Larder Lake	3,813	540	180	84	1,252	541	1,575	718	915	783	160	423	1,015	712	918	2,344	1,736	1,219	890	1,532	3,141	1,781
Montreal R.	866	1,321	2,573	344	98	126	63	28	2	56	294	293	134	81	143	174	400	471	471	290	126	156
Gowganda	.....	.....	3,064	513	258	194	68	23	14	51	113	52	145	215	101	55	33	444	220	96	24	40
Porcupine	.....	.....	.....	2,150	3,756	538	496	240	262	401	236	48	136	192	273	760	1,424	556	620	1,297	3,127	611
Kowkash	.....	.....	.....	.....	.....	.....	.....	.....	.....	160	135	2	9	21	3	148	206	438	150	28	250	368
Red Lake	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,827	2,018	1,100
At Toronto	.....	.....	.....	.....	.....	.....	.....	49	92	128	95	39	231	87	145	171	116	139	226	203	795	1,576
Total	13,996	4,634	9,746	5,792	9,001	3,104	4,320	1,913	2,519	2,470	1,936	1,534	2,918	2,160	2,459	5,686	6,092	5,222	4,751	13,496	15,564	15,046

*Joined with Timiskaming since 1911. †Office at Parry Sound closed in 1921. Records are now kept at the Department of Mines, Toronto.

STATEMENT OF MONEYS REMITTED BY MINING RECORDERS FOR THE FISCAL YEAR ENDING OCTOBER 31, 1928

Mining Division	Name of Recorder	Address	Purchase Price	Forest Reserve Permits	Miners' Licenses	Recording Fees	Maps	Miscellaneous Fees	Total
			$	$	$	$	$	$	$
Sudbury	Campbell, C. A	Sudbury	7,855 98	590 00	17,683 00	60,630 50	304 25	2,781 63	89,845.36
Porcupine	Donaghue, W. A	S. Porcupine	9,147 77	530 00	8,167 00	11,118 00	314 00	1,220 25	30,497.02
Larder Lake	Ginn, H. G	Swastika	37,854 86	20 00	7,832 00	20,215 00	688 00	1,045 00	67,654.86
Red Lake	Holland, H. E	Goldpines	2,522 12	.....	4,167 00	12,474 17	161 50	1,003 68	20,328.47
Kenora	Smith, J. D. C	Kenora	5,545.00	.....	2,445.00	3,735.00	37.00	115.65	6,877.65
Timiskaming	McAulay, N. J	Haileybury	5,844.19	190.00	7,651.00	5,207.25	78.50	196.75	19,167.69
Port Arthur	McGregor, C. F	Port Arthur	2,397.50	90.00	6,635.00	12,155.25	91.25	356.85	21,725.85
Gowganda	Coghill, J. M	Elk Lake	1,567.42	290.00	476.00	391.00	66.75	62.50	1,853.67
Montreal River	Coghill, J. M	Elk Lake	1,915.60	.....	889.00	1,608.00	12.75	392.00	4,817.35
Kowkash	O'Rourke, M. F	Tashota	59.00	180.00	1,455.00	3,049.00	38.50	43.95	4,825.45
Sault Ste. Marie	Miller, W. N	Sault Ste. Marie	3,557.73	350.00	3,815.00	6,883.00	105.50	206.00	14,917.23
		Total	72,267.17	2,240.00	61,215.00	137,466.17	1,898.00	7,424.26	282,510.60

Under the Mining Tax Act, a graduated tax is levied on the net profits of mining companies in excess of $10,000 per annum. The basic rate is 3 per cent.

The following statement, prepared by the Accounts Branch of the Department, gives details of the Profit Tax, collected under the supervision of G. R. Mickle, Mine Assessor, for the fiscal year ending October 31, 1928:—

DETAILS OF PROFIT TAX

GOLD:—		
Dome Mines, Ltd	$19,187.56	
Hollinger Consolidated Gold Mines, Ltd	142,578.34	
Lake Shore Mines, Ltd	39,693.26	
McIntyre Porcupine Mines, Ltd	8,337.75	
Sylvanite Gold Mines, Ltd	1,034.93	
Teck-Hughes Gold Mines, Ltd	22,186.73	
Wright-Hargreaves Mines, Ltd	12,533.01	
		$245,551.58
SILVER:—		
Castle-Trethewey Mines, Ltd	$338.85	
Frontier-Lorrain Mines, Ltd	5,213.08	
Mining Corporation of Canada, Ltd	631.53	
Nipissing Mining Co., Ltd	2,189.53	
		8,372.99
NICKEL-COPPER:—		
International Nickel Co. of Canada, Ltd	$ 82,971.13	
Mond Nickel Co., Ltd	19,138.13	
		102,109.26
Total		$356,033.83

Temiskaming Testing Laboratories

This plant, which is located at Cobalt and is equipped for sampling and assaying, has been operated by the Ontario Department of Mines since July, 1921, under the management of A. A. Cole, Mining Engineer of the T. & N. O. Railway Commission, and George Dickson, Superintendent.

The following is a comparative financial report for the years 1922 to 1928 inclusive:—

COMPARATIVE FINANCIAL STATEMENT OF THE TEMISKAMING TESTING LABORATORIES, 1922-1928

Year	Cash receipts	Earnings	Expenditures	Operating Profit	Operating Loss
1922	$18,096.19	$17,749.51	$19,173.19	.....	$1,424.68
1923	18,699.22	20,117.81	19,781.25	$336.56	.....
1924	26,032.20	25,417.61	23,206.66	2,200.95	.....
1925	19,922.37	20,041.08	20,043.31	.....	2.23
1926	20,302.51	21,119.98	20,658.19	461.79	.....
1927	19,387.66	19,400.55	20,012.09	.....	611.54
1928	14,875.58	14,369.66	18,181.68	.....	3,812.02

Following is a brief statement of the work of the year 1928:—

Assaying.—Gold, 4,379 samples; silver, 1,564; copper, 609; silver bullion, 49; cobalt, 96; nickel, 53; zinc, 324, lead, 142; silica, 88; tin, 18; iron, 13; miscellaneous, 26.

Ore Testing.—Four cyanide, two amalgamation, two concentration tests.

Silver Ore Milled and Sampled.—Consignments from 9 companies; weight, 1,042.24 tons; silver content, 1,210,723 ounces.

Base Bullion Melted.—59 bars cotaining 56,164.3 gross ounces of silver.

Gold Ore Purchased.—One lot or 860 pounds, for which $104.52 was paid.

Draughting Office, North Bay

In order to cope with the demand from prospectors and others for blue prints showing mining claims in good standing in the several Mining Divisions of the Province, apart from the Divisions served direct from Toronto, the Department of Mines established a Draughting Office at North Bay in February, 1920, with C. G. Watson in charge. As mining claims are recorded in each mining division, sketches and recording notices are forwarded by the Recorders to the Draughting Office, and the same practice applies when surveys are filed. Tracings are prepared from the data furnished and blue prints supplied to the Recorders and to the general public at a nominal charge. North Bay is a convenient centre and considerable time is saved through the mails compared with former practice when blue prints were prepared at Toronto. The office is equipped with an electric blueprinting machine.

During the fiscal year ending Oct. 31, 1928, there were 12,899 blue prints distributed from the North Bay office, and total receipts from this source were $3,385.74.

Provincial Assay Office

As an aid in the development of the mineral resources of Ontario an Assay Office was established at Belleville in July, 1898, by the Bureau (now Department) of Mines. For convenience the office was moved to 5 Queen's Park, Toronto, in November, 1911, and again in the spring of 1927 to the new East Block of the Parliament Buildings.

The Provincial Assayer, W. K. McNeill, reports as follows for 1928:—

FREE ASSAYS UNDER THE PROVISIONS OF THE MINING ACT OF ONTARIO

Mining Division	Number of Samples received for Free Assays during 1928										
	Gold	Silver	Copper	Lead	Zinc	Tin	Iron	Nickel	Tungsten	Cobalt	Total
Eastern Ontario*	13	7	..	1	..	2	1	1	..	..	25
Fort Frances*	69	13	9	4	4	..	..	1	..	..	100
Kenora	22	5	3	1	1	..	..	1	..	..	33
Kowkash	9	2	3	1	..	..	..	..	..	..	15
Larder Lake	60	22	13	4	6	1	1	..	..	1	108
Mississagi Reserve*	7	2	9	..	..	..	..	..	..	..	18
Montreal River	6	1	1	..	..	1	..	1	..	..	10
Parry Sound*	6	..	8	2	8	..	..	..	..	..	24
Porcupine	53	15	23	3	..	..	..	..	2	..	96
Gowganda	13	6	7	1	1	..	..	..	..	..	28
Port Arthur	20	6	5	1	4	1	..	3	..	..	40
Red Lake	80	7	..	1	..	1	..	..	1	..	90
Sault Ste. Marie†	23	17	11	4	3	..	..	..	..	..	59
Sudbury‡	187	62	88	32	33	2	3	20	1	2	433
Timagami Reserve*	13	6	2	..	..	..	..	..	..	..	21
Timiskaming	81	13	19	2	4	2	..	2	..	..	123
Patricia District	73	4	12	1	1	1	..	1	..	..	93
Total	735	188	213	58	65	11	5	30	4	3	1,316

*All mining claim records for these Divisions are kept at the office of the Deputy Minister of Mines, Toronto.

†Assays also included one for molybdenum.

‡Assays also included three for platinum.

The Assay Office has been in operation without interruption during the entire year and the usual variety of work has been done with the assistance of T. E. Rothwell and W. F. Green, Chemists and Assayers, also Robert Stewart and Reginald Eyre, Laboratory Assistants.

The following is a statement of the samples submitted by the general public for which the regulation fee was charged, and also those submitted by geologists and officers of the Department of Mines.

CUSTOMS ASSAYING AND GENERAL WORK, 1928

Gold	2,069 samples.
Silver	738 samples.
Copper	513 samples.
Lead	259 samples.
Zinc	225 samples.
Nickel	63 samples.
Iron	24 samples.
Platinum	18 samples.
Tin	14 samples.
Sulphur	8 samples.
Silica	4 samples.
Phosphorus	4 samples.
Cobalt	4 samples.
Titanium	4 samples.
Coal	4 samples.
Palladium	3 samples.
Insoluble	3 samples.
Antimony	2 samples.
Arsenic	2 samples.
Radium	2 samples were submitted on which reports were issued.
Miscellaneous	6 samples of other minerals were tested. These included 1 each of alumina, lime, magnesium, iridium, molybdenum and chromium.
Identification	116 samples were received by mail and reports issued. A large number were brought directly to the Laboratory; of these no record was kept.
Rocks	27 samples were submitted by geologists of the Department of Mines for complete analysis.
Total	4,112 as compared with 2,063 in 1927.

The schedule of charges, effective since June 1, 1926, for the Provincial Assay Office and Chemical Laboratory is as follows:—

TARIFF OF FEES FOR ANALYSIS AND ASSAYS

	Fee
1. Assays:	
Gold	$1 50
Silver	1 50
Gold and silver in one sample	2 50
Platinum minerals	5 00
Gold and platinum minerals in one sample	7 00
Separation of platinum minerals	Prices on application.
2. Iron Ores:	
Iron (metallic)	$1 50
Silica	1 50
Iron and insoluble residue	2 50
Ferrous oxide	2 00
Phosphorus	3 00
Sulphur	2 50
Iron, sulphur, phosphorus and insoluble	8 00
Manganese	3 00
Titanium	4 00
Complete analysis	Prices on application.

3. Limestones, Dolomites, Marls, Clays, Shales:

Determination of:

Insolubles	$1 50
Silica	2 50
Ferric iron	3 00
Ferrous iron	2 00
Alumina	3 00
Lime	2 00
Magnesia	2 50
Potash	5 00
Soda	5 00
Alkalies (in one sample)	6 00
Water (combined)	2 00
Moisture	1 00
Carbon dioxide	2 00
Sulphur	2 50
Phosphorus anhydride	3 00

4. Examination of Clay, Shale, or Cement Rock for Cement Manufacture:

Determination of:

Silica, Iron oxide, Alumina, Lime, Magnesia, Sulphur, and Volatile matter.....Prices on application.

5. Coke, Coal, Peat, etc.:

Determination of:

Moisture	$1 00
Volatile combustible	1 50
Fixed carbon	1 50
Ash	1 50
Sulphur	2 50
Phosphorus	3 00
Calorific value (B.t.u.)	5 00
Ultimate analysis	Price on application.

6. Mineral Waters.....Price on application.

7. Ores and Minerals:

Determination of:

Alumina	$3 00
Antimony	4 00
Arsenic	3 00
Bismuth	4 00
Cadmium	4 00
Chromium	5 00
Cobalt	5 00
Nickel	5 00
Cobalt and Nickel in same sample	6 00
Copper	2 00
Fluorite	4 00
Lead	2 00
Molybdenum	4 00
Manganese	3 00
Tin	4 00
Zinc	3 00

8. Rocks, Complete Analysis.....Price on application.

9. Slags, Sand, etc.....Price on application.

10. Identification of Minerals and Rocks not Requiring Chemical Analysis.....Free.

11. Test for Radio-Activity.....Free.

Any analytical work not specified in this list will be undertaken on application to the Provincial Assayer.

The pulp of each sample is retained for future reference.

TERMS

Money in payment of fees, sent in by registered letter, post office order, postal note, or express order, and made payable to the Provincial Assayer, must invariably accompany sample to ensure prompt return of certificate, as no examination is commenced until the regulation fee is paid.

DIRECTIONS

Samples will be dealt with in the order of their arrival. In every instance specimens and samples should be accompanied by statement specifying the precise locality from which they were taken.

Crushed samples representing large quantities, or samples less than five pounds weight, may be sent by mail as third-class matter. Samples not exceeding eleven pounds in weight may be sent by parcel post. The name and address of sender should be written plainly on each parcel. Instructions, with money in payment of fees, should be contained in a separate letter. Samples may be sent by express, charges prepaid.

Sample bags addressed to this laboratory for sending ore pulp by mail may be obtained free on application; also canvas bags for shipping.

Samples should be addressed as follows:

PROVINCIAL ASSAY OFFICE,
East Block, Parliament Bldgs.,
TORONTO, ONT.

Departmental Correspondence

The volume of correspondence necessary for the work of the Department of Mines at Toronto is considerable. Figures supplied by the Files Branch show that for the fiscal year ending October 31, 1928, communications received numbered 30,236.

Correspondence in connection with the office of the Minister of Mines is not included, nor is that pertaining to applications for patent or lease of mining lands,—the latter files being kept in the Department of Lands and Forests.

In addition, Branches of the Department, including those of the Mine Assessor, Mining Court, Mines Inspection, Publications and Statistics, Assay Office, Gas Commissioner, and Provincial Assay Office, carry on correspondence independently.

CLASSES FOR PROSPECTORS, 1928-29

By E. M. Burwash

Introduction

Commencing at Ottawa on November 13, 1928, classes were held throughout the winter at fourteen points, concluding at Haileybury on April 20. The courses used were in general like those of recent years. Classes for the identification of minerals and rocks were held during daylight hours, usually from 10 to 12 A.M. or from 2 to 4 P.M. The minerals and rocks used were the same as in previous years and were studied by the use of the tables compiled by Dr. Goodwin for purposes of identification by means of tests applicable in the field. In connection with this work there were short talks, by way of explanation, on the chemical composition and physical properties of minerals, and on such subjects as crystallization, hardness, elasticity, elements, compounds, acids, bases, the molecular and atomic theories, atomic weights, percentage composition, etc. In connection with the study of rocks, such considerations as the results of different rates of cooling and the presence of water in magmas were discussed. The chemical action of water, oxygen, and carbonic acid in weathering; the sorting action of water in transportation; and recrystallization due to regional shear and contact conditions were explained as simply as possible.

In the evening lectures on geology, new slides were introduced in order to freshen the interest by a slightly different treatment, but the general outline of the course remained as before, divided into five lectures under the headings:—

1. Erosion and Sedimentary Rocks.
2. Volcanoes and Igneous Rocks.
3. Mountain-Building and the Metamorphic Rocks.
4. Ore Deposits of Ontario.
5. The general and economic geology of the region in which the lecture was delivered.

Attendance

While the attendance was not on the whole equal to that of last year, the registration for the day classes averaging twenty-five as compared with thirty-one in 1927-28, the discrepancy could be partly accounted for by the great decrease in attendance at Ottawa where the arrangements for advertising were not as successful as in the previous season. Other causes which affected attendance more or less were: (1) the open season and light snowfall before Christmas, allowing of continued work on claims and other outdoor work until well on in December; (2) the removal during the summer of 1928 of a large number of men to northern Manitoba and points farther west, many of whom had not returned; (3) the introduction during the past year of airplane exploration on an unprecedented scale, which enables work to be carried on through the winter, supplies being sent in by plane; (4) an early spring called men out to freight

supplies to the new fields, especially the Crow River field. Toward the end of the season the attendance improved. At Mine Centre in January there were a good number for a place of that size, considerably more than at Fort Frances last year. At Matheson the attendance surpassed any previous record except one; and at Haileybury it reached 58 and exceeded that of any former year by 9.

Interest in the work by those who took part was well maintained, and the instruction on the whole seemed more effective than last year, which was the first year under the present instructor.

ANALYSIS OF THE WORK OF THE SEASON, 1928-29

Place	Dates	Total registration	Average attendance		Total study periods	
			Mineralogy	Geology	1929	1928
	1928					
Ottawa	Nov. 13-20	8	4	11	85	607
North Bay	Nov. 22-30	4	3	18	113	180
Sudbury	Dec. 4-12	16	8	12	117	179
Sault Ste. Marie	Dec. 13-21	28	17	9	184	330
	1929					
Chapleau	Jan. 7-15	26	10	9	126	.....
Port Arthur	Jan. 17-25	21	9	23	183	302
Mine Centre	Jan. 28-Feb. 2	28	17	37	286	.....
Kenora	Feb. 7-15	27	16½	22	244	290
Sioux Lookout	Feb. 18-26	26	15	25	247	266
Timmins	Feb. 28-Mar 8	17	10	22	189	247
Iroquois Falls	Mar. 9-18	16	9	7	107	.....
Matheson	Mar. 20-28	47	23	54	453	.....
Kirkland Lake	Apr. 2-10	29	15	30	266	440
Haileybury	Apr. 12-20	58	22	20	277	390
Total	Nov. 13-April 20	351	178½	299	2,877	.....
Average (14 places)	.....	25.07	12.7	21.35	205.5	.....

Average attendance, 50.66 per cent.

ATTENDANCE AT CLASSES FOR PROSPECTORS, 1921 to 1929

Place	1921	1922	1923	1924	1925	1926	1927	1928	1929	Average
Bancroft	.....	34	12	.....	.....	.....	.....	.....	.....	23
Bestel	.....	16	.....	.....	.....	.....	.....	28	.....	22
Blind River	.....	.....	.....	.....	.....	.....	68	13	.....	40.5
Cartier	.....	.....	.....	.....	.....	.....	21	.....	.....	21
Chapleau	.....	.....	.....	.....	53	22	.....	.....	26	33.6
Cobalt	.....	.....	28	.....	.....	.....	.....	.....	.....	28
Cochrane	.....	.....	.....	46	35	22	27	.....	.....	32.5
Coniston	.....	.....	.....	29	11	.....	.....	.....	.....	20
Connaught	.....	33	10	.....	.....	.....	.....	.....	.....	21.5
Dome Mines	.....	47	18	.....	.....	.....	.....	.....	.....	32.5
Dryden	.....	.....	45	.....	.....	.....	.....	.....	.....	45
Elk Lake	30	24	10	.....	.....	.....	.....	.....	.....	21.3
Englehart	.....	.....	.....	.....	.....	85	33	.....	.....	59
Fort Frances	.....	.....	.....	.....	.....	.....	.....	18	.....	18
Fort William	38	14	21	.....	.....	60	16	24	.....	29
Franz	.....	.....	.....	.....	.....	17	.....	.....	.....	17
Galetta	.....	.....	.....	.....	.....	27	.....	.....	.....	27
Gowganda	.....	26	.....	.....	.....	.....	.....	.....	.....	26
Haileybury	47	44	.....	24	.....	.....	49	48	58	45
Hearst	.....	.....	.....	48	25	.....	.....	.....	.....	36.5
Iroquois Falls	.....	.....	74	.....	.....	.....	41	.....	16	43.6
Kapuskasing	.....	.....	.....	.....	.....	.....	.....	10	.....	10
Kenora	.....	14	12	.....	.....	.....	26	37	27	38.6

ATTENDANCE AT CLASSES FOR PROSPECTORS, 1921 to 1929—*Continued*

Place	1921	1922	1923	1924	1925	1926	1927	1928	1929	Average
Kirkland Lake	28	64	22	22	17	39	31	41	29	32.55
Larder Lake	.....	.....	.....	.....	22	9	.....	.....	.....	15.5
Madoc	60	21	.....	.....	.....	.....	.....	.....	.....	40.5
Massey	.....	.....	.....	59	24	.....	.....	.....	.....	41.5
Matheson	.....	.....	.....	77	45	34	32	.....	47	47
Mine Centre	.....	.....	.....	.....	51	.....	.....	.....	28	39.5
Nakina	.....	.....	.....	.....	.....	51	.....	.....	.....	51
North Bay	15	.....	.....	.....	.....	.....	48	20	4	43.5
New Liskeard	.....	.....	.....	.....	45	55	.....	.....	.....	50
Ottawa	.....	.....	.....	.....	.....	.....	.....	70	8	39
Perth	.....	.....	.....	.....	.....	.....	.....	14	.....	14
Perth Road	.....	33	.....	.....	.....	.....	.....	.....	.....	33
Port Arthur	30	34	24	25	75	100	53	37	21	44.33
Renfrew	.....	.....	.....	.....	.....	.....	26	.....	.....	26
Sault Ste. Marie	110	109	26	32	27	74	60	30	28	55.1
Schreiber	.....	.....	32	54	.....	.....	.....	.....	.....	43
Schumacher	.....	.....	.....	.....	.....	.....	29	.....	.....	29
Sioux Lookout	.....	.....	.....	.....	37	30	46	24	26	32.6
South Lorraine	.....	.....	30	17	.....	.....	.....	.....	.....	23.5
South Porcupine	44	.....	12	.....	.....	.....	.....	.....	.....	28
Sudbury	21	50	38	38	34	49	37	39	16	35.77
Swastika	26	28	17	.....	.....	39	.....	.....	.....	27.5
Timmins	60	58	46	40	32	.....	.....	38	17	41.57
Total registration	509	649	477	511	533	713	643	492	351	542
Average registration	42.4	37.1	25.1	39.3	35.2	44.6	37.7	30.75	25.1	34.58
Average percentage of total registration in attendance	65.22	.....	86.8	.....	54.	52.5	49.9	51.81	50.66	55.84

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MINES OF ONTARIO IN 1928

By

Chief Inspector of Mines, D. G. Sinclair, Toronto; Inspectors, R. H. Cleland, Timmins; E. C. Keeley, Kirkland Lake; G. S. Jarrett, Sudbury; A. R. Webster, Toronto.

As an introduction to the descriptions of the mines and metallurgical plants of the province, the following list, alphabetically arranged for metals or minerals extracted and also for the names of the companies concerned, may be of use for reference purposes. The inclusion of a property in this list does not necessarily imply that it is a producing one or that it is being worked at the present time. The table contains the names of all operating properties and works inspected in 1928.

Lists of the principal stone quarries and clay pits are added at the end.

MINES AND METALLURGICAL WORKS

Operator	Mine	Manager	Address
AERIAL PROSPECTING			
Brett-Trethewey Mines, Ltd	.....	.....	43 Toronto St., Toronto
Consolidated Mining and Smelting Co., of Canada, Ltd	.....	.....	Drummond Bldg., Montreal.
Dominion Explorers, Ltd	.....	.....	914 Excelsior Life Bldg., Toronto.
Northern Aerial Minerals Exploration, Ltd	.....	John E. Hammell.	100 Adelaide St. W., Toronto.
COPPER			
Amity Copper and Gold Mines, Ltd	Amity	Sidney A. Pain	Boston Creek.
Patterson Copper Mines, Ltd	Patterson	W. E. Simpson	Boston Creek.
Potter Doal Mines, Ltd	Potterdoal	Paul Doal	Matheson.
Shield Development Co., Ltd	Tip Top	J. G. Harkness	Kashabowie
Sudbury Basin Mines, Ltd	Cheney	Jos. H. Travers	Thessalon.
White Lake Mines, Ltd	White Lake	O. G. Carstens	Blind River.
COPPER-ZINC-LEAD			
Sudbury Basin Mines, Ltd	Sudbury Basin	.....	503 Excelsior Life Bldg., Toronto.
Treadwell Yukon Co., Ltd	Errington	V. C. Clauson	Errington Mine.
FELDSPAR			
Bathurst Feldspar Mines, Ltd	Bathurst	J. E. Sullivan	R.R. 7, Perth.
Craig, T. H	Craig	T. H. Craig	398 Victoria St., Kingston.
Genesee Feldspar Co., Inc	Genesee	P. MacDonald	Hybla.
National Feldspar Co., Ltd	National	S. W. Windeler	R.R. 7, Perth.
Verona Quarries, Ltd	Verona	C. A. McMahon	Desert Lake.

MINES AND METALLURGICAL WORKS—*Continued*

Operator	Mine	Manager	Address
	GOLD		
Abba Mines, Ltd	Abba	C. D. Salkeld	Kirkland Lake.
Alschbach Gold Mining Co., Ltd	Alschbach	Clarence Alschbach	Goldthorpe.
Ankerite Gold Mines, Ltd	Ankerite	W. H. Seamon	South Porcupine.
Barry-Hollinger Gold Mines, Ltd	Barry-Hollinger	Jas. Houston	Boston Creek.
Bathurst Mines, Ltd	Bathurst	Frank Carnegie	Narrow Lake.
Beardmore Gold Mines, Ltd	Beardmore	W. A. Roberts	Beardmore.
Bidgood Consolidated Mines, Ltd	Bidgood	John McPhee	Kirkland Lake.
Blue Quartz Gold Mines, Ltd	Blue Quartz	J. C. Crow	1104 Northern Ontario Bldg., Toronto.
Bobjo Mines, Ltd	Bobjo	G. A. Howes	Sioux Lookout.
Brett-Trethewey Mines, Ltd	Brett-Trethewey		43 Toronto St., Toronto.
British Canadian Mines, Ltd	Foley	J. M. Aitken	8 Bloor St. E., Toronto.
Buckingham Mines, Ltd	Buckingham	Douglas A. Mutch	Haileybury.
Buff Munro Gold, Ltd	Buff Munro	Richard Haggerty	710 Erie County Bank Bldg., Buffalo, N.Y.
Cambro-Kirkland Mines, Ltd	Cambro-Kirkland	W. B. Airth	Kirkland Lake.
Canadian Champion Reef Mining Co., Ltd	Champion Reef	T. R. Bullock	Shiningtree.
Canusa Mining and Exploration Co., Ltd	Scottish-Ontario	Steve Monck	Timmins.
Cochenour-Willans Syndicate	Cochenour-Willans	W. M. Cochenour	Red Lake, via Sioux Lookout.
Coniaurum Mines, Ltd	Newray	John Reddington	South Porcupine.
Consolidated Mining & Smelting Co., of Canada, Ltd. (under option)	Hill-Tivey-Sloan	P. F. Osler	505 Confederation Life Bldg., Winnipeg, Man.
Continental Kirkland Mines, Ltd	Continental Kirkland	A. J. Keast	Kirkland Lake.
Cooper Gold Mines, Ltd	Minto	John Knox, Jr	Wawa, via Hawk Junction.
Crown Reserve Consolidated Mines, Ltd	Crown Reserve	N. J. Evered	Crown City.
De Santis Gold Mining Co., Ltd. (under option)	De Santis	Peter De Santis	Timmins.
Dome Mines, Limited	Dome	H. P. De Pencier	South Porcupine.
Dunkin Gold Mines, Ltd	Dunkin	Colin A. Campbell	Narrow Lake.
Federal Kirkland Mining Co., Ltd	Federal Kirkland	Lindsay Foss	Kirkland Lake.
Fort Hope Mines, Ltd	Fort Hope		Haileybury.
Furness Gold Mines, Ltd	Whalen-James	H. R. M. Turner	Box 542, South Porcupine.
Gold Hill Mines, Ltd	Gold Hill	D. H. Angus	Haileybury.
Gold Rock Mining Syndicate, Ltd	Gold Rock	Miles Walker	Wabigoon.
Goodfish Mines, Ltd	Goodfish	W. R. Sweet	Kirkland Lake.
Goodfish Mines, Ltd	Providence	W. R. Sweet	Kirkland Lake.
Grace Lake Gold Mines, Ltd	Grace Lake	O. E. Oberg	Boston Creek.
Grenfell-Kirkland Mines, Ltd. (under option)	Stitt	D. Hill	Kenogami Lake.
Harker Gold Mines, Ltd	Harker	J. E. Hammell	100 Adelaide St. W., Toronto.
Harris Consolidated Gold Mines, Ltd	Beaumont	Oscar Knutson	Box 512, South Porcupine.
Haslat-Duck Lake Mines, Ltd	Haslat-DuckLake	M. L. Bouzan	Schreiber.
Hayden Gold Mines, Ltd	Hayden	Seymour Stevens	Timmins.
Hewitt Mining Company, Ltd	Hewitt	George Gray	Timmins.
Hilltop Gold Mines, Ltd	Hilltop		1302 Bank of Hamilton Bldg., Toronto.

MINES AND METALLURGICAL WORKS—*Continued*

Operator	Mine	Manager	Address
	GOLD—*Continued*		
Hollinger Consol. Gold Mines, Ltd.	Hollinger	A. F. Brigham	Timmins.
Howey Gold Mines, Ltd.	Howey	H. G. Young	Red Lake, via Sioux Lookout.
Interprovincial Exploration Co., Ltd.	Interprovincial		437 St. James St., Montreal, Que.
Jackson-Manion Mines, Ltd.	Jackson-Manion.		1507 Bank of Hamilton Bldg., Toronto.
Jones Porter Mines, Ltd.	Jones Porter	John Jones	Box 1330, Timmins.
Kirkland Gold Belt Mines, Ltd.	Kirkland Gold Belt	K. B. Heisey	Kirkland Lake.
Kirkland Hunton Mines, Ltd.	Kirkland Hunton.	John McPhee	Kirkland Lake.
Kirkland Lake Gold Mining Co., Ltd.	Kirkland Lake Gold	William Sixt	Kirkland Lake.
Kirkland Premier Mines, Ltd.	Kirkland Premier.	W. R. Osborne	Kirkland Lake.
Lake Shore Mines, Ltd.	Lake Shore	E. B. Knapp	Kirkland Lake.
McIntyre-Porcupine Mines, Ltd.	McIntyre	R. J. Ennis	Schumacher.
McMillan Gold Mines, Ltd.	McMillan	E. J. McMillan	Sudbury.
March Gold, Ltd.	March	Joseph T.Baldwin	Box 533, South Porcupine.
Metals Development, Ltd.	Metals Development	J. C. Nelson	Jackson-Manion.
Mineral Research Corporation	Davidson-Carr	A. R. Globe	Savant Lake.
Moss Mines, Ltd.	Huronian	J. G. Harkness	Kashabowie.
Murphy Mines, Ltd.	Murphy	Lindsay Foss	Argonaut.
New York Porcupine Mines, Ltd.	New York Porcupine	Harry W. Darling.	South Porcupine.
Northern Red Lake Mines, Ltd. (under option)	Golden Star	Frederick S. Munson	Fort Frances.
Northern Red Lake Mines, Ltd. (under option)	Isabella	Frederick S. Munson	Fort Frances.
Northland Gold Mines, Ltd.	Northland	John J. Byrne	Northland Mines.
Olivet Gold Mines, Ltd.	Olivet	Earl Hunton	Crown City.
Patricia Dent Gold Mines, Ltd.	Patricia Dent	J. C. Dodd	Jackson Manion.
Pawnee Kirkland Gold Mines, Ltd.	Pawnee Kirkland.	John J. Byrne	Kirkland Lake.
Picard Gold Mines, Ltd.	Picard	E. A. Dowman	Jackson-Manion.
Polaris Gold Mines of Canada, Ltd.	Polaris	W. C. Churchill	Box1691,Timmins.
Porcupine Grande Gold Mines, Ltd.	Porcupine Grande	E. H. Orser	Hoyle.
Porcupine United Gold Mines, Ltd.	Rochester	Joseph T. Baldwin	Timmins.
Power and Mines Corporation, Ltd.	Grace	J. A. S. Roussac	Hawk Junction.
Red Lake Gold Shore Mines, Ltd.	Red Lake Gold Shore	C. B. Morgan	Red Lake, via Sioux Lookout.
Red Mammoth Gold, Ltd.	Smith-Morrison	M. Bouzan	Red Lake, via Sioux Lookout.
Ritchie Gold Mines, Ltd.	Ritchie	John J. Byrne	Argonaut.
St. Anthony Gold Mines, Ltd.	St. Anthony	H. A. Swart	Savant Lake.
Sylvanite Gold Mines, Ltd.	Sylvanite	C. E. Rodgers	Kirkland Lake.
Tashota Gold Mines, Ltd.	Tashota	W. A. Coughlin	Tashota.
Teck-Hughes Gold Mines, Ltd.	Teck-Hughes	D. L. H. Forbes	Kirkland Lake.
Telluride Gold Mines of Canada, Ltd.	Telluride	B. Ashley	Englehart.
Towagmac Exploration Company, Ltd. (under option)	Michael Boyle	W. R. McIlquham	Goudreau.
United Mineral Lands Corporation	Paymaster	M. Donovan	South Porcupine.
Vipond Consolidated Mines, Ltd.	Vipond	Robert E. Dye	Timmins.
Walsh-Katrine Gold Mines, Ltd.	Walsh-Katrine	J. P. Hussey	Crown City.
West Dome Lake Gold Mines, Ltd.	West Dome	D. M. McPhail	South Porcupine.
Wright-Hargreaves Mines, Ltd.	Wright-Hargreave	James E. Grant	Kirkland Lake.

MINES AND METALLURGICAL WORKS—*Continued*

Operator	Mine	Manager	Address
GRAPHITE			
Black Donald Graphite Company, Ltd.	Black Donald....	R. F. Bunting....	Calabogie.
GYPSUM			
Canada Gypsum and Alabastine, Ltd..	Caledonia.....	R. E. Haire.....	Paris.
Canada Gypsum and Alabastine, Ltd..	Lythmore.....	R. E. Haire.....	Paris.
LEAD			
Kingdon Mining, Smelting and Manufacturing Co., Ltd.....	Kingdon.....	R. R. Rose.....	Galetta.
LEAD AND ZINC			
North American Metals Corporation, Ltd.....	Dorion.....	H. E. Knobel....	Loon.
North American Metals Corporation, Ltd.....	Ogema.....	H. E. Knobel....	Loon.
Towagmac Exploration Co., Ltd.....	Lake Geneva....	W. E. Bowden...	Geneva.
NICKEL AND COPPER			
Falconbridge Nickel Mines, Ltd.....	Falconbridge.....	Ernest Craig.....	Box 1, Garson.
International Nickel Co. of Canada, Ltd.	Creighton.....	J. L. Agnew.....	Copper Cliff..
International Nickel Co. of Canada, Ltd.	Frood.....	J. L. Agnew.....	Copper Cliff.
McVittie-Graham Mines, Ltd.....	Moose Lake.....	W. R. Dunbar...	Sudbury.
Mond Nickel Company, Ltd.....	Frood Extension..	A. D. Carmichael.	Sudbury.
Mond Nickel Company, Ltd.....	Garson.....	A. L. Sharp.....	Garson.
Mond Nickel Company, Ltd.....	Levack.....	F. J. Eager.....	Levack.
Sudbury Offsets, Ltd.....	Sudbury Offsets..	.....	1004 Bank of Hamilton Bldg., Toronto.
SILVER			
Brocklebank, Arthur (under lease)	Kerr Lake.....	Arthur Brocklebank.....	Cobalt.
Castle-Trethewey Mines, Ltd.....	Castle-Trethewey.	Angus D. Campbell.....	Bestel.
Cobalt Contact Mines, Ltd.....	Green-Meehan...	J. M. C. Dunlop..	North Cobalt.
Cobalt Contact Mines, Ltd.....	Red Rock.....	J. M. C. Dunlop..	North Cobalt.
Cobalt Contact Mines, Ltd. (under option).....	Ruby.....	J. M. C. Dunlop..	North Cobalt.
Cobalt-Kittson Mines, Ltd.....	Cobalt-Kittson...	Archibald Nadeau	Cobalt.
Friday Mines, Ltd.....	Friday.....	J. R. Sproat.....	Timagami.
Keeley Silver Mines, Ltd.....	Keeley.....	W. J. Dobbins...	Silver Centre.
Kirk-Budd Mines, Ltd.....	Kirk-Budd.....	Cecil Cave.....	Cobalt.
Mining Corporation of Canada, Ltd...	Buffalo.....	M. F. Fairlie.....	Cobalt.
Mining Corporation of Canada, Ltd...	City.....	M. F. Fairlie.....	Cobalt.
Mining Corporation of Canada, Ltd...	Cobalt Lake.....	M. F. Fairlie.....	Cobalt.
Mining Corporation of Canada, Ltd...	Crompton.....	M. F. Fairlie.....	Cobalt.

MINES AND METALLURGICAL WORKS—*Continued*

Operator	Mine	Manager	Address
SILVER—*Continued*			
Mining Corporation of Canada, Ltd...	Frontier.....	M. F. Fairlie.....	Cobalt.
Mining Corporation of Canada, Ltd...	H. R. 64.....	M. F. Fairlie.....	Cobalt.
Mining Corporation of Canada, Ltd....	McKinley-Darragh.....	M. F. Fairlie.....	Cobalt.
Mining Corporation of Canada, Ltd...	Townsite.....	M. F. Fairlie.....	Cobalt.
Nipissing Mining Company, Ltd.....	Nipissing.....	Hugh Park.....	Cobalt.
Nipissing Mining Company, Ltd.....	Nipissing Lorrain.	Hugh Park.....	Cobalt.
O'Brien, M. J., Ltd.....	Cross Lake.....	J. G. Dickenson..	Cobalt.
O'Brien, M. J., Ltd.....	Miller Lake O'Brien.....	H. G. Kennedy...	Bestel.
O'Brien, M. J., Ltd.....	O'Brien.....	J. G. Dickenson..	Bestel.
Peterson Cobalt Mines, Ltd.....	Peterson Cobalt..	D. J. Russell.....	Cobalt.
Sandoe, Richard, and associates (lease).	Temiskaming....	Richard Sandoe..	Cobalt.
Shield Development Company, Ltd....	Cochrane.....	.....	132 St. James St., Montreal, Que.
Trembath, Thomas E., and partner....	La Rose.....	Thomas E. Trembath.....	Cobalt.
TALC			
Asbestos Pulp Co., Ltd.....	Asbestos Pulp....	Roy Taylor.....	Madoc.
Geo. H. Gillespie Co., Ltd.....	Henderson.....	Geo. H. Gillespie.	Madoc.
METALLURGICAL WORKS			
Algoma Steel Corporation, Ltd.....	Blast furnace....	Jas. H. Bell.....	Sault Ste. Marie.
Cobalt Reduction Co., operated by Mining Corporation of Canada, Ltd..	Silver refinery....	M. F. Fairlie.....	Cobalt.
Deloro Smelting and Refining Co., Ltd.	Silver refinery....	S. B. Wright.....	Deloro.
International Nickel Co. of Canada, Ltd.	Blast furnace....	Donald MacAskill	Copper Cliff.
International Nickel Co. of Canada, Ltd.	Nickel Refinery..	H. W. Walter....	Port Colborne.
Mond Nickel Company, Ltd.....	Blast furnace....	John F. Robertson	Coniston.
Steel Company of Canada, Ltd.....	Blast furnace....	R. A. Gillies.....	Hamilton.

QUARRIES

County	Operator	Address	Location	Product
Algoma district	Dominion Mines & Quarries, Ltd	Little Current	Killarney	Quartzite.
" "	Dominion Trap Rock Co	Bruce Mines	Bruce Mines	Crushed trap rock.
" "	Grenville Crushed Rock Co	Hawk Lake	Hawk Lake	Crushed granite for ballast.
" "	Manitoulin Quartzite, Ltd	Sheguiandiah	Manitoulin Island	Quartzite.
Bruce	Alabastine Co. of Paris, Ltd	Teeswater	Lot 14, con. VI, Culross	Hydrated lime.
Carleton	Belanger, Victor	Hawkesbury	Gloucester tp	Limestone for roads.
"	Robillard, H., and Son	Quarries, via Ottawa	Gloucester tp	Limestone for roads.
Cochrane district	Northern Development Department, Ontario Government	Cochrane	Lamarche tp	Crushed rock for road surfacing.
Dufferin	Ritchie Cut Stone Co., Ltd	Shelburne	Near Shelburne	Building stone.
Essex	Brunner Mond, Canada, Ltd	Amherstburg	Lots 6, 7, 8, con. I; lots 2, 3, con. II, Anderdon	Limestone for chemical works.
Frontenac	Freeman, L. G	106 Cowdy St., Kingston	Kingston tp	Building stone.
"	Roddy, J	Kingston	Kingston tp	Building and crushed limestone.
"	Silica Sand Co., Ltd	Geo. M. Thompson, Box 264, Kingston	Lots 19, 20, con. I, Pittsburgh	Sandstone.
Grenville	Grenville Crushed Rock Co., Ltd	J. P. Bains, Oxford Mills	Lots 8, E. ½ 9, con. IV; S. ½ lot 8, con. III, Oxford	Crushed and screened limestone for ballast.
Grey	Chalmers, Stewart	Owen Sound	Owen Sound	Lime.
"	Keeling, James	1179 16th St., Owen Sound	8th St., Owen Sound	Building stone.
"	Lapierre & Checkley	Owen Sound	Owen Sound	Limestone for building.
"	McKay, Alex. L	E. Rowbottom, Owen Sound	Owen Sound	Building stone; crushed stone.
"	Oliver Rogers Stone Co	Owen Sound	Owen Sound	Building stone; crushed stone.
Haldimand	Gordon Crushed Stone Co., Ltd	Hagersville	Walpole tp	Crushed stone.
"	Hagersville Contracting Co	Hagersville	Lots 13, 14, con. XIII, Walpole	Crushed stone for roads and concrete.
"	Hagersville Quarries, Ltd	Hagersville	Lot 13, con. XIII, Walpole	Crushed stone for roads and concrete.
Halton	Christie Henderson Co., Ltd	Kelso	Lot 4, con. V, Nassagaweya	Grey lime.
"	Credit Valley Quarries, Ltd	Glen Williams	Lot 26, con. X, Esquesing	Building stone.
"	Logan, Hugh	Glen Williams	Lot 27, con. IX, Esquesing	Building stone.
"	Robertson, D., & Co	Milton	Esquesing tp	Lime and building stone.

"	Routley, H. T.	R.R. 1, Georgetown	Con. VII, Esquesing	Crushed stone.
"	Toronto Lime Co., Ltd.	Limehouse	Esquesing tp.	Lime and building stone.
Hastings	Canada Cement Co.	Point Anne	Point Anne	Limestone for cement.
"	Canada Crushed Stone Corp., Ltd.	George Rayner, Bancroft	Dungannon tp.	Marble.
"	Quinlan, Robertson, and Janin	Crookston	Lot 10, con. X, Huntingdon	Building stone.
Kenora district	Horne, William	Butler, via Ignace		Monumental stone and paving blocks (granite).
Lanark	Cameron, James	Fallbrook	Lot 4, con. XI, Drummond	Pegmatite for road material.
"	Cameron, William	Carleton Place	Lot 24, con. XI, Drummond	Lime.
Leeds	Gordon, David J.	Gananoque	Lot 11, con. II, Leeds	Red granite.
"	McAdam, James	Box 173, Gananoque	Lots 10, 11, 12, Con. I, Leeds	Paving blocks and cut stone.
"	Street & O'Brien	Box 73, Gananoque	Lot 6, con. II, Leeds	Granite paving blocks.
Lincoln	Queenston Quarries, Ltd.	St. Davids	St. Davids	Crushed, monumental, sawn limestone.
"	Wickett, James A.	Geo. E. Stocker, 16 Salter St., Toronto	Grantham tp.	Crushed stone.
Norfolk	Routly, H. T.	Jarvis	Lot 19, con. XIV, Townsend	Crushed stone.
Ontario	Longford Crushed Stone, Ltd.	Longford Mills	E. part lots 23, 24, Front range, Rama tp.	Crushed stone.
Oxford	Beachville White Lime Co.	Beachville	Beachville	Stone, lime, agricultural lime.
"	Dufferin Construction Co.	Innerkip	Lots 8 and 9, con. XVII, E. Zorra	Limestone.
"	Standard White Lime Co.	Beachville	Beachville	High calcium, magnesium, and hydrated lime.
Perth	St. Marys Cement Co.	St. Marys	Blanshard tp.	Limestone for cement.
"	Thames Quarry Co.	St. Marys	St. Marys	Limestone.
Peterborough	Ontario Rock Co.	Preneveau	Lot 7, con. VI, Belmont	Crushed trap.
Prescott	Bissonnette, A.	Alfred	Longueuil tp.	Limestone.
"	McDonald, Neil A.	R. Allard, L'Orignal	Longueuil tp.	Limestone.
Renfrew	Dominion Rock Products, Ltd	Eganville	Lot 10, con. XVII, Gratton	Limestone.
"	Jamieson Lime Co.	Renfrew	Lot 5, con. II, Horton	Crystalline limestone and lime.
"	McDonald & McLeod	Pembroke	Wilson's farm, Pembroke	Crushed rock.
"	Markus, William	Pembroke	Lot 12, con. I, Pembroke	Limestone.
Russell	McDonell, Dibblee & Covey	Clarence	Con. I, Clarence	Limestone.
Simcoe	Langton, Thomas	Coldwater	Lots 19, 20, con. XII, Medonte	Crushed stone.
"	Ontario Stone Corp., Ltd.	R.R. 4, Orillia	Lot 10, con. IV, N. Orillia	Crushed stone.
Sudbury district	Mond Nickel Co., Ltd.	Coniston	At Coniston smelter	Quartzite for flux.
Thunder Bay district	Quinn Stone and Ore Co.	Fort William	Fort William	Crushed stone.

QUARRIES—*Continued*

County	Operator	Address	Location	Product
Timiskaming district	Abitibi Pulp & Paper Co	August Johnson, Haileybury	S. ½ lot 10, con. V, Bucke (owned); W. ½ lot 11, con. III, Bucke (leased)	Limestone.
Victoria	Canada Lime Co	Coboconk	Coboconk	Limestone.
"	Kirkfield Crushed Stone Co	Kirkfield	Lot 49, con. IX, Eldon	Crushed limestone.
"	Toronto Brick Co	Coboconk	Coboconk	Lime.
Welland	Bertie Township	Ridgeway	Lot 21, con. III, Bertie	Crushed rock for roads.
"	Bertie Township	Stevensville	Lot 8, con. VIII, Bertie	Crushed limestone for roads.
"	Canada Cement Co	Port Colborne	Port Colborne	Limestone for cement.
"	Canada Cement Co	Port Colborne	Lot 5, con. I, Wainfleet	Limestone for cement.
"	Law Construction Co	Ridgeway	Lot 13, con. V, Bertie	Limestone for roads.
"	Walker Bros	Thorold	Lots 31, 32, con. IX, Stamford	Limestone for flux and paper mills.
Wellington	Canada Crushed Stone Corporation, Ltd	Puslinch	Puslinch	Crushed limestone.
"	Canada Gypsum and Alabastine, Ltd	Elora	Nicol tp	Hydrated lime and agricultural lime.
"	Christie Henderson Co	R.R. 2, Puslinch	Lots 2, 3, con. I, Puslinch	Hydrated lime.
"	Christie Henderson Co	Hespeler	Lots 2, 3, con. IV, Puslinch	Hydrated lime.
"	Gow, James	Fergus	Fergus	Crushed limestone.
"	Innerkip Stone and Lime Co	Guelph	Guelph	Crushed limestone.
"	Ontario Reformatory	Box 1448, Guelph	Guelph	Crushed limestone for roads.
"	Standard White Lime Co	Guelph	Wellington tp	Hydrated lime.
Wentworth	Barton Township	Mount Hamilton	Lot 13, con. VII, Barton	Crushed and screened limestone.
"	Canada Crushed Stone Corp., Ltd	Dundas	Dundas	Crushed and screened limestone and building stone.
"	Gallagher Bros	R.R. 2, Hamilton	Lot 14, con. VI, Barton	Limestone and lime.
"	Marshall, James	Hamilton	Lot 14, con. VII, Barton	Limestone and lime.
"	Middleton, J	Ancaster	Ancaster	Building stone.
"	Wentworth Quarry Co., Ltd	Vinemount	Lot 4, con. V, Saltfleet	Crushed and screened limestone.

CLAY PITS

County	Operator	Address	Location
Halton	Caledon Shale Brick Co	Credit Forks	Lot 10, con. IX, Caledon.
"	Halton Brick Co	Terra Cotta	Lot 28, con. II, Esquesing.
"	Interprovincial Brick Co	Milton Heights	Milton Heights.
"	Milton Pressed Brick Co	Plant No. 1, Milton	Lot 1, con. I, Esquesing.
"	Milton Pressed Brick Co	Plant No. 2, Milton	Con. I, Esquesing.
"	Toronto Brick Co	Milton	Lot 14, con. I, Trafalgar.
Lincoln	Grimsby Brick & Tile Co	Grimsby	Lot 22, con. I, Clinton.
"	Paxton & Bray	230 Queenston St., St. Catharines	Queenston St., St. Catharines.
Peel	Brampton Pressed Brick Co	Brampton	Lot 9, Centre Rd., Chinguacousy.
"	Caledon Mountain Shale Brick Co	Credit Forks	Lot 10, con. IV, Caledon.
"	Cooksville Shale Brick Co	Cooksville	Con. III, Toronto.
"	Interprovincial Brick Co	Terra Cotta	Lot 29, con. V, Chinguacousy.
"	Milton Pressed Brick Co	Streetsville	Streetsville.
"	Streetsville Pressed Brick Co	Streetsville	Streetsville.
Perth	Barnhardt, W. H.	Stratford	Stratford.
"	Stratford Brick, Tile & Lumber Co	Stratford	Stratford.
Thunder Bay district	Fort William Brick & Tile Co	Fort William	Fort William.
Waterloo	Ott Brick & Tile Co	Kitchener	Kitchener.
Wentworth	Bartonville Pressed Brick Co	620 Lister Bldg., Hamilton	Bartonville.
"	Canadian Pressed Brick Co	Bartonville	Bartonville.
"	Crawford Bros	King andMacklin Sts., Hamilton	King and Macklin Sts., Hamilton.
"	Dominion Sewer Pipe and Clay Industries, Ltd.	Mimico	E. Flamborough tp.
"	Frid Bros	Macklin St., Hamilton	Dundas Rd. and Macklin St., Hamilton.
"	Hamilton Pressed Brick Co	Kensington Ave. S., Hamilton	Kensington Ave., Hamilton.
"	Hamilton and Toronto Sewer Pipe Co	R. H. New, Wentworth Ave., Hamilton	E. Flamborough tp.
"	New, Edward	133 George St., Hamilton	Ancaster Rd.
"	Ontario Sewer Pipe and Clay Products, Ltd.	Mimico	E. Flamborough tp.
York	Butwell, Richard	Humber Bay	Humber Bay.
"	De Laplante, J. E	Coleman	Dawes Rd., Toronto.
"	Don Valley Brick Works	Don Valley	Don Valley, Toronto.
"	Morley, W	Coleman	Dawes Rd., York tp.
"	Mt. Dennis Brick Works	2 Ruthven Place, Mt. Dennis	Mt. Dennis.
"	Ontario Paving Brick Co	353 Weston Rd., Weston	Weston Road, Weston.
"	Phippen and Field	150 Dawes Rd., Toronto	Dawes Road, York tp.
"	Pickett (Geo.) Co	Mt. Dennis	Mt. Dennis.
"	Pigott & Co	Eglinton Ave., Mt. Dennis	Mt. Dennis.
"	Price & Cummings	Humber Bay	Humber Bay.
"	Price & Smith	Greenwood Ave., Toronto	Greenwood Ave., Toronto.
"	Russell, Joseph, Estate	40 Blake St., Toronto	Blake St., Toronto.
"	Standard Brick Co	Greenwood Ave., Toronto	Greenwood Ave., Toronto.
"	Sun Brick Co	52 Toronto St., Toronto	Don Valley, Toronto.
"	Toronto Brick Co	Sun Life Bldg., Toronto	Greenwood Ave., Toronto.
"	Wagstaff, A. H., & Co	Greenwood Ave., Toronto	Greenwood Ave., Toronto.

AERIAL PROSPECTING

Aerial prospecting within the province of Ontario has come to the front largely in the years 1928 and 1929 and is perhaps the greatest single aid to the extension of our mining areas that we have ever had.

Previous to 1928, commercial flying companies were transporting prospectors and engineers into our northern areas, but it remained for the following two years to see companies organized purposely to do this work.

Some of the companies now using planes extensively in prospecting and in servicing their outlying camps are: Northern Aerial Minerals Exploration, Limited; Consolidated Mining and Smelting Company of Canada, Limited; Dominion Explorers, Limited; and Brett-Trethewey Mines, Limited. These companies do not all confine themselves to work within the province, but range the whole north country.

Northern Aerial Minerals Exploration, Limited

The largest and best known of these aerial prospectors is N.A.M.E. (Northern Aerial Minerals Exploration) organized by John E. Hammell, with headquarters at Sioux Lookout in the district of Kenora, Patricia portion. Here, under the direction of Gordon Duncan, chief of exploration, and Captain Oaks, chief of flying, the details of this new branch of mining have been worked out.

The following is a résumé, supplied by Mr. Duncan, of the work done in the province by this company during 1929 from the base at Sioux Lookout.

This base is the exploration and aerial headquarters for Canada. Permanent hangars with repair shops, office, and warehouses are located here, and here all major airplane repairs are done.

From this base, two sub-bases were established in the Patricia district for the field operations, the western at Pickle lake and the eastern at Fort Hope. Sufficient food, supplies, and gasoline were flown in during the winter and early spring to last for supplying and servicing of all the field parties during the entire summer. Advantage was thus taken of the fact that the planes can carry a much greater load on skis in the winter time than with floats in the summer.

Eighteen prospecting parties, consisting of two men each, were spotted before break-up on the ice by plane from the Sioux Lookout base. Nine parties were to work out of each base during the summer, under the direction of a mining engineer. Each party was supplied with a sectional canoe which can be carried in the plane, and sufficient grub to last well over the freeze-up period. The mining engineers in charge of each of these divisions made their headquarters for the summer at Pickle lake and Fort Hope. Each engineer had one plane with a pilot and mechanic. His duties were to visit his prospectors regularly, examine any finds they made, replenish their food supplies, move them to more favourable prospecting areas, and aid them in every way possible to make an important mineral discovery.

The area covered during the summer extended from Wunnimun lake on the north to Wendigo lake on the northwest, Birch lake on the west, the Canadian National track on the south, and thirty to fifty miles east of Fort Hope on the east. A little work was carried on south of the track during the latter part of the season.

This seems a tremendous area to be covered by eighteen prospecting parties during the summer. Unfortunately, however, the area proved on the whole very disappointing, due to the tremendous areas which consisted of granite, muskeg, and glacial drift boulders and sand. These areas could be quickly eliminated, from the air, without landing a prospecting party. The only available geological maps had the geology shown only along the main waterways. These were used as key maps, but the greenstone bands shown along the main waters proved very disappointing on being explored inland. They proved to be, in the majority of cases, very limited in massive granitic areas. Especially was this the case in the area north of Fort Hope.

It can consequently be seen that large areas could be quickly eliminated from prospecting by the engineer, whose duty it was also to carry on aerial reconnaissance, mapping out the favourable and unfavourable areas.

The most remote areas were prospected in the early season and, as the season progressed, the prospectors were continually being moved towards the track. Larger bands of greenstone were encountered nearer the track than in the remote areas, but there had been previous prospecting "booms" in the majority of bases; consequently, these bands required more detailed work if discoveries were to be expected.

Numerous discoveries were made. In each case the discovery was carefully examined by the mining engineer in charge. In cases where the discovery made sufficient promise, the mining engineer in charge of development was advised and a working party of not more than four men

were flown to the discovery and surface development started. In this way the relative value of a prospect was learned at once, and unnecessary expenses of staking and recording were eliminated.

It can readily be seen that a tremendous area can be prospected by one prospecting party with the use of aeroplanes, compared with the old method of paddling and packing in supplies and searching from place to place for "formation." In aerial prospecting, the prospectors are landed in an hour or two with their food and supplies and can start prospecting immediately. They are given a good look at the formation and topography from the air before they land. Quartz veins and iron oxidations are easily discerned in many cases. When they have covered the area, a few hours will land them in a new favourable area and they can carry on their work.

The following is a report by Mr. Duncan on the company's Crow River property, district of Kenora, Patricia portion, which was located in the 1928 season.

Development work was carried on during the summer on this important gold property, the discovery being made the summer before. Intensive surface exploration work opened up important discoveries. The area, however, is covered to such an extent with muskeg that most of the important ground could only be explored by drilling.

A diamond-drilling programme was started and the first three holes along the main showing, where rich values had been found, were very encouraging, a much greater width of the ore being shown by the cores with the values remaining high. Free gold was often noticed in the drill core.

The ore has been picked up in the muskeg with the first hole, and further drilling is being carried on in this direction, in order to determine how far the ore extends.

COPPER

Amity Copper and Gold Mines, Limited

The Amity Copper and Gold Mines, Limited, operated during 1928 at Boston Creek, Pacaud township, district of Timiskaming, with a force of 20 men. The capital is 3,000,000 shares of $1 par value. D. O. Johnson is president; J. E. Russell, vice-president; Gideon Grant, secretary-treasurer. Samuel Squires, F. L. McLean, and R. Jackson are directors. Sidney A. Pain is manager. The head office of the company is at 501 Lumsden Building, Toronto.

During 1928, the shaft was sunk from the 250-foot level to the 600-foot level; 76 feet of raising and 100 feet of winze-sinking was done from the 250-foot level; there was also 300 feet of drifting done on the 250-foot level.

Camp buildings, consisting of power-house, storehouse, dry-house, and magazine, were erected during the year.

Patterson Copper Mines, Limited

Patterson Copper Mines, Limited, operated their property in Pacaud township, district of Timiskaming, with a force of 20 men. During 1928 a shaft was sunk 20 feet and the following buildings were constructed: office, 25 by 30 feet; power-house, 30 by 50 feet; blacksmith shop, 20 by 25 feet; shaft-house, 21 by 30 feet; cookery and bunk-house, 28 by 50 feet; stable, 17 by 20 feet; cap-house, 6 by 10 feet; thaw-house, 8 by 8 feet.

Dana H. Porter was president of the company, and R. A. Whitely was treasurer. The head office is at 504 General Assurance Building, Toronto. R. M. Treloar was manager until October 15, 1928, and was succeeded by W. E. Simpson.

Shield Development Company, Limited

The Shield Development Company, Limited, has an authorized capitalization of 2,000,000 no par value shares, of which 1,100,000 have been issued. N. R. Fisher is president of the company; James Cooper, secretary-treasurer; and Alistair Frazer, vice-president. S. Gzowski, J. D. Patterson, and J. Jones are on the board.

The Tip Top holdings consist of a group of claims in Thunder Bay district about 9 miles south of Kashabowie. The workings are on claim K.65. Some years ago the property was worked and a considerable amount of copper ore was shipped. This was transported from the mine over narrow gauge track to the C.N.R.

The Shield Development Company decided to re-condition the light railway, as a means of access to the Moss property, some 15 miles southwest of the Tip Top mine. Later, with the improved condition of the copper market, it was decided to dewater and explore this property also. The original workings at the Tip Top mine consisted of an inclined shaft 200 feet deep with levels cut at 50, 100, 150, and 200 feet. Stopes were carried from the 100-foot level to surface, close to the shaft.

At the time of the last visit to the camp present operations had advanced development work about 150 feet on the three lower levels. There had not been sufficient work done at the time to form any conclusions as to the amount of ore available. However, the management since reports that two shoots have been opened up on the 200-foot level. The better of the two shows ore across a width of 30 feet; the other is reported to be slightly narrower. Average grade is said to be about 3 per cent. copper.

Surface equipment and buildings include a telephone line to Kashabowie, machine shed, stable, power-house, rock-house, and powder magazine. The camps, which are on the shore of Round lake about half a mile from the mine, consist of cookery and two sleep camps. A section of one of the sleep camps has been arranged for an office.

The company had the misfortune to lose the power-house by fire on April 29, 1929. A new one was built, and work proceeded with as little delay as possible.

Where the narrow-gauge line comes out to the Canadian National Railway, loading bins have been erected. The ore cars as they come from the mine will be elevated on an incline and dumped into bins. Chutes from the bins will load directly into railway cars.

J. G. Harkness is manager of the Tip Top mine, and W. F. Fancy is foreman. The company employs about 30 men.

Sudbury Basin Mines, Limited

Operations of the Sudbury Basin Mines, Limited, at the Cheney mine, a copper prospect in Gould township, district of Algoma, were suspended on March 4, 1929. To this date approximately 1,625 feet of drifting and 860 feet of crosscutting had been done on the 150-foot level.

Jos. H. Travers was mine superintendent and employed a force of about 40 men.

The company's capitalization and names of its officers are given on page 82 of this report.

White Lake Mines, Limited

The holdings consist of 10 claims (M.299-308) in township 1A in the Mississagi Forest Reserve. A road built and maintained by the Carpenter-Hixon lumbering firm makes the property accessible by automobile from the town of Iron Bridge, which lies about 45 miles by road southwest of the claims.

The claims were staked in 1926 by L. Bourke and W. Mills, of Blind River, accompanied by two Indians who had made the original discovery. Later Mills

and Bourke bought out the interest of the Indians and optioned the property to the Peterson Cobalt Mines, Limited. In the summer of 1928 the Marcus Daly Estate became interested in the property and did considerable stripping. The following winter a company known as the White Lake Mines, Limited, was incorporated.

In the spring of 1929, the new company built camps, installed a mining plant, and did some stripping and underground work. Veins had been exposed on the surface and it was decided to explore these by driving two adits from about lake level in preference to sinking a shaft. At the time of the last visit to the camp, July 24, 1929, the east adit had been driven on the break for 205 feet. The west adit crosscut the formation for a distance of 100 feet, at which point the break was struck and the adit driven along the vein 159 feet farther. Neither drift had advanced far enough to be vertically under the veins exposed on surface.

The mining plant consists of a Sullivan compressor with 600 cubic feet displacement, directly connected to a 120 h.p. Fairbanks Morse engine of the Diesel type. The blacksmith shop is housed in the same building as the compressor and consists of a Sullivan sharpener and a hand forger. Camps consist of two bunk-houses, cookery, and an office with quarters for the manager. A dry-house is in course of construction.

About 35 men are employed, 11 of whom are working underground. O. G. Carstens, Blind River, is manager.

The officers and directors of the company are: W. A. Lamport, president; J. C. Allan, secretary-treasurer; Donald G. Miller, and W. J. McCallum, directors. Donald G. Miller is consulting engineer.

The following statement of assets and liabilities is taken from the company's annual report, dated April 30, 1929.

ASSETS

Mining properties (satisfied by the issue of 950,000 shares at par)		$950,000.00
Buildings, machinery and equipment:		
Camp buildings	$1,172.12	
Machinery and equipment	18,862.69	
		20,034.81
Exploration, development, and office expenses		26,245.64
CURRENT ASSETS:		
Cash on hand and in banks	$2,510.10	
Inventory of supplies	2,372.36	
		4,882.46
Total		$1,001,162.91

LIABILITIES

CAPITAL STOCK:		
Authorized 2,000,000 shares of $1 each		$2,000,000.00
Issued 1,987,606 shares of $1	$1,987,606.00	
Less 802,250 shares held in escrow in terms of agreement dated February 28, 1928	802,250.00	
	$1,185,356.00	
Deduct discount on 235,350 shares	189,588.00	
		995,768.00
CURRENT LIABILITIES:		
Accounts payable	$4,620.25	
Advance account	774.66	
		5,394.91
Total		$1,001,162.91

NOTE.—In terms of an agreement dated February 24, 1928, the company agrees to pay the sum of $240,000 as further consideration for the mining properties, this amount to be satisfied by the application and payment of 30 per cent. of the net profits of the company.

COPPER-ZINC-LEAD

Sudbury Basin Mines, Limited

The officers of the company are: Jos. Errington, president; H. Lindsley, vice-president; H. Whittingham, secretary-treasurer; C. N. Thompson, assistant secretary-treasurer.

The Head Office is at 503 Excelsior Life Building, Toronto. The authorized capital is 2,000,000 shares of no par value.

The company was incorporated in Ontario in 1927 to develop claims which had been acquired by Joseph Errington in the Sudbury basin at Vermilion lake. Since incorporation the company has added to its property holdings and acquired in addition substantial share interests in other companies, which place it in the position of a holding company.

A recent unofficial statement sets forth its holdings in other companies as follows:—

Company	Shares	When acquired
Falconbridge Nickel Mines, Limited	1,250,000	1928
Sherritt-Gordon Mines, Limited	219,712	1927
Malartic Gold Mines, Limited	148,000	1927
Manitoba Basin Mining Company, Limited	33,334	1928
Osisko Lake Mines, Limited	51,350	1927
Bathurst Mines, Limited	10,000	1927
	Units	
T. W. Bathurst, Limited	1,175	1927
	Per cent. interest	
Oxford Lake Mines, Limited	40	1928
Manitoba Copper Company, Limited	30	1928

The holdings at Vermilion lake, Sudbury district, consist of 5,000 acres. This is the main operation and includes practically all of Vermilion lake and much other territory. The company's holdings adjoin those of the Treadwell Yukon Company on the west. Although no underground work has been done to date, surface exploration and diamond-drilling have definitely proved the existence of large deposits of copper-zinc-lead on this property. The indicated ore zone is 2,000 feet in length and contains two parallel ore bodies. Diamond-drilling at short intervals has been done on a section 1,400 feet in length and has indicated ore to a depth of 500 feet with widths ranging up to 100 feet.

During the winter of 1928-29 the company's development programme called for a diamond-drilling campaign. Three drills were placed in operation, two on the ice and one on the shore. Success in picking up the extension of the ore zone to the southwest is reported.

Joseph Errington announced in December, 1928, that the diamond-drilling and development work which had been carried out that year indicated that the company had picked up the extension of the Treadwell Yukon ore.

The account of operations at the Cheney mine appears on page 80 of this report.

Treadwell Yukon Company, Limited

The directors of the Treadwell Yukon Company, Limited, are: F. W. Bradley, C. A. Norris, C. D. O'Sullivan, J. W. Crosby, F. A. Hammersmith. The officers are: F. W. Bradley, president; C. D. O'Sullivan, first vice-president; C. A. Norris, second vice-president; J. W. Crosby, third vice-president; F. A. Hammersmith, secretary-treasurer; W. D. Miracle and D. L. Feathers, assistant secretary-treasurers—all of San Francisco, Cal. V. R. Prather, Wilmington, Del., is assistant secretary.

The mine management staff of the various enterprises is as follows: P. R. Bradley, consulting engineer, San Francisco, Cal.; Livingstone Wernecke, manager, Wernecke Mines, Yukon Territory; Joseph Errington, manager, Errington mine, Ont.; V. C. Clauson, general superintendent, Errington mine, Ont.; W. H. Blackburn, manager, Nevada Mines, Tyko, Nev.

The report issued by the president, F. W. Bradley, under date of December 31, 1928, shows the division of the capital stock of 1,500,000 common shares, as follows: Bunker Hill and Sullivan Mining and Concentrating Company, 750,000 shares; Alaska Treadwell Gold Mining Company, 329,683 shares; Alaska Mexican Gold Mining Company, 113,632 shares; Alaska United Gold Mining Company, 146,573 shares; individuals, 160,112 shares.

Errington Mine

Surface Improvements.—No. 3 shaft was started during 1928. The surface equipment for this work includes headframe, electric hoist, electrically driven compressor, blacksmith shop, dry-room and heating plant, together with boarding and sleeping accommodation for the crew.

A new headframe was built at No. 1 shaft, and two steam-heating plants were erected to heat all the buildings and shops in the vicinity of Nos. 1 and 2 shafts. Additions were made to various buildings, including the assay office, warehouse, carpenter shop, and concentrate bins.

The pilot mill was completed and put into operation April 21, 1928. The 1928 annual report of the company gives the following interesting information:—

The coarse crushing plant consists of one 10- by 20-inch jaw crusher and one set of 16- by 20-inch rolls, operating in closed circuit with a Hummer screen; the fine-grinding equipment consists of two 5- by 7-foot Allis-Chalmers ball mills and two Dorr classifiers. The flotation equipment originally installed consisted of 30 Minerals Separation Sub-A flotation cells with Tex rope drive, but additions made during the year have brought the total number of cells up to 60. The filtration plant consists of three Oliver filters, one for each zinc, copper, and lead concentrate. The mill is being worked up to full capacity as fast as its metallurgical efficiency can be improved. The new cells added from time to time aided in bringing the extraction from a low point at the start to about 60 per cent., so that by February 15 last the mill capacity was substantially increased; as the extraction is increased to 70 per cent. and better the mill will reach its expected maximum capacity of 300 tons per day. During the year, 32,092 tons of ore were milled, having an average assay of 0.029 ounces gold, 1.79 ounces silver, 1.02 per cent. copper, 1.12 per cent. lead, and 5.75 per cent. zinc. Owing to the experimental character of the milling operations, the recovery of the metallic content of the ore was low, and some of the concentrates produced were not marketable. The record of concentrate production and shipments is as follows:—

	Assay content					
	Tons	Gold	Silver	Copper	Lead	Zinc
COPPER CONCENTRATE		ounces	ounces	per cent.	per cent.	per cent.
Produced	1,081.96	0.17	8.78	11.49	6.33	6.48
Shrinkage and unmarketable	366.14	.17	6.70	9.30	5.90	6.38
Shipped	715.82	.17	9.84	12.61	6.55	6.53
LEAD CONCENTRATE						
Produced	513.15	0.20	13.83	2.78	29.30	7.77
Shrinkage and unmarketable	167.93	.18	13.06	3.18	25.63	8.13
Shipped	345.22	.25	15.42	2.07	35.88	7.01
ZINC CONCENTRATE						
Produced	2,744.61	0.04	2.94	1.26	1.06	45.27
Shipped	77.05	.03	3.25	1.69	.84	45.06
Stock on hand	2,667.56	.04	2.92	1.24	1.07	45.29

All marketable copper concentrate was shipped to Laurel Hill, Long Island, and all marketable lead concentrate to Maurer, N.J.; but the smelter returns from these shipments were not received in time to be included in the financial statements for the year 1928. There were two small shipments of zinc concentrate for experimental purposes, but the bulk of the zinc concentrate must remain on the ground until the opening of navigation on the St. Lawrence river this spring, when it will be shipped to European zinc plants.

Commenting on the development work completed during 1928, the report continues:—

Development Work.—No. 1 shaft was sunk 299 feet to a depth of 619 feet. The 500-foot level station was cut out, ore and waste pockets installed below this level, and a start made on the main crosscut from the level.

No. 2 shaft was sunk 75 feet to a depth of 675 feet, and all station facilities provided for a 500-foot level. The main crosscut on this level was driven northwest for 1,634 feet and intersected four veins, each about 60 feet in width.

No. 3 shaft was sunk to a depth of 409 feet, a station cut at 375 feet, and a crosscut started for the vein.

While nominally 300 feet below the collars of Nos. 1 and 2 shafts, the 300-foot level is probably not more than 150 feet below the silt-covered apex of the vein system, and for this reason the work done on the 300-foot level in Nos 1 and 2 shaft areas was chiefly for the purpose of prospecting and determining the lateral extent of the Ollier, the Larson, the Pit, and the Hargraft ore bodies, and partly to facilitate mining these ore bodies. The Ollier stope at the end of the year had a proved horizontal cross-section of 14,500 square feet, and the average assay of all samples of ore drawn from this stope was 0.033 ounces gold, 2.08 ounces silver, 1.08 per cent. copper, 1.20 per cent. lead, and 6.4 per cent. zinc. The Larson stope had a proved area of 4,000 square feet in horizontal cross-section and the average assay of the ore drawn from this stope during the year was 0.03 ounces gold, 1,55 ounces silver, 0.91 per cent. copper, 1.1 per cent. lead, and 5.4 per cent. zinc. The Pit ore body proved to be but 120 feet long by 4 feet wide, although the average width of the outcrop of this ore body is 20 feet. Samples taken of the ore drawn from this stope averaged 0.045 ounces gold, 2.15 ounces silver, 1.05 per cent. copper, 1.5 per cent. lead, and 6.9 per cent. zinc. But little work was done on the Hargraft ore body, so its dimensions are only partially outlined at this time; as far as known, this ore has a length of 120 feet and a width of 15 feet.

The main crosscut on the 500-foot level, No. 1 shaft, was advanced 292 feet, and in this distance three veins were intersected; these veins did not show commercial values at the points of intersection, but they are showing improved values as they are being further explored by east and west drifts.

The four veins intersected by the crosscut on the 500-foot level have been named Romig, Christie, Rheaume, and North. The Romig vein was drifted on a short distance both to the east and to the west in low-grade vein filling similar to that found by the diamond-drill cores from this vein.

The east and west drifts on the Christie vein have opened up an ore body 550 feet long without the eastern limit having yet been reached. So far, the average width is 12 feet, and the average assays are 0.038 ounces gold, 2.03 ounces silver, 0.60 per cent. copper, 1.0 per cent. lead, and 4.6 per cent. zinc. This Christie ore body has just been further explored by diamond-drilling in

depth. A drill hole at 70 degrees intersected the vein about 200 feet below the 500-foot level and cut 178 feet of vein section; the first 68 feet of this section was barren, the next 70 feet assayed 1.05 per cent. copper, 0.016 ounces gold, and 0.83 ounces silver; the next 40 feet assayed 1.08 per cent. copper, 0.3 per cent. lead, 3.2 per cent. zinc, 0.018 ounces gold, and 0.75 ounces silver.

The Rheaume vein, east and west drifts, have disclosed ore over a length of 475 feet, with an average width of 12 feet; this ore still continues beyond the face of the east drift. The average assay results from all samples so far taken from this ore body are 0.038 ounces gold, 2.3 ounces silver, 1.70 per cent. copper, 1 per cent. lead, and 3.5 per cent. zinc.

Three ore bodies with an aggregate length of 175 feet and an average width of 12 feet have been found by the North vein drifts, and the averages of all assays taken in this area are 0.038 ounces gold, 2.3 ounces silver, 0.36 per cent. copper, 1 per cent. lead, and 6 per cent. zinc.

In general, the results of the development work conform to the results of the diamond-drilling in the same area, with the exception that the underground work has proven greater regularity in ore occurrence than the drilling indicated. The No. 2 shaft area, according to the drilling results, is lower in grade than either the No. 1 or the No. 3 shaft area, and because a large proportion of the mill feed came from development work in the No. 2 shaft area the mill heads are below the normal average for the entire mine as indicated by the drilling.

The crosscut from No. 3 shaft on the 400-foot level has been advanced 1,475 feet, at which point the vein was struck. The vein proved to be 114 feet thick, but at the point cut does not contain commercial values. A raise is now being driven on the vein to intersect the ore cut by diamond-drill hole A 28.

The total development work done during the year comprised 783 feet of shaft work, 10,750 feet of drifts, raises, and crosscuts; and in addition there was 1,703 feet of drifting and 32 feet of raising for preparatory mining.

Future Development Work.—It is planned to sink to the 1,500-foot level and to have that horizon become the next main prospecting and working level for all shafts. Intermediate levels between this level and the 500-foot level will subsequently be driven as required for economical extraction of ore.

GOLD

Abba Mines, Limited

Abba Mines, Limited, operated their property in the township of Teck, district of Timiskaming, with a force of 15 men, during the first eleven months of 1928.

The officers and directors are: H. T. Pyke, president; W. E. Inkpen, secretary-treasurer; Wm. S. Coupland, vice-president; George A. Pyke and Estelle M. Pyke, directors. The head office is at 347 Bay Street, Toronto.

During the year camps were built and a plant installed. The shaft had been sunk to a depth of 115 feet when the mine closed in November, 1928.

Alschbach Gold Mining Company, Limited

The Alschbach Gold Mining Company, Limited, operated their property in the township of Grenfell, district of Timiskaming, with a force of 9 to 17 men.

During 1928 camps were built, the plant was installed, and the shaft was sunk 30 feet. From January 1, 1929, until the mine closed in May, 1929, the shaft was sunk to the 150-foot level and 200 feet of drifting and crosscutting was done.

The head office is at New Liskeard, and Clarence Alschbach is manager.

Ankerite Gold Mines, Limited

This company is capitalized at $2,000,000, divided into shares of $1 par value each, of which $1,500,000 has been issued. Together with these shares there is a bond issue of $500,000. The company owns three claims in the township of Deloro, district of Cochrane, known as M. E. 60, 61, and 62.

Early in 1926, the Ankerite Gold Mines, Limited, was formed to acquire the assets of the North American Gold Corporation. In the new company the Porcupine Goldfields Development and Finance Company, Limited, holds an 86⅓ per cent. interest, and the balance belongs to the North American Gold Corporation.

The officers of the Ankerite Gold Mines, Limited, are as follows: F. C. Baker, president; J. P. Ronaghan, secretary; F. Marsic, treasurer, all of New York. Additional directors are: C. E. C. Smith, National Club, Toronto, and W. S. Walton, Royal Bank Building, Toronto. The head office address is 233 Broadway, New York.

W. H. Seamon is manager at the property. During the year the following development work was completed: drifting and crosscutting, 1,436 feet; raising and winzing, 178 feet.

Total development on the property to January 1, 1929, is as follows: sinking, 1,302 feet; drifting and crosscutting, 12,696 feet; raising and winzing, 986 feet.

During 1928, some 66,606 tons of ore was milled with a bullion production of $289,960. During the year the average number of men employed was 101, distributed as follows: mill, 12; surface, 19; mine, 70.

Barry-Hollinger Gold Mines, Limited

Barry-Hollinger Gold Mines, Limited, operated their property at Boston Creek, Pacaud township, district of Timiskaming, during 1928, with a force of 75 men. The authorized capital of this company is 4,000,000 shares of $1 par value. H. C. Crow is president; R. Fennell is secretary-treasurer. Dr. E. H. Greene, James Dunn, and P. A. Barry are directors. Jas. Houston is manager.

The mill treated 23,059 tons of ore, from which $111,767.21 was recovered.

Development work consisted of the following: drifting, 1,085.5 feet; crosscutting, 459 feet; raising, 240 feet; sinking, 262.5 feet.

Bathurst Mines, Limited

The authorized capital of this company is 4,000,000 shares of no par value, of which 2,225,006 were issued at the end of 1927. Of these shares, 950,000 were held by T. H. Bathurst, Limited, and 500,000 by the Price-Logan Gold Mines, Limited.

The officers of the company are: T. W. Bathurst, president; E. P. Gleeson, vice-president. T. H. Rea, R. H. New, and Dr. F. Quin are directors. The head office is at 51 Sparks Street, Ottawa, and the mine office address is Narrow Lake, Ont.

The company's holdings include 30 claims of the Price-Logan, Daimpre, Bathurst, and Colburn groups, located about Car and Bathurst lakes, Skinner township, district of Kenora (Patricia portion).

The following buildings have been constructed of logs: two sleep camps, 20 by 20 feet; cookery, 36 by 36 feet; office, 24 by 18 feet; power-house, 40 by 37 feet; dry-house, 18 by 12 feet; blacksmith shop, 18 by 12 feet; residence, 18 by 12 feet; headframe, 43 feet in height; and staff-house, 16 by 16 feet.

The following plant was installed and placed in operation during the year: two 60 h.p. locomotive-type boilers; one Canadian Ingersoll-Rand air compressor, straight-line type FR-2, with a capacity of 528 cubic feet per minute; one Canadian Ingersoll-Rand hoist, 7 by 6 inches, type SSR. This hoist was replaced by an 11- by 8-inch of the same type in the new year.

The blacksmith shop is equipped with a Rand sharpener and furnace.

During the year the shaft was sunk 225 feet and one level broken off at the 200-foot horizon. When inspected in July, 1929, drifting on this level amounted to 1,741 feet, with 1,291 feet of crosscutting.

On June 15, 1929, a small mill was placed in operation from which $2,500 had been recovered, being production from a rich pocket on the surface and some underground ore. Mill equipment and practice is as follows: A 9- by 7-inch jaw crusher feeds direct to two steam stamps discharging to two copper plates, 7 by 3 feet, which overflow to a canvas table, 8 by 12 feet, where some fine gold and concentrates are caught.

When inspected, operations had been curtailed somewhat, and only twelve men were employed on the property. Frank Carnegie is manager.

Beardmore Gold Mines, Limited

A prospectus issued by the Beardmore Gold Mines, Limited, during the latter part of 1928, sets out the following particulars concerning the official organization: authorized capital, 5,000,000 shares of $1 par value each; shares issued for properties, 2,600,000; treasury stock, 2,400,000 shares.

The officers and directors are: Chas. D. Bertram, president; F. C. Sutherland, vice-president; Joseph Montgomery, secretary-treasurer; W. D. Drill, W. J. Perkin, Robert Thompson, directors.

The head office is at 207 Metropolitan Building, Toronto, Ont.

Commenting on the development work, at the time of its publication, the prospectus says, in part:—

> On the Powers vein two shafts have been sunk. No. 1 shaft was sunk with hand steel to a depth of approximately 45 feet. No. 2 shaft was sunk to a depth of 100 feet and a station cut at this horizon. Good ore was found all the way down in the shaft. The vein widened out from 15 inches on surface to 15 feet at the 100-foot level. Drifting both east and west on the ore is now going on, and it is the expectation of the mine superintendent to do about 150 feet of development work on this level this month. Porphyries are very much in evidence at this horizon. The plans of the management call for approximately 500 feet of development at this horizon, when shaft-sinking will again be resumed and the same plan of operation carried out on the 200-foot level.

At the time of the last visit to the camp, August 16, 1929, total development work was as follows: shaft No. 1, depth 45 feet, no lateral work; shaft No. 2, depth 200 feet, 92 feet of drifting on the 100-foot level and 56 feet of drifting on the 200-foot level.

The mining plant, located at No. 2 shaft, consists of a portable C. P. compressor, with a rated capacity of 220 cubic feet per minute; a Beaty 5- by 7-inch steam hoist attached to an upright boiler; and a hand forge. An open headframe stands over No. 2 shaft.

The camps include a cookery and sleep camps for 20 men, an office and superintendent's quarters combined, a root-house, a warehouse, and a stable.

The holdings consist of 32 claims in all. The shaft is on claim No. 4,803 and is a mile and a half distant from the town of Beardmore, on the Port Arthur–Long Lac division of the C.N.R.

W. A. Roberts, Beardmore, is manager.

Bidgood Consolidated Mines, Limited

Bidgood Consolidated Mines, Limited, has a capital of $3,000,000, in shares of $1 par value. The mine is in Lebel township, district of Timiskaming. Leo Erenhous is president; M. J. Wallace, vice-president, and W. B. McPherson, secretary-treasurer.

John McPhee is manager, and 40 men are employed.

The work for 1928, in the No. 1 shaft area, comprised 1,370 feet of drifting, 1,097 feet of crosscutting, 260 feet of raising, and 135 feet of sinking. The No. 1

shaft was sunk to a depth of 725 feet. The work was all done on the 300-, 400,- and 600-foot levels.

An office and staff-house, 26 by 40 feet, and one electric substation, were erected.

In the No. 2 shaft area, the work consisted of 2,355 feet of surface trenching, 1,729 feet of diamond-drilling, and 75 feet of sinking.

The following buildings were erected: power-house, 29 by 40 feet; boiler-house, 24 by 32 feet; Fuse- and cap-house, 8 by 10 feet; thaw-house, 8 by 10 feet; powder magazine, 10 by 12 feet; pump-house, 7 by 6 feet; blacksmith shop, 12 by 16 feet; shaft and headframe, 23 by 40 by 50 feet high.

Blue Quartz Gold Mines, Limited

This company has an authorized capital of $3,000,000, divided into shares of $1 par value. The officers are: H. C. Crow, president; J. A. Tuck, vice-president; Miss E. V. Marett, secretary-treasurer. The directors are: A. G. Parker, John Hallam, A. J. Bolton, W. W. Butler, J. H. W. Crow. The head office is at 1104 Northern Ontario Building, Toronto.

The property at Painkiller lake, Beatty township, district of Cochrane, was operated until June 12, 1928, when all work was suspended.

The total development work on the property is as follows: sinking, 750 feet; raising, 200 feet; crosscutting, 2,000 feet; drifting, 1,500 feet.

The camp consists of the following buildings: power-house, shaft-house, blacksmith shop, carpenter shop, storehouse, bunk-house, sleep camp, powder magazine, pump-house, stable, assay office, mine office, manager's bungalow, and two cottages for workmen.

Bobjo Mines, Limited

This company is capitalized at $5,000,000, in shares of $1 par; 2,948,005 shares have been issued.

The officers of the company are: R. J. Josey, president; L. K. Fletcher, L. Erenhous, F. D. Reid, and J. Parker, directors. The head office of the company is at 372 Bay Street, Toronto. The mine office address is, c/o Western Canada Airways, Limited, Sioux Lookout.

The property consists of 43 claims in Dent township, East Clearwater lake section of Kenora district (Patricia portion), and was formerly part of the Laidley claims optioned to the Coniagas Mines, Limited.

The following notes on the property are taken from the report of E. L. Bruce on the Gold Deposits of Woman, Narrow and Confederation Lakes:[1]—

> The largest deposit of quartz yet opened up occurs west of the porphyry dike on claim K.R.L. 6,631. It consists of an irregular mass, with its greater length north and south. From the eastern margin a large number of small quartz veins, ranging from stringers to veins two or three inches wide, curve away to the east towards the porphyry dike, which, at the north end of the quartz dome, is 60 feet distant from it.
>
> The wall rock is greenstone, part of which is spherulitic. Northwest of the quartz mass a small regular quartz vein strikes slightly west of north, cutting diorite. A small lamprophyric dike cuts through it without displacing it.
>
> The quartz is a white to bluish variety in which pyrite is sparingly disseminated. Native gold has been recognized at several places. Microscopic examination shows that the quartz has been fractured and cemented by later quartz, which forms a fine-grained mosaic around the fragments.

In the above-mentioned area a high-grade pocket was found on surface. The company then diamond-drilled the area with a view to picking up the formation and determining a shaft site.

[1]Ont. Dept. Mines, Vol. XXXVII, pt. 4, 1928, p. 46.

A complete mining plant was taken to the property early in 1929. This plant consists of two 70 h.p. boilers, one Canadian Ingersoll-Rand PRL compressor, 14 by 9 by 12 inches, 600 cubic feet per minute capacity, a Walker Bros. double-drum hoist, capable of sinking 500 feet, and a small generator for camp lighting. The blacksmith shop is equipped with a steel sharpener. Camp buildings for the accommodation of forty men have been erected.

At the time of inspection in July, 1929, a two-compartment shaft had been sunk 270 feet, with levels at the 125- and 250-foot horizons, on each of which considerable drifting and crosscutting had been done.

A small mill, consisting of a 3- by 2½-foot ball mill of the clean-up barrel type and a 6- by 8-inch jaw crusher driven by a small steam engine is in operation on the property. This is treating high-grade ore from the surface pocket. The bullion is recovered in the assay plant just recently put up.

When the property was inspected, twenty-eight men were employed. G. A. Howes is superintendent.

Brett-Trethewey Mines, Limited

The authorized capital of this company is 3,000,000 shares of $1 par value, of which 1,180,000 are issued. The officers of the company are: J. B. Tyrrell, president and managing director; F. L. Trethewey, vice-president; S. W. Black, secretary-treasurer; with G. Grant and R. G. O. Thompson, directors. E. T. Corkill is consulting engineer. The head office is at 43 Victoria Street, Toronto.

The company owns 24 claims in Barnet township, Cochrane district, and 16 claims in Clifford and Ben Nevis townships, district of Timiskaming. The work in 1928 comprised 8,590 feet of trenching and 50 test pits about 12 feet deep. The average number of men employed for the year was 6.

British Canadian Mines, Limited

British Canadian Mines, Limited, has an authorized capital of $3,000,000, in shares of $1 par value.

The officers are: J. M. Aitken, president; F. McQueen, secretary-treasurer. The directors are: W. W. Canham, A. G. Halstead, E. P. Barry, W. D. McKay, and H. F. Coombs.

The head office of the company is at 8 Bloor Street East, Toronto.

The Foley mine is situated on the shore of Shoal lake, about 6 miles south of Mine Centre, on the Canadian National railway, in Rainy River district, and consists of 193 acres. The company also holds in the neighbourhood an additional 1,164 acres of patented land under option or mining rights.

There is direct water transportation on Shoal lake from Fort Frances to the Foley mine.

The mine is being operated in a small way at present by the British Canadian Mines, Limited. At the time of the last inspection trip, August 7, 1929, a force of three men was doing little more than keeping the workings pumped out. The work on the property this year consisted of sinking a winze some 20 feet below the 200-foot level.

A section from a late prospectus gives the early history:—

The property was known as the "Foley Mine" and was operated by the Foley Mines, Limited, from 1894 to 1898. A 20-stamp mill was erected and operated on the property, and bullion to the value of about $100,000 was shipped. All supplies at that time were hauled in from Tower, Minn., a distance of 110 miles, under excessive costs. Two main shafts were sunk on the property, one to the 420-foot level, and some 3,200 feet of lateral work together with extensive surface stripping was done, developing 40,000 tons of proven ore.

A winze has since been sunk from the 420-foot level to the 850-foot level, opening the 500-, 600-, 700-, and 800-foot levels. Considerable drifting has been done on some of these levels. Recently it was decided to raise from the 420-foot level to surface above the winze. This work was carried some 160 feet and then stopped. The winze, previously mentioned, below the 200-foot level is being sunk to connect with the shaft raise above the 420-foot level. The present intention is to complete this shaft through to surface.

A mill sufficiently large to house machinery to handle 100 tons a day was built some years ago. Installation of machinery was commenced, but to date only a ball mill and a tube mill have resulted. The power plant which is adjacent to the mill (some 2,000 feet from the mine) is in good condition and contains the following machinery: a Pennsylvania belt-drive compressor, with a capacity of 550 cubic feet; two 120 h.p. semi-Diesel-type engines.

Buckingham Mines, Limited

The company owns a group of claims in Fawcett and Asquith townships, West Shining Tree area, Sudbury district.

J. E. Day, K.C., is president of the company, and W. H. Funk is vice-president. The head office of the company is 116 Federal Building, Toronto.

Douglas A. Mutch took charge of the property, as consulting engineer, in July, 1928. The old inclined shaft was straightened to the 160-foot level and some lateral work done. Erratic values were encountered, but no commercial ore was developed.

In the spring of 1929 a contract was let, calling for a minimum of 3,000 feet of diamond-drilling. The first hole was reported to have been drilled to a depth of 651 feet. Well-mineralized quartz was encountered, but commercial values were not forthcoming. No. 2 hole was laid out to cut the vein at a depth of 500 feet.

The company ceased operations in September, 1929, and at the time of writing, October, 1929, are reported to be endeavouring to re-finance.

The present capitalization is 4,000,000 shares of one dollar par.

Cambro-Kirkland Mines, Limited

Cambro-Kirkland Mines, Limited, has an authorized capital of 3,000,000 shares of $1 par value. The head office of the company is 32 Imperial Bank Building, 171 Yonge Street, Toronto. The property is in Lebel township, district of Timiskaming.

Gordon F. Summers is president; Leo Erenhous, vice-president; and Wm. B. McPherson, secretary-treasurer. W. B. Airth is manager.

In 1928 the shaft was sunk from the surface to the 800-foot level. Stations were cut on the 350-, 500-, 650-, and 800-foot levels. The average number of men employed was 35.

Canusa Mining and Exploration Company, Limited

This company is capitalized at $3,000,000, in shares of $1 each. There are 1,350,000 shares issued. The following is a list of officers: George J. Miller, Swanton, Ohio, president; T. R. Deacon, Toronto, secretary; Robert Schram, Detroit, treasurer. George J. Miller, Robert Schram, A. T. Waterfall, George Neukom, and Peter Maclaren are directors. The head office of the company is at 1701 Metropolitan Building, Adelaide Street East, Toronto. The mine office is at Timmins, Ont.

The property consists of 6 claims in Whitney township, district of Cochrane. These claims were formerly known as the Scottish-Ontario and were first worked in the early days of the Porcupine camp. Under this name and operated by a local syndicate, $5,893 was recovered, in a small mill, from an open cut, during 1927. The early operators sunk a shaft 90 feet and did 160 feet of crosscutting and 260 feet of drifting on a vein cut 50 feet north of the shaft.

In the summer of 1928, the present company optioned the property from the syndicate and erected the following surface plant: headframe 50 feet high, enclosed; power-house, 36 by 25 feet; change-house, 18 by 20 feet; blacksmith shop, 18 by 20 feet; tank-house and store-room, 16 by 16 feet; assay office, 16 by 30 feet; transformer house, 16 by 16 feet; thaw-house and magazine. The plant equipment consists of a locomotive-type boiler for heating; a Sentinel compressor, capacity 850 cubic feet per minute, driven by a 125 h.p. motor; a Jenckes hoist electrically driven by a 50 h.p. motor; all housed under one roof.

The following underground work has been done: The two-compartment 90-foot shaft was enlarged to a three-compartment at the 90-foot level and from here sunk to the 320-foot level. A level was cut at 305 feet. A crosscut was driven 135 feet south on the 90-foot level. On the 305-foot level crosscutting north amounted to 400 feet and south to 160 feet. One hundred feet from the shaft in the south crosscut a mineralized schist zone was cut and drifted on in two directions for a total of 135 feet.

The property was closed down on June 17, 1929, for lack of funds. It is expected to operate again this winter.

There were 20 men employed. Steve Monck was superintendent.

Cochenour-Willans Syndicate

This syndicate is doing extensive trenching on claims Nos. 7,607 and 320 of a group of 13 claims situated about four miles northeast of the Howey gold mine, on Red lake, district of Kenora (Patricia portion).

A small steam plant was put in operation early in 1929 and used to run drills on the surface doing deep trenching in a much schisted zone.

Twelve men are employed on the property. W. M. Cochenour is in charge of the operation.

Coniaurum Mines, Limited

This company has a capitalization of $6,000,000, divided into 1,200,000 shares of $5 par value. The capital was increased 200,000 shares in July, 1927. Of the total capitalization, 1,076,080 shares are issued.

The officers of the company are: R. W. Leonard, president; A. L. Bishop, vice-president; C. S. Kennedy, secretary-treasurer; Fraser D. Reid, general manager. The directors are: R. W. Leonard and A. L. Bishop, St. Catharines; Fraser D. Reid, Alex. Longwell, W. G. Watson, J. E. Day, and J. Y. Murdoch, all of Toronto.

The mines are in the township of Tisdale, district of Cochrane. The head office of the company is at St. Catharines, and the mine office address is Schumacher, Ont. The company is controlled by the Coniagas Mines, Limited, and was formed in June, 1924, to consolidate claims of the Goldale, Armstrong-Booth, Strong-Bow, and Newray properties. The Coniagas Mines, Limited, owns 692,750 shares in the company. They also own 65½ per cent. of the first mortgage bond issue of $800,000, due January 1, 1934.

During the early part of 1929 a situation arose whereby liabilities for wages and power could not be met; and upon application of the Toronto General

Trusts Corporation, as trustees for the bondholders, to the Supreme Court of Ontario, an order was made whereby F. D. Reid was appointed "receiver and manager." Under this arrangement production alone was carried on until midsummer, when Ventures, Limited, became interested in the property.

The following development work was done during the year 1928:—

	Feet
Drifting	2,412
Crosscutting	3,869
Raising	1,594
Diamond-drilling	5,030
Stopes and manways timbered	2,752

The total development work done to January 1, 1929, including work done by the Coniagas Mines, Limited (under the Newray option), was as follows:—

	Feet
Drifting	12,279
Crosscutting	23,661
Raising	5,079
Winzing	312
Shaft-sinking	2,111
Diamond-drilling	44,525
Stopes and manways timbered	2,752
	Tons
Waste hoisted	211,706
Ore hoisted	61,641

ORE DEVELOPED DURING 1928

Level	Location	Length	Width	Assay
		feet	feet	
400-foot	No. 2 vein	159	3.4	$12.45
400-foot	No. 5 vein	66	3.8	5.35
1,250-foot	No. 12 vein	340	4.2	18.20
1,500-foot	No. 12 vein	84	3.5	4.80
1,500-foot	No. 12 vein	35	3.1	18.33
1,750-foot	7 E.M.-2	94	3	9.33
2,000-foot	7 W. 10	108	3.1	5.17
2,000-foot	14 W. M-2	85	3.1	6.31
Total		971	.....	.....
Average		.....	3.6	$12.43

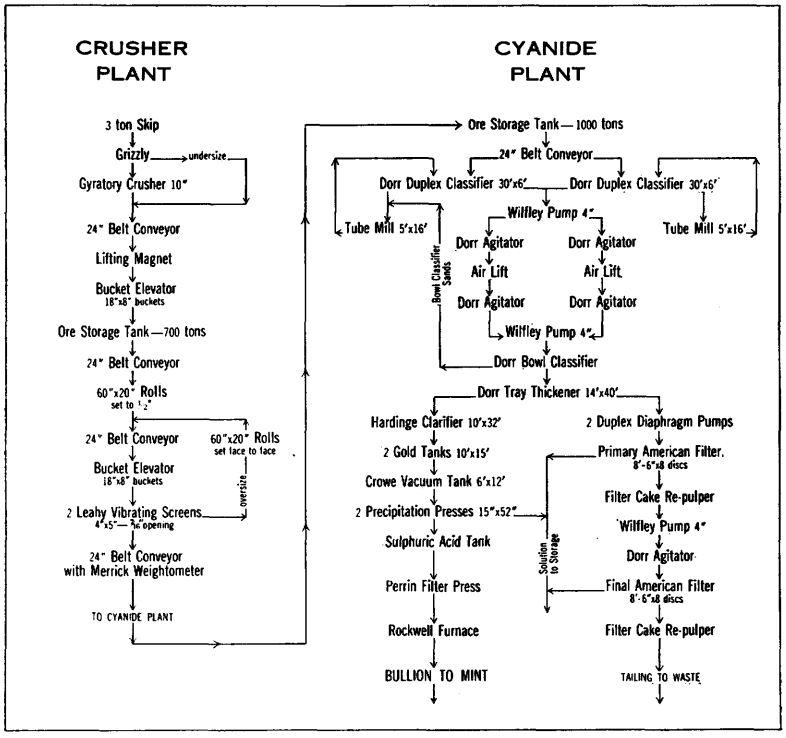
When milling operations commenced, there were 25,011 tons of ore on the surface. Of this amount 12,130 tons were milled during the year, leaving a balance of 12,881 tons on the surface.

	Tons
Broken ore on timber underground	20,701
Broken ore on surface	12,881
Total	33,582

The following is a summary of the milling operations for the year ending December 31, 1928.

Tons milled	52,005
Average per day	283
Bullion produced	$249,877.22
Loss in tailings	13,225.11
Total value of ore milled	$263,102.33
Average value per ton	$5.06
Average value per ton lost in tailings	.25
Recovery, per cent	95.3

The flow-sheet of the 500-ton mill erected and put in operation during the year is given below.



Coniaurum mill flow-sheet.

The following is taken from the report of the general manager:—

The grade of the ore developed on the different levels has been good. The veins are narrow, however, and this, coupled with the occurrence of minor faults and sharp variation in the dip of the veins, causes a much greater dilution of the ore in stoping than was anticipated.

The results from the work so far done on the 1,750- and 2,000-foot levels have been disappointing.

A steady improvement was experienced to the 1,500-foot level, and it was considered that conditions would continue to improve with depth. The veins on these levels so far drifted upon, however, occur in a tough, unschisted greenstone and the vein matter generally is below ore grade. It is hoped that this is a local condition and that developments east and west of the work already done will prove productive.

During the year the average number of men on the payroll was 175. John Reddington is mine manager.

Consolidated Mining and Smelting Company of Canada, Limited

Hill-Tivey-Sloan Group

This company, with a Canadian charter granted in 1906, has operated almost exclusively in British Columbia. Its capitalization is $15,000,000, divided into shares of a par value of $25 each, of which $12,721,575 had been issued up to December 22, 1927.

The officers and directors of the company are: J. J. Warren, president; W. L. Matthews, vice-president; S. G. Blaylock, vice-president; Sir Herbert Holt, E. W. Beatty, Sir Vincent Meredith, W. A. Black, F. G. Osler, J. C.

Hodgson, H. Joseph, and J. K. L. Ross. J. L. Riley is secretary. The head office of the company is at 707 Drummond Building, Montreal, Que., and the British Columbia office of the company is at Trail.

In November, 1927, the company took an option on the Hill-Tivey-Sloan group of claims lying along the east shore of Lost bay, Confederation lake. This group comprises 36 claims in the township of Earngey, district of Kenora (Patricia portion), held by a syndicate of Timmins people.

In a report on the "Woman and Narrow Lakes Area," by J. W. Greig,[1] a description is given of an outcrop on the claims:—

> A short distance from the east shore of Lost bay and just south of Gill's base line, a vein outcrops. A forest fire during the summer of 1926 removed all vegetation from the rocks here so that they and the vein are well exposed. The rocks are pillow lavas and associated breccias. The vein is continuous, being traceable southward (strike average about 8 degrees) for a distance of 60 chains to a swamp, under which it disappears. It is narrow throughout, being a mere stringer at the north and having a maximum width of about four feet. Over most of its length it is minutely contorted, the banding showing this up distinctly, and is but sparingly mineralized. The walls and the schist, which is in some places included in the vein, are rusty-weathering, due to carbonate. There appears to be a little native gold in the vein.
>
> The vein lies practically on the boundary between claims K.R.L. 4,502, 4,505, 4,583, and 4,585 to the west and K.R.L. 4,503, 4,506, 4,584, 4,586 to the east, the posts being on the vein.

The group of claims was first optioned to Hollinger Consolidated Gold Mines, Limited, and during 1927 exploration in the way of stripping and trenching was done and the vein sampled. Work was discontinued in October, 1927, and the option was not exercised.

After the option was taken up by the Consolidated Mining and Smelting Company, work was started at the claims on December 24, 1927, and the following buildings of log construction were erected: sleep camp, 23 by 36 feet; cookery, 23 by 34 feet; office, 18 by 24 feet; assay office, 20 by 24 feet; storehouse, 14 by 16 feet.

The following plant was installed: two 20 h.p. locomotive boilers; a Jenckes hoist, 8 by 10 inches; two Ingersoll-Rand gasoline-driven air compressors, 8 by 6 inches, each with a capacity of 220 cubic feet; a Leyner drill sharpener.

The plant is housed in log buildings, which include a boiler-house, compressor and hoist-house, and blacksmith shop. The headframe is 30 feet in height.

Work on the property up to the time of shutting down in October, 1928, was as follows:—

	Feet
Shaft-sinking	260
Crosscutting on the 150-foot level	27
Cross-cutting on the 250-foot level	80
Drifting on the 250-foot level	690
Diamond-drilling, 7 holes	3,653

The shaft and most of the crosscutting is on claim No. 4,306; the drifting is all on claim No. 4,505.

During the time of operation the men employed ranged from 25 to 40, depending on the amount of surface work going on.

Alex. Daigle was in charge of the work at the mine under P. F. Osler, 505 Confederation Life Building, Winnipeg, Man.

MacAulay Group

The MacAulay claims, K.R.L. 5,037-45, lie south of Lost bay of Confederation lake, about midway between the bay and Uchi lake. The company moved

[1]Ont. Dept. Mines, Vol. XXXVI, pt. 3, 1927, p. 108.

their plant, which was of a portable nature, to this group of claims when operations were stopped on the Hill-Tivey-Sloan group.

E. L. Bruce, in his report on this area[1] has the following to say with reference to this property:—

The workings on claim K.R.L. 5,038 show a different type of deposit from any of those described above. The outcrop is low-lying, and swamp obscures the relations. There is no definite vein, but instead a fracture zone with a trend somewhat west of south. The wall rock is slightly schistose greenstone of the type described above, and 15 feet northwest of the north end of the fracture zone the fragmental top of a flow occurs. Diorite outcrops a few feet farther west. To the east the greenstone shows ellipsoidal weathering. The zone of maximum brecciation has a length of somewhat over 400 feet, extending northward on to the Hollinger claims and fading out into the massive rock at both ends. The width over which fractures sufficiently closely spaced to give promise of commercial rock extend, is 27 feet at the widest point. The general arrangement of the fractures is in a diamond-shaped pattern. The quartz-filled fractures range from stringers to 4-inch veins; and at one place, near the edge, a vein parallel to the strike of the zone has a width of 1½ feet of quartz. This is exposed only in a trench. The diagonal stringers are not vertical; those striking northeast dip at an angle of 80° N.W.; the northwest ones dip at about the same angle to the northeast.

The quartz is white and vitreous and has very few metallic minerals in it. The rock between the stringers is heavily impregnated with pyrite. Gold is present in visible quantities along the contacts between quartz and country rock. In one place, a little galena occurs with the gold. Gold occurrences are consistent throughout the zone and are said to be in the wall rock rather than in the quartz, which is a reversal of the conditions in practically every other occurrence in the region. The average content is hardly sufficient to make the deposit workable under present conditions, but with railway transportation it may become so, provided that the zone can be traced or similar ones found along the strike.

Determination of the origin of the zone of brecciation would probably be of value in the search for the continuation or for others of similar type. No acidic intrusions outcrop in its immediate neighbourhood. The boss of granite at Okanse lake is 5 miles to the north and that at Perrigo lake 3 miles to the east. The south end of the zone seems to be curved eastward in somewhat the same manner as the ends of the Jackson-Manion lens are curved. The only suggestion that can be offered at the present stage of development is that the masses of diorite have acted as buffers so that when movements affected the area there was a torsion with a resulting formation of intersecting fractures along the planes of no distortion. The veins must be assumed to have come from a boss of granite somewhere in depth.

Previous operators had put a shaft down 100 feet on claim No. 5,038, and from the bottom of this the Consolidated did 100 feet of crosscutting and 404 feet of drifting. Six diamond-drill holes, with a total of 2,987 feet, were drilled from the surface.

The property was closed down in the early part of February, 1929, and the plant moved out.

Cooper Gold Mines, Limited

The authorized capitalization of the Cooper Gold Mines, Limited, is $3,000,000, divided into 3,000,000 shares of $1 par. The Pioneer Mining Corporation holds control of the Cooper through its ownership of 2,009,900 shares of the stock.

There has been no change in the officers and directors since our last report.

The Cooper Gold Mines owns 24 claims, known as the Cooper and the Minto blocks, containing about 830 acres. The property is located in township 29, range 23, in the Michipicoten area. The principal work during 1928 was on the Minto vein. A total of 4,785 feet of crosscutting and drifting was done during the year, and as a result it has been estimated that 59,400 tons of ore was fully developed, with an average value of $9.80 per ton.

In the fall of 1927, the plant was moved to the Jubilee shaft, and development since has been on the Jubilee vein. Development figures for 1929 up to July 31 show 1,482 feet of drifting, 2,093 feet of crosscutting, and 84 feet of shaft-sinking. At the time of the last visit to the property, the winze below

[1]Ont. Dept. Mines, Vol. XXXVII, pt. 4, 1928, pp. 50, 51.

the 4th level had reached its objective, a few feet below the 5th level, and development work was being commenced at the lower horizon.

Work was started in December, 1928, on the construction of a 20-ton test mill, near the Jubilee shaft. By the latter part of February, 1929, it was in operation. The purpose of the mill was to enable the management to carry out a series of bulk sampling tests on the ore of the Jubilee break. Up to August 8, 1929, the mill had treated 2,215 tons of ore.

The address of the mine office is Wawa, Ont., via Hawk Junction.

John Knox, Jr., is mine manager, and a force of 60 men is employed at the property.

Crown Reserve Consolidated Mines, Limited

The property of the Crown Reserve Consolidated Mines, Limited, is situated at Larder Lake, McVittie township, district of Timiskaming. Ziba Gallagher is president; W. H. Marsh, secretary; Leo Erenhous, managing director; and N. J. Evered, manager. Forty-nine men were employed during 1928.

The following work was done in 1928:—

	Feet
Crosscutting	5,240
Drifting	2,516
Shaft-sinking	500
Station-cutting	110

The 1,175-foot is the lowest level. The shaft is 1,200 feet deep.

Underground work was suspended on December 22, 1928. A crew of 6 men was retained until May 15, 1929, to take up the pipes, track, and pumps from the underground workings.

De Santis Gold Mining Company, Limited

The De Santis Development Company, Limited, was incorporated on December 28, 1926. Its authorized capital was $40,000, divided into 400 units of $100 par value each. An option agreement was reached between the De Santis Development Company, Limited, P. De Santis, and G. Romualdi, who were the original stakers of the claims in Turnbull township, Kamiskotia gold area.

Prior to the De Santis Development Company, Limited, taking over the De Santis Claims, P. De Santis, in 1923, brought out 600 pounds of picked ore by dog team, which was forwarded to the Government Testing Laboratory in Cobalt, which gave a return of $240 to the ton. Later on, in the winter of 1924, he also brought out 5,500 pounds of picked ore, which after being treated at the same laboratory, gave a return of $140 to the ton. By operating a small hand stamp-mill there were 13 ounces of gold recovered.

In May, 1928, the company was reincorporated under the name of "The De Santis Gold Mining Company, Limited" (no personal liability), with an authorized capital of $4,000,000, at a par value of $1 per share. The new company agreed to take over all the assets of the De Santis Development Company, Limited, and took up the option agreement with P. De Santis and G. Romualdi. The terms were as follows: "P. De Santis, G. Romualdi, and the De Santis Development Company, Limited, to receive 2,100,000 shares of the new issue, which give the De Santis Gold Mining Company, Limited, (no personal liability), an absolute title to 8 patented claims and 4 unpatented claims." The balance of 1,900,000 shares to remain in the treasury.

In July, 1928, there was a block of 50,000 shares offered in preference to the original stockholders, which were all absorbed in the limited time allowed.

The intention of the company at present is to issue another block of 200,000 shares at 50 cents per share; this to enable the directors to continue further development of the property, by sinking the shaft to a greater depth and to extend present lateral works.

The officers and directors of the company are as follows: Peter De Santis, president; Biagio Ferreri, vice-president; Giuseppe Giustini, secretary-treasurer; Luigi De Luca, Luigi D'Alessendri, Giacobbe Torlone, Ettore Marinacci, F. Prest, A. Fresco, Dominico Colomeco, directors.

The property consists of 8 patented and 4 unpatented claims, situated near the southwest corner of Turnbull township. The shaft and camp buildings are on claim No. 8,722.

Early in 1929 an option was taken on an additional 17 claims, adjoining and to the east of the original group. It is intended to do surface work on these claims during the summer of 1929.

The plant consists of two vertical boilers, 12 and 15 h.p.; one Canadian Ingersoll-Rand compressor, straight-line type, capacity 110 cubic feet per minute; and one 6- by 8-inch Jenckes hoist. The buildings are all of log construction and include a power-house, 20 by 40 feet; a cookery, 20 by 30 feet; sleeping camp, 20 by 30 feet; storehouse, 18 by 24 feet; and a two-storey office, 20 by 24 feet.

A shaft has been sunk to a depth of 150 feet, and 1,000 feet of drifting and crosscutting was done at the 125-foot level.

The vein is exposed in the shaft for a distance of 50 feet. The shaft is vertical, 5 by 9 feet, and 150 feet deep. The vein strikes north and dips steeply to the west. It is nearly vertical for several feet from surface, then dips out at an angle which brings it 30 feet west of the shaft at the 125-foot level. Where exposed in the north wall of the shaft, the quartz vein is 5 feet wide. In most places the quartz where seen is much narrower than this.

When development was in progress, the company employed 14 men.

Peter De Santis is manager.

Dome Mines, Limited

The authorized capital stock of Dome Mines, Limited, consists of 1,000,000 shares of no nominal or par value, of which 46,666 are held under an agreement in trust for the company; the dividends on these shares are returned to the treasury of the company.

The mine is in the township of Tisdale, district of Cochrane. The directors of the company are: Jules S. Bache and Morton F. Stern, New York; Alex. Fasken, Wallace Nesbitt, and R. F. Segsworth, Toronto; G. C. Miller and R. W. Pomeroy, Buffalo, N.Y.; Dwight B. Lee, Detroit, Mich.; and Innis P. Allen, Rochester, N.Y.

The executive officers of the company are: Jules S. Bache, president and treasurer; H. P. De Pencier, first vice-president and general manager; G. C. Miller, second vice-president; Morton F. Stern, third vice-president; Alex. Fasken, secretary; E. P. Goetz, assistant treasurer and assistant secretary; C. C. Calvin, assistant secretary; John B. Robinson, assistant secretary. The offices of the executive and financial departments are at 42 Broadway, New York, and the Toronto office is at 36 Toronto Street.

The following statements are taken from the annual report to shareholders for the year ending December 31, 1928.

ASSETS

CAPITAL:			
Mining claims and properties		$3,486,593.36	
Plant, etc., at depreciated replacement values as per appraisal plus additions since		2,976,732.42	
			$6,463,325.78
CURRENT:			
Cash on hand and in banks	$222,255.15		
Call loan	250,000.00		
Bullion en route	119,407.82		
Accounts receivable	15,422.47		
Interest receivable	73,527.18		
Government, railway, and other bonds at cost	2,290,526.46		
Supplies—mining, milling, and mercantile	234,785.60		
		$3,205,924.68	
DIVIDEND ASSURANCE FUND consisting of:			
Cash in bank	$13,767.78		
Government, railway, and other bonds at cost	2,473,375.00		
		2,487,142.78	
			5,693,067.46
PREPAYMENTS AND DEFERRED CHARGES			24,338.79
			$12,180,732.03

LIABILITIES

CAPITAL AND SURPLUS:			
Capital: Authorized 1,000,000 shares of no nominal or par value, all issued for the properties and assets of the old company, the Dome Mines Company, Limited, at $7 per share (of these shares, 46,666 are held in trust for the company and all dividends paid thereon are immediately returnable to the company)		$7,000,000.00	
Surplus		2,362,605.16	
			$9,362,605.16
CURRENT LIABILITIES:			
Accounts payable		$63,753.53	
Salaries and wages payable		60,743.40	
Accrued income and other taxes		137,352.21	
Dividend payable January 21, 1929	$250,000.00		
Less: Dividends on the shares held in trust for the company as above	11,666.50		
		238,333.50	
Unclaimed capital repayment and dividends		39,832.20	
			540,014.84
RESERVES:			
Operating equalization		$31,244.48	
Amortization of premium on bonds		13,136.41	
Depreciation plant and equipment, etc		2,233,731.14	
			2,278,112.03
			$12,180,732.03

EXPENDITURE

OPERATING AND MAINTENANCE:		
Mining, including hoisting	$805,963.83	
Development and exploration	506,007.94	
Crushing and conveying	79,004.17	
Milling	474,586.02	
Administration expenses, general and executive offices	159,815.18	
Provincial and municipal taxes	60,633.18	
Insurance	25,106.88	
		$2,111,117.20
Reserved for income taxes		94,893.86
Profit for year		1,939,222.40
		$4,145,233.46

REVENUE

EARNINGS:		
Amalgamation bullion	$2,553,262.11	
Cyanidation bullion	1,361,621.27	
		$3,914,883.38

NON-OPERATING REVENUE:		
Discounts	$986.14	
Miscellaneous	14,563.83	
Bond interest	208,557.30	
Bank and miscellaneous interest	6,242.81	
		230,350.08
		$4,145,233.46

APPROPRIATION ACCOUNT

Reserved for depreciation of buildings, plant, etc		$445,340.48
Dividends Nos. 42, 43, 44	$715,000.50	
Dividend No. 45 payable January 21, 1929	238,333.50	
		953,334.00
Surplus, December 31, 1928		2,362,605.16
		$3,761,279.64
Surplus, December 31, 1927	$1,860,431.56	
Less bonus to Mine Management and staff, for 1927 $15,330.00		
Workmen's compensation adjustments, etc 23,044.32		
	38,374.32	
		$1,822,057.24
Profit for year ended December 31, 1928		1,939,222.40
		$3,761,279.64

EARNINGS STATEMENT

For the year ended December 31, 1928

EARNINGS:		
Amalgamation bullion		$2,553,262.11
Cyanidation bullion		1,361,621.27
		$3,914,883.38
Non-operating revenue		230,350.08
		$4,145,233.46
OPERATING AND MAINTENANCE EXPENDITURE:		
Mining, including hoisting	$805,963.83	
Development	506,007.94	
Crushing and conveying	79,004.17	
Milling	474,586.02	
Bullion expense	21,119.16	
Fire protection	9,407.70	
Warehouse expense	10,023.87	
Auditors' expense	2,891.01	
Administrative expense:		
Mine office	96,185.69	
Executive offices	20,187.75	
Provincial and municipal taxes	60,633.18	
Insurance	25,106.88	
	$2,111,117.20	
Reserve for Dominion of Canada and U.S. Income tax	94,893.86	
		$2,206,011.06
PROFIT FOR THE YEAR		$1,939,222.40

Mining and Development

The following are particulars of the principal stopes:—

No. 301.—From this stope under the east end of the pits 3,199 tons, averaging $5.52 per ton, was drawn and 25,400 tons remains to be drawn.

No. 526.—The sill has been broken down into stope No. 638 and this stope drawn empty, yielding 18,375 tons, averaging $6.33 per ton.

Sixth Level.—From the eastern stope, No. 605, 1,542 tons, averaging $4.53 per ton, was drawn. From the eastern hanging-wall stopes, 1,955 tons, averaging $7.48 per ton, was drawn. This zone has been exhausted.

Seventh Level.—The sill of stopes Nos. 623-31 has been broken down into stope No. 741 and 5,555 tons, averaging $7.75 per ton, was drawn; 7,000 tons of broken ore remains to be drawn.

Eighth Level.—The drawing of stope No. 814 has been completed, yielding 917 tons, averaging $6.30 per ton. The stopes in the greenstone at this level, Nos. 809 and 841, yielded 3,855 tons, averaging $4.93; 1,975 tons remains to be drawn in stope No. 841.

Ninth Level.—From the eastern stopes of this level 50,972 tons, averaging $7.07 per ton, was drawn. This area is now exhausted. The first stope in the greenstone, No. 934, only supplied 686 tons, averaging $6.04 per ton; 19,700 tons remains to be drawn.

Another stope in the greenstone, No. 936, lying north of No. 934, supplied 6,497 tons, averaging $7.31 per ton; 1,500 tons of broken ore remains in it. It is expected that this stope will eventually be extended to the 8th level where a drift, No. 841, appears to be the upward extension of this ore.

Tenth Level.—Stope No. 1,020 yielded 2,201 tons, averaging $10.50 per ton, and has been exhausted. Stope No. 1,022 and the sills above it yielded 56,176 tons, averaging $9.27 per ton, and 48,300 tons of broken ore remains to be drawn. Stope No. 1,028 and the sill above it yielded 15,174 tons, averaging $9.21 per ton; only about 2,700 tons remains in this stope to be drawn.

From the first stopes in the greenstone, Nos. 1,041 and 1,042, 10,910 tons, averaging $5.52 per ton, have been drawn and 6,390 tons of broken ore remain. Stope No. 1,044, 175 feet north of stopes Nos. 1,041 and 1,042 in the greenstones, furnished 51,305 tons, averaging $6.99 per ton; and 45,000 tons of broken ore remain in it.

Stoping was started on another ore body in the greenstone 180 feet north of No. 1,044. This new stope, known as No. 1,054-1,055, yielded 1,503 tons, averaging $6.80 per ton.

Eleventh Level.—The hanging-wall area including sill No. 1,034 supplied 18,877 tons, averaging $8.85 per ton, and 16,975 tons of broken ore remains in it. Stope No. 1,117 supplied 424 tons, averaging $4.56 per ton, and is exhausted. Stope No. 1,136 in the greenstone furnished 65,377 tons, averaging $7.48 per ton; 72,500 tons of broken ore remains in it.

Stoping has just been started in another ore shoot in the greenstone 150 feet north of No. 1,136 ore body; this ore body, No. 1,140, produced 441 tons, averaging $5.34 per ton.

Twelfth Level.—The hanging-wall area, including the 11th level sill, furnished 36,090 tons, averaging $8.81 per ton; and 45,460 tons of broken ore remains in it. Stope No. 1,202 furnished 3,173 tons, averaging $7.81 per ton; and 16,940 tons of broken ore remains in it. The eastern stope, including sills Nos. 1,130 and 1,033, furnished 23,735 tons, averaging $10.44 per ton; and 17,560 tons of broken ore remains in it.

The downward extension of No. 1,136 ore body in the greenstone has been located and a stope, No. 1,235, opened up. This stope supplied 13,374 tons, averaging $7.39 per ton; and 11,900 tons of broken ore remains in it.

Thirteenth Level.—Stope No. 1,301 furnished 7,997 tons, averaging $7.37 per ton, and 28,000 tons of broken ore remains in it. Ore bodies Nos. 1,313-23 in the hanging-wall area furnished 15,095 tons, averaging $5.92 per ton; and 27,945 tons of broken ore remains in it. Stope No. 1,320 supplied 671 tons,

averaging $8.27 per ton, and is exhausted. Stope No. 1,302 supplied 1,304 tons, averaging $7.17 per ton; and 6,335 tons of broken ore remains in it.

Fourteenth Level.—Stope No. 1,403 supplied 681 tons, averaging $6.05 per ton, and 9,025 tons remains in it. Stope No. 1,405 supplied 4,357 tons, averaging $7.86 per ton; and 8,760 tons of broken ore remains in it.

Fifteenth Level.—Stopes Nos. 1,506-8 supplied 11,759 tons, averaging $6.36 per ton; and 46,270 tons of broken ore remains in it.

From stope No. 1,509 and stope No. 1,407 above it on the 14th level, 16,197 tons, averaging $6.26 per ton, has been drawn; and 18,950 tons of broken ore remains.

Sixteenth Level.—Stope No. 1,606 supplied 18,975 tons, averaging $7.16 per ton. This stope has been emptied. Stope No. 1,607 supplied 8,854 tons, averaging $10.35 per ton; and 7,800 tons of broken ore remains in it. The eastern stope, No. 1,612, only supplied 3,472 tons, averaging $5.75 per ton; 1,500 tons of broken ore remains in it.

Seventeenth Level.—The 17th level stopes, Nos. 1,702, 1,705, and 1,707, produced 3,293 tons, averaging $5.31 per ton. These stopes have been drawn empty.

Eighteenth Level.—Stopes Nos. 1,801-5 furnished 20,629 tons, averaging $7.96 per ton; and 13,900 tons of broken ore remains.

Development

The accompanying table gives details of the development accomplished during the year:—

SUMMARY OF DEVELOPMENT WORK FOR THE YEAR 1928

Level	Drifts	Cross-cuts	Drifts and crosscut slashing	Raises	Winzes	Box-holes	Raises, winzes, and boxhole slashing	Total	Diamond-drilling
	feet	feet	feet	feet	feet	feet	feet	feet	feet
3rd....	.....	11	45	.....	33	98	4	191	.....
5th....	.....	.....	.....	158	41	.....	21	220	.....
6th....	.....	.....	.....	112	53	.....	22	187	289
7th....	5	17	.....	192	48	.....	23	285	1,074
8th....	89	.....	8	230	36	59	27	449	713
9th....	315	247	77	147	122	95	13	1,016	1,197.5
10th....	1,093	539	195	387	120	1,007	17	3,358	1,576.5
11th....	516	286	140	276	144	608	41	2,011	769
12th....	754	520	103	429	102	317	95	2,320	1,732
13th....	669	1,273	155	305	.....	131	13	2,546	1,675.5
14th....	.....	.....	.....	4	18	51	.....	73	710
15th....	.....	.....	.....	.....	18	172	.....	190	1,555
16th....	234	301	93	94	235	238	2	1,197	3,997.5
17th....	420	24	21	358	63	36	9	931	813
18th....	867	313	64	270	.....	685	9	2,208	2,619.5
23rd....	253	11	11	.....	.....	.....	.....	275	1,382
Total..	5,215	3,542	912	2,962	1,033	3,497	296	17,457	20,103.5

Waste hoisted, 45,345 tons.

The work in the greenstone area north of the sedimentary basin has continued to be the most important development. Here about 9,200 feet of drifting, crosscutting, boxholing, raising, and sinking has been done during the year.

In addition to extensions of the ore bodies described in last year's report, one new shoot of some importance has been located 150 feet north of shoot No. 1,136 described last year. This new ore body was encountered at the 11th level and in drift No. 1,140 is 200 feet long, and at this level shows in the drift considerable fine visible gold. The drift gives an average assay of $17.77, due to this fine visible gold. The width is estimated at about 25 feet. This ore body has also been found at the 10th level, where it appears to be 230 feet long and 35 feet wide, and the two levels connected by raising. What appears to be the apex of it has also been found at the 9th level. A winze has been sunk for 60 feet below the 11th level and is in ore for this distance.

Crosscut No. 1,205 at the 12th level has been driven out to a point just east of this ore, but the ore has not been located as yet, either in this crosscut or in diamond-drilling.

At the 13th level a crosscut has been driven north into the greenstones and some drifting done in rather indefinite patches of ore, but no defined ore body has been located as yet.

In connection with the ore shown in drift No. 1,612 at the east end of the 16th level, considerable exploratory work has been accomplished, but only a small tonnage of low-grade material has been disclosed. A stope raise was put up 105 feet above the level in this low grade material, and a winze has been sunk to the 17th level, and 331 feet of drifting done at that horizon. The 17th level has also been connected with the 18th level by a winze, but no ore has been located in this ground.

Diamond-drilling to the north of drift No. 1,603 near its east end has disclosed a mineralized zone lying 600 feet north of the drift.

Hole No.	Bearing	Dip	Intersection	Length of hole
				feet
1181.....	N. 42° 45'W.	Hor.	Between 94 and 110 feet, assaying $6.23 over 16 feet..... Between 135 and 149 feet, assaying $3.35 over 14 feet..... Between 576 and 608 feet, assaying $7.43 over 32 feet.....	659
1174.....	N. 1° 51'W.	Hor.	Between 611 and 631 feet, assaying $3.19 over 20 feet..... Between 644 and 661 feet, assaying $3.82 over 17 feet.....	710.5

These two holes are 350 feet apart at the outlying ore zone. This ground is being penetrated by a crosscut from drift No. 1,603 which has not yet reached the area into which this ore may be expected to extend.

At the 23rd level the drift to the east has been continued 253 feet and a diamond-drill station cut from which holes to the north and south have been drilled across the greenstones. A hole to the north was drilled to the depth of 274 feet without encountering any ore; it was entirely in greenstone. The hole to the south passed through greenstone for 160 feet where the porphyry was intersected. Porphyry was penetrated for 47 feet, but no ore was found in this hole.

A set of manways remote from the working stopes has been put in to provide a second exit from the mine; this entailed 1,727 feet of raising and winzing.

During the year 20,103 feet of diamond-drilling was done. A number of

holes were drilled across the greenstone at the 6th and 7th levels to test them for a possible extension upwards of the ore zone found at the lower levels, but without success. Also many holes have been drilled in the vicinity of working stopes to test for possible extensions of the various ore bodies.

The stopes yielded 505,850 tons, averaging $7.7223 per ton, and development work 42,150 tons, averaging $4.4471 per ton, a total of 548,000 tons averaging $7.4703 per ton.

The expenditure on mining was $805,963.83, or $1.471 per ton milled, as against $1.233 during the preceding year. The increase in the cost of mining per ton milled is due to the fact that many corners above sublevels have been stoped, and also the tonnage broken was in excess of the tonnage milled.

The expenditure of development and exploration work charged to operating was $506,007.94 or $0.923 per ton milled as against $1.263 in the preceding year. This includes $51,883.25 for outside exploration work during the year.

The ore drawn from the Dome Extension ground during the year was 41,025 tons, containing $269,150.15, or $6.5606 per ton.

Ore Reserves

The ore brought into sight by the development work done during the year, together with additional ore found in the course of stoping, is more than equal to the tonnage milled during the year, and the reserves are estimated at 1,250,000 tons; this includes 600,000 tons of broken ore.

The Mill

The following are the results of the mill operation for the year:—

	Total value	Value, per ton	Extraction, per cent.
Heads	.....	$7.4703	.....
Amalgamation bullion	$2,553,262.11	4.6592	62.3697
Cyanidation bullion	1,361,621.27	2.4847	33.2610
Total	$3,914,883.38	$7.1439	95.6307

The tonnage milled during the year was 548,000, as against 543,300 for the previous year.

The extraction was 95.6307 per cent., as against 96.2279 per cent. during the previous year; the difference is believed to be due to an increased tonnage of ore coming from the greenstone stopes.

With regard to the locating of new properties of interest, the manager states that although their exploration engineers have been very busy they have not located any.

For the year the average number of men employed was 673, distributed as follows: underground, 423; mill, 82; surface, 168.

J. H. Stovel is general superintendent of the property, J. J. Jordon is mill superintendent, and W. J. Flewellen is mine superintendent.

Dunkin Gold Mines, Limited

This company has an authorized capital of $4,000,000, divided into shares of $1 par value each. Of these shares, 1,500,000 were issued for the property and 1,500,000 have been issued to carry on the development work, leaving the balance of the shares in the treasury.

The officers of the company are: R. Home Smith, president; J. H. Black, vice-president; J. S. Masson, secretary; Colin A. Campbell, manager. The

directors are: R. Home Smith, J. H. Black, J. R. L. Starr, J. S. Masson, Jas. A. Dunn, W. F. Spence, and S. A. Shoemaker. The head office of the company is the Northern Ontario Building, Toronto, and the mine address is Narrow Lake, Ont.

The company's holdings include thirteen claims at the end of the west arm of Narrow Lake, K.R.L. 4,428-30, 4,433-38, 4,447-49, 4,926, located in the township of Skinner, district of Kenora (Patricia portion).

Early in 1927, a considerable amount of assessment work was done on the properties, and the vein was uncovered for 250 feet with a width of from 2 to 12 feet. The vein has been traced by cross-trenches from the lake on claim K.R.L. 4,447. It runs east across K.R.L. 4,434 to the lake and shows up again on K.R.L. 4,435. The strike is N. 80° E., and the dip is 75° N.

A plant was hauled to the property and installed early in 1928. This includes the following: an 80 h.p. locomotive boiler; a Canadian Ingersoll-Rand air compressor, FR-1, straight-line, capacity 528 cubic feet per minute; a Canadian Ingersoll-Rand hoist, 7 by 6 feet, type SSR.

A headframe, 30 feet in height, was erected, the shaft being located near the centre of claim K.R.L. 4,434. Sinking of a three-compartment shaft was started by hand on July 25, 1928.

The shaft was sunk during the year to a depth of 271 feet with levels at the 125- and 250-foot horizons. The following drifting and crosscutting were done:—

Level	Cross-cutting	Drifting
	feet	feet
125-foot	56	.....
250-foot	423	227

The buildings at the property, all of log construction, include the following: two sleep camps, 20 by 30 feet and 16 by 22 feet; cookery, 20 by 30 feet; storehouse, 18 by 24 feet; office, 18 by 24 feet; power-house, 33 by 36 feet; dry-house, 18 by 22 feet.

A saw-mill with about 7,000 board feet capacity was erected on the lake-shore below the shaft-house during the winter.

When operations were in progress during the summer, a crew of 30 men was employed.

The property was shut down on March 29, 1929, and arrangements were made to sell the equipment.

Federal Kirkland Mining Company, Limited

Federal Kirkland Mining Company, Limited, has a capital of 5,000,000 shares of $1 par value. James E. Day, K.C., is president; Draper Dobie, vice-president; Robert R. Brown, managing director. The company owns 9 claims and a fraction, which includes the Kirkland Combined property, in Teck township, district of Timiskaming. Lindsay Foss was manager, and 30 men were employed.

The shaft was sunk from the 200- to the 700-foot level.

Fort Hope Mines, Limited

The authorized capital of this company is 3,000,000 shares of a par value of $1 each, of which 1,400,000 have been issued.

The officers of the company are: J. W. Morrison, president and managing director; R. D. Cumming, secretary. The directors are: E. H. Horne, Enfield, N.S.; Lorne Howey and Fred McLeod, Haileybury. The head office is at Haileybury, and the mine office is Fort Hope, Ont., via Tashota.

The company's holdings consist of 16 claims situated about 5 miles north of Fort Hope, a Hudson's Bay Company post, on Eabamet lake, an expanse of the Albany river, in the district of Patricia. Fourteen of these were purchased from Albany River Mines, Limited, and include claims P.A. 33 to 44 and P.A. 46 to 48. Two other claims, P.A. 49 and 50, were purchased from Fred G. McLeod.

The property is reached by canoe route in summer, 160 miles from Ombabika on the Canadian National railway. A winter road from Tashota, a distance of 115 miles, is also used for hauling supplies.

A plant was installed at the property early in 1928 and includes the following: two 50 h.p. locomotive boilers; a Canadian Ingersoll-Rand air compressor, 12 by 12 inches, type FL-1, three-drill capacity; a Jenckes hoist, 6 by 8 feet.

Buildings, all of log construction, include the following: power-house, 26 by 40 feet; blacksmith shop, 20 by 27 feet; cookery, 35 by 41 feet; two sleep camps, 21 by 27 feet; office, 25 by 27 feet.

Actual mining operations began about June 1, 1928. A two-compartment shaft was sunk 125 feet with a level at the 100-foot horizon, on which 300 feet of drifting and 30 feet of crosscutting was done. The property was closed down early in October, 1928. About 18 men were employed when the mine was operating.

Furness Gold Mines, Limited

This company has an authorized capital of $3,000,000, divided into shares of $1 par value each. The officers of the company are: John Cowan, president; Thos. Ramsay, vice-president; G. P. Campbell, secretary-treasurer; Jos. Houston, consulting engineer; H. R. M. Turner, superintendent. The directors of the company are: John Cowan, London, England; G. P. Campbell, Toronto; Thos. Ramsay, Hamilton; and H. L. Rathwell-Jackson, Broughton-in-Furness, England. The head office of the company is at 907 Kent Building, Toronto; and the mine office address is Box 542, South Porcupine, Ont.

The company owns 5 claims, known as the Whalen-James property, on the Shaw-Deloro boundary, towards the north. These claims comprise Nos. H.R. 885 (13,245), H.R. 887 (13,246), and H.R. 889 (13,247), in the township of Shaw, and H.R. 886 (T.R.S. 770), and H.R. 888 (T.R.S. 771), in the township of Deloro, district of Cochrane.

The plant consists of the following: one Chicago Pneumatic compressor, 14 by 12 inches, type NSB, capacity 524 cubic feet per minute, driven by a 100 h.p. induction motor; an Allis-Chalmers air hoist, 8½ by 10 inches; one 12 h.p. vertical boiler. The electric power for plant is obtained from the substation of the Northern Canada Power Company, Limited, at South Porcupine, over a line 3¼ miles in length. Power is transmitted at 12,000 volts and transformed at the plant to 550 volts.

The buildings comprise bunk-house, 40 by 24 feet; office, 18 by 20 feet; cookery, 40 by 22 feet; dry-house, 12 by 16 feet; power-house, 24 by 30 feet; and blacksmith shop, 10 by 14 feet. A headframe, 37 feet in height, was erected; and a two-compartment shaft, with compartments 5 feet 6 inches by 5 feet and 4 feet 8 inches by 5 feet, was sunk to a depth of 155 feet. A level was cut at a depth of 125 feet. The shaft is located on claim H.R. 887 near the

Shaw-Deloro boundary. Work was started in February, 1927, and carried on throughout the year. Together with the sinking of the shaft, 185 feet of drifting was done. Operations were suspended on May 11, 1928. Between January and May, 1928, 441 feet of drifting was done at the 125-foot level.

Gold Hill Mines, Limited

Gold Hill Mines, Limited, operated their property in Catharine township, district of Timiskaming, during 1928, with a force of 59 men. D. H. Angus is president and manager; and C. F. Tuer is secretary-treasurer. The directors are: D. H. Angus, C. F. Tuer, Robin Boyle, E. T. Hait, and G. H. Murphy.

During 1928 production was as follows:—

Ore raised	tons	6,035.4
Ore cyanided	tons	4,377.4
Gold bullion recovered	crude ounces	1,293.75
Crude bullion shipped	ounces	1,293.75
612.958 fine ounces gold		$12,670.96
195.420 fine ounces silver		113.62
Total		$12,784.58

In 1929 the shaft was sunk from the 800-foot to the 1,100-foot level, and 1,500 feet of drifting and crosscutting were done. The mine closed down in July, 1929.

A two-stamp mill was erected during the latter part of 1928. It ran for a short time only on ore from the shaft and from test pits sunk on the vein near by.

Transportation from Wabigoon is by water during the summer. The route crosses Wabigoon lake and follows up the Crooked river into Minnehaha lake. A 6-mile portage lies between Minnehaha and Anzhekumming lakes. During the winter suppiles are freighted over a winter road which was cut by the company.

Miles Walker is superintendent of the property, and about 20 men are employed.

Gold Rock Mining Syndicate, Limited

The company has a capital of 4,000 shares of no par value. Cash amounting to $153,050, has been derived by the disposal of 3,741 shares, which were issued and allotted.

The officers of the company are: T. W. Bathurst, 51 Sparks Street, Ottawa, president; H. L. Nichol, 315 Ottawa Elect. Bldg., Ottawa, secretary.

The syndicate was incorporated June 7, 1928, for the purpose of optioning a group of claims consisting of 753 acres in the Dryden gold area, district of Kenora. This was acquired from the Brading estate, the Mitchell-Brading estate, and the Haycock estate. The syndicate has since staked a further 240 acres in the district.

All work to date has been on the Haycock property. At the time of the last visit to the mine in August, 1929, a shaft had been sunk to a depth of 87 feet and 263 feet of crosscutting accomplished.

During the summer of 1928, camps were erected consisting of a bunkhouse and a cook-house to accommodate 40 men, an office and warehouse combined, superintendent's quarters, and a stable for five teams. The camps are located on the shore of Anzhekumming (Upper Manitou) lake, about 35 miles from the town of Wabigoon, on the Kenora to Ignace division of the C.P.R.

The mine buildings include enclosed headframe, hoist-house, blacksmith shop, boiler-house, and powder-house.

Goodfish Mines, Limited

Goodfish Mines, Limited, has a capital of 6,000,000 shares of $1 par value, of which 2,300,000 shares are issued. The head office of the company is at Kirkland Lake. A. J. Perron is president; George Cooper, vice-president; M. G. Hunt, secretary-treasurer. Robert Walker and Dr. J. A. Campbell are directors.

The company owns 15 claims, comprising 630 acres, including the Goodfish and the Providence properties in Morrisette township, district of Timiskaming.

The shaft was sunk to a depth of 620 feet, and 2,500 feet of drifting and 650 feet of crosscutting were done up to June, 1929, when the mine closed down. The average number of men employed was 40.

Grace Lake Gold Mines, Limited

Grace Lake Gold Mines, Limited, has a capital of 2,000,000 shares of no par value. The officers of the company are: W. Bush, president; L. Laidlaw, vice-president; Dr. A. E. Costello, secretary-treasurer; O. E. Oberg, general manager. The head office is at Post Office Building, Spooner, Wis.

The company's holdings are 160 acres in the township of Skead, district of Timiskaming, about 11 miles east of Boston Creek station.

In November, 1927, the shaft was dewatered and sunk to the 530-foot level. The lateral work consisted of 1,000 feet on the 112-foot level, 200 feet on the 329-foot level and 300 feet on the 494-foot level. The mine closed down in November, 1928. The average number of men employed was 20.

Grenfell-Kirkland Mines, Limited

This company has an authorized capital of 2,500,000 shares of $1 par value, of which 1,207,706 are issued. The officers of the company are: G. A. Young, president; F. A. Day, secretary-treasurer; J. Dunn, director; and D. Hill, managing director. The head office of the company is at 715 Excelsior Life Building, Toronto.

The company holds under option a group of five claims, known as the Stitt claims, in Grenfell township, district of Timiskaming.

The construction of camps was started in May, 1928. A bunk-house, 24 by 30 feet, an office, 20 by 24 feet, and a headframe, 24 feet high, were built. A shaft was sunk to the 100-foot level, and a small amount of crosscutting was done. The mine closed down in August, 1928. There were 12 to 18 men employed by the company.

Harker Gold Mines, Limited

Harker Gold Mines, Limited, has a capital of 5,000,000 shares of $1 par value and owns 18 claims in Harker township, district of Timiskaming. The officers of the company are: J. E. Hammell, president; A. L. Smith, vice-president; B. E. Martin, secretary-treasurer. The directors are: R. Fennell, A. L. Smith, H. E. Patriarche, and G. M. Huycke. E. W. Todd is consulting engineer.

The company started operations in April, 1928, and closed down in October, 1929. During this period the following work was done: A prospect shaft was sunk 2,000 feet west of the main shaft to a depth of 58 feet; 1,470 feet of surface trenching was done; and 7½ miles of road was built to Ghost River Landing, where a dock and storehouse were built.

In January, 1929, work was started at the main shaft, where 2,184 feet of drifting and crosscutting was done on the 250- and the 500-foot levels. The

shaft was sunk from the 500- to the 1,000-foot level, and 500 feet of drifting was done on the 500-foot and 1,000 feet on the 1,000-foot levels. The average number of men employed by the company was 40.

Harris Consolidated Gold Mines, Limited

This company has an authorized capital of $12,000,000, divided into shares of $1 par value each. The officers of the company are: L. G. Harris, president; R. T. Jeffrey, vice-president; E. M. Ivey, secretary-treasurer; Oscar Knutson, manager. The directors of the company are: L. G. Harris, R. T. Jeffery, and Dr. K. McVey, all of Toronto; N. C. Harrison and R. H. Johnson, both of Boston, Mass.; Sir A. Welby and Sir J. P. Newman, London, England. The head office of the company is at 807 Reford Building, Toronto 2. The mine address is Box 512, South Porcupine, Ont.

The company has claims in Tisdale, Whitney, Cody, and Robb townships in the Porcupine mining division, as well as holdings in the Larder Lake mining division. The Beaumont property, comprising some 15 claims located in the northeast portion of the township of Tisdale, district of Cochrane, forms a part of the holdings. Operations were resumed in October, 1927, at this property, which had been closed down since 1922.

A shaft had been sunk to a depth of 320 feet, and arrangements were made to deepen this shaft and carry on development. From October to the end of 1927, the buildings and plant were remodelled and a 75-foot headframe erected over the shaft on claim No. 12,765. This shaft has two compartments, each 4 feet 6 inches by 4 feet 8 inches. Sinking operations were resumed on April 1, 1928.

The plant at the Beaumont mine consists of the following: Canadian Ingersoll-Rand drill compressor, steam-driven, capacity 600 cubic feet per minute; Sullivan compressor, type WJ-4, in two units, each with a capacity of 700 cubic feet per minute; 90 h.p. Watrous horizontal return tubular boiler; Vulcan hoist, 10 by 14 inches; 10 h.p. engine for dynamo, capacity 200 lights. Electric power was obtained early in 1928 from the Northern Canada Power Company, Limited, the line that formerly served the Davidson mine being extended to the Beaumont mine. A 200 k.v.a. synchronous motor was installed to drive the Sullivan compressor and a 52-h.p. motor to drive the Vulcan hoist.

Previous operators of the Beaumont property had sunk a shaft 648 feet and broken off levels at the 150-, 300-, 450-, and 600-foot levels. During the summer of 1928 the shaft was sunk below the 700-foot level, and some crosscutting was done. Operations were discontinued in the fall of 1928.

Haslat–Duck Lake Mines, Limited

The Haslat–Duck Lake property is located about 16 miles north of Schreiber on Duck lake. The holdings consist of 26 claims in all. Most of the work has been done on claims Nos. 6,637, 6,638, and 6,739, district of Thunder Bay. The company has been operating for the past two years. Most of the work has been confined to the surface, and stripping has revealed several interesting showings. Some lead-zinc veins and some chalcopyrite veins have been uncovered.

During the winter of 1928-29 a small steam plant was taken in from Schreiber, and a shaft was sunk 100 feet. Forty-seven feet of crosscutting and 10 feet of drifting opened a vein which showed values of gold, silver, lead, and zinc. At the time the writer visited the property in August, 1929, these workings

were full of water, and work was being concentrated on test pits and trenching. R. C. Harrison was in charge of operations until January 10, 1929, when M. L. Bouzan succeeded him.

A cookery and sleep camps for 25 men offer comfortable accommodation, and a third building houses the office and manager's quarters. The remainder of the camp consists of an icehouse, a warehouse, and a stable for one team. At the shaft the power-house encloses a 25 h.p. upright boiler, a 5- by 7-inch steam hoist, and a blacksmith shop.

The company has a capital of 5,000,000 shares of $1 par value. The officers are: F. A. Kent, president; H. MacMahon, vice-president; W. F. Stewart, secretary-treasurer. J. M. Aitken, F. C. Loring, J. E. Thompson, and R. C. Harrison are directors.

Hayden Gold Mines, Limited

This company is capitalized at $5,000,000 in shares of $1 each. There are 4,000,000 shares issued.

The following is a list of the officers and directors of the company: Jas. S. Pierce, president; B. W. Lang, vice-president; W. Spaulding, secretary-treasurer. The directors are R. Berkinshaw, Joseph Montgomery, B. Sproule, E. D. Phillips, and Henry McK. Hasserot. The head office is at 509 Brisbane Building, Buffalo, N.Y., and the mine office is at Timmins, Ont.

The company's holdings are in the townships of Ogden and Deloro, district of Cochrane, and consist of 8 claims, with an option on 5 more directly west of the original group.

A diamond-drill campaign starting in December, 1927, has been carried on, and some 10,000 feet of drilling accomplished. An electrical survey has also been made during the year.

In May, 1929, the old buildings on the property were reconstructed, and following this some new structures were erected. A tile hoist-house, 30 by 32 feet, which also houses the compressor and a small 20 h.p. heating boiler, was built. A 10- by 16-foot electric substation, a 12- by 14-foot magazine, and a 12- by 16-foot boiler-house were also put up.

The camp buildings will accommodate about twenty-two men.

Previous operators on this property have sunk the main shaft 719 feet and established levels at the 100-, 200-, 300-, 400-, 550-, and 700-foot horizons. On all levels but the 550-foot the main vein on which the shaft started has been drifted on. The total lateral work on the property amounts to about 1,400 feet.

In August, 1929, the dewatering of the workings began, and in October the water was below the 550-foot level. As soon as the 300-foot level was dewatered, crosscutting was commenced; and in October the face had been advanced 150 feet.

There are 22 men employed on the property. Seymour Stevens is in charge of operations.

Hewitt Mining Company, Limited

The authorized capital of this company was originally 200,000 shares, of a par value of $5 each, and the company was incorporated on March 3, 1927. This capital has been redivided into 1,000,000 shares, of $1 par value each, and increased to 4,000,000 shares, of a par value of $1, as of January 12, 1928.

The officers of the company are: A. M. Wood, president; Ralph Hewitt, vice-president; Solomon Zeitlin, secretary; Geo. Gray, Timmins, consulting

engineer. The directors of the company are: A. M. Wood, Ralph Hewitt, Abraham Pollack, A. E. Hewitt, and Solomon Zeitlin.

Early in 1927, work was done on claim T.R.P. 6,057 and a pit sunk to a depth of 30 feet. Work was not actively carried on later in the year. In the winter of 1928, a plant was hauled to the property, which is about 20 miles south of South Porcupine, township of Tisdale, district of Timiskaming.

In a report by E. L. Bruce on McArthur, Bartlett, Douglas and Geikie townships,[1] the following reference is made to the property:—

> On claim T.R.P. 6,057, near the north boundary of Bartlett, there is a band of iron formation striking northwest, with the typical interbanding of silica and magnetite. In pits sunk on this band, flat veins of quartz are exposed. The thickness of the veins averages about one inch, and they are spaced several feet apart. These are said to have contained visible gold, but none was observed. Two chains northeast is a parallel zone of banded rock, which contains no magnetite, and the quartz bands are discontinuous and irregular as if they might have been introduced along a shear zone. Pyrite is fairly abundant and is more thickly disseminated in some bands. Also along the northeast wall, quartz veinlets up to a quarter of an inch in width cut into the wall. The outcrop consists of iron oxides from which gold can be panned, but a sample of several pieces of pyritized rock gave no gold on assay.

No work was recorded during 1928, and in the summer of 1929 the plant was up for sale.

Hilltop Gold Mines, Limited

The Hilltop Gold Mines, Limited, has a capital of 5,000,000 shares of $1 par value, of which 3,709,225 are issued. The company owns 480 acres in Catharine township, district of Timiskaming. The officers of the company are: A. M. Woolnough, president; A. C. Thorburn, vice-president; A. J. Young, secretary-treasurer; G. Wilkie and G. Tough, directors. The head office of the company is at 1302 Bank of Hamilton Building, Toronto.

An electric plant was installed in May and the shaft sunk to the 600-foot level. The mine closed in August, 1928. The average number of men employed for the year was 31.

Hollinger Consolidated Gold Mines, Limited

The authorized capital of this company is $25,000,000, in 5,000,000 shares of $5 par value each; 4,920,000 shares were outstanding on December 31, 1927.

The officers of the company are: Noah A. Timmins, president; L. H. Timmins, vice-president; John B. Holden, secretary and treasurer; A. F. Brigham, general manager; and John Knox, assistant general manager. The directors are: Noah A. Timmins, L. H. Timmins, Wilfred L. McDougald, Jules R. Timmins, and Leo H. Timmins, all of Montreal; John B. Holden and Wilson Bell, of Toronto. The mine is at Timmins, Tisdale township, district of Cochrane. The head office is at Timmins, Ont., and the general office is at 602 Royal Bank Building, Toronto.

During the year the company, besides operating the Hollinger mine, completed the preliminary exploration of its Kamiskotia property.

Supplementary Letters Patent were obtained during the year, allowing the company to deal in stocks and bonds of other companies. A securities subsidiary is being incorporated to look after this, but has not yet commenced to operate.

The company met with a disastrous mine fire on February 10, in which thirty-nine miners lost their lives. A full description of this is contained in Bulletin No. 67, "Mining Accidents of Ontario," published by the Department of Mines.

The following information is taken from the eighteenth annual report to the shareholders, covering operations for the year ending December 31, 1928.

[1]Ont. Dept. Mines, Vol. XXXV, pt. 6, 1926, p. 53.

ASSETS

CAPITAL:			
Mining properties			$22,493,785.17
Plant, brought forward from 1927		$1.00	
Plant, additions during 1928		2,333.15	
		$2,334.15	
Less depreciation for 1928		2,333.15	
			1.00
Investments in other companies and properties:			
Brought forward from 1927		$46,224.67	
Outlay during 1928		48,385.50	
		$94,610.17	
Less depreciation for 1928	$4,301.53		
Less expenditures on properties abandoned	33,385.50		
		37,687.03	
			56,923.14
Tailings disposal site:			
Brought forward from 1927		$21,042.00	
Less depreciation for 1928		12,625.20	
			8,416.80
Outlay to date in respect of Kamiskotia claims			396,557.00
			$22,955,683.11
DEFERRED:			
Material and supplies on hand		$546,404.37	
Solutions on hand		120,583.80	
Precipitates on hand		4,430.00	
Litharge, slags, etc., on hand		743.00	
Charges paid in advance, fire insurance		1,343.03	
			673,504.20
CURRENT:			
Cash on hand, in bank	$389,101.34		
Bullion in transit	471,790.42		
Accounts receivable	74,292.69		
		$935,184.45	
Investments:			
Dominion of Canada 5½% Victory Loan, 1933	$540,000.00		
Canadian National Railway bonds, 5%, 1954, guaranteed by Dominion of Canada	789,900.00		
Canadian National Railway bonds, 4½%, 1954, guaranteed by Dominion of Canada	526,790.00		
Province of British Columbia, 6% bonds, 1941	200,250.00		
Province of Saskatchewan, 4% bonds, 1957	231,562.50		
Lethbridge Northern Irrigation District, 6% bonds, 1951, guaranteed by Province of Alberta	250,000.00		
Daysland Drainage District bonds, 6%, No. 4, 1951, guaranteed by the Province of Alberta	100,000.00		
Province of Alberta 6% bonds, 1941	76,031.25		
Province of Ontario 6% bonds, 1935	93,000.00		
City of Toronto 6% bonds, 1940	115,808.00		
Montreal Island Power 5½% bonds, 1957	99,000.00		
Town of Timmins debentures	87,592.99		
Abitibi Power and Paper Company bonds, 5%, 1953	3,741,200.00		
Horne Copper Corporation 7% first mortgage ten-year sinking fund gold bonds, 1937	2,450,000.00		
Shares of other companies	2,018,000.00		
Accrued interest on investments	154,135.01		
		11,473,269.75	
			12,408,454.20
			$36,037,641.51

LIABILITIES

CAPITAL STOCK:		
Authorized	$25,000,000.00	
In treasury	400,000.00	
		$24,600,000.00
CURRENT:		
Wages unpaid	$161,305.24	
Accounts payable	406,782.55	
		568,087.79
Reserve for taxes, Dominion of Canada and municipal		200,000.00
SURPLUS:		
Balance of account from 1927	$11,466,245.52	
Deducted from surplus per profit and loss account	796,691.80	
Net surplus carried forward		$10,669,553.72
		$36,037,641.51

The following statements are taken from the general manager's report for the year ending December 31, 1928.

PROFIT AND LOSS STATEMENT FOR YEAR 1928

SOURCES OF INCOME:			
Gold and silver produced			$10,712,821.69
Interest on investments and other income			752,146.00
			$11,464,967.69
DISPOSAL OF INCOME:			
General charges		$814,046.23	
Milling charges		1,326,712.64	
Mining charges		5,044,928.28	
			7,185,687.15
Operating profit			$4,279,280.54
DEDUCT (taxes):			
Province of Ontario	$142,578.34		
Royalty to town of Timmins	55,227.92		
Municipal to town of Timmins	82,516.50		
Municipal to township of Tisdale	2,903.46		
Dominion of Canada re 1927	11,842.74		
Dominion of Canada and municipal reserve	200,000.00		
		$495,068.96	
DEPRECIATION:			
Plant	$2,333.15		
Tailings disposal site	12,625.20		
Investments in other companies and properties written down	4,301.53		
Expenditures on properties abandoned	33,385.50		
		52,645.38	
			547,714.34
Net profit from operations			$3,731,566.20
Profit on sale of securities		$32,492.00	
Appreciation of shares of other companies		851,250.00	
			883,742.00
			$4,615,308.20
Paid out in dividends			5,412,000.00
Deducted from surplus			$796,691.80

BULLION STATEMENT

Inventory, January 1, 1928:		
Solutions		$117,126.80
Slags, litharge, and miscellaneous		2,043.00
Total		$119,169.80
Values produced in 1928:		
Ore milled	$11,179,488.69	
Tailings loss	466,667.00	
		10,712,821.69
		$10,831,991.49
Inventory, December 31, 1928:		
Solutions		120,583.80
Slags, litharge, and miscellaneous		743.00
Precipitates held over		4,430.00
		$125,756.80
Bullion shipped and paid for during 1928		10,706,234.69
		$10,831,991.49

The yearly average costs are as follows:—

DISTRIBUTION OF GENERAL CHARGES

Account	Sundries	Labor	Stores	Total	Per ton ore milled
General miscellaneous charges and administration		$328,277.20	$63,811.36	$392,088.56	$0.2205
Surface services		48,834.59	31,246.61	80,081.20	.0450
Insurance	$13,738.11			13,738.11	.0077
Marketing bullion	40,394.40			40,394.40	.0227
Workmen's compensation		287,743.96		287,743.96	.1618
Milling charges		528,433.49	798,279.15	1,326,712.64	.7460
Mining charges		3,394,990.45	1,649,937.83	5,044,928.28	2.8366
Total charges	$54,132.51	$4,588,279.69	$2,543,274.95	$7,185,687.15	$4.0403

Employees

The average number of men employed during the year was 2,297, distributed as follows:—

MINERS:		MECHANICS:		GENERAL:	
Exploration	26	Operation	112	Mill and refinery	232
Development	417	Maintenance	187	Engineering staff	67
Production	1,083			Clerical staff	46
				Miscellaneous	127
Total	1,526	Total	299	Total	472

The Mill

Milling results were as follows:—

Ore milled ..... tons	1,778,470
Average value per ton	$6.28
Gross value	11,179,488.69
Deduct loss in tailings	466,667.00
Net value recovered	$10,712,821.69

Average tons per day	4,982
Per cent. of possible time run	87.0
Tons per 100 per cent. running time	5,726
Solution precipitated per ton ore	1.30
Value per ton in tailings	$0.26
Cyanide consumed per ton of ore....lbs.	0.472
Zinc consumed per ton of ore....lbs.	.055
Zinc consumed per ton of solution....lbs.	.042
Lime consumed per ton of ore....lbs.	2.438
Lead nitrate per ton of ore....lbs.	.013
Average value of pregnant solution	$4.65

The Mine

The development progress during the year was as follows:—

Level	Shafts	Drifts	Cross-cuts	Raises	Diamond drilling	Timbering		Excavation
						Shafts	Stopes	
	feet	feet	feet	feet	feet	feet	feet	tons
Surface					843			
100-foot		21			148		339	
200-foot		4,454	2,486		15,794		1,532	
300-foot		5,014	2,564		12,113		690	
425-foot		3,296	363	113	8,670		529	
550-foot		2,892	2,900	158	7,780		119	
675-foot		3,157	1,787	23	4,100		823	
800-foot		3,217	1,110	137	2,233		524	
950-foot		1,919	500	242	4,088		292	
1,100-foot		173	483	138	759			
1,250-foot		1,028	679		890		604	
1,400-foot		367	207		903		144	
1,550-foot		1,830	1,784	166	1,286		284	
1,700-foot		675	1,453	149	4,245			
1,850-foot		1,197	2,806	50	2,475		200	
2,000-foot		524	3,512	177	2,173		753	
2,150-foot		2,264	3,959		3,893		254	134
2,300-foot		3,296	6,271	96	4,522			1,030
2,450-foot		2,496	6,199		3,043			648
2,600-foot		1,500	6,144	7	4,512			906
2,750-foot	110	385	5,435	7	3,346	138		752
2,900-foot	36		69	5		31		176
3,050-foot	134			186		184		1,688
3,200-foot	150					244		
3,350-foot	150				809	150		390
3,500-foot	150					150		588
3,650-foot	150					150		
3,800-foot	150					150		
3,950-foot	150		409			150		
4,100-foot	41					20		
Total	1,221	39,705	51,120	1,654	88,625	1,367	7,087	6,312

The total sinking, drifting, crosscutting, and raising was 93,700 feet.

PRODUCTION

Level	Broken ore in mine, Jan. 1, 1928	Ore broken during 1928	Ore removed during 1928	Broken ore in mine, Dec. 31, 1928
	tons	tons	tons	tons
Above 100-foot	8,312	33,111	25,929	15,494
Above 200-foot	203,708	344,711	313,190	235,229
Above 300-foot	52,181	144,963	122,177	74,967
Above 425-foot	36,960	46,484	63,569	19,875
Above 550-foot	82,543	154,050	166,319	70,274
Above 675-foot	51,753	159,752	134,737	76,768
Above 800-foot	43,005	93,261	105,350	30,916
Above 950-foot	98,574	80,109	147,283	31,400
Above 1,100-foot	108,343	21,580	75,971	53,952
Above 1,250-foot	45,924	76,197	54,596	67,525
Above 1,400-foot	75,134	56,709	70,805	61,038
Above 1,550-foot	98,431	98,087	106,054	90,464
Above 1,700-foot	152,312	80,103	139,004	93,411
Above 1,850-foot	126,180	70,622	82,873	113,929
Above 2,000-foot	5,298	109,961	54,540	60,719
Above 2,150-foot	2,355	53,327	45,660	10,022
Above 2,300-foot	.....	36,079	30,247	5,832
Above 2,450-foot	.....	22,782	21,995	787
Above 2,600-foot	.....	14,038	13,978	60
Above 2,750-foot	.....	3,268	3,268	.....
Total	1,191,013	1,699,194	1,777,545	1,112,662

SUMMARY OF ORE RESERVES

Vein No.	Tons	Value per ton	Estimated gross value, Dec. 31, 1928	Estimated gross value, Dec. 31, 1927
Veins over $10:				
97	102,134	$16.57	$1,691,931	$3,695,761
200	3,039	15.37	46,713	58,881
206	38,401	14.29	548,900	477,270
84	180,999	13.16	2,381,486	3,224,029
64	4,078	11.91	48,583	8,322
48	5,480	11.80	64,670	78,467
38	5,650	11.39	64,356	64,191
1	75,722	11.21	849,183	1,110,425
92	110,455	11.20	1,236,848	1,505,076
5	20,093	10.83	217,595	175,496
50	116,427	10.67	1,242,558	1,036,377
15	48,418	10.59	512,813	608,567
88	41,920	10.48	439,131	488,841
13	17,867	10.43	186,390	213,315
86	138,198	10.27	1,419,959	1,894,526
58	74,218	10.24	760,062	931,481
66	47,906	10.14	485,963	753,661
16	15,090	10.01	151,043	151,665
96	1,095	10.00	10,950	27,641
Total	1,047,190	$11.80	$12,359,134	$16,503,992
Veins, $10 to $8:				
114	209,670	$9.96	$2,088,721	$1,507,990
63	68,708	9.85	676,731	948,923
14	36,553	9.78	357,413	259,199
4	26,986	9.77	263,771	331,119
26	23,555	9.71	228,634	472,193
8	10,481	9.69	101,543	86,254
56	42,582	9.68	412,096	511,118
124	1,757	9.58	16,825	86,609

SUMMARY OF ORE RESERVES—*Continued*

Vein No.	Tons	Value per ton	Estimated gross value, Dec. 31, 1928	Estimated gross value, Dec. 31, 1927
Veins, $10 to $8—*Continued*:				
20	60,167	$9.53	$573,120	$263,164
59	46,324	9.52	441,130	600,054
2	91,366	9.52	869,374	1,063,585
65	95,939	9.48	909,927	815,896
85	287,662	9.48	2,727,739	3,207,431
91	168,708	9.34	1,575,695	1,814,454
47	24,391	9.26	225,943	124,148
101	77,854	9.13	710,969	962,403
55	279,883	9.08	2,541,194	3,293,560
37	16,646	9.00	149,822	103,296
93	32,978	9.00	296,697	.....
44	85,737	8.98	770,246	846,580
52	42,022	8.88	372,982	396,706
113	7,330	8.85	64,844	163,882
53	148,580	8.75	1,300,251	1,430,301
99	18,031	8.72	157,257	139,466
111	11,291	8.71	98,327	105,116
68	56,626	8.66	490,333	475,890
51	42,860	8.61	368,966	549,163
87	32,542	8.55	278,232	396,983
61	4,543	8.50	38,615	87,513
214	8,843	8.49	75,049	.....
54	104,773	8.46	885,920	980,823
19	5,467	8.45	46,196	276,656
9	32,969	8.37	275,920	443,077
21	5,044	8.31	41,916	248,024
12	178,649	8.12	1,451,096	1,792,928
Total	2,387,517	$9.17	$21,883,494	$24,784,504
Veins, $8 to $6:				
39	3,787	$7.89	$29,895	$29,879
177	30,063	7.88	236,842	66,029
112	39	7.87	307	41,054
33	63,848	7.82	499,042	775,443
107	312,753	7.75	2,424,072	2,584,593
95	172,160	7.48	1,288,437	1,332,292
17	8,748	7.43	65,007	316,672
226	12,542	7.39	92,660	139,685
150	5,364	7.35	39,426	39,426
82	5,882	7.20	42,350	42,059
115	13,947	7.02	97,915	113,064
10	15,793	6.94	109,628	161,626
220	17,663	6.93	122,437	45,962
3	12,596	6.84	86,149	86,614
67	20,705	6.82	141,148	114,645
18	28,433	6.68	189,932	.....
218	10,375	6.54	67,889	.....
7	9,183	6.50	59,727	61,574
153	3,692	6.48	23,924	99,789
224	5,128	6.43	32,994	37,088
Total	752,701	$7.51	$5,649,781	$6,087,494
Total ore reserves	4,187,408	$9.53	$39,892,409	$47,375,990
Drift bottoms and pillars	.....	.....	.....	1,099,993
Surface outcrops	33,720	6.87	231,620	348,000
Probable ore under $6	2,336,194	4.75	11,086,206	11,401,556
Total	6,557,322	$7.81	$51,210,235	$60,225,539

There is a notable change in the stoping method gradually taking place at the mine, especially since the back-filling in the older sections has been completed, allowing waste filling for slice and fill stopes.

Filling, consisting of sand and gravel from the "gravel claims" and waste from development, has been placed in open stopes and slice and fill stopes at the rate of 3,500 to 4,000 tons daily for the last two years.

Operations in shafts have been reduced to four main ones, namely: Central, depth 3,160 feet, used for hoisting ore and waste in four compartments and men in one compartment; Main and No. 11, depth 2,750 feet, used for men and materials; Schumacher, depth, 3,950 feet, used for hoisting development rock from the eastern section of the mine to the 2,750-foot level and men and materials to surface.

In general comment the manager makes the following statements:

Hollinger.—During the year under review development has been actively carried on below the 2,000-foot level and discloses most of the veins in place, but with reduced values, which is further reflected in the decreased total of our reserves, as indicated in the body of the report.

The Schumacher shaft was sunk to the 3,950-foot level, where 250 feet of crosscutting has been completed. A vein of satisfactory value is indicated by diamond-drilling, about 200 feet south of the shaft.

Some promising veins, the importance of which has not been determined yet, have also been disclosed in other sections of the mine, as a result of the development work carried on, notably on the 2,600-foot level.

Kamiskotia.—The exploration of this property was completed during the latter part of April, and since has been temporarily closed down until railway facilities are available. Meantime some test shipments have been made with a view to determining the best method of treating the ore and the type of concentrator to be erected, so that there will be no delay when transportation has been provided. Estimates of ore, based on copper at 14½ cents per pound, are enumerated below. At current prices the figures are very materially augmented:—

Tonnage	1,000,000
Gross value, copper only	$8,700,000.00

In the president's letter to the shareholders, the following statement regarding Kamiskotia is made:—

Your directors have taken up with the provincial government the question of the extension of the Temiskaming and Northern Ontario railway through the Kamiskotia district so as to enable the property of this company, as well as other properties, to be opened up, and the government now has the matter under consideration. The building of a railway will not only serve a promising new mining area, but should prove of value as a colonization road. Your directors look for a favourable decision, and once a railway is assured they are prepared to build a concentrator and resume active operations on your Kamiskotia property.

Early in the new year C. G. Williams and Victor Emery resigned their positions as general superintendent and mine superintendent to enter consulting practice. Arthur Young is now mine superintendent, and E. L. Longmore is mill superintendent.

Howey Gold Mines, Limited

This company has an authorized capital of $5,000,000, divided into shares of $1 par value each. The officers of the company are: J. E. Hammell, president; W. S. Cherry, vice-president; G. M. Huycke, secretary; R. T. Birks, treasurer; H. G. Young, manager. The directors of the company are: J. E. Hammell, W. S. Cherry, A. Wende, R. T. Birks, G. E. Eastwood, H. C. Mockridge, and H. E. Strickland. The head office of the company is at 801 Dominion Bank Building, Toronto. The address of the mine is Red Lake, via Sioux Lookout, Ont.

The company's holdings lie at the southeast corner of the lower part of Red lake and include the following claims situated in Dome and Heyson town-

ships, district of Kenora (Patricia portion): K. 740-43, 1,400-406, 1,364-72, 1,397-99, and 867. These claims lie directly north of Favel on the Canadian National railway.

Hudson, a station on the Canadian National railway (mileage 1,132.7 from Montreal), is the starting point for power-boat lines which take travellers, without change, to Goldpines (Pine Ridge) at the west end of Lac Seul; from there smaller boats are used down the English river, the Mattawa river, Pakwash lake, Gull Rock lake, Keg lake, and the Chukuni river into Red lake. From Hudson to Goldpines the distance is 115 miles, and from Goldpines to Red lake, 60 miles.

A scow in the approach of one of the marine railways on the route to Red lake.

In winter there is a well-travelled road to Goldpines from Hudson, cutting off a part of the lower water route and making the distance 78 miles. Another route leads from Sunstrum, another station at mileage 1,152.7 on the Canadian National railway, to Goldpines. The rest of the winter route to Red lake follows very much the line of the summer route over the lakes.

Summer or winter there is excellent air service provided by the Western Canada Airways, with a base at Hudson, from which point Red lake can be reached in about an hour and a half. The journey by water requires two whole days.

Early in the spring of 1929 the Government constructed four marine railways at the portages along the route to Red lake, at an estimated cost of $50,000, half of which was paid by the mines of the district. This allows small scows to go direct from Lac Seul to Red lake without unloading.

Development

The following statements on development work accomplished and ore chutes developed are taken from the report of the manager, of April 10, 1929.

	Shafts and stations	Drifts	Crosscuts	Diamond-drilling	
				Surface	Underground
	feet	feet	feet	feet	feet
Accomplished during 1928	.....	6,009.7	4,305.8	3,852	2,019
Accomplished during 1927	626.1	855.7	863.2	.....	.....
Total	626.1	6,865.4	5,169	3,852	2,019

The total to date is; shafts, stations, and lateral work, 12,660.5 linear feet; diamond-drilling, 5,871 linear feet. The total expenditure on this account for the year amounted to $258,288.34.

The above work is about equally distributed over the four levels of the mine and has opened approximately 1,500 linear feet of vein structure from the west Boundary to the east, with the following economic results:—

Level	Length	Width	Assay
	feet	feet	
125-foot	1,087	19.2	$7.13
250-foot	426	14.6	7.00
375-foot	537	7	6.54
500-foot	714	18.6	8.33
Total	2,764	.....	.....

The total length of ore for the four levels of the mine is 2,764 linear feet of an average width of 16 feet and an average grade of $7.25 in gold per ton.

It is safe to say that the average width for the whole mine as now reported at 16 feet will eventually be materially increased. There is also the possibility that when the ore body is completely opened up for production, the average grade for the mine will show improvement.

Diamond-Drilling

During the year we performed 5,871 linear feet of drilling; 2,019 linear feet of this was done underground in the ore zone to assist development, and 3,852 linear feet from the surface as exploration. The exploration drilling has proven favourable structure and geology for 1,800 feet east of our present development faces on the main vein. It also gave us an intersection, 10 feet in width, of $10 ore 500 feet east of present development faces, with several other holes showing encouraging values over fair widths. We also drilled two holes on a parallel vein 1,000 feet north of our No. 1 vein and encountered low but encouraging values in gold. On the 500-foot level we have crosscut towards this vein and are, at the present time, within 150 feet of intersecting it.

The total expenditure in this account for the year was $19,576.04.

Power

We are pleased to report that we have entered into an agreement with the Ontario Hydro-Electric Commission for 2,000 h.p. of electrical energy at the price of $25 per h.p. at their plant at Ear Falls. Your company is to build the transmission line, of about 45 miles, to the property at an estimated cost of approximately $200,000. The estimated cost of power delivered at the mine will be $32.50 per h.p. The Hydro-Electric Commission will proceed at once with the development of 5,000 h.p. at Ear Falls, and this power will be available in about a year from this date.

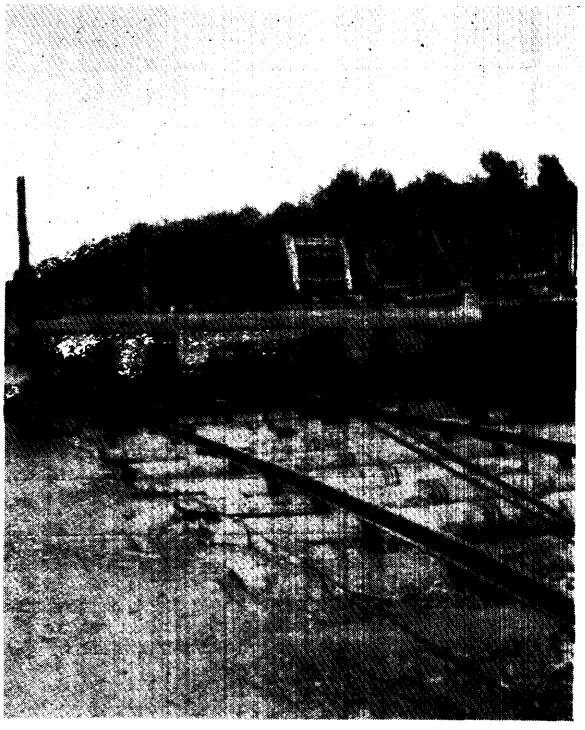
Mill

Our engineers have about finished metallurgical tests on our ore, and we are pleased to report that 95 to 98 per cent. of the gold can be recovered by grinding through 40 mesh. As most of the gold ores in Northern Ontario have to be ground through 200 mesh to recover the gold, it is evident that the Howey ore will respond to treatment of gold extraction with much less grinding and thus less power. Plans are being prepared now, and a milling plant of 500 tons daily capacity will be transported to the property and erected this year.

General

Our programme of development this year is to open up four new levels at 125-foot intervals between the 500- and 1,000-foot levels. We have just completed the station at the 750-foot level and expect to have shaft-sinking completed in June this year. We also will develop the North vein from the 500-foot level and the eastern section of No. 1 vein from this level, which gives good promise as based on diamond-drill results.

At the time of inspection the shaft had reached a depth of 1,070 feet, and the cutting of a shaft pocket at this depth was in progress. There were four



Truck and winch of the marine railway at Snake falls on the route to Red lake.

new levels broken off, and it was expected to start crosscutting to the vein shortly. The mill foundations were rapidly being placed, and supplies for construction were being landed regularly.

The mill, as now planned, is to have a capacity of 500 tons daily. It is so arranged that with slight additions it can be stepped up to 1,000 tons.

Interprovincial Exploration Company, Limited

Interprovincial Exploration Company, Limited, has a capital of 500,000 shares of no par value and 10,000 shares of preferred stock. The company owns 26 claims in Ben Nevis township, 6 in McVittie township, and 6 in McGarry township, district of Timiskaming. The officers of the company are: E. A. Robert, president; D. K. Goodfellow, secretary-treasurer; J. H. Cassidy, R. Beaudry, G. L. Wyer, P. J. Roche, and G. M. Pender, directors. C. A. Sheehan was mine manager. The mine closed down in May, 1929.

A shaft was sunk 346 feet on the Ben Nevis claims, and stations were cut on the 125-, 225-, and 325-foot levels. Crosscutting consisted of 34 feet on the 125-foot level, 480 feet on the 225-foot level, and 420 feet on the 325-foot level.

The following buildings were erected: power-house, 42 by 46 feet; blacksmith shop, 16 by 18 feet; pump-house, 12 by 14 feet; powder-house, 18 by 20 feet; three bunk-houses, 16 by 18 feet; two storehouses, 12 by 16 feet; office, 24 by 30 feet; stable, 20 by 30 feet; hay-shed, 16 by 20 feet; boat-house, 14 by 16 feet; and two storehouses at the lake, 12 by 16 feet. Nine miles of road was cut to connect with the Ossian Gold Mines road, and 5 miles of wagon road was built to connect with the boat route. The head office is at 437 St. James Street, Montreal, Que.

Jackson-Manion Mines, Limited

The Jackson-Manion Mines, Limited, is capitalized at $5,000,000 in shares of $1 par value; 2,500,000 shares have been issued.

The officers of the company are as follows: W. H. Russell, president; H. E. Harcourt, vice-president; H. Keefer, secretary; H. A. Currie, treasurer. W. J. Sheppard, J. B. Tudhope, Hon. J. D. Chaplin, Hon. R. J. Manion, and Hon. A. Turgeon are directors. The head office is located at 1507 Bank of Hamilton Building, Toronto.

The company is interested in 25 claims in the townships of Dent and Mitchell, Woman Lake area, district of Kenora (Patricia portion).

The Woman Lake area is accessible from the Canadian National railway by way of Hudson and Goldpines (Pine Ridge), the latter at the outlet of Lac Seul. Large motor boats navigate between these two points, a distance of 115 miles. From Goldpines there are two water routes, the most used of which is that down the English river to the mouth of the Chukuni, up the Chukuni to Pakwash (Shallow) lake, and Bruce lake to Trout Lake river, and up to Woman river, which is followed to Woman lake.

The area may be reached by air, the Western Canada Airways, Limited, maintaining an excellent passenger, mail, and express service. The trip from Hudson to Woman lake may be made in about an hour and thirty minutes by plane. The boat trip requires two days.

Active development was carried on throughout the year. The shaft reached a depth of 404 feet, with three levels, at the 125-, 250- and 375-foot horizons. To the end of March, 1929, the following work had been accomplished.

Level	Cross-cutting	Drifting		Raising	Diamond-drilling[1]
		North	South		
	feet	feet	feet	feet	feet
125-foot	80[2]	288	188	.....	.....
250-foot	161	279	95	95	295
375-foot	78	13	69	.....	582

[1]Surface diamond-drilling (to July 20, 1929), 4,900 feet.
[2]To and through the vein.

Work on the property was suspended early in August, 1929.

During the early months of 1929 a force of 65 men was maintained at the property under the superintendence of D. M. Thomson.

Jones-Porter Mines, Limited

This company is capitalized at $3,000,000, divided into shares of $1 each. There are 1,607,800 shares issued. The officers and directors are: A. J. Doane, president; M. H. McArthur, secretary-treasurer. William A. Porter, John Jones, L. L. Anthes, W. G. Harris, all of Toronto, and L. T. Burwash, of Ottawa, directors. The head office of the company is at 169 Yonge Street, Toronto.

The holdings of the company, in the southeastern portion of Deloro township, district of Cochrane, consist of 14 claims in a group. Gold was discovered on claim No. 10,800 in the summer of 1925.

Early in 1928 a shaft was put down 138 feet and a station cut at the 125-foot level. No further work underground has been done, but early in 1929 the plant of the old Croesus mine at Matheson was moved to the property and partially erected.

Kirkland Gold Belt Mines, Limited

Kirkland Gold Belt Mines, Limited, operated their property 5 miles east of Kirkland Lake, in the township of Lebel, district of Timiskaming, with a force of 25 men, from July, 1928, to July, 1929, when the mine closed down.

The officers and directors of the company are: John F. Bookser, president; George W. Morris, treasurer; Ray H. Bennett, Frank Waldeman, and M. C. Smith, directors. K. B. Heisey was consulting engineer, and the head office is at 510 Kent Building, Toronto.

During the period of operation the work was as follows: 2,000 feet of surface trenching and 300 feet of rock trenching and test-pitting. On a porphyry-trachyte contact, about 1,500 feet long, one section of continuous ore was uncovered, averaging $11.20 in gold and silver, over an average width of 54 inches and a length of 135 feet. A total of 2,000 feet of diamond-drilling was done with fair results. A three-compartment shaft was started early in 1929 and sunk to a depth of 250 feet, and about 200 feet of crosscutting was done on the 250-foot level.

Kirkland Hunton Mines, Limited

Kirkland Hunton Mines, Limited, operated their property, in the township of Teck, district of Timiskaming, during the first ten months of 1928, with a working force of 17 men. From November, 1928, to February, 1929, the work consisted of diamond-drilling only. The mine closed in March, 1929. Leo Erenhous is president; Simon N. Stein, vice-president; and W. B. McPherson, secretary. John McPhee is manager.

The following work was accomplished during 1928 and up to the time the mine closed.

Level	Drifting	Cross-cutting	Sinking	Raising	Slashing
	feet	feet	feet	feet	feet
125-foot	.....	.....	.....	55	.....
85-foot	.....	155	.....	.....	.....
375-foot	50	140	125	25	.....
500-foot	525	547	.....	45	40
675-foot	.....	.....	.....	20	25

Diamond-drilling, 1,667 feet.

Kirkland Lake Gold Mining Company, Limited

Kirkland Lake Gold Mining Company, Limited, has an authorized and issued capital of 5,000,000 shares of a par value of $1.

The directors of the company are: D. B. Hanna, J. B. Tyrrell, W. D. McPherson, K.C., R. G. O. Thomson, A. C. Matthews, A. M. McQueen, all of Toronto; J. A. Dalton, Kingston, Ont.; Cyrus A. Birge, Oakville, Ont.; and J. C. Haight, Waterloo, Ont.

The officers are: D. B. Hanna, president; J. B. Tyrrell, vice-president and managing director; and R. Graham, secretary.

During the year Wm. Sixt, formerly general superintendent, was made manager.

There are 105 men employed at the property, which is situated in the township of Teck, district of Timiskaming.

The following extracts are taken from the president's report for the fiscal year ended December 31, 1928:—

Reference was made in the 1927 annual report to the sinking of a winze from the 2,475-foot level, some 400 feet south of the main shaft. During 1928 sinking was continued, and at the present date the winze has been sunk to 3,405 feet and stations cut at the 2,600-, 2,725-, 2,850-, 2,975-, 3,100-, and 3,225-foot levels. Bodies of ore of varying lengths have been encountered east and west of the winze on the 2,600-, 2,725-, 2,850-, and 2,975-foot levels as far as these levels have been developed, and stoping on some of the levels is proceeding. On the 3,100-foot level a station and crosscut were driven, but no lateral work has yet been done. On the 3,225-foot level the station and main crosscut were completed, and the geological conditions on this level are considered the best for finding ore. As sinking continues, there are consistent evidences that your mine has the geological formations which carry with it every possibility for gold deposition and the formation of wide ore bodies.

Whilst the operations during the year, so far as mill production in gold is concerned, give a result somewhat lower in value compared with the previous year, it must not be assumed that the condition of the mine is in any sense less encouraging to your directors in so far as the ultimate expectation is concerned of reaching larger and more consistent ore bodies at depth.

During the year 57,883 tons were treated at the mill, producing $414,596.01, against a total expenditure of $383,319.27. In this item of cost there is included $140,120.81 for exploration and development, or $2.42 per ton on the total tonnage sent to the mill. The average recovery per ton of ore milled was $7.16. This figure is lower than it might have been, due to the company's policy of milling all ore encountered in the progress of development work where a gold return would produce a profit over the milling cost.

Capital expenditures during the year totalled $58,000, made up as follows:—

Additions to buildings	$2,700
New hoist and other underground equipment	37,155
Surface equipment, including 100 h.p. motor, steel sharpener, and oil tank	8,600
Mill equipment, including new filter plant	9,760

Notwithstanding the large expenditures on capital account, exploration, and increased development work, the net working capital at the close of the year was $226,192.51, represented by Dominion Government bonds, bullion, cash, and inventories.

Your attention is directed to the managing director's report, which covers in some detail the operations at the mine during 1928.

Your directors take this opportunity to express their appreciation to Mr. J. B. Tyrrell, Mr. Sixt, your mine manager, and the staff generally for loyal and efficient services during the year.

The following extracts are from the managing director's report:—

Development was continued energetically throughout the year.

The winze was sunk from 2,730 feet to 3,251 feet, and crosscuts were driven from the winze to the main vein on the 2,725-, 2,850-, and 2,975-foot levels, and stations have been cut at the 3,100- and 3,225-foot levels.

Drifting has been prosecuted on the various levels as follows: 2,475-foot, 151 feet; 2,600-foot, 597 feet; 2,725-foot, 1,103 feet; 2,850-foot, 647 feet; 2,975-foot, 422 feet. Stoping has been carried on, or at least begun, on all the levels down to the 2,725-foot level.

The mill ran steadily throughout the year, milling 57,883 tons with an average extraction of 86.6 per cent., yielding gold and silver to the value of $414,596.01. As far as I am able to learn, this extraction is about the same as the average from all the mines in the Kirkland Lake district. We are endeavouring to raise it, and in the last three months of the year we did raise it to 89.9

per cent. A much higher extraction is obtained from the ore in the Porcupine district in mills precisely similar to our own, but unfortunately the cause of our lower extraction and higher gold loss has not yet been definitely determined. When the character and peculiarities of the ore from all the mines of Kirkland Lake have been more carefully studied, and when the reasons for the great loss of gold have been discovered, we will have a much better chance of taking the proper measures to prevent that loss.

The cost per ton milled, exclusive of capital expenditure, but including all overhead charges, was as follows:—

Development and exploration	$2.42
Mining	2.53
Milling	1.69

During the year an Oliver filter was installed in the mill. A new drill-sharpener was placed in the steel-shop. A large electric hoist with double drums, 6 feet in diameter, and a capacity of hoisting 3,000 feet at a rate of 1,500 feet a minute, with motor, air-receiver, large wheels, etc., was installed in the chamber previously cut out at the top of the winze on the 2,475-foot level. Transformers were installed, and a heavy electric cable was carried down the shaft from the surface to the 2,475-foot level. We have, therefore, made provision for sinking continuously to a depth of 5,500 feet and mining and hoisting ore from that depth.

During the year's operation we have opened up bodies of good ore at the 2,600-, 2,725-, and 2,850-foot levels. At the 3,100- and 3,225-foot levels, the stations have been cut and the crosscuts towards the vein have been driven 40 and 15 feet, respectively.

On the 2,725-foot level, porphyry was encountered on the south wall of the vein. This porphyry extended farther and farther westward as we sank to lower levels, being almost as far west as the main crosscut on the 2,975-foot level. Below this level, porphyry was encountered in the winze, and it occurs in the crosscuts on the 3,100- and 3,225-foot levels, and in the bottom of the winze at 3,250 feet. This is the first time that a heavy body or tongue of porphyry has impinged against the fault vein in this mine. On the 2,725-foot level a dike of fine-grained diabase was also encountered 80 feet west of our eastern boundary. This is doubtless the downward extension of the diabase dike which outcrops on the surface 800 feet east of our eastern boundary, and which is therefore dipping westward.

At the 2,850-foot level, a diamond-drill hole was bored southward horizontally to a depth of 893 feet for the purpose of prospecting the Chaput-Hughes property. The bore-hole penetrated a low-grade vein, but no commercial ore was encountered.

During the year Mr. Wm. Sixt, has been promoted to the position of manager, and it is a pleasure to testify to the excellent work done by him, and by J. Dixon, the mill superintendent, P. J. Harris, the mine captain, and all the staff and men under them.

Kirkland Premier Mines, Limited

Kirkland Premier Mines, Limited, is a reorganization of Kirkland-Rand, Limited. J. T. Tebbutt is president, and W. R. Osborne, superintendent. The property is in the township of Teck, district of Timiskaming. The head office is at 637 Craig Street West, Montreal.

During the year 1928 and up to June, 1929, when the mine closed down, 1,500 feet of crosscutting and drifting and 70 feet of sinking were done. The average number of men employed was 20.

Lake Shore Mines, Limited

Lake Shore Mines, Limited, has a capitalization of 2,000,000 shares of a par value of $1 each.

The executive officers are: Harry Oakes, president and managing director; W. H. Wright, vice-president; Dr. W. P. St. Charles, treasurer; Kirkland Securities, Limited, secretary. The directors are: Harry Oakes, Louis Oakes, Albert Wende, Ernest Martin, and William H. Wright.

During 1928 an average of 480 men was employed at the mine and works under the general supervision of E. B. Knapp, Kirkland Lake, Ont.

The following extracts are taken from the fourteenth annual report of the company for the fiscal year ended June 30, 1929:—

During the year 367,015 tons of ore were treated, yielding bullion to the amount of $5,504,858.64. This shows an increase of 129,053 tons milled over last year, with a corresponding increase in bullion of $1,875,541.07.

TOTAL PRODUCTION AND DIVIDENDS SINCE THE COMMENCEMENT OF MILLING OPERATIONS IN 1918

Period	Months	Tons milled	Bullion production	Dividends paid
Mar. 1, 1918, to Nov. 30, 1918	9	14,948	$369,680.31	$100,000
Dec. 1, 1918, to Nov. 30, 1919	9	11,907	294,513.72	100,000
Dec. 1, 1919, to Nov. 30, 1920	12	18,889	483,701.93	80,000
Dec. 1, 1920, to Nov. 30, 1921	12	21,681	460,186.37	120,000
Dec. 1, 1921, to June 30, 1923	19	36,825	833,664.89	160,000
July 1, 1923, to June 30, 1924	12	24,223	578,242.59	160,000
July 1, 1924, to June 30, 1925	12	96,838	1,812,494.66	600,000
July 1, 1925, to June 30, 1926	12	125,676	2,235,184.40	700,000
July 1, 1926, to June 30, 1927	12	214,335	3,105,047.85	1,200,000
July 1, 1927, to June 30, 1928	12	237,962	3,629,317.57	1,600,000
July 1, 1928, to June 30, 1929	12	367,015	5,504,858.64	2,000,000
Total	.....	.....	$19,306,892.93	$6,820,000

Mining and Development

During the year 526,284 tons of ore were broken. Of this amount 92,922 tons were from development and 433,362 from mining, of which 367,015 tons were hoisted and milled and the balance, 159,269 tons, added to the broken ore reserves, which now amount to 393,297 tons, valued at $6,524,797.23.

No. 3 shaft has been completed from the 1,000- to the 2,000-foot level, with stations cut at 200-foot intervals. Crosscuts connect this with No. 1 shaft on all levels to the 1,600-foot level.

A steel headframe for the No. 3 shaft is now on order, also a 12- by 8-foot hoist. An additional compressor unit is also being installed.

No. 2 vein has been opened up to the western boundary on the 1,200- and 1,400-foot levels, and on the 1,600-foot level the drift extends the entire length of the property. Approximately 600 feet of drifting has been done on this vein on the 1,800-foot level, with values slightly better than any level yet encountered. The vein has also been cut on the 2,000-foot level, and shows excellent widths and values.

As more information is now available on the 1,600-foot level than on any other level, careful attention has been given to an estimate of the ore reserves between this and the 1,400-foot level, which shows a value of $13,000,000.

DEVELOPMENT FOOTAGE FOR YEAR 1928

Level	Drifting	Crosscutting	Raising	Shaft-sinking	Ore passing	Winzes	Total footage	Diamond drilling	Boxholes	Station-cutting	Total cubic footage
	feet	feet	feet	feet	feet	feet	feet	feet	cu. ft.	cu. ft.	cu. ft.
200-ft.	.....	6	.....	.....	.....	20	26	.....	.....	12,159	12,159
400-ft.	513	31	159	.....	.....	.....	703	.....	.....	.....	.....
600-ft.	544	25	180	.....	.....	.....	749	.....	.....	.....	.....
800-ft.	1,117	157	433	.....	.....	.....	1,707	491	3,372	.....	3,372
1,000-ft.	263	132	5,197	60	193	.....	5,845	182	21,800	20,000	41,800
1,200-ft.	3,233	306	850	186	.....	.....	4,575	1,264	7,600	20,377	27,977
1,400-ft.	2,408	270	1,425	199	.....	.....	4,302	1,413	14,800	12,200	27,000
1,600-ft.	2,478	560	263	273	.....	.....	3,574	3,620	.....	21,346	21,346
1,800-ft.	588	43	.....	145	.....	.....	776	.....	.....	29,781	29,781
2,000-ft.	.....	.....	.....	184	.....	.....	184	.....	.....	.....	.....
Total..	11,144	1,530	8,507	1,047	193	20	22,441	6,970	47,572	115,863	163,435

SUMMARY OF ORE AND WASTE HOISTED FOR THE YEAR 1928

Level	Ore from development	Ore from mining	Waste
	tons	tons	tons
200-foot	200	.....	2,435
400-foot	2,973	16,239	17
600-foot	2,476	26,208	116
800-foot	10,067	120,309	163
1,000-foot	20,321	76,833	15,956
1,200-foot	23,378	11,735	12,390
1,400-foot	18,757	22,769	8,066
1,600-foot	11,586	.....	15,444
1,800-foot	3,078	.....	6,711
2,000-foot	86	.....	5,960
Total tonnage	92,922	274,093	67,258

SUMMARY OF DEVELOPMENT AND EXPLORATION WORK SINCE BEGINNING OF OPERATIONS

	Feet
Drifting	38,335
Crosscutting	8,134
Raising	21,806
Sinking	4,462
Ore passing	1,754
Winze	245
Diamond-drilling	23,409
	Cu. ft.
Boxholing	166,011
Station-cutting	277,989
Sump	26,239

Milling

The mill operated very satisfactorily during the year, and results obtained through double filtration have been very gratifying. An additional ball and tube mill were installed during the latter part of the fiscal year, as well as a Symons cone crusher, filters, presses, and refinery equipment.

The increased tonnage opened up underground has made additional milling equipment necessary and three ball mills and six tube mills, together with the necessary tanks, filters, and other equipment, have been ordered and when installed will effect a material increase in milling capacity.

Costs

No special attempt has been made during the year to bring the cost per ton milled, as given below, to a minimum. The slightly high figures are favorably reflected in the amount of ore placed in sight and the development on the lower levels, as well as the increase in broken ore reserves.

	Total cost	Cost per ton
Development	$856,540.97	$2.34
Mining	947,169.03	2.58
Milling and refining	448,201.56	1.22
General and administrative expense	73,631.64	.20
Total	$2,325,543.20	$6.34
Depreciation	297,199.86	.81
Grand total	$2,622,743.06	$7.15

General

The most interesting item of the year's work was the opening up of a vein system parallel to No. 2 vein, which has been proven to exist from the 200- to the 1,600-foot levels. This will compare favourably in grade to No. 2 vein, and is known to extend from our western boundary east to a point near the Wright-Hargreaves line.

The problem of mine backfilling has already been considered, and gravel claims to the east have been secured. Preliminary work, preparatory to handling daily tonnage of material from these claims, is now in progress.

New shops of fireproof construction are now being erected. Plans for a new office building have been completed, and construction is now under way.

McIntyre-Porcupine Mines, Limited

The authorized capital of this company is $4,000,000, divided into 800,000 shares of a par value of $5, of which 798,000 are issued.

The officers of the company are: J. P. Bickell, president; W. J. Sheppard, vice-president; M. P. Van Der Voort, secretary; Balmer Neilly, treasurer; R. J. Ennis, general manager. The directors are: J. P. Bickell, Toronto; W. J. Sheppard, Waubaushene; J. B. Tudhope, Orillia; Jos. Errington, Toronto; and D. H. McDougall, Stellarton, N.S.

The mines and plant are at Schumacher in the township of Tisdale, district of Cochrane. The head office of the company is at Schumacher, Ont., and the executive offices at the Standard Bank Building, Toronto.

The following information is taken from the seventeenth annual report of the company, for the fiscal year ending March 31, 1929:—

ASSETS

CURRENT ASSETS:			
Cash in banks and on hand		$2,773.06	
Bullion in transit		191,125.19	
Special bank deposit		1,300,000.00	
Dominion of Canada bonds (par value, $1,000,000)		996,500.00	
Canadian National Ry. bonds (par value, $250,000)		244,375.00	
Accounts receivable		14,032.07	
Interest receivable		24,611.51	
Supplies on hand at cost		257,198.32	
			$3,030,615.15
INVESTMENTS:			
Blue Diamond Coal Co., Ltd., and Canadian Coal Fields, Ltd		$354,992.23	
Advances to subsidiary company		590,000.00	
Other investments		35,001.00	
			979,993.23
FIXED ASSETS:			
Mining properties		$4,194,338.97	
Plant and equipment, April 1, 1928	$3,499,107.71		
Net additions this year	51,879.13		
		3,550,986.84	
			7,745,325.81
DEFERRED CHARGES:			
Development undistributed, outside properties		$79,900.43	
Operating and administrative prepayments		24,286.86	
			104,187.29
			$11,860,121.48

LIABILITIES

Current Liabilities:			
Payrolls payable		$59,962.86	
Accounts payable		102,603.03	
Provision for municipal, provincial, and Dominion taxes		158,733.63	
Provision for sundry liabilities		15,929.58	
			$337,229.10
Reserves:			
General reserve		$400,000.00	
Reserve for depreciation of plant and equipment		3,323,355.90	
			3,723,355.90
Capital Liabilities:			
Capital stock authorized, 800,000 shares at $5 par value		$4,000,000.00	
Capital stock issued, 798,000 shares at $5 par value			3,990,000.00
Surplus			3,809,536.48
			$11,860,121.48

The profit and loss statement is as follows:—

Earnings:			
Bullion recovery			$4,212,624.82
Operating Costs:			
Mining and developing	$1,626,125.43		
Crushing and conveying	73,483.19		
Milling	372,347.88		
Miscellaneous camp costs	64,336.62		
		$2,136,293.12	
Administrative and General Expense:			
Management and general expense, mine	$83,805.52		
Administrative and general expense, Toronto office	81,224.56		
Transfer, registrar, stock issue, and dividend expense	8,127.75		
Insurance	15,461.50		
		188,619.33	
Total operating costs, before providing for taxes and depreciation			2,324,912.45
Operating profits, before providing for taxes and depreciation			$1,887,712.37
Non-Operating Revenues:			
Interest and discounts earned		$125,365.61	
Miscellaneous earnings		5,390.02	
			130,755.63
			$2,018,468.00
Appropriations:			
Provision for municipal, provincial, and Dominion taxes for current year			115,154.34
Net profit for the year, before depreciation provision, transferred to surplus account			$1,903,313.66

The following is the surplus account:—

Surplus as at April 1, 1928			$3,563,555.16
Add net profit, year ending March 31, 1929, before providing for depreciation			1,903,313.66
Sundry adjustments			3,688.37
			$5,470,557.19
Deduct:			
Dividend No. 38, June 1, 1928		$199,500.00	
Dividend No. 39, Sept. 1, 1928		199,500.00	
Dividend No. 40, Dec. 1, 1928		199,500.00	
Dividend No. 41, Mar. 1, 1929		199,500.00	
		$798,000.00	
Development undistributed, written off		230,960,40	
Provision for depreciation, buildings and equipment		355,098.68	
Workmen's compensation special assessment for 1927 re silicosis		25,948.66	
Amount transferred to general reserve		251,012.97	
			1,661,020.71
Surplus as at March 31, 1929			$3,809,536.48

The following data are taken from the report of the general manager covering operations for the fiscal year ending March 31, 1929.

PRODUCTION

Ore treated.....tons	538,165
Value per ton.....	$8.24
Gross value.....	4,433,378.00
Bullion recovered.....	4,212,624.82
Bullion recovered per ton.....	7.83
Bullion contained:	
Gold, 202,421.039 fine ounces.....	$4,184,413.92
Silver, 49,081,790 fine ounces.....	28,210.90
Total.....	$4,212,624.82

PRODUCTION SINCE THE BEGINNING OF MILLING OPERATIONS IN 1912

Period	Months	Tons milled	Value per ton	Gross value	Recovery per ton	Total value
1912.....	12	14,500	$7.00	$101,555.16	$5.25	$76,166.38
1913.....	12	31,979	7.85	251,314.45	7.05	225,752.25
Jan. 1, '14 to Mar. 31, '15..	15	85,654	8.87	760,232.16	8.39	718,331.71
Apr. 1, '15 to Mar. 31, '16..	12	105,758	7.71	815,345.49	7.38	779,990.94
Apr. 1, '16 to June 30, '17..	15	195,307	10.00	1,954,793.28	9.55	1,864,914.28
July 1, '17 to June 30, '18..	12	178,327	10.05	1,793,197.55	9.61	1,714,258.00
July 1, '18 to June 30, '19..	12	179,874	9.78	1,759,627.40	9.29	1,671,646.03
July 1, '19 to June 30, '20..	12	188,835	11.52	2,175,891.31	11.02	2,080,178.44
July 1, '20 to June 30, '21..	12	171,916	11.67	2,005,672.00	11.08	1,904,326.36
July 1, '21 to June 30, '22..	12	193,971	10.69	2,074,088.40	9.99	1,937,105.07
July 1, '22 to June 30, '23..	12	240,615	9.96	2,397,303.00	9.35	2,249,741.63
July 1, '23 to June 30, '24..	12	360,140	9.69	3,488,863.00	9.14	3,291,178.22
July 1, '24 to June 30, '25..	12	400,259	9.43	3,774,068.00	8.86	3,546,637.52
July 1, '25 to June 30, '26..	12	460,909	8.72	4,020,326.00	8.25	3,804,774.90
July 1, '26 to Mar. 31, '27..	9	385,409	8.08	3,113,500.07	7.67	2,957,060.97
Apr. 1, '27 to Mar. 31, '28..	12	520,460	8.09	4,207,553.00	7.66	3,987,634.94
Apr. 1, '28 to Mar. 31, '29..	12	538,165	8.24	4,433,378.00	7.83	4,212,624.82
Total.....	.....	4,252,078	$9.20	$39,126,708.27	$8.71	$37,022,322.46

MINING

	Tons
Ore broken in stopes.....	398,556
Ore from development.....	53,810
Total.....	452,366
Ore hoisted.....	537,147
Waste hoisted.....	50,769
Total.....	587,916
Waste used as back-fill.....	99,538

Broken ore reserves now stand at 209,680 tons, valued at $8.05 per ton, 84,984 tons less than shown at the end of the preceding year. This reduction is the result of our more general adoption of either the timbered or the cut-and-fill methods of stoping. During the year 40 per cent. of the ore extracted was produced by either of the last-mentioned methods. It is satisfactory to note in this connection that the grade of the ore thus mined closely approximates the estimated value as determined by channel sampling. This improved method is being applied as rapidly as arrangements can be made for supplying waste fill.

SUMMARY OF ORE HOISTED, 1928-1929

Level	Tons	Assay	Value
500-foot	2,967	$7.75	$22,935
600-foot	6,828	4.15	28,342
1,000-foot	8,930	13.25	118,324
1,125-foot	13,761	5.80	79,833
1,250-foot	15,502	6.85	114,126
1,375-foot	14,182	5.55	78,743
1,500-foot	5,953	5.25	31,303
1,625-foot	9,893	10.35	102,475
1,750-foot	33,979	6.30	214,553
1,875-foot	119,142	7.40	885,108
2,000-foot	84,079	8.80	742,380
2,125-foot	36,585	7.40	271,811
2,250-foot	47,977	6.35	304,482
2,375-foot	46,675	7.65	356,295
2,500-foot	80,376	10.20	820,068
2,625-foot	399	7.05	2,819
2,750-foot	32	16.80	538
2,875-foot	2,963	6.00	17,797
3,375-foot	4,247	3.25	13,752
3,500-foot	2,001	3.35	6,710
3,625-foot	207	4.40	914
3,875-foot	469	3.55	1,678
Total	537,147	$7.85	$4,214,986

Development

Development work performed during the year amounted to 34,371 feet, an increase of 7,834 feet over the preceding year. This work included 18,216 feet of drifts, of which 2,216 feet was on line and 16,000 feet in vein material; 6,180 feet was in ore of an average grade of $8.05 per ton over drift width.

No. 3 Vein.—Stopes produced 65,053 tons of an average grade of $8.60 per ton. From the 1,625- to the 2,250-foot levels, 4,240 feet of drifting was done, of which 1,639 feet was in ore of $7.90 grade over drift width.

No. 5. Vein.—Stopes produced 26,803 tons of $7.70 ore. On the 500-, 600-, and 1,625-foot levels short lenses of ore averaging $7.70 per ton have been developed.

No. 7 Vein.—Stopes produced 172,298 tons of ore of an average grade of $9.60. On the 2,500-foot level, 833 feet of drifts opened up 410 feet of ore of $9.70 grade over drift width.

No. 8 Vein.—Stopes produced 30,610 tons of ore with an average grade of $6.20. No development work was done on this vein during the year.

No. 9 Vein.—Production from stopes was 48,504 tons of ore with an average value of $8.70 per ton. No development work was done on this vein during the year.

No. 10 Vein.—Stopes in the western section of this vein produced 91,130 tons averaging $5.40 per ton. This vein is a quartz type of ore body containing patches of high-grade ore. Muck samples show 20 per cent. higher results than channel samples. On the 2,250- and 2,375-foot levels, 1,208 feet of drifts developed 507 feet of $8 ore. No work was done on the eastern or higher grade section of this vein, mentioned in last year's report, which lies south and east of No. 11 shaft.

No. 12 Vein.—No work was done on this vein during the year.

No. 13 Vein.—Stopes are just being cut out on this vein and so far there has been produced 14,472 tons of $12 ore. On the 2,000-, 2,250-, 2,375-, 2,875-, 3,375-, and 3,875-foot levels, 2,163 feet of drifting developed 1,025 feet of ore with an average value of $10.10 over drift width. Good ore is indicated in this vein form the 1,875- to the 3,875-foot levels and is only partially developed on the above-mentioned levels.

No. 14 Vein.—Stopes have just been started on this vein and to date it has produced 13,616 tons of $8.30 ore. Development work on the 1,750-, 1,875-, 2,375-, 2,875-, and 3,375-foot levels amounted to 4,453 feet, of which 1,571 feet was in ore of $6.70 grade over drift width. A much better grade of ore is indicated by diamond-drilling from the 1,625- to the 3,750-foot horizon, but this ore body is only partially developed on the above-mentioned levels. On the 3,625-foot level, "C" crosscut driven south from No. 11 shaft exposed 39 feet of ore averaging $9.60 per ton. The ore is of a heavy sulphide type usually favourable on this property to the development of extensive ore bodies.

No. 16 Vein.—Stopes produced 15,979 tons of $10.40 ore. Development on the 2,125-, 2,250-, and 2,375-foot levels amounted to 1,017 feet, of which 300 feet was in ore of $7 grade.

No. 11 Shaft.—Development work at No. 11 shaft was confined to crosscuts to the ore zone and drifts in No. 3, 13, and 14 vein systems, with good results so far on the 1,625-, 1,750-, 1,875-, 2,000-, 2,250-, 2,375-, 2,875-, 3,375-, 3,550-, and 3,625-foot levels. Where the crosscut south on the 3,750-foot level intersected breaks corresponding to the probable positions of veins Nos. 13 and 14, values were low. No drifting has yet been done off the crosscut, but when commenced ore bodies should be developed as indicated by results obtained on the 3,625-foot level. On the 3,875-foot level work was concentrated on drives to the southwest and northeast through the basic schist and parallel to the vein systems. The drive to the southeast (D1) was advanced 2,400 feet, or to within 1,000 feet of the west property line. The northeast drive (D2) was advanced 1,800 feet, or to within 1,900 feet of the east property line.

In the basic schist area a small amount of crosscutting and diamond-drilling from the main drives has been accomplished, and to date four veins other than the ones cut by the original crosscut have been definitely located. Drill intersections have varied from less than commercial grade to well over mine average. However, the work accomplished to date is so small in comparison with the area to be explored that no general and definite statement can safely be offered at this time other than the fact that the basic schist area on this horizon is greater than upon any upper horizon, and that it is similar in its characteristics and in its relationship to the porphyry.

The main drives will be continued to the east and west boundary lines.

Connections on all haulage levels have been made with No. 11 shaft, and an ore pass has been completed from the loading station below the 3,875- to the 1,625-foot level. The shaft is now ready to handle ore from all parts of the mine, and mill tonnage will move through it about July 1, 1929. This will provide an opportunity to replace timber in No. 6 shaft which has been in continuous operation since 1912.

ORE RESERVES BY CLAIMS, 1928-1929

	Tons	Assay	Value
McIntyre claims	724,393	$7.15	$5,177,780
McIntyre Extension claims	173,002	9.05	1,568,661
Jupiter claims	816,425	8.55	6,978,253
Plenaurum claims	102,779	7.50	767,108
	1,816,599	8.00	14,491,802
Broken ore	209,680	8.05	1,687,403
Total	2,026,279	8.00	$16,179,205

SUMMARY OF DEVELOPMENT AND EXPLORATION YEAR 1928-1929

Period	Drifts	Cross-cuts	Raises	Winzes	Shafts	Stations	Sumps	Pockets and passes	Total footage	Total excavation	Diamond-drilling
	feet	feet	feet	feet	feet	cu. ft.	cu. ft.	cu. ft.	feet	cu. ft.	feet
1	2,043	635	192	.....	.....	3,843	.....	.....	2,870	3,843	2,234
2	1,630	884	317	.....	.....	.....	.....	.....	2,831	.....	2,048
3	1,753	619	264	.....	.....	.....	.....	.....	2,636	.....	2,062
4	1,585	1,053	267	.....	.....	.....	.....	.....	2,905	.....	1,981
5	1,928	1,019	201	.....	.....	.....	.....	.....	3,148	.....	2,238
6	1,248	1,318	255	.....	.....	.....	.....	.....	2,821	.....	1,689
7	1,364	1,216	309	.....	.....	.....	.....	.....	2,889	.....	1,740
8	1,348.5	1,298	262.5	.....	.....	.....	.....	.....	2,909	.....	1,915
9	1,068	1,277	290.5	.....	.....	.....	.....	.....	2,635.5	.....	2,278
10	1,344	1,380	349	.....	.....	.....	.....	.....	3,073	.....	2,433
11	1,418	1,093	390	.....	.....	.....	.....	.....	2,901	.....	2,330
12	1,487	909	357	.....	.....	11,100	.....	.....	2,753	11,100	2,546
Total	18,216.5	12,701	3,454	.....	.....	14,943	.....	.....	34,371.5	14,943	25,494
Previous years	112,013.8	52,449.3	10,856.4	597.7	12,619.9	607,977	36,823	139,699	188,519.1	784,499	186,550.5
Total	130,230.3	65,150.3	14,310.4	597.7	12,619.9	622,920	36,823	139,699	222,890.6	799,442	212,044.5

OPERATING COSTS

	Total	Per ton milled
MINING:		
Exploration	$43,492.04	$0.0808
Development	375,063.73	.6970
Breaking and stoping	1,196,390.33	2.2230
Examination of prospects	11,179.33	.0208
Total mining costs	$1,626,125.43	$3.0216
Crushing and transporation	$73,483.19	$0.1365
Milling	372,347.88	.6919
Heating and maintenance—buildings and camps	56,279.70	.1046
Mercantile store and welfare expenses	8,056.92	.0150
Bullion marketing and general expense—mine office	83,805.52	.1557
Administration and general expense—Toronto office	89,352.31	.1660
Insurance—general	15,461.50	.0287
Total	$2,324,912.45	$4.3200

ANALYSIS OF MINING COSTS PER TON MILLED

	Stoping	Drifting	Cross-cutting	Raising	Stations and sumps	Total cost	Cost per ton
Labour	$580,256.45	$120,295.90	$90,654.81	$29,107.33	$560.54	$820,875.03	$1.5253
Explosives	77,764.41	61,750.43	35,508.28	9,922.35	103.08	185,048.55	.3439
Supplies	48,443.38	18,908.08	19,226.14	8,732.25	206.43	95,516.28	.1775
Power	38,746.13	11,127.27	4,563.07	3,933.96	47.22	58,417.65	.1085
Timbering	136,501.28	.....	133.72	377.59	97.10	137,109.69	.2548
Shaft repairs	5,612.77	.....	.....	.....	.....	5,612.77	.0104
Back-filling	45,459.27	.....	.....	.....	.....	45,459.27	.0845
Steel-sharpening	24,039.57	17,306.40	11,928.87	3,014.47	52.12	56,341.43	.1047
Drill repairs	11,496.26	5,193.87	3,583.50	1,723.35	56.06	22,053.04	.0410
Surveying and Engineering	18,586.79	5,343.56	3,255.73	2,652.54	50.79	29,889.41	.0555
Sampling and Assaying	32,125.98	4,436.67	3,903.90	2,916.95	.....	43,383.50	.0806
Pumping	7,738.81	1,422.28	1,051.34	117.75	.....	10,330.18	.0192
Ventilating	4,053.24	3,014.71	5,278.31	1,699.85	36.55	14,082.66	.0262
Tramming	69,669.06	21,324.82	12,722.30	3,774.34	45.86	107,536.38	.1998
Surface tramming	.....	1,034.15	3,505.37	2,199.85	57.70	6,797.07	.0126
Hoisting	95,896.93	23,194.25	25,398.27	17,448.94	443.91	162,382.30	.3017
Total	$1,196,390.33	$294,352.39	$220,713.61	$87,621.52	$1,757.36	$1,800,835.21	$3.3462
Less: Charged to undistributed development	.....	.....	147,548.26	80,075.53	1,757.36	229,381.15	.4262
	$1,196,390.33	$294,352.39	$73,165.35	$7,545.99	.....	$1,571,454.06	$2.9200
Exploration	.....	.....	.....	.....	.....	43,492.04	.0808
						$1,614,946.10	$3.0008
Examination of Prospects	.....	.....	.....	.....	.....	11,179.33	.0208
Total	.....	.....	.....	.....	.....	$1,626,125.43	$3.0216
Unit cost per ton	$2.2230	$0.5470	$0.1360	$0.0140	.....	.....	.....

MILLING COSTS

	Labour	Supplies	Repairs and maintenance	Power	Total	Cost per ton
Ball milling	$9,200.06	$23,358.61	$396.30	$12,496.37	$45,451.34	$0.0845
Tube milling	6,845.14	49,718.23	1,215.00	30,485.39	88,263.76	.1640
Classification	7,630.54	3,017.20	516.90	3,645.09	14,809.73	.0275
Pumping and elevating	5,976.20	5,604.11	521.40	4,054.93	16,156.64	.0300
Agitation	5,976.20	1,869.93	396.70	5,863.97	14,106.80	.0262
Thickening	5,976.20	2,556.10	871.50	2,142.67	11,546.47	.0215
Clarification	9,979.83	1,590.80	113.50	1,647.56	13,331.69	.0248
Precipitation	6,019.88	12,403.04	280.30	2,006.14	20,709.36	.0385
Re-agents	.....	68,978.41	.....	.....	68,978.41	.1282
Filtration	14,904.73	4,388.75	928.80	3,452.87	23,675.15	.0440
Refining and assaying	16,512.01	7,334.00	62.70	512.24	24,420.95	.0454
Heating	.....	6,767.07	78.70	.....	6,845.77	.0127
Tailings disposal	5,003.50	11,641.06	3,878.17	2,415.73	22,938.46	.0426
Mill alterations	.....	806.35	307.00	.....	1,113.35	.0020
Total	$94,024.29	$200,033.66	$9,566.97	$68,722.96	$372,347.88	$0.6919

The mill operated to full capacity with improved metallurgical results and lower costs.

ADDITIONS TO PLANT, BUILDINGS, AND EQUIPMENT

Milling and crusher plants	$11,824.16
Workshops and equipment	3,820.29
Surface transportation equipment	9,093.97
Surveying instruments and office equipment	390.76
General buildings and dwellings	13,774.05
Hoisting equipment	4,414.91
Surface thawing equipment	3,455.52
Heating plant, No. 11 shaft	16,495.47
Surface water mains	1,665.68
Underground haulage equipment	29,761.16
Sundry underground equipment	25,397.40
Toronto office	5,491.14
	$125,584.51
Less construction incomplete, March 31, 1928	69,494.94
	$56,089.57
Add construction incomplete, March 31, 1929	102,084.19
	$158,173.76
Less equipment and buildings, sold or demolished	106,294.63
	$51,879.13

Under "General Remarks" the manager makes the following statement:—

Operations have been carried along without interruption and under favourable conditions throughout the year. The outstanding feature of the year's development was the locating and opening up of vein systems Nos. 13 and 14. These ore bodies are favourably located as regards formation and structure. They have already been traced from the 1,625- to the 3,875-foot levels, and promise production comparable with Nos. 5 and 7 veins, which up to this time have been our most important producers.

D. E. Keeley is mine superintendent and J. J. Denny is mill superintendent. During the year the average number of men on the payroll was 818.

McMillan Gold Mines, Limited

The head office of the McMillan Gold Mines, Limited, is in Sudbury and the officers and directors are as follows: J. H. Banks, 511 Fifth Avenue, New York, president; G. A. Foot, Sudbury, Ont., vice-president; C. B. Goldsborough,

secretary-treasurer; E. J. McMillan, F. C. Fraser, Geo. Arents, Jr., R. L. Patterson, Jos. Errington, W. J. Galligan, directors.

Throughout 1928-29 the company continued to develop the gold property in Mongowin township, district of Sudbury. The holdings consist of 36 claims, with the shaft and mine buildings on claim No. 6,225.

The only addition to the surface plant since the publication of our last report is a blacksmith shop, containing an oil forge and a steel-sharpener.

The president's report for the year ending December 31, 1928, sets forth the following development work:—

325-Foot Level:	Feet
Crosscutting from shaft	28
Drifting east of shaft	737
Drifting west of shaft	362
Crosscutting east of shaft	468
Crosscutting west of shaft	68
525-Foot Level:	
Drifting east of shaft	1,278
Crosscutting east of shaft	442

Summary of Work to December 31, 1928

	Feet
Diamond-drilling	2,350
Sinking	550
Crosscutting	1,300
Drifting	2,413

In summarizing the results obtained, the president states in part:—

The greater part of the work has been within the area between the shaft and the diabase intrusion some 400 feet east. Within this area the ore sections on the 325-foot level have given assays averaging $9.30 for a total length of 282 feet, and on the 525-foot level $10.45 for a total length of 267 feet. The average assay for both levels would be $9.90; the average total length 275 feet, and the average width 40.2 inches. This does not include the wide ore body on the 525-foot level on which more work must be done, or the portions of No. 2 Pit vein not yet opened up.

The work done outside the above area is confined chiefly to the drifting west of the shaft on the 325-foot level and the drifting through east of the diabase intrusion on the 525-foot level. This considerable amount of drifting, with comparatively little crosscutting, has been in part to prepare the way for diamond-drilling to the south and for further crosscutting later. These sections west of the shaft and east of the diabase are as yet but partially explored.

The drifting east of the diabase has picked up an ore body which has not yet been fully exposed.

In June, 1929, Percy E. Hopkins, who had recently examined the property, reported that ore zones on the 325-foot level have an average gold content of $7.33 per ton. The zones have a length of 245 feet, with an average width of 34.9 inches. Two zones on the 525-foot level, having a length of 213 feet and an average width of 43.9 inches, gave values averaging $7.93 per ton in gold.

E. J. McMillan is in charge of the property.

March Gold, Limited

This company has an authorized capitalization of $1,500,000, divided into shares of $1 par value each. The shares formerly had a par value of 10 cents, but the change was ratified at a meeting of shareholders held June 15, 1927. The parent company in the United States has a capitalization of $3,500,000, divided into shares of $1 par value each.

The officers of the company are: Henry Kobler, president; B. C. Conderman, vice-president; Samuel B. Darlich, secretary; F. J. C. Bull, treasurer; Bernard N. Hyman, chairman of the board. Jos. T. Baldwin is manager at the property. The directors of the company are: Bernard N. Hyman, Henry Kobler, Samuel B.

Darlich, Geo. R. Feine, F. J. C. Bull, Charles J. Schmidt, Henry Tiedt, Gustave Loesch, and Jacob Schwingel, all of Buffalo, N.Y., and B. C. Conderman of Hornell, N.Y. The head office of the company is at 402 Wallbridge Building, Buffalo, N.Y., and the mine office address is Box 533, South Porcupine, Ont.

The company owns five claims in the township of Deloro, district of Cochrane. These claims comprise H.R. 823, H.R. 833, and H.R. 900 of the original March group and the Maidens-McDonald group, H.R. 832 and H.R. 926, purchased from the Coniagas Mines, Limited.

There are five shafts sunk on the property, No. 1 situated on H.R. 823 being the first sunk by the March Gold, Limited, to a depth of 800 feet. No work has been done through this shaft for several years. No. 2, an incline, 60° N., is sunk on H.R. 833 to a depth of 190 feet and is connected at the 170-foot level with No. 3, a vertical, three-compartment shaft located on H.R. 833.

An inclined shaft, known as No. 4, located on H.R. 832, is sunk along No. 6 vein at 65° N. to a depth of 220 feet (vertical), the work having been done by the original holders. This shaft is now connected with No. 3, which lies 460 feet to the southwest.

A vertical shaft sunk to a depth of 115 feet on H.R. 833 is not connected with other workings of the March or Maidens-McDonald groups. The plant erected at this shaft has been dismantled.

All underground work of the past year has been confined to claims H.R. 926 and 832. The total development footage for the year ending December 31, 1928, is as follows:—

	Feet
Crosscutting	644
Drifting	832
Raising	357
Sinking	173
Diamond-drilling	639

Crosscutting north on the 425-foot level, from No. 3 shaft, cut the No. 5 vein, which is the best so far discovered. Drifting west a distance of 80 feet and east to the Ankerite line disclosed ore in all but a few sections. This was partly stoped during the year. To the north on this level, 150 feet of crosscutting was done, head room cut, and a winze sunk. The winze was completed to a depth of 273 feet, and two stations at the 550- and 675-foot horizons were cut early in 1929. On the 300-foot level, 200 feet of drifting on the No. 5 vein showed no new ore.

The mill operated from May 1 throughout the year, with a total production of $133,835.91 from 32,627 tons of ore.

The mine employs 84 men, 50 underground and 34 in the mill and on surface.

Metals Development, Limited

This company is capitalized at $2,500,000, in shares of $1 par value. There are 1,896,818 shares issued.

The following is a list of officers and directors of the company: M. H. Lebel, of Montreal, president; W. R. Salter, vice-president; M. F. Blue, secretary-treasurer; H. S. Crabtree, H. Borgford, Toronto; W. J. Evans and T. E. Armstrong, New Liskeard, and W. L. Forest, directors. J. W. Morrison is consulting engineer.

The company is interested in several claims in the North Clearwater lake section, district of Kenora (Patricia portion). The property is best reached from Woman lake. A fair road, about a mile in length, has been built to the camp location on claim No. 5,603.

Surface work has been done on 17 claims and has shown up several long breaks. Two systems of veins have been located.

The veins first located had a strike almost due north, but the most promising occurrence of gold is in a vein of banded quartz on claim No. 5,603, which strikes N. 47° E. and dips 50° S. Minerals found in this vein are galena, sphalerite, pyrite, some chalcopyrite, and gold.

When inspected in July, 1929, an inclined shaft had been put down on the vein to a depth of 100 feet, and 61 feet of drifting had been done on the vein. This work has all been in ore of a fair grade showing spectacular native gold at times.

The property is equipped with a Sullivan portable compressor, 125 cubic foot capacity, gasoline driven, and a small Turbo hoist, driven by the compressor. A horse whim was in process of construction in July. New camp buildings have been put up on claim No. 5,603 sufficient to house 20 men.

When inspected, 7 men were employed on the property. J. C. Nelson is manager.

Mineral Research Corporation

The company is operating on the old Davidson-Carr property located in Thunder Bay district, at the north end of Northeast bay of Sturgeon lake, about six miles by direct line east of the St. Anthony mine. The property can be reached by water from Sturgeon lake proper, or from a point on the Canadian National railway, five miles east of Savant Lake station. The route is across Buckingham lake, with a portage of a mile and a quarter into Northeast bay, and a short paddle to the mine. The winter road starts from a point on the west shore of the bay due west of the mine, and terminates five miles away at mileage 76 on the Canadian National railway, where supplies are put off for the property.

In the winter of 1928-29, a small steam plant was installed on the property and the following camp buildings were erected: headframe, 18 feet high; hoist-house and blacksmith shop combined, 12 by 20 feet; boiler-room and compressor house combined, 30 by 15 feet; office, 18 by 20 feet; bunk-house for twenty-six men, 22 by 40 feet; stable, 14 by 14 feet; and icehouse, 10 by 10 feet.

Underground operations consisted of sinking a 60-degree inclined shaft on the vein to a depth of 160 feet, and doing 30 feet of drifting on the 130-foot level and 230 feet on the 160-foot level. At the time of inspection on July 10, 1929, the mine was partially filled with water, and underground operations for the present were discontinued. A diamond-drill campaign was in progress from the surface, of which 424 feet had been done in two holes.

Three veins besides the one sunk on have been located on the surface. The vein system has a general strike of N. 45° W. and dips 60° N.

Twelve men were employed on the property. A. R. Globe is in charge of operations.

Moss Mines, Limited

The capital stock of the company consists of 4,000,000 shares of $1 par value. Of this 2,679,293 shares have been issued. The officers are: N. R. Fisher, president; Alistair Frazer, vice-president; James Cooper, secretary-treasurer. Russell Blackburn, C. S. Gzowski, F. B. Little, Frank M. Rose, and J. D. Patterson are directors.

The property was originally called the Huronian mine and is one of the oldest in Ontario, having been operated first in 1871. The workings are on lot

H. 1, and the holdings include 900 acres in the township of Moss. Supplies are now brought in from Kashabowie, 80 miles west of Fort William on the Canadian National railway, over a light railroad as far as the Tip Top mine, thence by canoe and portage across Round lake, Crooked river, and Jackfish lake to the Moss mine. The distance from Kashabowie by this route is about 26 miles.

The old shaft sunk by the Huronian Company followed the vein and bottomed at the 125-foot level. The new vertical three-compartment shaft which was started in 1927 was completed to 400 feet on October 15, 1928, and stations were cut at the 125-, 250-, and 375-foot levels. By January 1, 1929, installation of the cage had been completed and crosscutting and drifting on all three levels was proceeded with.

On the 125-foot level drifting west has connected the new section with the Huronian mine. The west face of the old workings is now being driven to explore below some favourable surface showings on the western extension of the vein.

The following table shows the lateral work accomplished since the completion of the shaft to July 31, 1929.

Level	Drifting	Crosscutting
	feet	feet
125-foot	190	25
250-foot	880	135
375-foot	650	435

Recent additions to the surface plant and camps include a telephone line to connect with the Tip Top–Kashabowie line, a powder magazine, and a cookery and sleep camps with accommodation for 50 men.

About midsummer, 1929, the company was employing an average of 26 men underground and 24 on surface. J. G. Harkness is superintendent of the property, with A. G. McKenzie as engineer and mine foreman.

Murphy Mines, Limited

Murphy Mines, Limited, has an authorized capital of 3,000,000 shares of $1 par value. The head office is in the Northern Ontario Building, 330 Bay Street, Toronto. R. R. Brown is president; Draper Dobie, vice-president; James Day and E. M. Murphy, directors. T. R. Buchanan is manager, and Lindsay Foss, superintendent. The property is in Gauthier township, district of Timiskaming.

During 1928 development consisted of sinking No. 1 shaft 650 feet, cutting stations 5,140 cubic feet, crosscutting 883 feet, drifting 87 feet; sinking No. 2 shaft 96 feet, crosscutting 136 feet, drifting 10 feet.

Northern Red Lake Mines, Limited

This company holds two claims, A.L. 113, the Isabella, and A. L. 114, the Golden Star, in the Mine Centre area, Rainy River district, under option from W. E. Stone of Mine Centre and H. Williams of Fort Frances.

Considerable work was done on the Golden Star property in the early days. This work terminated about 1900. A shaft was sunk some 480 feet and stoping was done above the lateral work on each of four levels. One raise was driven through to surface from the old workings and came out about 125 feet south of the shaft. The original mill was on the shore of Bad Vermilion lake about half a mile from the shaft.

Early in 1928 a 25-ton Gibson mill, consisting chiefly of a Blake crusher, Gibson rod mill, amalgamation table, concentrating table, and flotation cell, was installed on the Golden Star property; and a small amount of material obtained from an open cut on the continuation of the vein east of the old Golden Star workings was treated.

A test pit, reported to be some 15 feet deep, was sunk on the Isabella property.

Work was suspended in July, 1928.

The officers and directors are: Frederick S. Munson, Fort Frances, president and treasurer; Joseph M. Kollar, Detroit, Mich., secretary; Harold I. Watkins, Ferndale, Mich., vice-president; Frederick S. Munson, Fort Frances, managing director.

H. A. Olsen is in charge of the property.

Northland Gold Mines, Limited

Northland Gold Mines, Limited, operated their property in Gauthier township, district of Timiskaming, with a working force of 20 to 30 men. John J. Byrne is managing director. The other officers and directors are: Harry P. Hermance, president; J. A. Legris, secretary-treasurer; P. S. Patterson, W. A. Newell, M. J. Stearns, and J. Carruthers, directors. The head office is at Northland Mines, Ont.

At No. 1 shaft, on the 1,000-foot level, operations were carried on steadily from the first of the year until August 9, at which date all underground work ceased at No. 1 shaft. During this period the following work was done: cross-cutting, 626 feet; drifting, 1,235 feet; slashing, 45 feet.

At No. 2 shaft, work commenced on September 5 and was carried on until December 10. During this period the work comprised: drifting, 335.8 feet; slashing, 30 feet; sump, 8 feet.

During the year diamond-drilling explorations amounted to 1,740.6 feet.

Olivet Gold Mines, Limited

The Olivet Gold Mines, Limited, operated their property a mile east of Ritchie mine, in the township of Gauthier, district of Timiskaming, with a force of 10 men. The officers are: J. O'Connor, president; Albert Singer, vice-president; James C. Singer, secretary-treasurer. W. W. Snider, W. F. W. Fisher, Thomas T. Carter, J. H. L. Patterson, and F. H. Bigwood are directors. K. B. Heisey is consulting engineer. Earl Hunton was manager in 1928.

During the year the work comprised 2,000 feet of trenching and 100 feet of test-pitting. The head office is at 202 C.P.R. Building, Toronto.

Patricia Dent Gold Mines, Limited

This company is interested in a group of claims about four miles north of the Jackson-Manion on the west shore of Clearwater lake, district of Kenora (Patricia portion).

Two shafts have been sunk, each to a depth of 50 feet. These are on claims Nos. 4,134 and 4,135. There are many small breaks on the property and these have been much trenched. There is camp accommodation for 20 men. When inspected in July, 1929, there were 7 men employed. The work was in charge of J. C. Dodd.

Pawnee Kirkland Gold Mines, Limited

Pawnee Kirkland Mines, Limited, has a capital of $3,000,000 in shares of $1 par value. The officers are: C. Fred Jordan, president; Roy W. Weldon, secretary; George W. Morris, M. C. Smith, O. B. Earle, and J. Y. Murdoch, directors. The head office is at 504 Kent Building, Toronto.

John J. Byrne was manager, and 25 men were employed at the property in Lebel township, district of Timiskaming.

The following is taken from the manager's report for 1928:—

During the first nine months, operations were confined mostly to the 750-foot level, where No. 2 vein was opened up and a long crosscut driven to explore what was thought to be a favourable area north of the shaft. In October and November, work was confined to the further opening of the No. 2 vein at the 125- and 250-foot levels. A diamond-drill hole was put down to explore a wide mineralized zone on the south side of the property, and 200 feet of surface trenching was done north of the shaft where some promising surface breaks occur. Work was suspended on December 1, and the mine closed.

Plant, equipment, and buildings were left in first-class condition and operations can be resumed on short notice.

During the year the following development work was done:—

Operation	Feet	Total cost	Cost per foot
UNDERGROUND:			
Crosscutting	995.6	.....	.....
Drifting	1,605.8	.....	.....
Sumps	7	.....	.....
Slashing	82	.....	.....
Total	2,690.4	$78,078.38	$29.02
Diamond-drilling	500	$2,133.26	$4.266
Surface trenching and test-pitting	200	476.07	2.38
Clearing land	.....	1,823.03	.....
Total	.....	$82,510.74	.....

Since the beginning of operations in 1926 a total of $212,105.72 was expended as follows: operations, $168,826.81; buildings, $21,316.86; equipment, $21,962.05.

The following table shows footage of development on each level during this period:

Level	Cross-cutting	Drifting	Slashing
	feet	feet	feet
125-foot	53.2	259.5	5
250-foot	91.5	274.1	8
375-foot	9	.....	.....
500-foot	135.5	133.5	20
625-foot	4.5	.....	.....
750-foot	1,030	1,255.8	49
Total	1,323.7	1,922.9	82

In addition to the above, the following footage was accomplished: sinking, 780 feet; stations, 16,288 cubic feet.

Polaris Gold Mines of Canada, Limited

This company was incorporated under the laws of Ontario on January 5, 1928, with a capitalization of 5,000,000 shares, par value $1. There are 2,660,000 shares issued, of which 2,500,000 are for property.

The officials of the company are as follows: Ralph T. Polk, president; Manley D. Davis, vice-president; Harry Thompson, secretary-treasurer; all of Detroit, Mich. W. C. Churchill, Detroit, R. F. Stibbard, Timmins, Ont., W. E. F. Paine, Toronto, and J. H. S. Kerr, Toronto, are directors.

The holdings of the company are: 4 claims, Nos. 13,362, 13,365, 13,363, and 13,367, in the township of Mountjoy; 6 claims due east of claim P. 13,650 in the township of Jamieson, Kamiskotia area; and 4 claims in Whitney township, previously known as the Fitzgerald Veteran claims, all in the district of Cochrane.

The activities of the company have been centred for the most part on the Mountjoy claims. The company started clearing and erecting a plant on May 15, 1928, and sinking began in August.

The plant consists of a single-drum Jenckes steam hoist, 8 by 12 inches; air compressor, 250 cubic foot per minute capacity; a 3- by 8-foot air receiver; and a 70 h.p. boiler, all housed in one building, 30 by 30 feet. There is also on the property a blacksmith shop and storehouse combined, 14 by 32 feet, and an office and first-aid room combined, 12 by 16 feet. Two cottages were built for the management.

The shaft has two compartments, the hoisting compartment being 4 feet 10 inches by 4 feet 9 inches. The shaft on April 15, 1929, had reached a depth of 216 feet.

While sinking was in progress there was an average of 14 men employed on the property.

The property stopped operations on April 15, 1929. When work is again resumed it is planned to place more equipment, capable of going to 1,000 feet.

W. C. Churchill was manager until the shut-down.

Porcupine United Gold Mines, Limited

The Porcupine United Gold Mines, Limited, has an authorized capital of 1,500,000 shares of $1 par value, all of which is issued to the Porcupine United Gold Mines, Incorporated, except the qualifying shares issued to the directors.

The officers of the company are as follows: Bernard N. Hyman, president; Ray M. Stanley, vice-president; Henry Kobler, treasurer; Samuel B. Darlick, secretary; Charles Schmidt, director, all of Buffalo, N.Y. The head office is located at 330 Wallbridge Building, Buffalo, N.Y. Offices are also maintained by Colonel Newton M. Young in the Excelsior Life Building, Toronto. The mine office is at Timmins, Ont.

Porcupine United Gold Mines, Incorporated, is organized under the laws of Delaware with a capitalization of 3,500,000 shares of fully paid and non-assessable stock of the par value of $1 a share. The officers of the company are the same as those of the limited company and the following are the directors: Charles Schmidt, William Kam, Gustave Loesch, Herman Mayer, George Feine, all of Buffalo, and Mark P. Murtha of New York. The offices are the same as those of the limited company.

The group of claims in actual development are those adjoining the Hollinger mine and formerly worked as the Rochester mine. All the work on the property is concentrated on claim No. 13,427.

The property, acquired under option late in 1928, was dewatered to the 500-foot level and sampled. Later the mine was completely dewatered to the 900-foot level, the lowest workings.

Short, narrow, high-grade veins, showing native gold, which had been previously developed by other operators and to some extent by this company, are being stoped and the ore treated in a small mill erected in the early part of 1929.

The following is a summary of the ore treatment: An ore bin of small capacity in the headframe of the shaft supplies the feed to a 10- by 7-inch jaw crusher. Passing through a small set of rolls, the ore is carried by conveyor belt to the mill and hoisted by a bucket elevator to a second mill-feed bin.

The ore is ground in a Hardinge ball mill, diameter 4½ feet, and the discharge is to two 8- by 4-foot copper amalgamating plates with blankets at the foot. The plates discharge to a Dorr drag classifier in closed circuit with the ball mill and plates. The overflow of the classifier goes to two James tables, the concentrates from which are sent to the March Gold mill for cyanidation. About 70 per cent. of the gold is caught on the plates and blankets. The mill is treating about 15 tons daily.

There are 21 men employed at the property.

Jos. T. Baldwin is manager, and R. A. Vary is in charge of the mill.

Power and Mines Corporation, Limited

The company operates the Grace mine in the Michipicoten area, district of Algoma. The holdings consist of 43 claims, covering 1,240 acres, in township 29, range 23. The workings are on claims D.J.7 and D.J.8.

Two major breaks have been located on the property, the Nyman and the Grace. All underground work to date has been done on the latter.

The officers and directors of the company are: Sir Frederick O. W. Loomis, president; Granville Gilmore, vice-president; W. H. Perram, secretary-treasurer; Nap. G. Kirouac, R. A. Darwin, directors.

The authorized capitalization is 300,000 7 per cent. cumulative preferred shares of $5 par and 1,500,000 common shares of no par value.

The head office is at 1130 St. Patrick Street, Montreal.

Underground work which was stopped in April, 1928, was again resumed in September of the same year. In February, 1929, owing to financial difficulties, the company was again forced to discontinue operations.

A summary, by months, of the development work done during this latter period is given below. The figures include drifting, crosscutting and raising.

	Feet
September, 1928	215.8
October, 1928	360.8
November, 1928	371
December, 1928	311
January, 1929	271
February, 1929	253

J. A. S. Roussac is manager of the property.

Red Lake Gold Shore Mines, Limited

This company has an authorized capital of 5,000,000 shares without any nominal or par value. There have been 2,500,000 issued for the property and 400,000 for further development; 2,100,000 are in the treasury.

The officers of the company are: Charles V. Gallagher, president; Robert W. Breuls, vice-president; Harry A. Newman, secretary-treasurer; Charles B. Morgan, managing engineer. The directors are: Charles V. Gallagher and

Frederick Laforest, of South Porcupine; Robert W. Breuls, Harry A. Newman, and Ira E. Hough, of Toronto. The head office is at 1102 Excelsior Life Building, 36 Toronto Street, Toronto. The mine office is at Red Lake, Ont.

The company owns 20 claims occupying a solid block situated west of the Howey Gold Mines, Limited, and north of the holdings of the McIntyre-Porcupine Mines, Limited. They lie on the south shore of Red lake and extend into the lake across the northern boundary of the property, all in Dome township, district of Kenora (Patricia portion). These claims comprise the Gallagher group of 6 claims, the Campbell group of 10 claims, the Gallagher and Campbell of 4 and 2, staked since the incorporation of the company. The claim numbers are as follows: K.R.L. 818-22, 1,741, 2,134-40, 5,888-90, 5,944-46, and 6,005.

There is a great variety of rock formations on the property, but the granites and porphyries are the most abundant. The granite in places grades from a true light-coloured acid rock to a more basic type. Throughout the mass there are several volcanic flows highly metamorphosed. Chloritic schist is frequently observed along the contact of the porphyry and Keewatin rocks, showing evidence of much movement and shearing. Where the alteration has not proceeded to the extreme point in the flows, the rock resembles an andesite. At other points there are small flows of rhyolite.

To the end of 1927, some four veins had been uncovered, Nos. 1 and 2 being on K.R.L. 1,741. No. 1 has a southeasterly strike and is reported to have been stripped over a length of more than 300 feet. The vein has a width of 18 inches, but good values are said to prevail to greater widths, the vein itself carrying high gold values.

The No. 2 vein has been uncovered for 300 feet and is located again several hundred feet farther along the southwestern strike.

No. 3 vein has been stripped for a distance of over 900 feet on claims K.R.L. 1,741 and 2,134 and apparently it extends across the north corner of claim K.R.L. 2,137. Its strike is approximately northwest. The main portion of this vein consists of porphyry intermingled at intervals with considerable siliceous material, mostly quartz. The whole body is well mineralized. This vein has been picked up on K.R.L. 822. Substantial gold values have been reported from the vein.

No. 4 vein, striking northeast, is located on claim K.R.L. 820 and extends on to claim K.R.L. 822, along the McIntyre line, a few feet north of the boundary. With vein and vein matter together, there is a width of 3 to 10 feet, and the vein has been stripped for a length of 380 feet. Spectacular gold showings are reported from this vein.

Early in 1928, preparations were made to develop the property by sinking operations. A plant, consisting of the following, was moved to the property: two 60 h.p. locomotive boilers; a Canadian Ingersoll-Rand air compressor, type PRS-3, capacity 720 cubic feet per minute; a Canadian Ingersoll-Rand hoist, 7 by 6 inches, type SSR; a Leyner drill-sharpener.

The plant had not been erected when the area was visited in the summer of 1929.

Red Mammoth Gold, Limited

This company has an authorized capital of 150 shares of no par value. The provisional directors of the company are: W. J. Boland, president; W. B. McHenry, secretary; and H. I. Coward, director. Percy E. Hopkins is consulting engineer. The head office of the company is at 407 Bank of Hamilton Building, Toronto, Ont.

During 1928, this company had under consideration the purchase of some 66 claims located on the northeast shore of Red lake between Wilson and East bays, in Dome township, district of Kenora (Patricia portion). The main group in the claims is known as the Smith-Morrison and was staked in the winter of 1925.

Exploration work has revealed a vein ranging in width from 20 to 80 feet and striking N. 40° E. It has been traced along the strike for a distance of 2,600 feet. The vein consists of rusty carbonate schist, in which there are lenses of ankerite. Attractive values in gold have been found at places in the vein.

The following plant has been installed: a Canadian Ingersoll-Rand gasoline-driven air compressor, two-drill capacity; a Little Tugger hoist, type 9-HR.

A headframe, 35 feet in height, has been erected and work started on a two-compartment shaft, compartments 4 feet 6 inches by 5 feet and 3 feet 6 inches by 5 feet. This shaft is located centrally towards the north boundary of claim No. 1,022. It was sunk to a depth of 70 feet with a level cut at the 65-foot horizon, on which a little work has been done.

The following camp buildings, all of log construction, are on the property: two sleep camps, 26 by 20 feet; cookery, 40 by 20 feet; office, 18 by 20 feet.

Twenty men were employed under the direction of M. Bouzan.

The property was closed down during the winter of 1928-29.

Ritchie Gold Mines, Limited

Ritchie Gold Mines, Limited, has a capital of 3,000,000 shares of $1 par value, of which 800,000 shares are in the treasury. The officers and directors of the company are: O. E. Earle, president; J. J. Byrne, vice-president and managing director; G. M. Hagen, secretary-treasurer; A. P. Earle and T. J. Day. The head office is at Room 607, 11 King Street West, Toronto.

Development for the year 1928 consisted of sinking a 5- by 7-foot shaft to a depth of 40 feet. Test-pitting and trenching amounted to approximately 15,000 cubic feet, and diamond-drilling to 3,000 feet. The property is situated in Gauthier township, district of Timiskaming, and an average of 15 men was employed.

St. Anthony Gold Mines, Limited

The St. Anthony Gold Mines, Limited, is capitalized at $3,000,000 in shares of $1 par value, 1,757,252 of which have been issued.

The officers of the company are: A. E. Matthews, president; T. S. Giles, secretary; A. S. Dickson, treasurer; R. W. Brigstocke, A. R. Osborne, T. Magladery, W. F. Jamieson, and G. W. Ecclestone are directors. The head office is in the Toronto General Trusts Building, Toronto, and the mine office address is Savant Lake, Ont.

The company holds 11 claims, H.W.744-46, B.G.151-54, H.W.699, S.V.415, S.V.396 (power site), and B.G.168, in the Thunder Bay district, Sturgeon lake area. It is also interested in 45 claims in Montbray township, Quebec.

The Sturgeon lake property was first worked about 1900, and as early as 1902 two shafts, each 100 feet deep, had been sunk and considerable open cut work done. It was in active operation and produced until 1908. The most recent attempt at operation was made in 1917 when the Kerr Lake Mining Company of Cobalt did 1,500 feet of drifting and crosscutting and 250 feet of raising and sinking.

The mill was also run for a short time for sampling purposes at this time.

There are five levels, and stoping has been done on the four upper ones. The deepest working is the 500-foot horizon.

The present company started work on the property on October 14, 1928, doing 3,000 feet of diamond-drilling from surface. After the freeze-up 45 car loads of supplies, mostly coal, were freighted to the mine by tractors from Savant Lake station on the Canadian National railway, a haul of about 12 miles.

Early in the new year the dewatering of the shaft and workings started and was completed in May, by which time the old upper workings had been completely sampled.

At the time of inspection in July, 1929, the mill was nearly ready to operate. The mill is of an early design, and it is expected that a cyanide unit will be added, with a view to making a better recovery than former operators and also to treating the old tailing dump. This dump is supposed to contain 30,000 tons of $3.50 grade.

The mine is reached in summer by a 3½-mile road from Savant Lake to the north end of Sturgeon lake and from there by water for about 8½ miles. The company at present operates a 36-foot motor launch on Sturegon lake. The route is the same in winter.

There were at the time of inspection 33 men on the payroll. H. A. Swart is superintendent at the property.

Sylvanite Gold Mines, Limited

Sylvanite Gold Mines, Limited, has an authorized capitalization of $3,300,000 in shares of $1 par value, of which 3,299,500 shares have been issued.

The officers of the company are: Edward L. Koons, president; William L. Marcy, vice-president; W. S. Walton, secretary; Clark L. Ingham, treasurer; Welles V. Moot, managing director; and C. E. Rodgers, general manager.

The directors are: Edward L. Koons, William L. Marcy, Clark L. Ingham, Ralph Hochstetter, Oliver Cabana, Jr., Welles V. Moot, all of Buffalo, N.Y., and James Y. Murdoch, of Toronto.

The mine and works, situated in the township of Teck, district of Timiskaming, employed an average force of 180 men during the year 1928.

The general manager's report for the year ended March 31, 1929, is as follows:

Production

During the period, 70,833 tons of ore were milled with bullion recovery of $737,573.12, or $10.41 per ton. The mill ran 95.7 per cent. of the total time and treated an average of 194.1 tons per day, while on the basis of 100 per cent. operation this represented 202.7 tons per day. The highest tonnage for any given 31-day period was 6,290, or at the daily rate of 202.9 tons.

Mining

The total tonnage of ore broken was 90,030. Waste hoisted to surface amounted to 16,421 tons.

Broken ore reserves were estimated at 49,634 tons, distributed as follows: in stopes, 43,106 tons; on surface dump, 6,528 tons.

Development and Exploration

Claim L. 2,101.—Work in this section continued to expose good ore during the year. Stoping operations were carried on from the 850-foot level, and a raise was driven to a point slightly above the 700-foot horizon. This raise was all in ore. In addition, diamond-drilling from surface, to explore the area between 200 and 500 feet below, indicated results comparable with those obtained by stoping and gave reasonable assurance that two commercially important vein systems extend to or near the surface.

Below the sylvanite 1,000-foot level, the southeastern portion of this claim has assumed increasingly promising possibilities due to recent work done by a neighbouring company adjacent to your south and east boundaries. Mining operations of this company there, are stated to have proved the existence of ore at various levels from 1,250 to 2,000 feet. The reported extent and grade of these ore occurrences close to the boundary, combined with the favourable results obtained from your diamond-drilling below the 1,000-foot level, strongly indicate that ore can be mined on claim L 2,101 to a depth of probably 2,000 feet, or more.

To more economically mine the southeastern part of this claim, a shaft (No. 4) will be sunk from surface. The first objective, which it is expected will be reached this year, will be slightly below 700 feet. It is also planned to provide for the extension of the shaft to much greater depths as required.

Claims L 2,100, L 2,226, L 2,227.—The No. 2 or main working shaft was deepened from 1,632 to 2,030 feet. From this new work crosscuts were run to the south on the 1,750- and 2,000-foot levels. The south end of the crosscut at the 1,750-foot level intersected what is known as the Main South vein, and up to the end of the fiscal year this was drifted upon for only about 100 feet. Where exposed by crosscutting, the sheared and crushed zone with quartz inclusions and irregular quartz stringers consisted chiefly of a series of mineralized sections extending over a width of about 30 feet. Another crosscut, driven north from the drift at a point east of the main crosscut, indicated similar conditions.

Consistent values of commercial grade were not encountered during the limited advance; yet the character and persistence of the well-defined mud seam, identified vertically for several hundred feet, together with promising structure in a strong fracture which has already produced important ore sections, warrants further exploration on this and other levels with reasonable chances of success.

One other vein offering good possibilities, and upon which exploration is planned, was encountered in the main crosscut on the 1,750-foot level about 100 feet south of the shaft. There are indications that this vein will eventually be traceable at least to the 1,500- and 2,000-foot levels.

At the 2,000-foot level the crosscut had not reached its objective, namely the Main South vein. It had, however, cut two vein fractures, one of which will likely prove to be a continuation of that showing at 100 feet on the 1,750-foot level.

On the levels above the 1,750-foot stoping was carried on to approximately 450 feet below surface. This work was not confined to a single vein but was distributed among three vein systems, two south and one north of No. 2 shaft. Each series contributed a substantial part of the mill feed.

One of the most important new developments on the No. 1,001 vein series, south of the shaft, was that on the eastern part of claim L 2,100. What promises to be quite an extent of medium and high grade ore was found here, approximately at the 1,000-foot horizon. It is also confidently expected that additional work will prove further ore extensions in this highly favourable section.

North of the shaft the year's work disclosed the gratifying fact that ore tonnage was greatly increased in working places Nos. 1,056, 1,058, 1,203, and 1,204, beyond what was previously indicated. The grade also, in comparison with earlier operations, was more than maintained.

Several important problems in faulting were successfully solved during the year. Chief among these was the tracing of ore continuations beyond certain minor faults, as well as the locating of Nos. 1,003 and 1,023 vein system east of the major fault on claim L 2,226 and the No. 1,375 series west of this same fault extension on claim L 2,100. In the case of Nos. 1,003-1,023, fair possibilities for ore extensions were encountered; while at No. 1,375 vein structure, width and general appearance were excellent and gave reasonable grounds for believing that further exploration may be successful.

FOOTAGES OF DEVELOPMENT AND EXPLORATION

Class of work	Total	Beginning of operations to Mar. 31, 1929
	feet	feet
Drifting	1,311	14,067
Crosscutting	2,180	9,494
Raising, development	1,581	3,491
Raising, stope	699	
Box-hole raising	1,051	1,906
Box-hole pillar drifts	315	
Sublevel drifts, development	587	1,438
Sublevel drifts, stope	442	
Shaft-sinking	398.5	2,280.5
Total	8,564.5	32,676.5
Diamond-drilling	2,779	17,834
	cu. ft.	cu. ft.
Shaft station and sumps	23,784	95,607

It will be noted from the above table that raising was a large item and amounted to 3,331 feet. This work, however, furnished very valuable information aside from improving ventilation and stoping conditions in various parts of the mine.

Operating Costs

	Expense	Cost per ton milled
Development and exploration	$170,695.21	$2.410
Mining	234,177.27	3.306
Milling	94,025.89	1.327
General and administrative charges	74,584.91	1.053
Total	$573,483.28	$8.096

The largest single item included in these costs, and one which is greatly in excess of any other, is that for electric power. The power rate charged by the power company is unreasonably high, and the cost for the year amounted to $1.04 per ton milled.

In comparing operating costs with those of 1927-28, we find the following: Development and exploration for 1928-29 was $1.553 higher; mining, $0.118 higher; and milling, $0.316 lower, per ton milled. Or, assuming the 1927-28 figure of $0.857 for development and exploration and taking 1928-29 costs for mining and milling, we would have, for this year just ended, a total cost of $5.490 per ton milled. This, compared with $5.787 for last year, shows a difference of $0.297 per ton milled in favour of operation for the year ending March 31, 1929.

Development and exploration reached a high total but was, in my opinion, fully warranted, having due regard to the future working and value of your property. The $0.118 increase in mining cost can be explained by a proportionate increase in raise, sublevel, and other exploratory work carried on from stopes and charged to stoping.

Mill feed for the period was drawn from an average of 17 working places, scattered over about 1,600 feet vertically and 3,500 feet in horizontal extent. This was done with the object of developing a wide area, rather than to confine all stoping to what past work indicated as the best and most accessible sections. Costs were thereby increased, yet much exceedingly valuable information was obtained.

Diamond-Drilling

Two diamond-drills were operating at the end of the year. It is planned by this means to explore some of the large and favourable areas as yet unprospected, as well as to carry on a more intensive development programme in what are now ore-producing sections.

New Buildings and Equipment

During the fiscal year the following mine buildings and plant additions were made:—

Thaw-House for Exploration (12 by 16 feet).—Provision was made for transferring this work from underground to the surface. This required the installation of a power transmission line, heating arrangement, etc.

Electrical Repair Shop (12 by 28 feet).—A building previously used elsewhere on the property was moved and converted into a shop for this purpose.

Office Basement (32 by 64 feet).—All material enclosed by the office foundation walls was removed and a concrete floor was laid. Provision was thus made for a very considerable addition to storage space for supplies.

Staff-House (18 by 46 feet).—The old office was moved, added to, and changed into a comfortable living and mess quarters for the staff.

Manager's Residence (46 by 35 feet).—One of the finest residences in the north was erected, with provision for every convenience and comfort.

Hoist-House and Hoist (32 by 44 feet).—Late in 1928 a new hoist was put in service. This is capable of hoisting at 1,500 feet per minute from a depth of approximately 4,000 feet and lifting 20,000 pounds. Suitable housing and heating was provided for this equipment.

Summary

Considering the mill capacity, the nature and extent of the ore occurrences as thus far determined, and the extensive development and exploration work which was carried on continuously throughout the year, profits were substantial and quite satisfactory. In addition, broken ore reserves were increased from 30,437 to 49,634 tons, or 63 per cent.

With the new hoist in operation your mine is now equipped to carry exploration to much greater depths than was previously possible. It is also a reasonable expectation that future work will continue to add additional tonnages to known ore bodies as well as to disclose new and important sources of ore.

Tashota Gold Mines, Limited

The capitalization of Tashota Gold Mines, Limited, is $2,000,000 in shares of $1 per value.

The officers of the company are: H. H. Vaughan, president; R. M. Davy, vice-president; P. W. Ogden, secretary-treasurer; W. G. Cumming, F. C. Shorey, and Robt. W. Norrington, directors.

The company holds 8 claims, K.K.522-26, 536, 537, and 562, all in one block in the Tashota area, district of Thunder Bay, and in addition 21 claims in the Boston Creek area, McElroy township, district of Timiskaming.

In all, four veins have been located on claim K.K.524 by pits and trenches. The northernmost or "A" vein dips approximately 80° N. and strikes N. 75° E. During the year a complete plant was set in operation on the property and a shaft sunk on "A" vein to a depth of 235 feet, with levels at the 100- and 200-foot horizons.

Underground operations were discontinued in February, 1929, at which time 80 feet of drifting had been done on "A" vein on the 100-foot level and 400 feet of drifting on three veins as well as 320 feet of crosscutting on the 200-foot level.

At the time of inspection in July, 1929, the mine was full of water and a surface diamond-drill campaign was under way. At that time 3,900 feet of drilling had been accomplished. One hole, it is understood, cut good values to the west of the underground workings.

The plant equipment consists of the following: Ingersoll-Rand air compressor, type POC-2, direct-connected, oil engine driven, 600 cubic feet per minute; Ingersoll-Rand hoist, 6 by 7 inches, type SSR, with such accessories as an oil-burning forge, drill-sharpener, rock drills.

A complete set of camps, consisting of two bunk-houses, cook-house, store-house, office, tool shed, compressor building, hoist-house, blacksmith shop, water tank, powder magazine, and a cap and fuse house, was erected.

The property is reached in the summer by a water route, of about 16 miles length, leaving the transcontinental line of the Canadian National about half a mile west of Paska station and following a chain of lakes forming the head-waters of the North Branch of the Onaman river to a point somewhat below the foot of Barnum lake, from which point a trail has been cut a distance of about five miles in a southerly direction to the property, crossing the South Branch of the Onaman river about two miles from the property.

Owing to the route starting on the height of land, the streams are mainly very small, and much difficulty has been experienced in keeping sufficient water to permit of freighting supplies over the route during the height of the summer season. Several small timber and earth dams had to be erected during the summer of 1928 to maintain the water levels on the smaller creeks along the route between the steel and the head of Whitefish lake.

In winter a road of about 16 miles length is used. This connects with the railway at Tashota.

When underground operations were in progress the mine employed about 34 men. At the time of inspection 17 were employed.

W. A. Coughlin is the manager of the property.

Teck-Hughes Gold Mines, Limited

Teck-Hughes Gold Mines, Limited, has an issued capital of 4,777,144 shares of $1 par value.

The officers of the company are: Charles L. Denison, president; Albert W. Johnston, vice-president; George C. Miller, secretary; William C. Himrod, treasurer; K. P. Emmons, assistant-treasurer.

The directors are: Charles L. Denison, Robert W. Pomeroy, Albert W. Johnston, J. F. Thompson, all of New York; and George C. Miller, Conrad E. Wettlaufer, and W. W. Reilley, of Buffalo.

D. L. H. Forbes, Kirkland Lake, is general manager.

Approximately 500 men were employed in the mine, mill, and about the works during 1928.

The report of the general manager for the fiscal year ended August 31, 1929, is as follows:—

During this period 331,150 tons of ore were treated, and bullion amounting to $4,889,127.32, or $14.764 per ton, was recovered. This recovery is equivalent to 236,511.587 ounces of gold, or 0.7142 ounces of gold per ton of ore. The gross revenue was $4,980,339.47, or $15.039 per ton. The total direct operating cost was $1,961,811.17, or $5.924 per ton. Depreciation written off on buildings and plant amounted to $215,944.98, or $0.652 per ton, making the total of direct and indirect charges $2,177,756.15, or $6.576 per ton. After making a provision of $259,065.32 for federal and provincial taxes, the net surplus was $2,543,518.00.

The following is a statement of operating costs:

	Total cost	Cost per ton of ore treated	Cost per ounce of gold produced
Development and exploration	$382,632.86	$1.155	$1.618
Mining	894,917.56	2.702	3.784
Milling	457,177.60	1.381	1.933
General expense	227,083.15	.686	.960
Total direct charges	$1,961,811.17	$5.924	$8.295
Depreciation	215,944.98	.652	.913
Total direct and indirect charges	$2,177,756.15	$6.576	$9.208

Included in the above operating costs is the sum of $234,408.67 paid to the Northern Ontario Power Company, Limited, for an average monthly power demand of 3,932 horsepower. This is equivalent to a charge of $59.62 per horsepower year.

Construction work charged to capital account absorbed $180,802.11, practically all of which was expended on surface equipment and buildings for South shaft. By the end of the fiscal year this construction work was all completed and South shaft sunk to a depth of 1,422 feet.

Central shaft was sunk from the 19th to the 25th level and completely equipped for the handling of ore and waste from all six of the new levels as well as for the crushing and skip loading of ore coming from levels below the 13th down to the 19th.

A total development footage of 8,522.9 was accomplished during the year, and the combined total length of all mine workings at August 31 came to 65,143.6 feet. Classified under the usual headings the work done was as follows:

	Feet
Drifting	3,022.3
Crosscutting and shaft stations	1,375.7
Raising	2,118.0
Shaft-sinking	2,006.9
Total	8,522.9

Diamond-drilling amounted to 11,450.7 feet.

New ore was found on the 6th, 7th, 10th, 15th, 20th, 21st, and 25th levels. Although drifting along the ore zone on new levels below the 19th had proceeded only short distances and only on the 20th, 21st, 22nd, and 25th levels by the end of the fiscal year, a total ore length of over 800 feet had been opened up on these levels and the conditions of ore deposition had been proved to be similar to those on upper levels. The average width of the ore zone on the new levels was found to correspond with the average width on other levels, while satisfactory indications of ore bodies, of excellent grades and good stoping widths, were obtained from crosscuts and drill-holes. The opening up of the 20th and 21st levels is being attended to first and will be followed by a gradual development of the 22nd, 23rd, 24th, and 25th levels along with the sinking of Central

shaft extension three-compartment winze from the 25th to the 30th level. This work is planned for completion by the time the South shaft will have reached the 30th level and be ready for connection with Central shaft workings.

Development work produced 11,363 tons of ore that was treated in the mills and 58,250 tons of waste rock that was dumped on surface.

While the year's programme of underground work was in the nature rather of preparation for deep mining and possible further expansions than of finding new ore, we were able at the same time to develop sufficient new ore to replace the tonnage extracted and to leave the reserves of blocked and broken ore undiminished at the end of the year.

Telluride Gold Mines of Canada, Limited

Telluride Gold Mines of Canada, Limited, has a capital of $2,000,000 in shares of $1 par value. The officers are: D. M. Gilpin, president; L. L. Brennan, secretary; D. B. Gilpin and Geo. W. Rogers, directors.

During the year a shaft was sunk from the 150-foot level to the 350-foot level, with a 25-foot sump; stations were cut at the 250- and 350-foot levels. Lateral work amounted to 250 feet of drifting on the 250-foot level.

The company owns 480 acres in Skead township, district of Timiskaming. The head office is at 405 Northern Ontario Building, Toronto.

Towagmac Exploration Company, Limited

The holdings known as the Michael Boyle option are situated about 5 miles east of mile 171½ on the Algoma Central railway. The property consists of 30 claims in a block. The plant is located on claim No. 2,021 in township 27, range 25.

During the summer of 1928 considerable work was done on a quartz outcrop and very encouraging gold values were obtained. A mining plant, consisting of a 260 h.p. loco-type boiler, a 110 h.p. Diesel engine, and an Ingersoll-Rand compressor, was moved in that fall. Rather than sink, it was decided to explore the vein with an adit. About 250 feet of crosscutting and 200 feet of drifting was done with the result that values corresponding to those above could not be located. Underground work was discontinued in July, 1929, and the force of 10 men was employed at trenching and other surface work.

Camps consist of 2 bunk-houses and a cook-house for 30 men, an office building, and a root house. At the adit a power-house, assay laboratory, and blacksmith shop have been erected. The management has installed a fire pump, and 400 feet of hose is available for protection purposes.

The officers and board of Towagmac Exploration Company, Limited, are as follows: J. J. McFadden, president; W. P. Alderson, vice-president; A. A. MacKay, vice-president; A. H. Chitty, secretary-treasurer; A. A. McMartin, W. B. George, N. A. Timmins, E. L. Meyers, directors.

The head office is at 921 New Birks Building, Montreal.

Mr. W. R. McIlquham has been in charge of the work at the Michael Boyle.

United Mineral Lands Corporation

This company is a consolidation of the interests of the Premier Paymaster Mines Company, the United Mineral Lands, Limited, and the Porcupine Paymaster Mines, Limited. The holdings of the Canadian company are in Deloro township, district of Cochrane, and comprise ground formerly owned by the Standard Gold Mines, Limited, and the McLean Gold Mines, Limited, the claims lying along the north border of Deloro township.

During the year ending December 31, 1928, the following underground work was done on the Paymaster property:—

Level	Diamond-drilling	Drifting	Raising
	feet	feet	feet
100-foot	185	247	.....
200-foot	.....	17	.....
300-foot	4,016	764	125
400-foot	.....	413	17
600-foot	.....	246	.....
800-foot	2,693	742	.....
Total	6,894	2,430	143

On the 425-foot level of the adjoining Ankerite mine, 21 feet of crosscutting and 502 feet of drifting were done. This work lies for the most part on the company's property.

During the year the new concentrator was put in operation but not thoroughly tested before the company ceased active work in November.

A small staff of underground men continued development by drifting and diamond-drilling throughout the remainder of 1928 and well into 1929. Since early summer, 1929, no work other than pumping has been done on the property.

M. Donovan is mine manager, and from 15 to 30 men have been employed since the curtailing of the work.

Vipond Consolidated Mines, Limited

The authorized capital of this company is $2,500,000, divided into shares of $1 par value, of which 2,250,000 are issued.

The officers of the company are: F. H. Hamilton, president; John H. Black, vice-president; J. Ingram, secretary.. The directors are: F. H. Hamilton, John H. Black, W. H. Stafford, R. T. Shillington, Sir A. Hamilton Grant, A. S. Hamilton, E. Turk.

The head office of the company is located at Suite 1206, Star Building, 80 King Street West, Toronto. The mine office is at Timmins.

The company owns 320 acres in mining claims and controls 889,612 shares of the 1,150,000 issued in the Inspiration property (3 claims), both this and the Vipond holdings proper lying in the southwest portion of the township of Tisdale, district of Cochrane. Together with these the Vipond company has a three-quarter interest in the Ridgeley claims (6 in number), lying immediately east of the Coniaurum.

The balance sheet for the year ending July 31, 1929, is given in the seventh annual report of the company as follows:—

ASSETS

CAPITAL:		
Mining claims and properties, as per balance sheet, July 31, 1924	$1,432,442.84	
Acquired during year ended July 31, 1927, from British Porcupine Mines, Limited, less subsequent adjustments	213,149.19	
		$1,645,592.03
Mine, mill, camp and office buildings, plant machinery and equipment, as appraised July 31, 1924	$301,240.87	
Additions at cost to July 31, 1928, including British Porcupine Mines, Limited	154,337.87	
Additions at cost for year ended July 31, 1929	18,666.51	
		474,245.25
Shares in other companies at cost		117,540.27
		$2,237,377.55
CURRENT:		
Cash on hand and in banks	$53,474.91	
Provincial and railway bonds at cost (market value $526,000)	537,584.60	
Bullion en route and on hand	57,851.71	
Accounts and interest receivable	6,829.65	
Mining and milling supplies	30,225.81	
		685,966.68
DEFERRED:		
Insurance and other prepayments	$13,928.69	
Syndicate participations and deferred expenditures on outside properties	11,410.86	
		25,339.55
		$2,948,683.78

LIABILITIES

CAPITAL:		
Capital stock authorized (2,500,000 shares at $1 per share) issued and outstanding	$2,250,000.00	
Surplus	357,840.33	
		$2,607,840.33
CURRENT:		
Accounts and wages payable	$37,803.13	
Accrued charges	6,941.53	
		44,744.66
RESERVES:		
Reserve for depreciation of buildings, plant, and machinery	$279,311.70	
Reserve for Dominion income and provincial production taxes	16,787.09	
		296,098.79
		$2,948,683.78

The operating account for the year ending July 31, 1929, shows the following:—

EXPENDITURE

Development	$107,124.39
Mining, including hoisting	196,773.96
Crushing, conveying and milling	121,132.42
Shipping and marketing bullion	5,201.39
General camp maintenance	12,222.83
Administration and general expense, mine	20,655.61
Administration and general expense, Toronto office	7,961.52
Transfer, legal, and directors' fees, etc	17,731.70
Insurance, including compensation	20,349.98
Provincial and municipal taxes	8,387.07
Balance carried down	300,544.14
	$818,085.01

REVENUE

Bullion proceeds, plus exchange	$797,113.78
Bond and bank interest earned	20,971.23
	$818,085.01

The profit and loss appropriation account for the year ending July 31, 1929, is as follows:—

DEBIT

Examination expenditures on outside properties written off	$6,419.19
Reserved for depreciation of buildings, plant, and machinery	61,190.62
Reserved for Dominion income taxes	10,168.20
Surplus July 31, 1929, carried to balance sheet	357,840.33
	$435,618.34

CREDIT

Surplus July 31, 1928	$135,019.80
Sundry adjustments	54.40
Balance brought down	300,544.14
	$435,618.34

During the period ending July 31, 1929, 100,540 tons of ore were hoisted, of an average grade of $7.93 per ton, and produced bullion to the value of $797,-113.78. The cost per ton milled during this period was $5.15 as against $5.44 for the same period last year.

The following report on operations at the mine is taken from the annual report of the manager, Robt. E. Dye:—

Results of Development

During the fiscal year under review, active exploration and development work was conducted in various parts of the property. Fair results were obtained in several places, but by far the most important developments of the year took place in the 709 drift area on No. 9 vein southeast of the Central system. In this area a productive zone was encountered extending from the 866-foot level up to the 400-foot horizon. An ultimate production of approximately $1,000,000 in ore of $9 per ton grade is now assured from this section with chances of extending the present known limits of the ore zone.

Work in the northern part of the property at the 400-foot level has recently come into an ore occurrence which it seems certain is a continuation of some of the southerly Hollinger veins. At the time of writing, October 30, an ore section is exposed at the 400-foot level for a length of 175 feet, which assays in excess of $7 per ton over an average width of 110 inches. The area is now being investigated at the 500-foot level by means of a crosscut. This very considerable body of indicated ore was not taken into account in arriving at the ore reserves estimate presented herewith.

Summary of Underground Operations

During the fiscal year ended July 31, 1929, the following development work was done:—

Operation	Feet	Total cost	Cost per foot
Drifting and crosscutting	6,243	$77,421.53	$12.40
Raising	473	8,665.98	18.31
Diamond-drilling, underground	8,113	14,558.96	1.79

Some 100,259 tons of ore was hoisted, of which 88,733 tons was taken from the stopes. The cost of ore delivered to the primary crushing plant averaged $1.97 per ton.

The Mill

The mill operated continuously during the year and the following results were obtained:—

Tons milled	100,540
Average value per ton	$8.63
Gross value	867,749.38
Bullion recovered	797,113.78
Average running time	95.5 per cent.

Production

From bullion produced during the year	$797,113.78
From bullion produced during former years	3,688,216.90
Total	$4,485,330.68

The above figures do not include bullion produced by the Porcupine Crown before this property was acquired by the company.

COST OF PRODUCTION

	Total cost	Cost per ton
Development	$107,124.39	$1.07
Ore extraction	196,773.96	1.96
Crushing, conveying, and milling	121,132.42	1.20
Shipping and marketing bullion	5,201.39	.05
General camp maintenance	12,222.83	.12
Administration at mine	20,655.61	.21
Head office expense	7,961.52	.08
Corporate expense	17,731.70	.18
Taxes	8,387.07	.08
Insurance	20,349.98	.20
Total	$517,540.87	$5.15

Ore Reserves

As at July 31, 1929, the ore reserves were estimated at 127,500 tons of an average value of $8.16 per ton, or a total gross value of $1,040,000. This represents an increase of 10,600 tons and of $150,000 in gross value over the corresponding figures for the previous year.

During the period covered by this report, a total of 100,259 tons of ore of a gross value of approximately $868,000 was extracted. It will be seen, therefore, that the ore developed during the year amounted to approximately 110,800 tons of ore of an estimated gross value of $1,018,000. These figures do not make any allowance for the ore section recently exposed at the 400-foot level in the northern part of the property, from which a considerable tonnage of ore is already assured.

Walsh-Katrine Gold Mines, Limited

Walsh-Katrine Gold Mines, Limited, operated their property in Katrine township, district of Timiskaming, with a force of 20 men. The officers and directors of the company are: Hugh Walsh, president; W. O. Taylor, secretary; E. L. Gilpin, treasurer; and E. G. Goudey. J. P. Hussey is general manager, and K. B. Heisey is consulting engineer.

Up to the end of 1928 the following work was done: A shaft was sunk 520 feet, and stations were cut on the 140-, 250-, 375-, and 500-foot levels. There was a total of 2,000 feet of drifting and crosscutting.

West Dome Lake Gold Mines, Limited

This company has an authorized capital of 7,000,000 shares of no par value. All the undertakings of the Consolidated West Dome Lake Mines, Limited, were taken over by this company on incorporation for a consideration of 3,500,000 fully paid shares of no par value. Of the shares remaining in the treasury, 403,895 shares were taken up by the shareholders at 10 cents under the offering made June 18, 1927; 667,000 shares were subscribed for by the directors at 15 cents; 10 shares were issued to the incorporators; and 300,000 shares were sold under an underwriting arranged by the directors. The balance of unsubscribed shares in the treasury on December 31, 1927, was 2,129,095.

The holdings of the company consist of 8 mining claims and a fraction of the Ritchie veteran claim situated in the southeastern portion of the township of Tisdale, district of Cochrane, adjoining the property of the Dome Mines, Limited, on the west.

The officers of the company are: Sir Henry Pellatt, president; Wm. H. Kinch, vice-president; F. L. Hutchinson, secretary-treasurer; D. M. McPhail, manager. The directors of the company are: Sir Henry Pellatt, M. P. Van Der Voort, R. L. Baker, Toronto; Wm. A. Taylor, A. A. McKelvie, F. L. Hutchinson, New Liskeard, Ont.; and Wm. H. Kinch, Buffalo, N.Y.

The report to the shareholders for the period ending December 31, 1928, contained the following from the president's letter:—

The mill was not operated during 1928, but was started in January, 1929, when development had reached the 1,325-foot level and, as a result of the improvements carried out, has been treating an increased tonnage very efficiently. Unfortunately the grade of ore treated has been lower than we anticipated. This has been due to irregularities and narrowing of the veins as stoping has proceeded, causing dilution; also results to date from development on the 1,325-foot level have been disappointing. While good values have been obtained in short sections on this level, the vein widths have been too narrow to make ore. On this level we are evidently working on a lean horizon. This has occurred before on upper levels but at present we lack money to carry development to deeper and possibly more favourable ground.

The mine has not been meeting operating expenses since the mill was started, and the company lacks development capital. The share offering made to shareholders with the report issued December 1, 1928, was subscribed only to a very small extent. It is not possible to sell the remaining treasury shares on the present basis, and some form of reorganization is therefore necessary if development is to continue and if the excellent chances which the company has in some sections of its property are to be tested. The eastern section, in particular, where vein widths are much better and the geology highly favourable, warrants more exploration. So far, work has necessarily been confined to one level in that section.

You will find enclosed with this report, notice of the annual general meeting and of a special general meeting called to consider a by-law covering a proposed reorganization of the company. The reorganization provides for the formation of a new company with a capital of 3,500,000 shares of no par value and the sale to such new company of all the assets and undertakings of this company for 1,500,000 shares, being equal to one share for each four shares of this company now issued. This would leave 2,000,000 shares in the treasury of the new company.

The following statements are from the report of the manager:—

Mining

Development and exploration work during the year was as follows:—

Level	Drifting	Cross-cutting	Raising	Sinking	Slashing
	feet	feet	feet	feet	feet
1,050-foot	1,371½	567½	100	.....	281½
1,050-foot sub	16	17	.....	.....	.....
1,200-foot	878½	73½	166	136½	71
1,325-foot	4½	35	.....	.....	6
Total	2,270½	693	266	136½	358½

In addition to the above, a station, 13 by 11 by 10 feet, was cut at the 1,325-foot level.

Development

Development work underground was confined to drifting east and crosscutting north on the 1,050-foot level and drifting east on the 1,200-foot level. A raise was put through from the 1,200-foot level to the 1,050-foot level and then continued by sinking from the 1,200- to the 1,325-foot level.

On the 1,200-foot level a total length of 630 feet of ore was developed, namely "B" and "C" lenses. The "B" lens contained a length of 246½ feet by 3.66 feet in width, average grade $15.33. The "C" lens contained a total length of 383½ feet divided into three sections as follows: No. 1 section, 231 feet by 2.5 feet wide, average grade $5.12; No. 2 section, 127½ feet by 2.63 feet wide, average grade $8.26; No. 3 section, 25 feet by 2.5 feet wide, average grade $6.88.

On the 1,050-foot level drifting was carried east for a distance of 2,800 feet from the Main shaft and considerable exploration carried on by crosscutting, short drifts, and raises. In this easterly section a length of over 450 feet of low-grade ore was developed in three shoots. In places this ore is from 15 to 20 feet wide, and in my opinion this section warrants a great deal more development.

When production started at the beginning of 1929, 81 men were employed, 56 of these being underground.

Wright-Hargreaves Mines, Limited

Wright-Hargreaves Mines, Limited, has an authorized capital of 5,500,000 shares of no par value.

The officers of the company are: Oliver Cabana, Jr., president; Edwin Lang Miller, vice-president and secretary; Gerard F. Miller, treasurer; James E. Grant, general manager. The directors are: Oliver Cabana, Jr., James Y. Murdoch, Edwin Lang Miller, W. H. Wright, and Oliver G. Donaldson.

An average of 405 men was employed at the mine during 1928.

The report of the general manager, as contained in the eighth annual report of the company for the year ending December 31, 1928, is, in part, as follows:—

During the year, 256,331 tons of ore were treated, and the bullion recovered therefrom amounted to $1,845,923.74, with an average value per ton of $7.20.

The mill operated 94.779 per cent. of its possible running time, and treated an average of 700 tons per day.

The analysis of operating costs, reproduced below, shows a total cost per ton milled, including the year's expenditure for exploration and development, of $5.334 per ton.

Analysis of Operating Costs

	Total	Cost per ton milled
Development and exploration	$326,863.00	$1.275
Stoping	349,332.78	1.363
Transporting ore (hoisting, etc.)	231,227.78	.902
Milling charges	270,945.50	1.057
Market bullion	12,803.43	.049
New road construction and general surface	5,866.55	.023
Stock transfer and registrar charges	19,692.86	.077
General and undistributed charges (storehouse; maintenance; miscellaneous; mine buildings; administration and management; property taxes, insurance, interest and exchange; legal expenses, contributions, and miscellaneous)	107,664.57	.420
Depreciation plant and equipment	43,009.55	.168
Total	$1,367,406.02	$5.334

Summary of Development and Exploration

December 31, 1928

	Drifting	Shaft-sinking	Cross-cutting	Diamond-drilling
	feet	feet	feet	feet
December 31, 1927	32,259.5	3,633	4,491.5	14,923.5
Fiscal year	11,981	823	2,886.5	13,461
December 31, 1928	44,240.5	4,456	7,378	28,384.5

Since the commencement of operations in May, 1921, to December 31, 1928, the total bullion production was $11,137,208.54, from 1,032,817 tons milled, with a value per ton of $10.78. During 1928, the mine has had many discouraging conditions arise which materially contributed to a decrease in bullion produced for the year.

The mining to date has been conducted on what is known as the north or No. 1 vein and south or No. 2 vein between two major faulting systems.

The No. 2 vein to date has produced its best values above the 700-foot level. The ore mined below that horizon, although enriched in places, produces a milling grade of $6 to $7 per ton. The ore from No. 1 vein, being of a higher grade, has been mixed with the No. 2 ore, thus producing a better grade of ore for the mill. The ore in the No. 1 vein was in the shape of a lens with the top 500 feet below the surface and with its greatest length at the 1,125-foot level, where it was 1,100 feet long. The lens bottomed between the 1,750- and 1,875-foot levels. The bottom and ends of this lens became so narrow that with the dilution, it did not improve the ore going to the mill from No. 2 vein for part of the year.

However, a new vein has appeared on the 2,000-foot level in approximately the same location as No. 1 vein. It is slightly different in character and dips to the south in contrast to No. 1, which was approximately vertical. On this level the new vein has been opened up for 700 feet, of which 540 feet is in ore.

A vein of similar characteristics and dip has been opened on the 1,250-foot level on the east claim for 800 feet, 550 feet of this length being stoping ground with the probability of more being added when further prospecting has been done. The present east heading is still in the ore body, which, however, is narrower than the part of the ore shoot already opened up. This east drive has 125 feet to go along the vein before reaching the boundary. The same ore body has also been opened up on the 1,500-foot level in the east claim, and a crosscut on the 1,375-foot level has at present 200 feet to go to reach it.

While the ore opened on the 2,000-foot level in the central claim has not been connected with the ore occurring on the 1,250- and 1,500-foot levels in the east claim, the location of the two occurrences, the character of the vein material, and the similarity in the dip suggests strongly that further work in the east claim will prove these ore bodies to be connected and to occur along the same vein series.

As outlined in our 1927 report, both shafts have been sunk to the 2,000-foot horizon, No. 1 being 2,030 feet and No. 3 being 2,100 feet deep. An ore pocket with loading equipment has been installed at No. 3 shaft below the 2,000-foot level, also excavations for pumping, transformer, and charging stations have been made at that level.

On completion in September of the work in the shafts and stations, additional air and machines were released for exploration purposes and fast progress has been made in opening up the veins both to the east and to the west. As the development work progressed, more favourable results were met with in the east drives than in the west, and for this reason more attention has been paid recently to the east sections of the property than to the west.

In addition to the ore developed on the northeast part of the property, a new ore shoot has been opened up on the 1,750-foot level beginning about 1,000 feet east of No. 3 shaft and paralleling No. 2 vein. For a distance of 65 feet now opened up, it shows an average value of over $15 across the width of the drift. This ore is being drifted on to the east and resembles the ore occurring in the north vein series rather than that of the south or No. 2 vein.

Crosscutting is now proceeding south on this level to cut the easterly extension of No. 2 vein, east of a fault which throws it to the south about 110 feet. This crosscut is located 1,050 feet east of the No. 3 shaft.

Values adjacent to the shaft on the south vein on the 1,875-and 2,000-foot levels have not shown any improvement over intermediate levels. However, recent diamond-drill work has indicated ore of good grade on the 2,000-foot level to the east of the shaft, 60 feet north of the present drift which followed one of the fractures composing the No. 2 vein series. A crosscut is now nearing this objective.

Drifting is proceeding in the west section of the property, along the south or No. 2 vein, from the No. 3 shaft, on the 400-, 1,000-, 1,750-, and 2,000-foot levels.

These drives are being extended with the object of exploring the easterly continuation of the Lake Shore north vein which is displaced northward about 550 feet by a large fault occurring in the west section of the property. This vein corresponds to the north vein in the central part of the Wright-Hargreaves and, owing to the displacement, the section of the vein lying to the west of the fault is most easily approached from the south or No. 3 shaft.

The mill has operated continuously during the year with the exception of unavoidable shut-downs caused by power failure, or the necessity for repairs. Only such minor changes or additions were made in the mill as were considered necessary to increase the efficiency of the milling process. These changes consisted of improvements in the clarifying and flotation methods.

The capacity of the mill has been a large factor in contributing to the speed and economical development of the mine. It has made it possible to make a profit on all ore encountered in drifting, provided such ore contained more gold than it would cost for milling, plus the amount left in the tailings. As most of the ore mined during the year has been of low grade, any smaller tonnage would have resulted in a decrease in gold production, corresponding approximately to any decrease in tonnage.

Expenditures on the surface have been kept as low as possible and consisted of an addition to the office for a drafting room and vault, an addition to the steel shop, and an addition of 600 k.v.a. to the transformer capacity.

Underground, in addition to regular equipment, there has been added one diamond-drill, one locomotive complete with charging equipment, and an electric sinking hoist. This hoist, which has a capacity of 6,000 pounds pull, was installed on the 1,250-foot level at the No. 3 shaft.

GRAPHITE

Black Donald Graphite Company, Limited

The mine and mill of the Black Donald Graphite Company, Limited, were operated throughout 1928 and until February 28, 1929, when the mill was completely destroyed by fire. The property is situated 14 miles from Calabogie, in Brougham township, Renfrew county.

The vertical, two-compartment shaft had been completed to a depth of 340 feet in January, 1929, and a drift run 280 feet to the north, when all mining was discontinued owing to the loss of the mill. This drift will be extended to intersect the ore body about 50 feet below the present working at the inclined shaft.

During the period of operation, 196 tons of graphite were produced. An average force of 45 men was employed.

R. F. Bunting, Calabogie, is manager.

GYPSUM

Canada Gypsum and Alabastine, Limited

The Canada Gypsum and Alabastine, Limited, operated the mines and mills at Caledonia, Seneca township, and Lythmore, Oneida township, Haldimand county, during the entire year.

The officers of the company are: R. E. Haire, president and managing director; O. R. Whitby, vice-president; S. H. J. Reid, secretary-treasurer.

At Caledonia 83,762 tons of rock were mined and the final production was: 52,437 tons of plaster, 17,000,000 square feet of gypsum board, and 1,790,000 square feet of gypsum block.

During the year the plant was enlarged by the addition of one of the latest board machines and dryers.

An average force of 220 men was employed under the superintendence of L. V. Robinson.

The Lythmore mine, employing an average of 43 men, produced 12,935 tons of rock, from which 8,601 tons of plaster was made.

LEAD

Kingdon Mining, Smelting and Manufacturing Company, Limited

The company operates a producing lead property on the Ottawa river. Their plants in Fitzroy township, Carleton county, were operated continuously through the year.

The total development in the mine during the year 1928 amounted to 1,555 feet and was distributed as follows: 1,025-foot level, 143 feet; 1,150-foot level, 410 feet; 1,275-foot level, 1,002 feet. Stoping was, for the most part, on the 1,025- and 1,150-foot levels.

An average force of about 190 men was employed at the mine, mill, and smelter throughout the year.

R. R. Rose is mine superintendent; J. U. MacEwan, smelter superintendent; and R. E. Vear, mine foreman.

LEAD AND ZINC

North American Metals Corporation, Limited

This company is capitalized at 3,000,000 shares of no par value.

The officers and directors are: F. J. R. Forster, 55 Waterloo Street, Stratford, Ont.; W. L. McIlveen, 129 Adelaide Street West, Toronto; T. B. Gleave, C. S. Irish, N. F. D. Beard, J. Bennett, Stuart H. Glass, D. J. Nickle, all of Toronto, and H. E. Knobel, Loon, Ont.,

The holdings consist of two properties in the township of Dorion, district of Thunder Bay, and constitute 15 claims in all. Past work has resulted in

two shafts being sunk and a limited amount of underground work being done from each. The Dorion, an inclined shaft 100 feet deep, has not been worked for some years. Lateral work on the first level consists of about 80 feet of drifting. The workings are full of water. The vein is reported to have shown spotty values of galena. In this vicinity an adit was also driven crosscutting the formation, and 120 feet and 60 feet of drifting were done from the adit. Work was carried on at the shaft known as the Ogema mine during 1927 and up to July, 1928. It was again dewatered in the spring of 1929 and about 30 feet of drifting was done on the 200-foot level. The property shut down pending the result of an examination by Percy E. Hopkins. The Ogema shaft is 200 feet deep, and lateral work to the extent of 120 feet of crosscutting and 150 feet of drifting has been done.

H. E. Knobel, of Loon, Ont., is in charge of the property.

Towagmac Exploration Company, Limited

Lake Geneva Mine

The holdings belonging to this group, consisting of 25 claims and being part of lots 6, 7, 8, and 9, concession V, and lots 6, 7, and 8, concession VI, in the township of Hess, were staked by J. H. Collins in October, 1924. The Babson interests of Chicago formed a syndicate to promote the property and in May, 1925, commenced surface work with a capitalization of $40,000. Trenching opened small showings of lead and zinc. That fall 2,360 feet of diamond-drilling was completed. The property then lay idle until September, 1927, when Towagmac Exploration Company, Limited, optioned the property from the Babson interests. Two thousand feet more diamond-drilling was done, and the following underground work has been completed to date:

	Feet
No. 1 shaft	250
Crosscut, 160-foot level	25
Crosscut, 235-foot level	54
Drift, 235-foot level	760
Raising, 235-foot level	340

This work has opened an ore zone 700 to 800 feet long and 5 to 6 feet wide with fair grade.

The terms of the option, as well as calling for a certain amount of underground work, stated that within two years a new company was to be formed. During the summer of 1929, in accordance with this clause, the Lake Geneva Mining Company, Limited, was formed. The authorized capital is 1,000,000 shares of $1 par. The division of the stock was as follows: Towagmac Exploration Company, 700,000 shares; Babson interests, 250,000 shares; treasury stock, 50,000 shares.

The officials of the Lake Geneva Mining Company are as follows: J. J. McFadden, president; T. W. Lawson, vice-president; W. L. Paterson, secretary; N. A. Timmins, G. L. Babson, J. H. Collins, directors.

To date the Towagmac Exploration Company has almost completed the terms of the option, and it is expected that the new company will shortly take control of the property.

Surface buildings consist of blacksmith shop, temporary headframe, power- and hoist-house, carpenter shop, dry-house, powder magazine, thaw-house, fuse- and cap-house, cook-house with sleep camps above, two smaller bunk-

houses and office building enclosing manager's quarters. The power-house enclosed a 600-cubic foot displacement Ingersoll-Rand compressor directly connected to a 110 h.p. Diesel-type engine, which also drives a 110-volt D.C. generator for lighting purposes. The hoist, which is also in the power-house, is a 7- by 6-inch Ingersoll-Rand air-operated type SSR. The blacksmith shop is equipped with: Ingersoll-Rand No 34 drill sharpener, oil furnace, hand forger, hand-operated drill press. All buildings excepting the powder-houses are electrically lighted.

W. E. Bowden is in charge of the property.

NICKEL AND COPPER

Falconbridge Nickel Mines, Limited

This company was incorporated August 28, 1928, with an authorized capitalization of 5,000,000 shares of no par value, of which 2,800,000 shares have been issued. T. Lindsley is president; H. Lindsley, vice-president; and N. F. Parkinson, secretary-treasurer; with W. S. Morlock and J. G. Hardy on the board. The head office address is 407 Excelsior Life Building, Toronto.

The holdings consist of 2,240 acres in Falconbridge and Garson townships, Sudbury district.

Some diamond-drilling had been done on the property prior to 1919. During the spring of 1928 an extensive drill campaign was carried on, proving a large body of fair-grade nickel-copper ore on the upper horizons. One pilot hole was drilled to intersect the ore at about 1,000 feet. This core showed 4½ per cent. combined values. The break has been traced on surface for over 7,000 feet.

A three-compartment shaft was started on September 17, 1928. By the end of the year it had been completed to below the 350-foot level and a crosscut driven to intersect the ore on the 225-foot level. This crosscut intersected 73 feet of ore.

Sinking to the 225-foot level was done with a portable gasoline compressor and a 6- by 8-inch Jenckes hoist. The permanent headframe was then installed and the old hoist replaced by a 4-foot Ingersoll-Rand double-drum hoist geared to a 100 h.p. General Electric motor. A 900 cubic foot compressor, direct connected to a 150 h.p. General Electric motor took the place of the original equipment.

The building programme during 1928 consisted of the new headframe, power-house, bunk-house, cookery, powder magazine and thaw-house, and office.

Operations during 1929 have worked a miraculous change in the appearance of the property both underground and on surface. The shaft has been completed to the immediate objective, 40 feet below the 1,000-foot level. Drifting has proceeded on the 225-foot level both east and west of the main crosscut, with very gratifying results. On the 350-foot level and the 1,000-foot level the crosscut intersected 16 and 20 feet of ore, respectively. Considerable drifting has also been done on both these levels.

On surface the rock-house has been nearly completed. Three new bunk-houses have been built in the vicinity of the mine, as well as a machine shop, a dry-house, and a warehouse. The compressor capacity has been increased by the installation of a 1,900 cubic foot Bellis & Morcom compressor.

At the time of writing the smelter is well under way. Work has been held up somewhat by slow deliveries and by the fact that the spur line, which was to

have been ready to handle the construction material, is still under construction. However, the company plans to have the plant operating before the end of the year. It is designed to handle 350 tons per day.

Ernest Craig is in charge of the property.

International Nickel Company of Canada, Limited

Previous to 1929, the entire stock of the International Nickel Company of Canada, Limited, was owned by the International Nickel Company of New Jersey. During the latter part of 1928 by an exchange of stock the Canadian company became an independent organization, with head office at 67 Wall Street, New York. An extract from their 1928 annual report explains the action:—.

> The International Nickel Company of New Jersey, prior to 1929, owned the entire capital stock of the International Nickel Company of Canada, Limited, and accordingly results of operations of the International Nickel Company of Canada, Limited, have heretofore been published in the annual reports of the International Nickel Company of New Jersey.
>
> During the latter part of 1928, a plan of reorganization was consummated whereby the International Nickel Company of Canada, Limited, previously a fully owned subsidiary, issued its stock direct in exchange for stock of the International Nickel Company of New Jersey, over 99 per cent. of both preferred and common stock of the New Jersey company being thus voluntarily exchanged. The operating assets of the New Jersey company, located in the United States, were transferred to a new corporation, known as the International Nickel Company, Inc., organized under the laws of Delaware, all of the capital stock of which is now owned by the International Nickel Company of Canada, Limited.

The officers and board of the company differ to some extent from that of the New Jersey company, which appeared in our previous report. The new officers are as follows: Charles Hayden, chairman of the board of directors; Robert C. Stanley, president; John L. Agnew, vice-president; John F. Thompson, assistant to the president; James L. Ashley, secretary and treasurer. The other directors are: John L. Agnew, Copper Cliff, Ont.; John P. Bickell, Britton Osler, Toronto; J. W. McConnell, Montreal; James A. Richardson, Winnipeg; Sir Harry McGowan, Rt. Hon. Lord Melchett, Hon. Henry Mond, Robert L. Mond, D. Owen Evans, London, England; Rt. Hon. Lord Weir, Glasgow, Scotland; James L. Ashley, John Foster Dulles, Charles Hayden, Robert C. Stanley, Andrew V. Stout, William E. Corey, William N. Cromwell, New York; William T. Graham, Greenwich, Conn.; Reg. Halladay, Cresskill, N.J.; William J. Hutchinson, Seward Prosser, Englewood, N.J.; Thomas Morrison, Grant B. Shipley, Pittsburgh, Pa.; William W. Mein, San Francisco, Cal.

The financial statements shown below are from the 1928 annual report of the International Nickel Company of Canada, Limited.

CONSOLIDATED GENERAL BALANCE SHEET DECEMBER 31, 1928

ASSETS	International Nickel Company of Canada, Limited, and subsidiaries Dec. 31, 1928	International Nickel Company (New Jersey) and subsidiaries Dec. 31, 1927
PROPERTY ACCOUNT:		
Properties owned and operated as at December 31, 1927	$68,456,428.31	$67,020,058.31
Less amount written off for dismantlement	142,508.71	230,602.84
	$68,313,919.60	$66,789,455.47
Additions, less recoveries	7,958,610.81	1,666,972.84
	$76,272,530.41	$68,456,428.31
DEDUCT Reserves:		
Depreciation of plants	$11,852,063.46	$10,776,739.08
Depletion	4,560,025.19	4,183,503.30
	$16,412,088.65	$14,960,242.38
	$59,860,441.76	$53,496,185.93
SUNDRY INVESTMENTS	2,058,896.67	1,571,277.32
	$61,919,338.43	$55,067,463.25
CURRENT ASSETS:		
Inventories	$7,278,429.46	$9,821,478.67
Accounts and bills receivable	4,246,974.39	2,633,888.82
Interest receivable	137,184.39	59,762.19
Deferred instalments on subscriptions for common stock	151,320.00	.....
Advances	87,395.11	121,014.09
Government securities	2,730,100.00	2,730,100.00
Loans on call (secured)	17,600,000.00	2,200,000.00
Cash	1,848,666.69	1,737,454.65
	$34,080,070.04	$19,303,698.42
LIABILITIES	$95,999,408.47	$74,371,161.67
CAPITAL STOCK:		
Issued or issuable in exchange for stock of the International Nickel Company (now Nickel Holdings Corporation) deposited under agreement dated Oct. 31, 1928, 7 per cent. cumulative preferred (89,125 shares, $100 par value)	$8,912,500.00	$8,912,600.00[1]
Common stock, no par value (11,258,208 shares)	46,909,200.00	41,834,600.00[1]
	$55,821,700.00	$50,747,200.00
Ten-year serial 5 per cent. purchase money notes	$1,800,000.00	$2,100,000.00
CURRENT LIABILITIES:		
Accounts payable and pay rolls	$2,245,733.59	$828,055.90
Taxes accrued	1,214,893.45	703,256.47
Reserved for preferred dividend payable February 1, 1929	155,968.75	133,689.00
	$3,616,595.79	$1,665,001.37
FUNDS AND RESERVES:		
Insurance and contingent	$1,245,603.55	$995,457.12
Retirement system	345,689.20	.....
	$1,591,292.75	$995,457.12
SURPLUS:		
Capital surplus represented by surpluses of subsidiaries at acquisition on November 1, 1928	$16,030,641.57	
Earned surplus	17,139,178.36	$18,863,503.18
	$33,169,819.93	$18,863,503.18
	$95,999,408.47	$74,371,161.67

[1]Preferred stock of the International Nickel Company (N.J.) carried a rate of 6 per cent. The common stock of the New Jersey company, outstanding December 31, 1927, consisted of 1,673,384 shares of a par value of $25 each.

CONSOLIDATED GENERAL PROFIT AND LOSS STATEMENT OF COMBINED COMPANIES

(For Twelve Months Ended December 31, 1928)

		December 31, 1928 (12 months)	December 31, 1927 (12 months)
EARNINGS OF ALL PROPERTIES after deducting manufacturing, selling, expense ordinary, repairs and maintenance		$16,076,595.52	$8,861,895.59
OTHER INCOME, less interest on purchase money notes		629,999.05	123,729.90
TOTAL INCOME		$16,706,594.57	$8,985,625.49
DEDUCT:			
General office expense	$967,478.56		603,029.06
Reserved for federal and franchise taxes (estimated provision)	1,188,678.59		614,498.87
		2,156,157.15	$1,217,527.93
NET OPERATING INCOME		$14,550,437.42	$7,768,097.56
DEDUCT:			
Retirement system and insurance reserve	$556,765.02		
Orford works property expense			108,156.91
Depreciation and depletion (provision for)	1,594,354.98		1,595,395.93
		2,151,120.00	$1,703,552.84
PROFIT FOR THE YEAR		$12,399,317.42	$6,064,544.72
DIVIDENDS:			
Preferred	$557,034.25		534,756.00
Common	4,331,095.25	4,888,129.50	3,346,768.00
BALANCE TO SURPLUS		$7,511,187.92	$2,183,020.72

QUARTERLY CONSOLIDATED GENERAL PROFIT AND LOSS STATEMENT OF COMBINED COMPANIES

(For twelve months ended December 31, 1928)

	1st Quarter Mar. 31, 1928	2nd Quarter June 30, 1928	3rd Quarter Sept. 30, 1928	4th Quarter Dec. 31, 1928
EARNINGS OF ALL PROPERTIES after deducting manufacturing, selling expense, ordinary repairs and maintenance	$2,977,806.78	$4,018,952.27	$4,130,467.39	$4,949,369.08
OTHER INCOME, less interest on purchase money notes	46,562.45	82,925.58	140,719.25	359,791.77
TOTAL INCOME	$3,024,369.23	$4,101,877.85	$4,271,186.64	$5,309,160.85
DEDUCT:				
General office expense	179,998.82	214,506.41	204,365.54	368,607.79
Reserved for federal and franchise taxes (estimated provision)	253,574.21	312,240.35	330,524.83	292,339.20
NET OPERATING INCOME	$2,590,796.20	$3,575,131.09	$3,736,296.27	$4,648,213.86
DEDUCT:				
Retirement system and insurance reserve	98,174.03	207,680.62	118,855.19	132,055.18
Depreciation and depletion (provision for)	384,702.04	388,849.17	399,191.34	421,612.43
PROFIT	$2,107,920.13	$2,978,601.30	$3,218,249.74	$4,094,546.25
DIVIDENDS:				
Preferred	133,689.00	133,689.00	133,687.50	155,968.75
Common	836,692.00	836,692.00	1,255,035.00	1,402,676.25
BALANCE TO SURPLUS	$1,137,539.13	$2,008,220.30	$1,829,527.24	$2,535,901.25

With reference to the merger between the Mond and International Nickel companies, the 1928 annual report makes the following comment:—

Since the close of the fiscal year ended December 31, 1928, with which this report primarily deals, your company has, through an exchange of stock, acquired a controlling interest in the stock of the Mond Nickel Company, Limited, of England, whose mines and smelter are located in the Sudbury District of Ontario, adjacent to your properties. This logical and economic fusion of interests will obviate, to a great extent, the necessity of duplicating mining and smelting operations with attendant heavy capital expenditures. Many further economies can be expected as a result of having operations conducted by a single organization. Your management believes that great benefits will accrue, not only to you as stockholders, but to consumers of nickel throughout the world.

Copper Cliff Smelter

Referring to operations in 1928, the company's annual report says:—

The smelter at Copper Cliff ran throughout the year exclusively on ore from your Creighton mine. During recent months matte production has been so increased that at the present time there is being produced approximately the same tonnage of matte per month as was required during the peak of war operations, 1917-18.

Owing to uninterrupted operations and the large tonnage of Bessemer matte produced, costs recorded are the lowest in the history of your smelter.

Regarding the construction programme the president continues:—

Plans for the new smelter are perfected and contracts for the necessary steel work have been awarded. There will be installed in this plant, the most modern of its kind, five 1,000-ton reverberatory furnaces and thirty 10-hearth Herreshoff roasting furnaces. The foundation for a 500-foot stack is finished, as are also foundations for receiving bins, crushing and screening plant. Work has been actively pushed throughout the winter months to permit an early erection of steel in the spring of 1929. In order to furnish additional water for the concentrator a new pipe line is being laid to Kelley lake, a distance of about two miles.

Huntington Works

During the past year the Huntington works was operated without interruption at the highest rate of production so far attained. Concurrent with an increase in the sales of rolled Monel metal there was a corresponding increase in the sale of rolled nickel, especially of rolled nickel anodes for electroplating. No material installation of equipment was made during the year.

Creighton Mine

Creighton mine operated continuously through 1928 supplying all the ore for the smelter at Copper Cliff. The major portion of the production came from shrinkage stoping between the 16th and the 23rd levels. About 40 per cent. of this production was from the main ore body. No. 4 shaft has been completed to below the 40th level loading pockets and the pockets cut out. About the end of the year, work was proceeding on the excavation of the crusher station on the 40th level.

The average number of men employed daily for the year was 623.

R. D. Parker succeeded W. J. Rolfe as superintendent in September, 1928. Chas. Lively is mine captain; and J. Treasure and J. Brown, assistant captains.

Frood Mine

In commenting on the development work at the Frood mine during 1928, President Stanley gives the following interesting summary:—

The surface plant at the Frood mine is, to a large extent, completed, with headframe erected and the rock-house in operation. Hoists and compressors have been installed in the power-house. These hoists are amongst the largest in Canada, the main hoist designed to handle skips containing 10 tons of ore from the 2,000-foot level and 7 tons of ore from the 2,800-foot level, and the cage-hoist with a capacity for raising or lowering 60 men. A change-house capable of taking care of 1,300 men, together with mine and survey offices, is in use. The drill-sharpener house, warehouse, machine shop, electrical repair shop and boiler shop have been erected and most of the necessary machinery has been installed. The yard has been graded and service tracks for supplies and ore provided.

Good progress has been made on underground work. The main shaft (28 by 16 feet) was completed to a depth of 3,040 feet, and a ventilating shaft is now being sunk and has reached the 1,200-

foot level. Approximately 9,922 linear feet of drifting and crosscutting have been completed and the underground development to date amounts to approximately 13,762 linear feet. In addition, approximately 220,589 cubic feet were excavated for stations and ore and waste pockets. A total of 166,443 tons of rock was hoisted in accomplishing this work.

Development has not progressed sufficiently to enable your management to report exact tonnages or average metal contents in the lower levels of the Frood ore body. Many feet of crosscuts have been driven, and reserves of high-grade ore sufficient to run your smelter for many years are now proved. On the 1,200-foot level, 100 feet of ore has been crosscut and channel samples show copper 1.77 per cent., nickel 2.61 per cent., and rock 5 per cent.

On the 1,600-foot level 48 feet of ore has been crosscut, and channel samples show copper 2.90 per cent., nickel 2.15 per cent., and rock 9.3 per cent. On the 2,000-foot level 39 feet of ore has been crosscut, and channel samples show copper 2.09 per cent., nickel 1.93 per cent., and rock 5.9 per cent. This crosscut is not complete. On the 2,400-foot level 64 feet of ore has been crosscut, and channel samples show copper 3.6 per cent., nickel 1.5 per cent., and rock 28 per cent. On the 2,800-foot level 139 feet of ore has been crosscut, and channel samples show copper 12.14 per cent., nickel 2.66 per cent., and rock 19.2 per cent.

It should be noted that the ore delivered to the smelter will show considerably higher metal contents than indicated by these analyses, since the rock percentage is, to a large extent, removed before the ore is shipped from the mine.

McVittie-Graham Mines, Limited

The officers and board of directors of the McVittie-Graham Mines, Limited, are as follows: Wm. McVittie, Sudbury, Ont., president; Norman R. Fisher, 132 St. James Street West, Montreal, vice-president and managing director; Edward C. Pratt, Geo. E. Leighton, and Ralph E. Allen, directors.

Returns of the company filed December 31, 1928, show that of the capital stock of 5,000 7 per cent. preferred shares, par value $100, and 5,000,000 common shares, par value $1, 5,000 preferred shares and 1,750,000 common shares have been issued and allotted for properties, rights, and $52,500. Common shares to the extent of 436,000 were sold at a discount of 75 per cent.

The company controls a total of 3,000 acres in the Sudbury district. These are located in the townships of Graham, Creighton, Snider, Garson, Capreol, Maclennan, Norman, Falconbridge, Blezard, Denison, and Drury. With the exception of the Howland and Totten properties the claims are owned outright. The company's holdings include groups adjoining the Creighton, Garson, and Worhtington mines.

Although extensive surface work and some diamond-drilling has been done on several of the groups, most of the work during 1928 was on the Moose Lake property near Skead Siding. With the aid of a portable compressor and a small mining plant, a two-compartment shaft was started in September.

In the spring of 1929 control of the company passed to interests comprised of the British Metals Corporation, N. A. Timmins interests, and F. M. Connell. It is reported that these parties paid $300,000 into the treasury.

A mining plant was moved into the Moose Lake property, and W. R. Dunbar was placed in charge. The shaft was continued to 265 feet, and a total of 115 feet of crosscutting and 466 feet of drifting was done on the 250-foot level. Mining operations were stopped in the early part of July, 1929, to allow for the completion of a diamond-drill campaign underground. Results to date, in general, show encouraging nickel values with low copper.

The mining plant on the property consists of a 4- by 10-inch Jenckes hoist, a Sullivan straight-line compressor, two steam boilers, and a well equipped blacksmith shop. The camps include two bunk-houses, cookery, warehouse, office, and stable.

Mond Nickel Company, Limited

The Mond Nickel Company, Limited, was registered in England in 1914 and was a reconstruction of a company by the same name registered in 1900.

Since January 1, 1929, it has become a subsidiary of the International Nickel Company of Canada, Limited.

During 1928 no changes were made in the directorate of the company.

The capital structure prior to the exchange of shares on January 1, 1929, was as follows:

Authorized		Issued
£ 500,000	7 per cent. cumulative preference shares of £1 each, fully paid.....	500,000
1,500,000	7 per cent. cumulative "A" preference shares of £1 each, fully paid..	1,250,000
2,000,000	7 per cent. non-cumulative preference shares of £1 each, fully paid..	2,000,000
1,500,000	Ordinary shares of 10s. each, fully paid.....	1,250,000

Coniston Smelter and Plants

The smelter, sintering plant, concentrator, and acid plant operated continuously throughout 1928. The average force employed for the year was 651 men.

Garson Mine

Production from the Garson mine was maintained at approximately 700 tons per day throughout 1928. Roughly 40 per cent. of this ore came from above the 8th level, and 60 per cent. from the 10th. The waste, which amounts to 300 tons per day, has all been returned to the mine to refill the No. 1 vein system above the 6th level.

Sinking of the main shaft commenced in December, 1928. By April, 1929, it had been completed to its present bottom, 35 feet below the 14th level. The 6- by 10-foot shaft, inclined at 55 degrees, which was started in 1927, was completed during 1928 from the 1,200-foot level to surface. As well as forming an emergency exit, this will serve as a ventilation shaft. A 50,000 cubic foot fan is to be installed in a steel housing on surface.

The major portion of the ore developed during the year was in connection with Nos. 12-1 and 12-3 ore bodies on the 1,200-foot level.

The average force for the year 1928 was 315 men.

A. L. Sharp was in charge of the property.

Levack Mine

During 1928 the Levack mine of the Mond Nickel Company was in continuous operation. Underground work was mainly confined to stoping on the 7th level. A small amount of development work, comprising 949.5 feet of drifting and crosscutting and 1,012 feet of raising, was done. The total tonnage hoisted during the year was 413,000 tons, practically all of which was drawn from the 7th level.

Following the amalgamation of the International Nickel Company, Incorporated, and the Mond Nickel Company, Limited, a programme of greatly increased production at Levack is being undertaken.

To this end the five-compartment main shaft is being deepened from the 8th level to the 13th level, which will permit the opening up of two new haulage levels, the 8th and the 11th, and the establishment of a new loading pocket at the 12th level. A new hoist, handling two 6-ton skips in balance in the No. 3 and No. 4 compartments, is being installed.

During 1928 the average force employed at the mine was 355 men.

The operations during the year were in charge of F. J. Eager, superintendent.

Frood Extension Mine

The Frood Extension has a four-compartment shaft 3,350 feet deep. Sinking, which was started on December 5, 1927, was completed in the spring of 1929. Levels have been cut at 400, 750, 900, 1,200, 1,400, 1,700, 2,000, 2,800, 3,100, and 3,300 feet.

The company started to reopen this property in 1927 to replace the Victoria mine. Diamond-drilling disclosed 70 feet of ore running 22 per cent. copper and 1½ per cent. nickel, and it was decided to sink the shaft to 4,000 feet to prove discovery. The Frood deposit, it is reported, increased its copper values at least ten times between 2,000 and 3,100 feet.

A. D. Carmichael was in charge of the property during 1928.

An average force of 128 men per day was employed throughout 1928.

Sudbury Offsets, Limited

The company owns and has been developing during 1928-29, 46 claims in Foy township, Sudbury district, on the north rim of the basin. Work to date has been in the nature of stripping and diamond-drilling.

In connection with the development, Cyril T. Young, president of the company, stated as follows:—

> A surface outcrop, 30 feet or more in width and over 200 feet long, has been diamond-drilled, 9 out of 10 of the holes catching ore. The massive ore assayed around 4 per cent. combined nickel-copper. Drilling is proceeding to depths of from 500 feet to 1,000 feet. The drilling programme, on which tenders have been called for, covers several thousand feet of drilling on another nickel outcrop about half a mile farther west along the offset. The company is amply financed to carry on with development work for at least another year.

The company was incorporated on July 6, 1928, with head office at 1004 Bank of Hamilton Building, Toronto.

Cyril T. Young, 1 Toronto Street, Toronto, is president; and Daniel W. Lang, Sterling Towers Building, Toronto, secretary-treasurer. The company is capitalized at 5,000,000 shares of $1 par. The original share issue was 2,700,005.

SILVER

Arthur Brocklebank

Kerr Lake Mines, Limited, ceased pumping Kerr lake on April 5, 1928. The property, which is in Coleman township, district of Timiskaming, was leased to Arthur Brocklebank on October 20, 1928. Two men were employed underground. A pillar was taken on No. 7 vein on the 90-foot level, and ore is being picked over in the stopes. No work, other than picking over the dumps, was done during the summer. A 3-ton shipment of high-grade ore, about 3,000 ounces per ton, was made to the Temiskaming Testing Laboratories.

Castle-Trethewey Mines, Limited

Castle-Trethewey Mines, Limited, has a capital of $2,000,000 in shares of $1 par value. The board of directors comprises: J. P. Bickell, president; J. B. Tudhope, vice-president; Balmer Neilly, secretary-treasurer; W. J. Sheppard, S. R. Wickett, and D. H. McDougall, directors. The executive offices are in the Standard Bank Building, Toronto.

Angus D. Campbell is mine manager, and 120 men are employed at the property, which is in Haultain township, district of Timiskaming.

The following is taken from the manager's report for the fiscal year ending March 31, 1929:—

PRODUCTION

Concentrates shipped, dry tons	319.98	
Ounces, per ton	2,974.30	
Total fine ounces silver recovered	951,718.00	
Total pounds cobalt recovered	40,339	

REVENUE

Total ounces paid for	917,672.20	
Average price obtained per ounce	$0.5614	
Revenue from sale of silver		$533,612.98
Total pounds cobalt sold	38,151	
Revenue from sale of cobalt		5,332.15
Total revenue		$538,945.13

PRODUCTION SINCE COMMENCEMENT OF OPERATION

Period	Months	Tons milled	Ounces per ton recovered	Gross production, ounces	Gross value, silver and cobalt
Feb. 1, '22 to June 30, '22	5	Sorting	.....	40,000	$28,000.00
July 1, '22 to June 30, '23	12	Sorting	.....	62,811	41,146.80
July 1, '23 to June 30, '24	12	7,607	46.03	350,147	229,656.95
July 1, '24 to June 30, '25	12	30,273	30.62	927,088	637,712.10
July 1, '25 to June 30, '26	12	34,425	29.03	999,234	683,601.48
July 1, '26 to Mar. 31, '27	9	29,136	26.18	762,861	426,928.53
Apr. 1, '27 to Mar. 31, '28	12	40,250	21.32	858,044	486,186.47
Apr. 1, '28 to Mar. 31, '29	12	43,186	22.04	951,718	546,937.28
Total	.....	184,877	.....	4,951,903	$3,080,169.61

SUMMARY OF DEVELOPMENT

	No. 3 Shaft, Feet
Drifts	7,868.3
Crosscuts	2,379.1
Raises	864
Winzes	10.5
Total	11,121.9

Total footage of drifts, raises, and winzes on veins at No. 3 shaft 8,732.3
Percentage of this footage in ore 11.5

SOURCES OF ORE FROM MINE

	Tons	Grade, ounces	Total, ounces
Development	4,448	12.9	57,321
Stopes	38,728	24.8	959,293
Total	43,176	23.5	1,016,614
Waste rock hoisted	33,679	.....	.....
Total hoisted	76,855	.....	.....

MILLING

	Tons	Ounces per ton	Total
Ore treated from mine	43,186	.....	.....
Silver recovered	.....	22.04	[1]951,718
Silver in tailings	.....	1.5	64,896
Total	.....	23.54	1,016,614

[1]Smelter returns.

CONCENTRATES PRODUCED (Estimated)

	Pounds	Ounces
Metallics	.....	5,916
Jigs	206,423	407,422
Sands	332,009	480,101
Slimes	70,092	23,258

OPERATING COSTS

	Total cost	Cost per ton	Cost per ounce
Development	$130,506.57	$3.021	$0.137
Mining	81,631.01	1.890	.084
Tramming and hoisting	30,282.74	.701	032
Milling	54,101.32	1.250	.057
Shipping	9,348.11	.216	.009
Smelting and refining	20,404.14	.472	.021
General expenses, mine	15,572.81	.360	.018
Corporate legal, transfer, and administration, Toronto office expense	15,145.50	.358	.016
General maintenance	2,272.66	.052	.002
Insurance and miscellaneous	5,514.51	.127	.006
Total	$364,779.37	$8.447	$0.382

ANALYSIS OF DEVELOPMENT COSTS

	Total cost	Cost per foot
LABOUR:		
Drilling and blasting	$33,563.94	$3.02
Pumping and timbering	839.28	.08
Steel-sharpening	1,651.98	.15
Drill repairs	502.57	.04
Supervision, engineering, and assaying	6,145.36	.55
Tramming	20,984.84	1.89
Hoisting	12,246.57	1.10
Total labour	$75,934.54	$6.83
Explosives	27,720.98	2.49
Supplies	10,473.99	.94
Power	7,735.28	.70
Surface, general	8,641.78	.78
Total	$130,506.57	$11.74

ANALYSIS OF MILLING COSTS
(Tons milled, 43,186)

	Labour	Supplies	Power	Total	Cost per ton
Crushing and hoisting	$5,283.83	$3,635.86	$2,450.06	$11,369.75	$0.263
Jigging	2,685.70	745.03	1,438.87	4,869.60	.113
Ball milling	5,370.23	4,958.54	4,453.47	14,782.24	.342
Tabling	5,131.56	474.02	2,225.53	7,831.11	.182
Drying and bagging	2.00	137.48	788.82	928.30	.021
Water supply	788.76	300.34	791.27	1,880.37	.044
Heating	304.31	1,353.88	.....	1,658.19	.038
Supervision and assaying	4,640.46	358.81	98.27	5,097.54	.118
Tailings disposal	17.54	136.34	.....	153.88	.003
Repairs and maintenance	4,596.29	934.05	.....	5,530.34	.119
Total	$28,820.68	$13,034.35	$12,246.29	$54,101.32	$1.25
Cost per ton	$0.667	$0.302	$0.283	$1.25	.....

Development

Extensive development was carried on throughout the year, 10,247.4 feet of drifting and crosscutting and 864 feet of raising being done. Vein No. 22 under development at the end of last year proved up well under further development and stoping, 540,000 ounces having been milled from it during the year. Development on the new deep levels at 775 feet and 850 feet has so far found no ore, none of the ore shoots on the higher levels reaching this far into the diabase sill, though the veins persist. The 775-foot level northwest crosscut is exploring an area favourably located fairly close to the lower contact of the diabase sill. One vein, No. 26, which outcrops at the surface and which was drifted on the 475-foot level has been cut at this depth. Other veins which had better surface showings should be cut by this crosscut soon at points closer to the lower contact than where vein No. 26 was cut.

On the 850-foot level, a crosscut driven southeast has cut the extensive main faulting, which roughly parallels the upper contact of the diabase sill at this mine and in the neighbourhood of which the veins on the upper levels have proved productive. Some calcite veins have been cut at this point, and further exploration will be carried on along this faulted area. Small ore shoots continue to be found on the levels above the 550-foot, but the unexplored favourable areas on these levels are now small.

New Plant and Equipment

The "Net Addition" to "Plant and Equipment" account during the year was $2,808.05. The chief mill items were an enlarged ore bin and a double-deck table. Other items were a new steel-sharpening shop and an electrically driven pump for underground. Increased compressed air for mining was secured by putting into auxiliary use the 750 cubic foot compressor previously in use at No. 1 shaft.

Milling

The mill handled nearly an extra month's tonnage during the year, though the total costs of milling were lowered. Lower tailing losses were also obtained. The grade of ore milled was almost exactly that of the previous year.

General

With total operating costs reduced and the tonnage handled increased, the year's profits were considerably larger than those of the previous year. Only small capital expenditures have been incurred and practically all the profits were turned into cash assets.

The ore to maintain the grade treated and to allow increased mill tonnage came chiefly from new development and mining on No. 22 vein. The maintenance of mill tonnage and profits depends on the results of new development, which continues on an extensive scale in promising ground.

Cobalt Contact Mines, Limited

The Cobalt Contact Mines, Limited, own the Green-Meehan and the Red Rock properties in Bucke township, district of Timiskaming, and operate the adjoining Ruby property, which is under option to the company. J. M.

Aitken is president, George Coles is vice-president, and James A. Stewart is secretary-treasurer. The head office of the company is at 8 Bloor Street East, Toronto. J. M. C. Dunlop is manager, and 30 men are employed.

Underground development for 1928 amounted to 1,670 feet of drifting and crosscutting, and 3,500 tons of stoping. Ore shipped was as follows: 37,971 ounces of silver, 6,420 pounds of cobalt, and 7,903 pounds of copper.

Milling operations were suspended in February, 1928.

Cobalt-Kittson Mines, Limited

The Cobalt-Kittson Mines, Limited, operated their property in Kittson township, district of Timiskaming, during 1928 with a force of 20 men under Archibald Nadeau as manager. The company is capitalized at 40,000 units of $10 par value. The officers are: J. H. Paré, president; W. H. Mitchell, secretary-treasurer. The directors are: David Champaux, Wilfrid Duclos, and A. Nadeau. M. B. R. Gordon is consulting engineer.

A shaft was sunk to the 450-foot level; 450 feet of drifting was done on the 450-foot level, and 275 feet of drifting on the 250-foot level.

Friday Mines, Limited

Friday Mines, Limited, operated their property in the township of South Lorrain, district of Timiskaming, with a force of 9 men. The directors of the company are: J. R. Sproat, managing director, R. C. Vokes, G. A. Beirkamp, C. H. Gray, and W. H. Schaffer. The head office of the company is at Timagami, Ont.

During the summer, camps were built and a small plant was installed. A shaft was started in September. To the end of 1928 the work comprised 60 feet of shaft sinking, 50 feet of drifting and 20 feet of crosscutting.

Keeley Silver Mines, Limited

The Keeley Silver Mines, Limited, has an authorized and issued capital of $2,000,000 in shares of $1 par value.

The officers and directors of the company are: F. H. Hamilton, London, England, president; W. H. Stafford, Almonte, Ont., vice-president; L. Ehrlich, London, England; John H. Black, Toronto; R. T. Shillington, Haileybury, Ont.; E. Turk, London, England, and A. S. Hamilton, Toronto.

W. J. Dobbins, Silver Centre, Ont., is mine manager.

The mine and works, situated in South Lorrain township, district of Timiskaming, employed a force of 96 men during 1928.

The manager's report, as contained in the annual report of the company for the fiscal year ended February 28, 1929, is as follows:—

Summary of Underground Operations

During the year, the following underground development has been carried out:—

	Feet	Cost per foot
Drifting and crosscutting	9,233.5	$13.54
Raising	1,546	16.03

Some 16,032 tons of ore was hoisted. Of this amount, 14,770 tons was taken from the stopes; the remainder came from development.

Results of Development

As indicated by the foregoing figures, a large amount of crosscutting, drifting, and raising has been performed during the year on the upper contact. This was carried out in order that all possibilities in that area might be exhausted. As a result of this work, several small shoots of ore were opened up, which while in no case large, yet in total were sufficient to carry on production.

There is still some work to be performed in this section with possibilities of some further ore still remaining.

In August, 1928, by arrangement with the Mining Corporation of Canada, Limited, exploration of the lower contact of the diabase sill was commenced through the workings of the adjoining Frontier property at the 1,400-foot level. This development has been continuous since that date, and small patches of silver have been found from time to time.

While these occurrences have been decidedly encouraging in that they give proof of mineralization, no ore body of commercial size had been developed at the close of the fiscal year.

Mill Statistics

During the year, 13,147 tons of ore was milled. Abbreviated statistics are as follows:—

Ore milled	13,147 tons
Heads, average	27.7 ounces
Tails, average	3.9 ounces
Extraction, average	85.8 per cent.
Average running time	85.1 per cent.

Production

Production for the year (based on actual smelter returns) was as follows:—

	Pounds, net	Silver, ounces	Cobalt, pounds
Picked ore	225,532	367,487.46	47,289
Concentrates	766,993	317,509.54	53,600
Total	992,525	684,997	100,889

The corresponding figures for the silver and cobalt produced during the previous year were 994,582.75 ounces and 92,962 pounds, respectively.

PRODUCTION DURING PREVIOUS YEARS

	Pounds, net	Silver, ounces	Cobalt, pounds
1913	322.00	872.70	.....
1914	2,327.40	3,183.03	.....
1918	145,048.00	39,557.25	1,061.00
1919	31,766.00	4,565.82	3,160.30
1920	119,770.00	8,253.44	9,896.86
1921	676,411.50	313,230.88	60,566.72
1922 and 1st 2 months 1923	2,286,497.00	1,146,961.56	196,927.00
Fiscal year, 1923-24	1,973,832.75	1,600,739.68	171,357.00
Fiscal year, 1924-25	2,668,241.75	1,880,351.88	228,450.00
Fiscal year, 1925-26	2,077,548.00	1,514,407.48	181,054.00
Fiscal year, 1926-27	2,064,742.50	1,640,007.96	185,830.00
Fiscal year, 1927-28	1,203,207.50	994,582.75	92,962.00
Total	13,249,714.40	9,146,714.43	1,131,264.88
Fiscal year, 1928-29	992,525.00	684,997.00	100,889.00
Total production to February 28, 1929	14,242,239.40	9,831,711.43	1,232,153.88

Cost of Production
(Based on 13,228 tons of ore treated, producing 684,997 ounces of silver)

	Total cost	Cost per ton	Cost per ounce
Development	$150,707.94	$11.39	$0.220
Ore extraction	68,379.13	5.17	.100
Ore sorting	7,610.02	.58	.011
Milling	27,291.04	2.06	.040
Shipping and marketing	34,954.42	2.64	.051
Administration	27,852.87	2.11	.041
General Maintenance	14,245.12	1.08	.021
Head Office expense	9,331.30	.71	.013
Corporate expense	21,292.75	1.60	.031
Taxes	480.00	.04	.001
Total	$362,144.59	$27.38	$0.529

Ore Reserves

While no calculation of ore reserves has been attempted, there still remains a sufficient amount of high-grade and mill rock in the mine to maintain the present rate of production for a few months.

Kirk-Budd Mines, Limited

During the year 1928, the Kirk-Budd Mines, Limited, did 100 feet of drifting on the 100-foot level of their property in Gillies limit, district of Timiskaming. Six men were employed, under the management of Cecil Cave.

Mining Corporation of Canada, Limited

The Mining Corporation of Canada, Limited, has an issued capital of $8,300,250 in shares of $5 par value. The directors and officers of the company are: J. P. Watson, president; E. H. Rose and G. M. Clark, vice-presidents; A. B. Stodart, J. G. Watson, C. E. Trafford, directors; M. F. Fairlie, mine manager; and G. C. Ames, secretary. The head office is in the Atlas Building, 350 Bay Street, Toronto. The company operates mines at Cobalt, Coleman township, and at South Lorrain, South Lorrain township, district of Timiskaming.

The average number of men employed at Cobalt was 180, of whom 40 were employed in the mill of the Cobalt Reduction Company, a subsidiary of the corporation. The working force in South Lorrain averaged 95 men for the year, of whom 20 men were employed on H.R. 64.

The year's operations resulted in a net profit of $494,975.28. Two dividends, each of $207,506.25, were declared. The production from the Cobalt and South Lorrain properties was less than in 1927. The total production was 1,313,958 ounces, of which 918,266 ounces were from the Cobalt properties, reserves in which are estimated at 25,000 tons containing 600,000 ounces.

Since the close of the financial year the corporation has acquired 700,000 shares of Base Metals Corporation, Limited, and 80 per cent. of the issued capital of Mincor Exploration and Development Company, Limited, which owns 230 claims in the Sudbury district.

The following is taken from the resident manager's report for the year 1928:

At the Cobalt properties, underground operations were widely spread during the year, in an effort to complete finally the extraction of ore in a number of outlying veins, especially in the City and Townsite areas. This cleaning-up process while resulting in added tonnage reduced considerably the grade of ore going to the mill.

At the South Lorrain properties, as forecast in the last annual report, the high-grade ore shoots which have given a silver production of more than six million ounces, were exhausted, and operations at the Frontier and Crompton mines will be discontinued at an early date.

Production

As a result of these conditions, silver production shows a severe decline from that of the past few years, being 1,313,958 ounces in 1928 as compared with 2,119,771 ounces for 1927.

PRODUCTION IN 1928

	Tons treated	Ounces produced
Cobalt properties	52,954	918,266
South Lorrain properties	3,980	395,692
Total	56,934	1,313,958

Included in the above production, the following tonnages were disposed of, without treatment at the local plant of the corporation: 136.26 tons of high-grade silver ore containing 321,833.89 ounces; 30.39 tons of medium-grade silver ore containing 11,800.88 ounces; 333.86 tons of low-silver high-cobalt ore containing 11,271.24 ounces.

There was an increase in the production of cobalt ore, the total weight of cobalt metal paid for being 112,655 pounds, as compared with 95,016 pounds in the previous year. This does not include cobalt metal contained in concentrates. A somewhat better tariff on cobalt ore obtained during the latter part of the year.

The details of tonnage treated, production, etc., from mill ore are given in the table below:—

Tons of mill ore treated	56,434
Assay value, ounces per ton	20.51
Ounces contained	1,157,437.21
Ounces returned by Reduction Company	969,051.91
Percentage returned under contract	83.72

Past Production.—The table below gives the production by years from the mines of the corporation. The aggregate amounted to 46,015,985 fine ounces at December 31, 1928.

PRODUCTION IN FINE OUNCES TO DECEMBER 31, 1928

	Cobalt mines	South Lorrain mines	Total
Prior to 1908	118,616	.....	118,616
Year ended December 31, 1908	633,516	.....	633,516
" " " 1909	442,254	.....	442,254
" " " 1910	471,965	.....	471,965
" " " 1911	1,777,002	.....	1,777,002
" " " 1912	2,827,826	.....	2,827,826
" " " 1913	3,784,718	.....	3,784,718
January 1, 1914 to March 31, 1914	866,622	.....	866,622
April 1, 1914, to December 31, 1914	3,185,124	.....	3,185,124
Year ended December 31, 1915	4,563,956	.....	4,563,956
" " " 1916	4,457,441	.....	4,457,441
" " " 1917	4,485,542	.....	4,485,542
" " " 1918	1,708,252	.....	1,708,252
" " " 1919	1,230,653	.....	1,230,653
" " " 1920	1,664,018	.....	1,664,018
" " " 1921	1,226,717	.....	1,226,717
" " " 1922	1,462,269	.....	1,462,269
" " " 1923	727,115	1,333,334	2,060,449
" " " 1924	851,280	521,878	1,373,158
" " " 1925	898,008	1,134,097	2,032,105
" " " 1926	1,105,456	1,104,597	2,210,053
" " " 1927	1,217,180	902,591	2,119,771
" " " 1928	918,266	395,692	1,313,958
Total	40,623,796	5,392,189	46,015,985

Mining Operations

Cobalt.—In spite of an increase in tonnage of mill ore from the Cobalt properties, there was a decrease in silver production owing to lower grade of ore. The head assay of ore going to the mill was 20.50 ounces, as compared with 28.34 ounces for the previous year. The total silver content of mill ore treated in 1928 for Cobalt properties was 1,084,946 ounces, as compared with 1,410,581 ounces in 1927.

The Cobalt Lake mine again supplied the bulk of tonnage and silver production, resulting however in further depletion of ore reserves, as exploration work was generally disappointing. The northern section of the property, which contained the largest remaining area of hitherto unexplored ground, was definitely proven barren and further work there has been discontinued.

On No. 2 vein and its branches a considerable amount of new ore was put in sight and there still remains an appreciable tonnage for extraction during the coming year.

In the southern section, work on No. 1 vein and in its vicinity gives promise of developing new ore, though the area remaining is limited in extent.

Production during the year from Cobalt Lake came from veins Nos. 2, 4, 5, 6, 11, 14, 15, 16, and 25. A comparatively small tonnage now remains in these veins with the exception of No. 2.

At the Townsite mine, in the No. 4 shaft area, extraction was completed on veins Nos. 43, 55, and "O," and work discontinued. Work in No. 1 shaft area was also practically finished.

On the City property a small tonnage of new ore was developed in the northwest section but work here as well as in the north section will be completed early in the coming year.

On the Buffalo property new ore was developed late in the year near the east boundary, and this will receive further attention.

On the McKinley-Darragh, connection was made with the second level of the Townsite and remaining ore, mainly the upper surface sections of old veins, will be removed.

The widespread character of underground operations at the Cobalt properties adds to present difficulties of work, and it may be of interest to note that the total footage of drifts and crosscuts has now reached almost fifty miles.

South Lorrain.—The following shipments of ore represent the production of the Frontier and Crompton properties for the year: 3,510 tons of mill ore with head assay of 20.65 ounces and silver content of 72,491.10 ounces; 333.86 tons of cobalt ore assaying 33.76 ounces and containing 11,271.24 ounces; 136.26 tons of high-grade ore assaying 2,361.91 ounces per ton and containing 321,833.89 ounces of silver.

The total silver content of all classes of ore from the Frontier and Crompton properties was 405,596.23 ounces, as compared with 910,536.49 ounces for the previous year. This decline in production, as noted in quarterly reports, has been due to the exhaustion of the high-grade ore shoots of the Woods and Watson veins.

Extensive exploration work was carried out on the 14th and 15th levels at the lower contact of the diabase and Keewatin formations but with negative results. With the completion of the extraction of all remaining ore on the three producing veins, operations will be discontinued early in the coming year.

Crosscutting and drifting will be done by the corporation, under contract with the Keeley Silver Mines. The future results of this work on the 14th level may have some bearing on further operations on the Crompton property at this deep horizon.

On claim H.R. 64, a two-compartment shaft is being sunk for the exploration of a group of claims lying two miles east of the Frontier and owned by the corporation. The existence of strong fault veins in Cobalt series sediments has been proven, and these veins will be explored at an horizon near the contact with the Keewatin formation. At the end of the year, 130 feet of sinking had been completed.

Rouyn, Quebec.—At the Murray property, lying immediately north of the Noranda Mines, Limited, active development was begun late in the year. Shaft-sinking will be carried to a depth of approximately 900 feet, at which horizon as well as at the 500-foot, lateral work will be done by crosscutting and diamond-drilling. At the end of the year shaft-sinking had reached a depth of 400 feet. This work is being done by a subsidiary company, the Quemont Mining Corporation, Limited.

Bell River, Que.—A group of claims in this area, north of Senneterre, was taken under option by the corporation and diamond-drilling of a wide sulphide ore body was begun late in the year. No commercial values in copper or gold were proved and option was dropped.

Many examinations of properties in various districts were made by corporation engineers. In some cases options were taken but later abandoned.

A large number of prospectors were employed throughout the season in Quebec, Ontario, and Manitoba, but no major finds are to be recorded.

Ore Reserves

At the Cobalt properties, although ore with a silver content of 1,084,946 ounces was milled, the same tonnage as at the end of the previous year remains in reserve. This tonnage is approximately 25,000. with silver content of approximately 600,000 ounces.

THE COBALT REDUCTION COMPANY, LIMITED

Concentrating Plant.—This plant ran 363 days during the year. Forty-five stamps ran 386,821 out of a possible 392,690 stamp-hours, or 98.50 per cent. of the possible running time.

The tonnage of mill ore treated in the low-grade plant was 57,969, against 54,360 tons in 1927.

This tonnage was shipped by:—

	Tons
The Cobalt mines of the Mining Corporation of Canada, Limited	52,924
The South Lorrain mines of the Mining Corporation of Canada, Limited	3,510
Lorrain Trout Lake Mines, Limited	378
Sundry	1,157
Total	57,969

Comparative details of concentration treatment for 1928 and 1927 follow:—

	1928	1927
Tons treated	57,969.00	54,360 00
Average assay	21.06	27.82
Ounces contained	1,220,992.25	1,512,117.86
Tons concentrate produced	424.68	432.56
Average assay	1,651.30	2,194.37
Ounces contained	701,273.76	949,197.34
Percentage of extraction by table concentration	57.43	62.77

Flotation Plant.—All the slime produced by crushing and grinding, and the table-tailing (after regrinding in tube mills), was treated by flotation.

Details of tonnage, extraction, etc., are given below:—

	1928	1927
Tons of slime treated	57,544.05	53,927.22
Average assay	9.03	10.44
Ounces contained	519,718.49	562,920.52
Tons of flotation concentrate produced	745.28	809, 70
Average assay	586.18	559.19
Ounces contained	436,867.00	452,776.84
Percentage of extraction	84.06	80.43

SUMMARY OF MILLING OPERATIONS

	1928		1927	
	Total	Extraction	Total	Extraction
		per cent.		per cent.
Tons of ore milled	57,969.00	.....	54,360.00	.....
Average assay	21.06	.....	27.82	.....
Ounces contained	1,220,992.25	.....	1,512,117.86	.....
Table concentrate produced, ounces	701,273.76	57.43	949,197.34	62.77
Flotation concentrate produced, ounces	436,867.00	35.78	452,776.84	29.94
Total ounces produced	1,138,140.76	93.21	1,401,974.18	92.71

General Costs.—The total cost of operations was $211,490.63, against $225,019.54 in 1927.

The cost of marketing the table and flotation concentrate produced, including freight, smelter treatment, and refining charges, value of smelter deduction, etc., is included under "Operation" in the table below, and amounted to $75,630.38 in 1928, or $1.304 cents per ton of ore treated.

TOTAL COST OF OPERATION

	Labour	Material	Other	Total	Per ton
Administration and general	$6,136.34	$907.08	$5,714.46	$12,757.88	$0.220
Operation	51,258.44	28,437.10	112,011.51	191,707.05	3.307
Head office	.....	.....	7,025.70	7,025.70	.121
Total cost of operation	$57,394.78	$29,344.18	$124,751.67	$211,490.63	$3.648

Earnings.—The gross earnings were made up of customs charges to the Mining Corporation of Canada, Limited, and subsidiaries, and treatment charges on purchased ores, etc.

The operating profit was:—

By earnings		$247,397.23
Less total cost		211,490.63
Profit at plant		$35,906.60

There were no capital expenditures during the year.

Net Profit.—The net profit was:—

By profit at plant		$35,906.60
Less federal taxes	$105.99	
Written off plant	34,436.68	
		34,542.67
Net profit		$1,363.93

The above amount was paid out in dividends to the Mining Corporation of Canada, Limited.

Nipissing Mining Company, Limited

Nipissing Mines Company, Limited, has a capital of 1,200,000 shares of $5 par value. The officers and directors of the company are: E. P. Earle, president and treasurer; Alexander Fasken, secretary; J. T. Crabbs, Richard T. Greene, August Heckscher, David Fasken, and Hugh Park, directors. The head office is in the Excelsior Life Building, Toronto, and the New York office is at 165 Broadway.

The operating company is the Nipissing Mining Company, Limited, with a capital of 2,500 shares of $100 par value. The officers and directors are: David Fasken, president; E. P. Earle, vice-president and treasurer; Alexander Fasken, secretary; J. T. Crabbs, E. P. Earle, David Fasken, and Hugh Park, directors. The operating officials are: Hugh Park, general manager; E. V. Neelands, manager; J. M. Carter, mill manager; and H. S. Wilson, geologist.

The net value of the Nipissing shipments in 1928 was $1,167,177.77, and the net income of the operating company was $356,533.22. During the year $360,000 was paid in dividends, making a total to date of $29,040,000, or $24.20 per share. The operating company's surplus at the end of the year was $3,702,427.91.

The average number of men employed at the property at Cobalt, Coleman township, district of Timiskaming, was 240, of whom 60 were employed in the mill. In addition an average of 36 men was employed in the Nipissing Lorrain mine, South Lorrain township, district of Timiskaming.

The general manager reports as follows for the year 1928:—

SHIPMENTS IN 1928

	Tons	Silver, fine ounces	Net value
Silver bullion	62.328	1,815,661.31	$1,056,447.59
Residue and ore	1,214.264	90,069.16	112,912.84
Total shipments	1,276.592	1,905,730.47	$1,169,360.43
Less custom bullion	.131	3,831.43	2,182.66
Shipments of Nipissing product	1,276.461	1,901,899.04	$1,167,177.77

PRODUCTION IN 1928

	Silver, fine ounces	Gross value	Net value
Shipments in 1928	1,901,899.04	$1,175,363.52	$1,167,177.77
On hand at mine, December 31, 1928	1,025,693.30	797,046.63	784,709.97
Total	2,927,592.34	$1,972,410.15	$1,951,887.74
On hand at mine, December 31, 1927	1,017,710.27	808,989.65	796,561.47
Nipissing production	1,909,882.07	$1,163,420.50	$1,155,326.27

TOTAL SHIPMENTS TO DECEMBER 31, 1928

Year	Dry weight, pounds	Silver, Gross ounces	Gross value, silver plus cobalt, nickel, and arsenic paid for	Net Value received
1904	124,659	32.13	$24,163.90	$23,887.52
1905	939,373	753,153.90	505,638.28	471,666.61
1906	4,019,494	2,214,821.60	1,576,852.94	1,421,655.54
1907	4,804,426	2,239,551.89	1,373,088.57	1,234,492.35
1908	7,009,998	2,893,031.44	1,526,686.32	1,364,478.03
1909	12,825,169	4,646,869.21	2,417,767.21	2,180,407.02
1910	13,388,039	5,596,135.80	3,008,957.80	2,742,842.58
1911	5,829,254	4,678,074.14	2,507,196.98	2,381,712.54
1912	3,701,726	4,719,578.21	2,893,276.54	2,827,317.62
1913	2,657,250	4,844,169.41	2,945,335.30	2,920,714.26
1914	868,425	3,999,862.51	2,226,429.66	2,207,427.72
1915	383,868	4,623,957.78	2,425,065.85	2,383,877.91
1916	4,275,804	3,819,768.50	2.737,569.36	2,687,530.85
1917	5,922,508	3,798,801.54	3,338,682.41	3,239,151.62
1918	4,148,760	4,116,076.70	4,238,666.53	4,165,353.98
1919	1,473,354	3,080,069.93	3,561,440.07	3,539,573.85
1920	7,386,488	2,814,852.28	2,627,937.76	2,539,250.71
1921	211,980	3,016,760.42	1,754,345.83	1,745,411.07
1922	6,036,449	3,845,011.83	2,906,102.87	2,886,719.20
1923	226,372	3,227,887.52	2,104,394.04	2,093,829.16
1924	1,401,472	2,828,287.06	1,923,171.13	1,911,213.31
1925	1,357,912	2,413,697.18	1,698,025.28	1,686,601.52
1926	1,673,998	1,966,299.62	1,270,749.51	1,260,692.96
1927	1,983,848	1,961,028.46	1,166,299.12	1,157,191.97
1928	2,552,922	1,901,899.04	1,175,363.52	1,167,177.77
Total	95,203,548	79,999,678.10	$53,933,206.78	$52,240,177.67

COST OF PRODUCING SILVER

(Based on production of 1,909,882.07 ounces and 63,592 tons)

	Total cost	Per ton ore	Per ounce silver
			cents
Diamond-drilling	$73,470.90	$1.155	3.847
Exploration	78,797.53	1.240	4.126
Development	67,627.88	1.063	3.541
Stoping	193,805.14	3.048	10.147
Assaying and engineering	11,354.24	0.179	0.594
Residue and dumps	7,614.33	0.119	0.399
Administrative and office	35,426.63	0.557	1.855
Camp maintenance	15,434.73	0.243	0.808
Insurance and taxes	54,329.50	0.854	2.845
General and legal	11,940.11	0.188	0.625
High-grade mill	39,910.06	0.628	2.090
Low-grade mill	203,811.90	3.205	10.671
Marketing product	8,094.23	0.127	0.424
Corporation, New York office and travelling	14,202.72	0.223	0.743
Total	$815,819.90	$12.829	42.715
Less rent, exchange, and miscellaneous income	8,932.62	.140	.467
Net cost	$806,887.28	$12.689	42.248

SUMMARY OF PRODUCTION

	Total	Per cent.
Gross value of production	$1,163,420.50	100.00
Total cost of production	806,887.28	69.35
Profit on operations at Cobalt	$356,533.22	30.65

SOURCES OF PRODUCTION

From underground:	Tons
Shaft No. 19	12,007
Shaft No. 49	15,798
Shaft No. 63	20,853
Shaft No. 73	10,111
Shaft No. 92	4,423
	63,192
In battery bin, December 31, 1927	750
	63,942
In battery bin, December 31, 1928	350
Total ore milled	63,592

The various products treated in the high grade plant were:—

HIGH-GRADE ORE TREATMENT

	Tons	Assay	Ounces contained
Concentrate	611	2,150	1,313,783
By-products	30	2,363	70,891
Total	641	2,160	1,384,674

The refinery treated precipitate and custom bullion containing 1,915,365 fine ounces. Shipments of bullion amounted to 1,815,661 fine ounces; shipments of residue amounted to 1,126 tons.

LOW-GRADE MILL

	Tons	Assay	Ounces contained
Ore treated	63,592	30.68	1,951,247
Recovered in products:			
Precipitate	24	25,169	604,059
Coarse concentrate	515	2,410	1,241,381
Fine concentrate	86	472	40,592
Total recovery	.....	.....	1,886,032

Average tailing, 1.03 ounces; recovery, 96.66 per cent. Thirty stamps ran 345 days, 7 hours, or 94.31 per cent. of possible running time. They crushed 184.2 tons per day, or 6.14 tons per stamp per day.

LOW-GRADE MILL COSTS

(Based on 63,592 tons milled)

	Total cost	Cost per ton
No. 73 crushing plant	$2,522.98	$0.040
Aerial tram	2,235.87	.035
Surface tram	9,471.43	.149
Crushing and elevating	12,860.97	.202
Batteries	19,814.46	.311
Tube mills and classifiers	26,453.71	.416
Concentration	14,930.63	.235
Cyanide treatment	69,707.58	1.096
Filtering and discharging	11,005.52	.173
Clarifying and precipitation	11,620.67	.183
Refining	10,388.05	.163
Heating	12,681.92	.199
Water service	3,424.96	.054
Residue dam	1,391.31	.022
Research	740.15	.012
Total	$209,250.21	$3.290

The cost per ton was: labour, $1.146; supplies, $1.305; power, $0.676; shops, $0.186; credits, $0.023; total, $3.290.

COST OF CHEMICALS AND MAIN SUPPLIES AT LOW-GRADE MILL

	Total pounds	Cost per pound	Total cost	Pounds per ton	Cost per ton
Sodium cyanide	265,152	$0.1848	$48,999.10	4.170	$0.771
Lime	253,825	.0063	1,609.25	3.991	.025
Pebbles	283,838	.0139	3,938.91	4.463	.062
Sodium sulphide	52,432	.0413	2,166.98	.825	.034
Caustic soda	25,350	.0377	956.65	.399	.015
Aluminum	3,027	.2400	726.48	.048	.011
Hydrochloric acid	6,384	.0291	185.92	.100	.003
Steam coal	1,723,200	.0047	8,155.64	27.098	.128
Total	.....	.....	$66,738.93	.....	$1.049

SUMMARY OF UNDERGROUND WORK, 1928

Shaft No.	Drifting	Cross-cutting	Raising	Total	Stoping
	feet	feet	feet	feet	cu. yds.
19	199	276	313	788	4,253
49	29	518	12	559	3,551
63	1,124	775	182	2,081	6,229
73	277	614	115	1,006	2,197
92	122	46	20	188	704
177	538	2,000	314	2,852	375
404	94	25	26	145	363
Total	2,383	4,254	982	7,619	17,672

Diamond-drilling, 8,070 feet.

Summary of Results

General operating results at Cobalt were somewhat more favourable than those of the previous year. The production of silver was 1,909,882 ounces, a slight increase over 1927. Costs were reduced by 4.6 cents per ounce. There was a decrease of 15,000 tons treated at the low-grade mill, but the head assay was 30.68 ounces per ton, as against 23.65 ounces in 1927.

The average official price of silver was 58.18 cents per ounce, this being a slight increase over the previous year. The variation between high and low monthly averages was 3.3 cents, being 60.3 cents in May and 57 cents in February.

Shipments for the year contained 1,901,899 gross ounces fine silver. The total production to date is in excess of 81,000,000 ounces.

There was a decrease in the amount of underground work, due to the fact that many portions of the property have now been fully explored. Stoping operations were confined to a number of open cuts and small veins. Known ore reserves amount to 17,000 tons containing 596,000 ounces, a decrease of about 90,000 ounces from the preceding year. In the absence of any discovery of major importance to replace the production from shaft No. 19, the production for 1929 is not expected to equal that of 1928.

At Cobalt, continued favourable development was encountered at shaft No. 19, where the vein discovered early in 1928 developed in a satisfactory manner at both the 100- and 150-foot levels, particularly the former. A large part of the year's production came from this vein. More recently, another vein in the same vicinity was located but it does not compare in importance with the main vein. There were also additional discoveries of modest size at tunnel No. 28 and in the vicinity of the older workings at hill No. 49. Operations on the town side of the lake continued throughout the year, but the production obtained was mainly mill rock.

At South Lorrain, work in the conglomerate in the southern part of the property was not gratifying. A number of small calcite veins containing low assays in silver were encountered, but none were important. Several diamond-drill holes were completed under Lake Timiskaming without favourable results. Stoping operations were concluded in the fall. Production in 1928 amounted to 65,000 ounces of silver and one car of cobalt ore. Shipments to date contained 240,000 ounces of silver and 135 tons of cobalt ore. In addition, about 120,000 ounces of silver are contained in a mill dump, of no value at the present price of silver. All operations ceased in the early part of 1929.

A large amount of diamond-drilling and surface work was done on two properties taken under option during the year, but they both were allowed to lapse. More recently, options have been taken on a group at Vamp lake, Manitoba, and on three groups in the Pickle Lake–Crow River district. Several diamond-drill holes have already been drilled on the former with as yet inconclusive results; supplies are now being taken in to the latter for spring and summer work.

At the property of the Robb-Montbray Mines, Limited, a large amount of additional underground work and diamond-drilling was done. The shaft was deepened and work was concentrated at three new levels, the lowest being at 525 feet. General results from this work were disappointing. Geological conditions were similar to those occurring at the upper levels, but values were usually confined to small isolated patches. Considerable diamond-drilling was done on various parts of the property, sections being obtained at depths from 300 to 1,000 feet. As no additional encouragement was obtained all work was suspended in January, 1929.

As in former years, the company had a number of field men in various districts in the search for new properties. Employed in this work were sixteen prospecting parties and six examining engineers, a total of thirty-eight men. Several hundred properties were examined, a few options were taken, and several groups of claims were staked. Part of this work continued throughout the winter, a field office being maintained at The Pas, Man.

Prominent in the work of exploring new areas was the feat of eight men under the leadership of H. S. Wilson and D. W. Cameron in reaching an area south of Chesterfield inlet on the west coast of Hudson bay early in the summer, one party going overland from Great Slave lake and

the other up the coast from Fort Churchill. A number of claims were staked, but much more work is required before the necessary information as to the economic importance of the area can be obtained.

M. J. O'Brien, Limited

Miller Lake O'Brien Mine

The Miller Lake O'Brien mine, Nicol township, district of Timiskaming, is owned and operated by M. J. O'Brien, Limited. J. G. Dickenson is general manager, and H. G. Kennedy, assistant manager. One hundred men are employed.

The development work done in 1928 comprised 2,295 feet of drifts, 198 feet of crosscuts, and 85 feet of sinking. The tonnage broken in the stopes was 24,000.

O'Brien Mine

The O'Brien mine in Coleman township, district of Timiskaming, is owned and operated by M. J. O'Brien, Limited. J. G. Dickenson is general manager, W. A. O'Flynn is assistant manager, and 170 men are employed.

Underground development during 1928 amounted to 1,192 feet of drifting, 223 feet of raising, and 12 feet of sinking.

The tonnage broken was 51,019; ore hoisted, 49,068 tons; waste hoisted, 1,393 tons.

At the Michael shaft on the east side of Cross lake, the development work during 1928 was 3,365 feet of drifts, and 119 feet of raising.

The tonnage broken was 17,465; ore hoisted, 4,950 tons; waste hoisted, 11,909 tons.

Peterson Cobalt Mines, Limited

Peterson Cobalt Mines, Limited, has an authorized capital of 3,000,000 shares of $1 par value, of which 100,000 are preferred shares. The officers of the company are: W. A. Lamport, president; J. C. Haight, vice-president; P. M. Gott, secretary-treasurer; and D. J. Russell, engineer. The mine is in the township of Coleman, district of Timiskaming. The head office is at 301 Royal Bank Building, Toronto.

The following work was done during the year: crosscutting and drifting, 278 feet; diamond-drilling, 1,400 feet.

The average number of men employed for the year was 5.

Richard Sandoe and Associates

The Temiskaming mine in Coleman township, district of Timiskaming, was leased to Richard Sandoe and two partners. From November 20, 1927, to June 5, 1928, work consisted of sorting ore from the stopes on the 200-foot level, and the collection and shipping of sands from the mill. Shipments comprised 7,522 pounds in April, assaying 2,230 ounces of silver; 5,830 pounds in July, assaying 2,777 ounces; and 59 tons of sands, assaying 56 ounces, in October, 1928.

Shield Development Company, Limited

The Shield Development Company, Limited, operated the Cochrane property, in the township of Coleman, district of Timiskaming, with a force of 12, until the mine closed in July, 1929.

The development work for the year 1928 and to the time the mine closed was as follows:—

Crosscutting and drifting	1,305.75	feet
Sinking	215	feet
Raising	12	feet
Station-cutting	380	cubic feet
Cobalt ore shipped	4	tons

The officers are as follows: N. R. Fisher, president; James Cooper, secretary-treasurer; Alistair Frazer, vice-president; S. Gzowski, J. D. Patterson, and J. Jones, directors. The head office of the company is at 132 St. James Street, Montreal, Que.

Thomas E. Trembath and Partner

La Rose mine in Coleman township, district of Timiskaming, was leased to Thomas E. Trembath and partner in June, 1928. The work done consisted of stoping and taking out pillars on a sub-level 27 feet below the first level in No. 3 shaft. Shipments included 3 tons of high-grade ore, assaying about 2,900 ounces, and 2½ tons of cobalt ore early in November, and one ton of cobalt ore in July.

TALC

Asbestos Pulp Company, Limited

The Asbestos Pulp Company, Limited, operated the mine and mill in Hastings county, near Madoc, continuously during 1928. The shaft was deepened from 325 feet to 391 feet and a crosscut was run at the lower level for a distance of 65 feet to the ore. Drifts were extended on the vein 125 feet east and 60 feet west, and stoping was begun. The talc at this depth is about 14 feet wide.

Ore was mined during the year east of the shaft for a distance of 125 feet between the 5th and 3rd levels and west of the shaft between the 4th and 3rd levels.

The production for the year was 3,814 tons of crude ore and 4,085 tons of milled talc.

An average of 25 men was employed. Robert Tannahill, Belleville, is president; and Roy Taylor, Madoc, is secretary and manager.

Geo. H. Gillespie Company, Limited

The Geo. H. Gillespie Company, Limited, operated the talc mine and mill at Madoc throughout the year. The talc was mined from the east end of the vein between the 6th level, at a depth of 225 feet, and the 4th level. No new development work was carried on.

They employed an average of 21 men. George H. Gillespie, Madoc, is manager.

METALLURGICAL WORKS

Algoma Steel Corporation, Limited

The blast furnaces of the Algoma Steel Corporation, Limited, at Sault St. Marie, Ont., operated as follows, during the year 1928: No. 1 furnace operated continuously excepting for 34 days, from June 13 to July 21, when it was being

relined. No. 2 furnace was idle all year. No. 3 furnace ran, without a shutdown, from January 1, to December 31. No. 4 furnace was blown in on June 2 and ran steadily till the end of the year.

Jas. H. Bell is blast furnace superintendent.

Deloro Smelting and Refining Company, Limited

The plant operated throughout the year at normal capacity, except during September and part of October when the Cobalt Oxide Plant was completely shut down for about six weeks as a result of a serious fire.

The officers of the company are: M. J. O'Brien, president; J. A. O'Brien, vice-president; F. A. Bapty, secretary-treasurer; S. F. Kirkpatrick, managing director. S. B. Wright is general manager, and R. A. Elliott is superintendent.

International Nickel Company of Canada, Limited

The refinery at Port Colborne was operated continuously throughout the year.

Steel Company of Canada, Limited

"A" and "B" furnaces were both operated continuously during 1928 and produced 320,547 tons of pig iron. This was an increase over any previous yearly output and an increase of 79,454 tons over the year 1927.

On an average 130 men were employed. R. A. Gillies, Port Colborne, is blast furnace superintendent.

MINING ACCIDENTS IN 1928

By

Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, G. E. Cole, Timmins; D. G. Sinclair, Sudbury; J. G. McMillan, Cobalt; A. R. Webster, Toronto.

Accidents during 1928

During the year 1928 at the mines, metallurgical works, quarries, clay, sand, and gravel pits regulated by the Mining Act, there were 2,558 accidents to employees reported to the Department of Mines up to January 15, 1929. Forty-three of the accidents resulted in the death of eighty-five men. The fire in the Hollinger mine on February 10 caused the death of thirty-nine men. Not including this disaster, there was an increase over the previous year of fourteen men killed. The total number of non-fatal accidents shows an increase of seventy-one over the previous year, which is a decrease of about one and a half per cent. of injuries to men employed.

Distribution	Fatal	Non-fatal	Total
Mines, underground	31	1,628	1,659
Mines, surface	2	451	453
Metallurgical works	4	108	112
Quarries	2	243	245
Clay, sand, and gravel pits	4	85	89
Total	43	2,515	2,558

Fatal Accidents

A comparison of fatal accidents for the last five years is given in the following table:—

Distribution	1924	1925	1926	1927	1928
Mines, underground	23	30	20	19	31
Mines, surface	1	1	3	4	2
Metallurgical works	2	2	3	3	4
Quarries; clay, sand, and gravel pits	14	9	6	7	6
Total	40	42	32	33	43

By months the fatalities occurred as follows:—

January	5	July	3
February	43	August	2
March	2	September	3
April	6	October	7
May	4	November	1
June	6	December	3
Total			85

Classifying the fatalities according to the industry gives the following:—

Gold mines	59
Nickel mines	14
Metallurgical works	4
Lead mines	2
Quarries	2
Gravel pits	4
Total	85

ANALYSIS OF FATALITIES AT MINES, 1924-28

Cause	1924	1925	1926	1927	1928
	per cent.	per cent.	per cent.	per cent.	per cent.
Fall of ground	25	19.35	17.39	26	6.6
Run of ore or rock	.....	.....	.....	17.4	5.3
Shaft accidents	29.16	19.35	26.09	21.3	9.3
Explosives	16.66	25.8	43.48	4.3	12
Miscellaneous, underground	25	29.03	.....	8.69	64
Surface	4.16	6.45	13.04	21.7	2.6

TABLE OF FATAL ACCIDENTS IN MINES, METALLURGICAL WORKS, QUARRIES, AND GRAVEL, SAND, AND CLAY PITS, 1903-1928

Year	Persons killed at metallurgical works and mines	Persons employed at metallurgical works and producing mines	Persons employed at non-producing mines (estimated)	Total persons employed	Fatal accidents per 1,000 employed
1903	7	3,499	400	3,899	1.79
1904	7	3,475	400	3,875	1.8
1905	9	4,415	500	4,915	1.83
1906	11	5,017	750	5,767	1.9
1907	22	6,305	1,140	7,445	2.93
1908	47	7,435	1,750	9,185	5.11
1909	49	8,505	2,000	10,505	4.66
1910	48	10,862	2,000	12,862	3.73
1911	49	12,543	2,000	14,543	3.37
1912	43	13,108	2,000	15,108	2.84
1913	64	14,293	2,000	16,293	3.93
1914	58	14,361	1,500	15,861	3.6
1915	22	13,114	1,500	14,614	1.51
1916	51	14,624	2,000	16,624	3.07
1917	36	16,791	1,000	17,791	2.02
1918	32	14,726	500	15,226	2.1
1919	39	11,926	1,000	12,926	3
1920	29	10,486	1,000	11,486	2.61
1921	24	8,436	1,000	9,436	2.54
1922	30	9,500	1,500	11,000	2.72
1923	30	10,500	1,500	12,000	2.5
1924	40	11,000	1,500	12,500	3.2
1925	42	11,500	1,500	13,000	3.23
1926	32	11,500	1,500	13,000	2.46
1927	33	13,311	2,000	15,311	2.1
1928	85	15,787	2,000	17,787	4.76

The occupation and nationality of the men killed are set out in the following table:—

Occupation	English-speaking	Finn	Austrian	Jugo-Slav	Norwegian	Roumanian	Italian	Egyptian	Swede	Czecho-Slovak	Ukrainian	Bulgarian	Russian	Pole	Total
Timberman	8	5	1	....	....	1	....	....	1	....	....	....	....	....	16
Loader	7	2	....	2	1	....	1	....	....	....	....	....	....	1	14
Miner	5	3	1	2	....	....	....	....	....	....	1	1	....	....	13
Labourer	3	1	....	2	....	....	....	1	1	2	....	....	....	....	10
Shaftman	3	2	....	....	....	....	....	....	....	....	....	....	....	1	6
Trammer	....	1	1	1	....	....	....	....	....	....	....	....	....	....	3
Powder man	2	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Chute-blaster	2	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Shift-boss	2	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Deckman	1	....	....	....	....	....	....	....	....	....	....	....	1	....	2
Motorman	1	....	....	1	....	....	....	....	....	....	....	....	....	....	2
Teamster	2	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Carpenter	1	....	....	....	....	....	1	....	....	....	....	....	....	....	2
Farmer	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Driller	....	....	....	....	....	1	....	....	....	....	....	....	....	....	1
Sampler	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Transport boss	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Brakeman	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Blaster	....	....	1	....	....	....	....	....	....	....	....	....	....	....	1
Electrician	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Engine operator	....	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Foreman	....	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Total	42	16	4	8	1	2	2	1	2	2	1	1	1	2	85

The ages of the men killed were as follows:—

Age	17-20	21-25	26-30	31-35	36-40	41-45	46-50	Over 50	Total
Number killed	2	8	22	12	19	10	6	6	85

Infection

Records show that infection followed in 269 cases out of 2,515 non-fatal accidents in 1928.

Location	Number of accidents	Accidents followed by infection	Per cent. infection
Mines, underground	1,628	199	12.2
Mines, surface	451	39	8.6
Metallurgical works	108	6	5.5
Quarries	243	21	8.6
Clay, sand, and gravel pits	85	4	4.7
Total	2,515	269	10.7

Accidents from Explosives

Cause	Number of accidents	Number injured	
		Fatal	Non-fatal
Struck by rock from blast	5	.....	5
Premature explosion	3	2	2
Delayed too long lighting fuse	8	4	6
Drilled into explosives	2	2	2
Sledging, struck explosive	1	.....	1
Returned to delayed blast	2	.....	2
Handling explosives	3	2	4
Walked into blast	1	1	1
Concussion from blast	1	.....	1
Total	26	11	24

Prosecutions

Before Magistrate Thos. Stoddart, at Sudbury, on May 10, 1928, Mike Pontanen, a skip tender in No. 3 shaft, Frood mine, of the International Nickel Company, was fined $20 for a contravention of Regulation 98, Section 163, Mining Act, 1927, on April 23, in that he entered a skip for the purpose of travelling thereon without giving the required 3-bell "man signal."

Before Magistrate Thos. Stoddart, at Sudbury, on May 10, and an adjourned hearing on May 19, Alfred Bartlett, a hoistman at No. 3 shaft, Frood mine, of the International Nickel Company, was charged with having acted in an improper manner in response to a signal to hoist a skip from a position below the 2,800-foot level to that level, in that he first lowered the skip some distance before hoisting to the point indicated in the signal, in contravention of Regulations 98 and 221, Section 163, Mining Act, 1927. The case was dismissed.

Fred J. Baker, hoistman at No. 1 shaft, Frood mine, was tried before Police Magistrate J. S. McKessock, of Sudbury, on October 15, 1928, on a charge that, "at the town of Frood, in the district of Sudbury, on or about the 23rd day of September, 1928, while acting as hoistman in the mine of the International Nickel Company, by doing negligently or omitting to do an act which it was his duty to do, did cause grievous bodily injury to the person of Nestor Peltola, contrary to Section 284 of the Criminal Code of Canada."

Baker was found guilty by the magistrate and fined $200 and costs or, in default, three months' imprisonment.

Baker entered an appeal from the conviction on the principal ground that the conviction was not supported by the evidence, which appeal was allowed and the conviction set aside.

An appeal to the Supreme Court of Canada has been entered by the Department of the Attorney-General for Ontario against the judgment of the First Divisional Court of the Appellate Division of the Supreme Court of Ontario on the grounds that, "The said judgment of the First Divisional Court conflicts with the judgment of the Court of Appeal for Saskatchewan in the case of the King *vs.* McCarthy reported in 1921, Western Weekly Reporter, at page 433."

This appeal is to be heard early in February, 1929.

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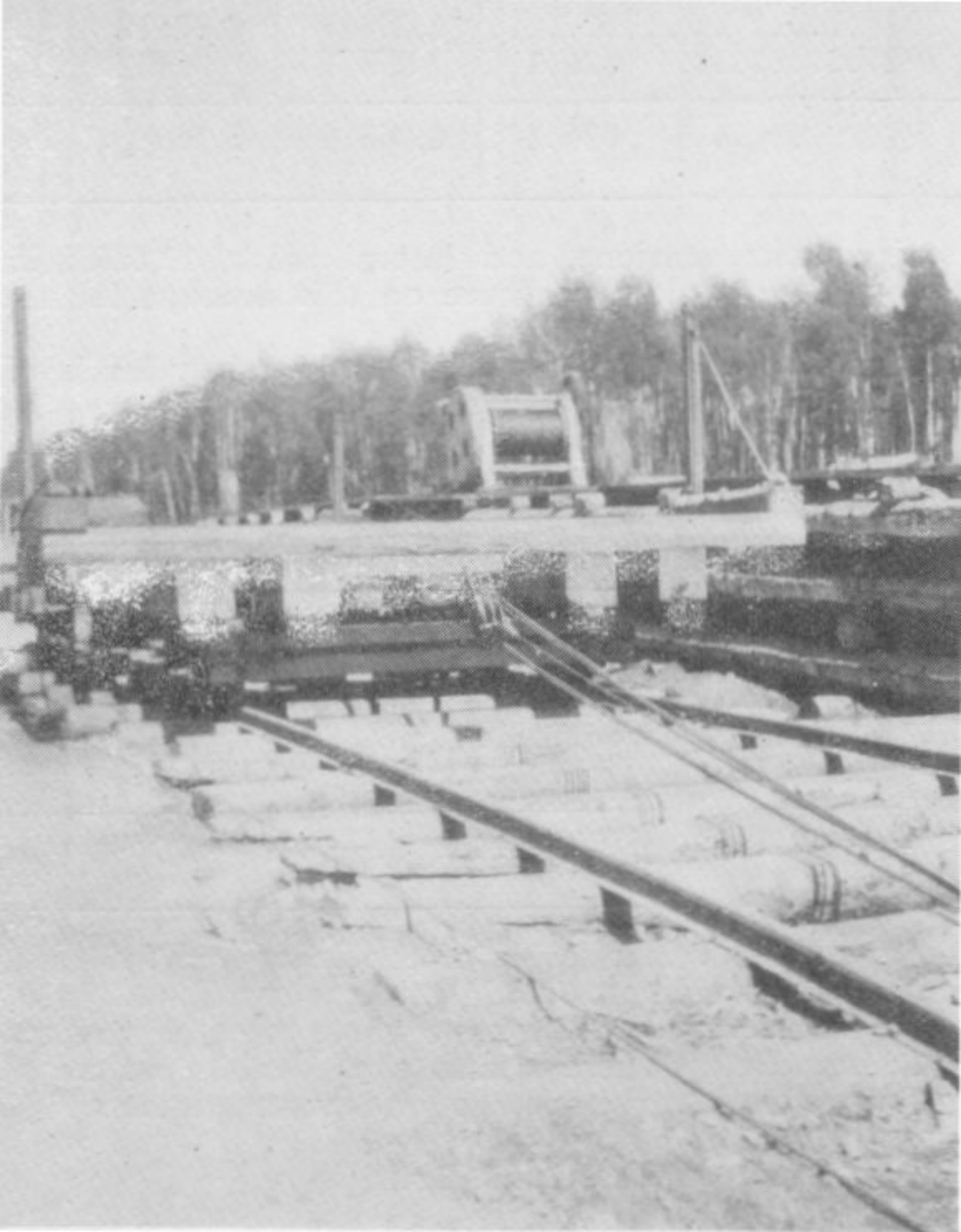

PROVINCE OF ONTARIO

DEPARTMENT OF MINES

HON. CHAS. MCCREA, *Minister of Mines* THOS. W. GIBSON, *Deputy Minister*

THIRTY-EIGHTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXVIII, PART II, 1929

Geology of the Fort Hope Gold Area, District of Kenora (Patricia Portion), by E. M. Burwash - - - - - - - - - - 1-48

Geology of the Area between Favourable Lake and Sandy Lake, District of Kenora (Patricia Portion), by M. E. Hurst - - - - - - - - - - - - - - - - - 49-84

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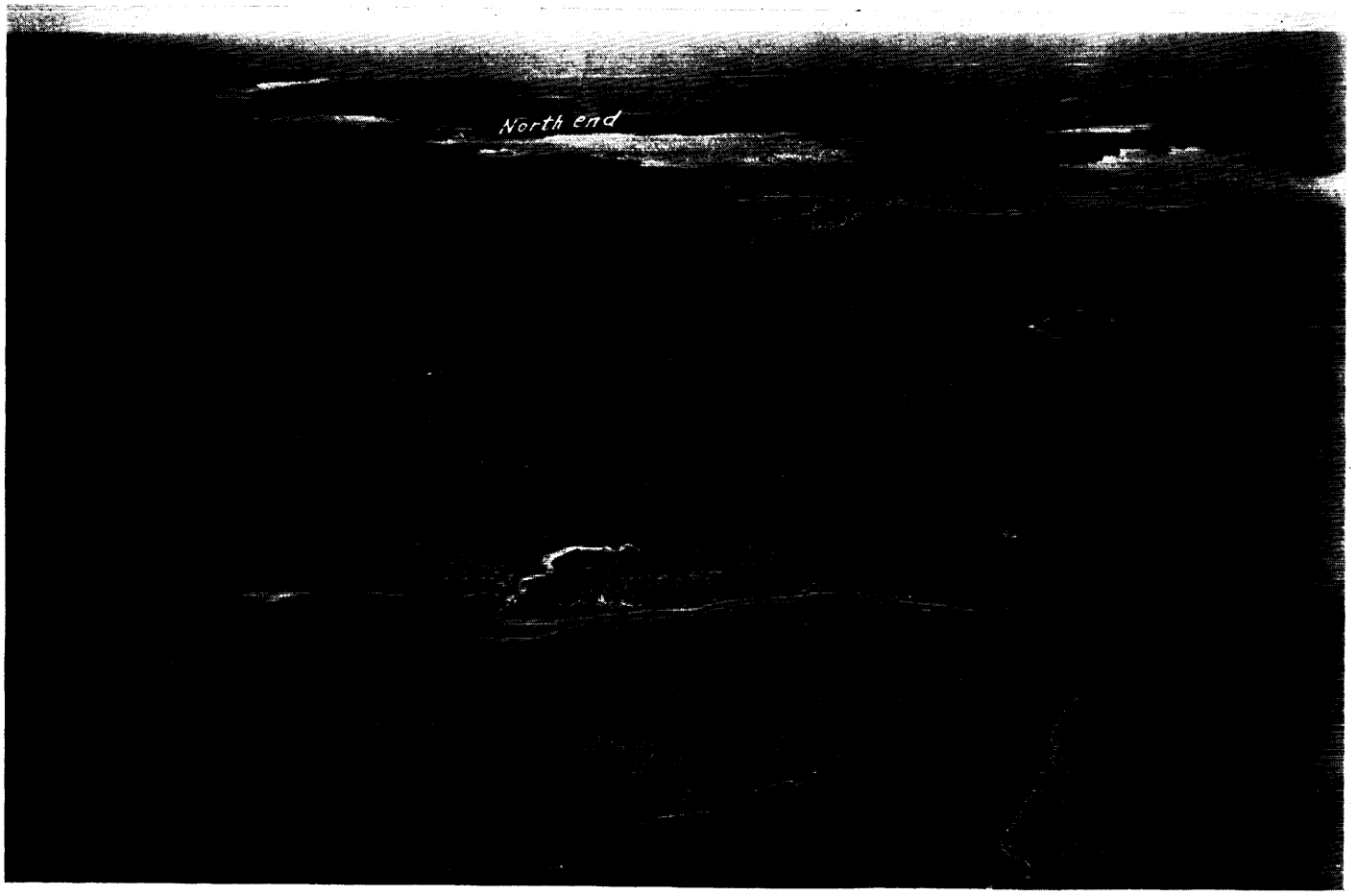
COLOURED GEOLOGICAL MAPS

(In pocket at back of report)

Map No. 38*a*—Favourable Lake to Sandy Lake Area, District of Kenora (Patricia Portion). Scale 2 miles to the inch.

Map No. 38*b*-1—Fort Hope Area, District of Kenora (Patricia Portion). Scale 70 miles to the inch.

Map No. 38*b*-2—Route Map, Lake Nipigon to Albany River, Districts of Thunder Bay and Kenora (Patricia Portion). Scale 4 miles to the inch.



Aerial view of Fort Hope and vicinity with Albany river in the foreground. "X" marks the location of the Fort Hope mine, and Round lake lies just above it. The marked peneplation of the surface is well indicated.

Geology of the Fort Hope Gold Area, District of Kenora (Patricia Portion)

By E. M. Burwash

Introduction

A discovery of gold-bearing ore having been made in July, 1927, near Fort Hope, Patricia portion of Kenora district, the writer was commissioned by the Ontario Department of Mines to make a geological examination of the adjacent area for the purpose of determining the character of the ore deposits and the structure, lithology, and extent of the rock formations in which they occur.

There are several routes by which the Fort Hope area may be reached from the Canadian National railway. A winter road for horses and tractors has been cut from Tashota, by way of Toronto (Cross) and Summit lakes, the Kapikotongwa, Ottertail (Otter),[1] Ogoki, and Kagianagami rivers to Kagianagami lake, thence northward crossing the Portage (Mattawa) river to the Albany river near the outlet of Eabamet lake. The Fort Hope mine is near the northwestern bay of Eabamet lake, and the total distance by road to Tashota is slightly over 100 miles.

Several summer routes are available for canoe travel. Those which start at Ombabika and Jackfish bridge are the most direct, and the Ombabika route is that in general use. It follows the Ombabika river to Summit lake and descends the Kapikotongwa northward from that lake for about 25 miles to the Makoki river, from which a portage route leads to the Ottertail river, which is followed to the Ogoki. The route is then down the Ogoki for five miles, up French creek, across French lake and a 40-chain portage to Mahamo lake, from which the Kagianagami river follows a circuitous course to Kagianagami lake. The main route then follows the Opichuan river northward to the Albany, which is reached at Abazotikichuan lake, about 25 miles below Fort Hope.

An alternative route from Kagianagami lake northward has its point of departure from the north end of the western bay of that lake, and following a chain of small lakes and creeks crosses to the Opichuan waters and later to the Portage river, by which it descends to the Albany. It involves 19 or 20 portages but avoids poling up several rapids on the Albany and the somewhat difficult Frenchman's rapid. By the Opichuan route there are 8 or 9 portages.

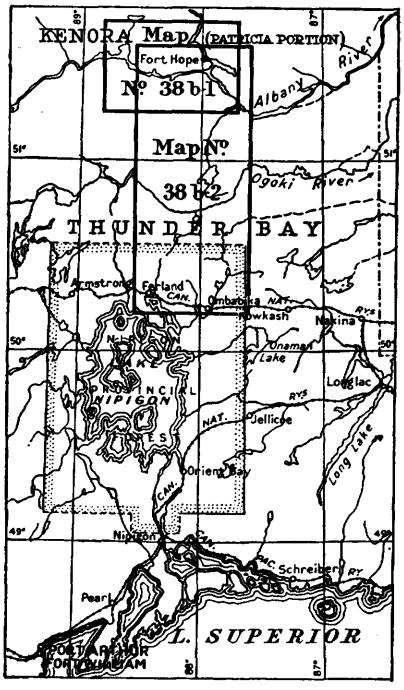
The route which starts at Jackfish bridge, near Ferland, follows the Little Jackfish river for 25 miles over 13 portages to South Summit lake. Passing over the height of land portage it continues to the Ogoki river via Mojikit lake and river, with one portage, and thence to the junction of the Ogoki and Ottertail with 4 more portages, a total of 19 portages, as compared with 14 on the route from Ombabika, which here joins the Little Jackfish route. From this point to Fort Hope there are two alternative routes as already described.

It had been proposed some time previously that the waters of the Ogoki river should be diverted southward through the Little Jackfish valley into Lake Nipigon for the purpose of increasing the power available on the Nipigon river. It was therefore thought advisable to make a geological examination of this river valley, especially with reference to its possible resources in precious metals,

[1]The Indian name of this stream is Zhob-schquay, *cf.* Robt. Bell, Geol. Surv. Can., Rept. of Progress, 1871, p. 107.

the discovery of which might be affected by the raising of the water-levels involved in the execution of the plan. The nature of the material that forms the river banks and the relative youth or maturity of the valley were also matters of importance, in view of the probable diversion through it of a stream much larger than that which has excavated and now occupies it. Banks of sand or clay would undoubtedly suffer extensive erosion under such conditions, unless the rate of flow were kept very slow by works designed for that purpose.

The writer with three assistants proceeded on June 9 to Ferland, a station on the Canadian National railway opposite the northwestern part of Ombabika bay, Lake Nipigon. Canoes had previously been shipped to Ferland and were

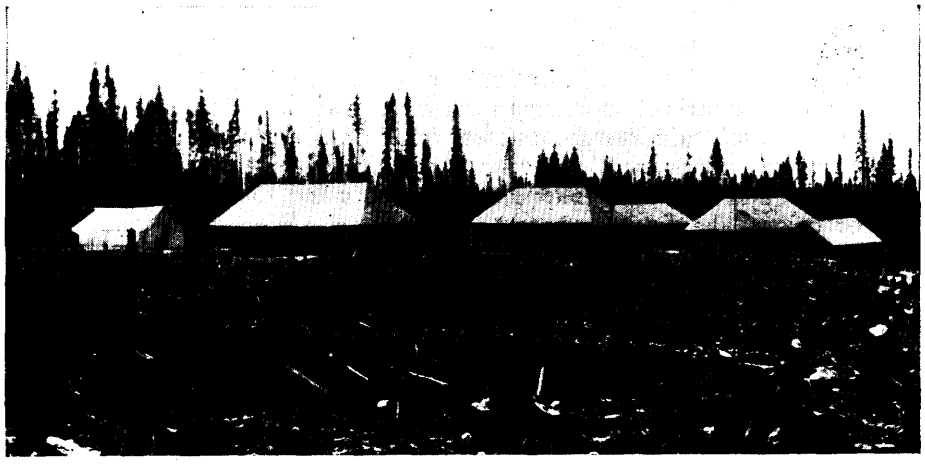


Key map showing the position of the Fort Hope gold area and of the routes leading to it. Scale, 70 miles to the inch.

transported by gasoline car three and a half miles eastward to the starting point on the Little Jackfish river, which is there crossed by a high steel trestle. After collecting equipment and supplies there, the party began the ascent of the stream on June 13 and arrived at Fort Hope on July 5, having examined the geology along the route from Little Jackfish bridge, more particularly as far as the junction of the Ogoki and Ottertail rivers. The period from July 5 to September 10 was occupied in making as complete a survey as the time allowed of the schist area which lies between Eabamet and Miminiska lakes and extends from the Albany river northward to the contact of the Keewatin schist with a granite area on the Cedar lake and Attawapiskat lake routes. Leaving Fort Hope on September 10, we returned by Portage river and the chain of lakes which lies to the west of the Opichuan river route from the Albany to the Ogoki

river and forms an alternative route of travel as far as Kagianagami lake. From the Ogoki southward to the railway we followed the usual route by way of the Ottertail, Kapikotongwa and Ombabika rivers to Ombabika station on the Canadian National railway.

The routes followed in going and returning furnish a double geological traverse of the country from the railway to the Albany river. The geological data obtained on these traverses have been separately mapped (map No. 38*b*-2) and will be described separately as forming a distinct area, which was dealt with in a more cursory manner than the Fort Hope field, where more complete areal mapping (map No. 38*b*-1) was attempted.



General view of buildings, Fort Hope mine, July, 1928.

Acknowledgments

The writer was assisted in the field by Andrew R. Graham, of the University of Toronto, and by W. T. Boyes and Neil D. Runnalls, of the Western University of Ontario, and would here express his indebtedness to these gentlemen for their willing assistance and interest in the work. The officers in charge of the Hudson's Bay Company's posts and that of Revillon Frères at Fort Hope, the Provincial Forestry Service at Sioux Lookout, C. R. Ferguson at the Fort Hope mine, and many others in lesser degree contributed greatly to the advancement of the work of the season, and their courtesy is gratefully acknowledged.

Previous Exploration

Our earliest accounts of the Albany river are derived from the records of the Hudson's Bay Company.[1] In 1671, the Jesuit Albanel made his way across to James bay from the Saguenay by way of Lake Mistassini and organized trade with the Indians in the valleys of the Nottaway and Rupert. The Hudson's Bay Company about the same time established themselves at Rupert House (Fort Charles) and Fort George on the east side of James bay.

In 1674, finding the trade with the hinterland east of the bay cut off by the French, Charles Bailey, Governor of Rupert's Land, made an exploration of the mouths of the Moose river and of the Albany (Chechouan or Schatawan)

[1]*See* references by A. P. Low, Geol. Surv. Can., Vol. III, pt. J, 1887-88, p. 9.

river. In the following year a post was established on Hays island at the mouth of the Moose and another at the mouth of the Albany. A short time later Albany became the head post and a depot was established at Charlton island.

In 1783, orders were issued to the Governor[1] "to penetrate into the country and draw down the Indians by fair and gentle means to trade with us"; but the English company's servants were not as yet equal to the French as *voyageurs*, and nothing further is heard of this plan.

In 1685, the French explorer Duluth built a trading fort at the outlet of Lake Nipigon, which was well placed to reach the Indians of the upper Albany valley to the north. The Moose and Albany posts were both taken in 1694 by Pierre le Moyne d'Iberville, who had arrived at the bay by way of the Ottawa river and Lake Abitibi with a force of 120 men. Fort Albany was renamed Fort Ste. Anne. It is said that the post was not a commercial success under the management of the French, but they at least undertook the exploration of the river, since the earliest known map was made by one G. Delisle in 1703. The river is called Rivière du Parray, and was apparently used as part of a route to Lake Winnipeg.[2] Fort Ste. Anne reverted to British control and to its former name in 1714, and in 1720 Henley House was founded 150 miles upstream and ten miles below The Forks, where the Albany and Kenogami join. It was built to contain a garrison of eight men "as a check to the Indians who carried on a trade with the French." It was reported in 1748 that it "did in some measure answer the purpose, but if they would build further in the country it would have a good effect."

During the next century the number of posts in the Albany region had increased to four, Albany Factory, Martins Falls, Osnaburgh, and Lac Seul, all placed at strategic points and supported by the trade of 1,100 Indians. Henley House had been abandoned before 1856, and a post on Miminiska lake called Gloucester House has also long been in ruins. Fort Hope was established about 1890 at the junction of the Albany with routes leading north to the Attawapiskat and Winisk rivers, and convenient to others leading southward to the Ogoki and Lake Nipigon. Before the construction of the National Transcontinental railway, it was cheaper to bring supplies to Fort Hope from Fort Albany than from the Canadian Pacific railway, but after the opening of the National Transcontinental the route from the railway by the Ombabika river was the most practicable and a number of Indians were employed as canoe-freighters on it. It has now been virtually superseded as a freight route to Fort Hope by the winter road from Tashota, with the result that many of the Indian freighters are now out of employment, though canoe-freighting still continues, especially to points north of Fort Hope. The Revillon Frères established a post at Fort Hope in 1912, soon after the opening of the National Transcontinental railway. A new Hudson's Bay outpost has been opened recently at Cedar lake, which lies 13 miles north of Miminiska lake and is reached from that point by ascending the Cedar river.

Within the last year the Department of Lands and Forests of Ontario has established an airplane base at Fort Hope for use in the forest protection service, and has installed a radio station equipped for both receiving and broadcasting, so that travel and communication to Eabamet lake are now easy and expeditious. Anglican and Roman Catholic missions and an Indian school have been established there for some time.

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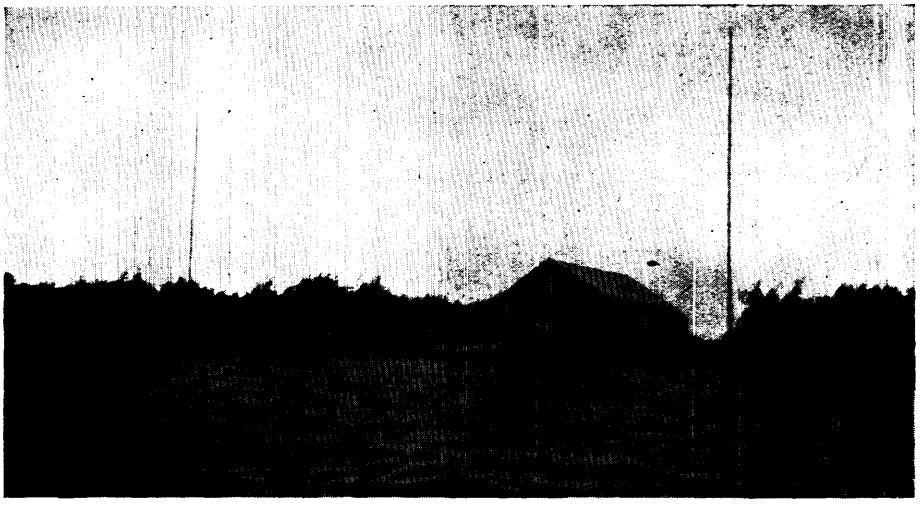
[1] *See* "The Great Company," by Beckles-Willson, and "The Remarkable History of the Hudson's Bay Company," by George Bryce, London, 1900, p. 489.

[2] A. W. G. Wilson, Geol. Surv. Can., Mem. 1, 1910, pp. 11-14.

Up to the period of the Confederation of the provinces of the Dominion, no maps of the region were available for the public. The first detailed published maps were those drawn from micrometer and compass surveys by the Geological Survey of Canada. The geological work done by the writer during the season of 1928 was largely over ground covered previously by Bell,[1] Dowling,[2] McInnes,[3] and others, of the Geological Survey. In 1871, Dr. Bell traversed the route from Lake Nipigon by way of the Ombabika river, Kagianagami lake and the Opichuan river to the Albany, which he followed downstream from its junction with the Opichuan at Abazotikichuan lake. In 1886,[4] he surveyed the Albany from Lake St. Joseph downstream to the Eabamet river, where he turned northward through Eabamet, Round, and Opikeigen (Rib)[5] lakes on the way to the Attawapiskat river. The country between the mouths of the Eabamet and



Radio station of the Ontario Forestry Service at Fort Hope.

Opichuan rivers was surveyed and geologically examined in that season by his assistant, John MacMillan, to connect the traverse of 1886 with that of 1871.

In 1898, D. B. Dowling traversed the Little Jackfish river for 15 miles from Lake Nipigon, and the Onaman (Vermilion) for a similar distance. He reports on the sand terraces which rise about a hundred feet above Lake Nipigon and are dissected by the lower courses of these rivers. He also mentions the occurrence on the Little Jackfish of "greenish gneisses and schists, similar to those of the Coutchiching series," referring no doubt to the rocks exposed on Zigzag lake.[6] In the year 1900, among the parties sent out by the Department of Crown Lands of Ontario there were two which explored parts of this territory or that immediately adjacent. Party No. 6, on which the geological observer was A. H. A. Robinson, followed the Ombabika river route from Lake Nipigon to the Albany by way of the Kapikotongwa, Ogoki, Kagianagami, and Opichuan

[1]Robt. Bell, Geol. Surv. Can., Rept. of Progress, 1871-72.
[2]D. B. Dowling, Geol Surv. Can., Sum. Rept., 1898.
[3]W. McInnes, Geol. Surv. Can., Sum. Repts., 1894, 1902; and Pub. No. 1080, 1909.
[4]Geol. Surv. Can., Vol. II, 1886.
[5]Called by Bell "Fishing lake" (op. cit.).
[6]D. B. Dowling, Geol. Surv. Can., Vol. XI, 1898, pp. 95-99A.

rivers. He gives a good account[1] of the rock exposures, soil, forest, and waterways of this route and of the Ogoki below French creek. F. J. Snelgrove,[2] geologist with party No. 7, gives information of interest with regard to rocks and lacustrine deposits on Whitewater, Highland, and Whiteclay lakes, which lie on the Ogoki above the mouth of Mojikit river.

In 1902, W. McInnes[3] examined the sand deposits around the north and west shores of Lake Nipigon and gives very good descriptions of the deposits on the Whitesand and Pikitigushi (Mud) rivers. W. A. Parks[4] in 1902 examined the country to the northeast of Lake Nipigon, including parts of the Onaman, Ombabika, and Little Jackfish rivers.

From 1903 to 1905, McInnes[5] explored the Winisk and Attawapiskat rivers, which he reached by way of the Albany and the route northward from Eabamet

Fort Hope mine, July, 1928, showing headframe behind the blacksmith shop. The incomplete boiler-house also contains hoist and compressors.

lake. He describes the physiographic features of the country and the fish, game, forests, soil, and climate.

In 1906, W. H. Collins[6] ascended the Wabinosh river from Lake Nipigon and examined a strip of country from Caribou lake westward along the line of the National Transcontinental railway survey. He describes a belt of hornblende and micaceous Keewatin schists which strike east-northeast from Caribou lake and "probably connect with a large area of the same age lying farther east."

W. J. Wilson made a general reconnaissance of the rivers in the parts of Algoma and Thunder Bay districts lying to the east of the route from Ombabika north; and his report,[7] published in 1909, is accompanied by a map[8] compiled by Wilson and Collins on which all the information acquired by previous explorers

[1]"Report of the Survey and Exploration of Northern Ontario, 1900," Dept. of Crown Lands, 1901, pp. 158-172.
[2]Ibid, p. 187.
[3]Geol. Surv. Can., Vol. XV, 1902-3, pp. 211-12A.
[4]Ibid, p. 213A.
[5]Report on a Part of the North West Territories of Canada Drained by the Winisk and Upper Attawapiskat Rivers, Geol. Surv. Can., Pub. No. 1080, 1909.
[6]Geol. Surv. Can., Sum. Rept., 1906, pp. 103, 105.
[7]Ibid, Pub. No. 980, 1909.
[8]No. 964.

in the area discussed in the present report was inserted. This map is the only one published up to the present which gives geological details of the Fort Hope area. A photographic reconnaissance of the area from the railway to the Albany river has since been made and is used as the base of the geological map of that region which is published with this report.

In 1919, the meridian that forms the boundary between the districts of Kenora and Thunder Bay was extended northward to and beyond Lake St. Joseph; and in 1926, the Ombabika river route was traversed as far as the Ogoki river, which was ascended as far as Waboose falls. In 1928, these two traverses were connected by a traverse down the Albany from Lake St. Joseph and up the Opichuan to the Ogoki. These surveys, made in each case with transit and stadia by J. S. Dobie, O.L.S. and D.L.S., have made it possible to

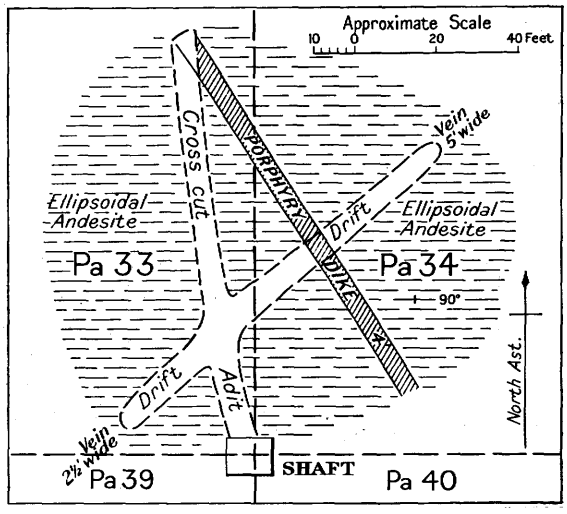


Diagram of workings at the 100-foot level, Fort Hope mine. The vertical shaft is sunk on the vein outcrop, which dips slightly to the northwest. The strike of the vein is 40 degrees. The width of the dike is 4 feet and the strike is 160 degrees.

correlate the present maps correctly with the general system of provincial surveys. The writer is also indebted to C. McLennan, of the staff of the Hydro-Electric Power Commission of Ontario, for surveys of the Little Jackfish river, Mojikit lake and river, and parts of the Ogoki river as far downstream as the Waboose falls, where they connect with Mr. Dobie's survey. The altitudes given in each of these traverses has supplied interesting data for correlating the levels of the post-glacial lakes which occupied part of the area.

Organized prospecting was undertaken in the area from Opikeigen lake westward by the Nipissing Mining Company of Cobalt in 1924 or 1925 without immediate result, except as to gaining a detailed knowledge of the country. In June, 1927, Lorne Howey, with a party which included W. Smith, I. McNeeley, A. Donovan, C. R. Ferguson, and C. Chellew, left Armstrong and travelling by way of Caribou lake, where some claims were staked, descended the Ogoki and reached Fort Hope on July 13. After examining the shores of Opikeigen lake they camped below the rapid at the outlet of Round lake on July 16. A

few days later they discovered the Fort Hope vein in greenstone schist which rises in a low rounded knoll above the surface of the muskeg about a mile and a quarter west by south from their camping place. Sixteen claims were at first staked, and to these a large number have since been added. Work on the development of the property was commenced on the first of February in the following year under the direction of C. R. Ferguson, and at the time of our visit in September, the shaft had been sunk more than a hundred feet. A station had been cut at the 100-foot level and some drifting done on the vein and on a porphyry dike which cuts it near the shaft. On the surface, values averaging about $20 a ton were reported over a width averaging 34½ inches for a length of 575 feet. The site of the mine is about 4½ miles northwest by north from Fort Hope, or rather more by the lake and a roadway cut from the shore to the camp. A number of other prospectors were attracted to the locality, and some further staking and preliminary work were done in the vicinity of Round lake, on Lily Pad creek, and on a creek which enters Opikeigen lake at its southwest corner.

Geology of the Routes from the Railway to the Albany River

The geological sequence observed on this route is briefly summarized in the following table:—

QUATERNARY		
	Recent:	Upper Lakes: Sand and silt deposited at low levels of the later stages of Lake Algonquin and Lake Ojibway.
		Lower Lakes: Coarse gravel and sand (earlier Lake Algonquin period) deposited at high levels on the south slope of the Hudson Bay–Lake Superior watershed.
	Pleistocene:	Boulder clay underlying the later lacustrine deposits but not as a general rule extending over the tops of high hills. Terminal and ground moraines.
		Great erosional unconformity
PRE-CAMBRIAN		
	Keweenawan:	Dikes and stocks of diabase intruding the older granites and schists.
		Intrusive unconformity
	Algoman or Laurentian:	Granite and gneiss, the latter undoubtedly largely formed by granitoid injection into older schists.
		Intrusive unconformity
	Keewatin:	Younger sediments, which occur on the Ombabika route and the Albany river.
		Older lavas, mainly rhyolite and ellipsoidal andesite, much of it altered to schist.

Pleistocene and Recent

At Jackfish bridge, about a mile from the north end of Ombabika bay, the Little Jackfish river emerges from a ravine about 90 feet deep which is cut in a post-Pleistocene terrace. The bottom of the ravine is excavated for about 20 feet or more in a blue sandy silt. The upper part of the banks is more sandy. In the bottom, boulder clay is exposed. Immediately east of the bridge a rock outcrop rises above the whole deposit, marking its eastern edge. The sand terrace extends westward as far as Ferland station, about 3½ miles, and is bounded by high rocky hills immediately beyond that point. The valley between is filled with a level-topped sand deposit, through which the Little

Jackfish river and Seymour creek have cut valleys several miles long, indicating that the greatest extent of the deposit lies from north to south. Northward from Little Jackfish bridge the valley is distinctly a young one which has not yet reached its greatest depth. It has cut through the loose deposits of sand above the clay-silt below, and in some places has reached the higher parts of the till beneath the clay-silt. The tops of the boulder-clay ridges at present act as obstructions in the stream, producing short rapids with boulder-paved bottoms. Between are rather quiet reaches of river with steep banks of silt or sand rising directly from the water, without any intervening flood plains, to a height of over a hundred feet. It is evident that the addition to the present small stream of a volume as great as that of the Ogoki river, as proposed (4,000 second-

Waboose falls, Ogoki river, June, 1928. The descent is 24 feet over granite rocks. The larger channel of the river and falls is behind the island on the left of the picture.

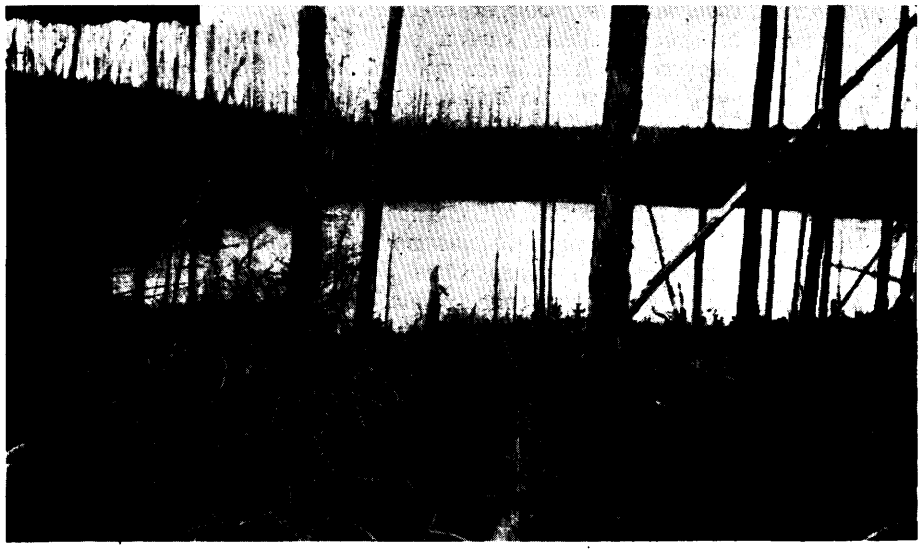
feet), would drown out the present obstructions, greatly increase the velocity of the current, and produce a very rapid widening and deepening of the present narrow V-shaped valley, discharging a great amount of sediment, mainly sand, into Ombabika bay. To what extent this could be prevented, if necessary, by the construction of a dam or dams is a matter for investigation by hydraulic engineers.

The sand and silt deposits represent sedimentation in a post-glacial lake. The silt which lies at the bottom was deposited in deeper water, and the sand was deposited in shallower waters at a later time. Ferland is 967 feet above sea-level, 119 feet above Ombabika bay, and 365 feet above Lake Superior. This 967-foot level no doubt represents the top of the deposits in Lake Algonquin at a stage during its retirement from the height of land between Lake Superior and Hudson bay. At a point on the Little Jackfish about three miles north of the railway, where the altitude of the river is approximately 880 feet, the level of the top of the upper terrace or surface of the sand plain is 100 feet above the river, or 980 feet, with an intervening terrace at 940 feet. Farther north the sand deposit becomes thinner, the banks recede, and low granite outcrops appear above the drift just south of the first lake, which has an altitude of 968 feet. On

the west side a muskeg borders the lake; behind this a granite ridge rises to a height of perhaps 50 feet. On the next three lakes, which lie at levels of 969, 993, and 1,004 feet, respectively, the drift deposits are mainly morainic, but a thin covering of sand or gravel appears in places. On Zigzag lake (1,016 feet), the shores are largely covered with till, which in one place takes the form of a pronounced ridge, which extends some distance in an east-northeast direction from the east side of the lake. Overlying the till on both Zigzag and Crescent lakes, there are deposits of sand and gravel. Of these the largest lies on the west side of Zigzag lake just north of some old Indian houses at the western extremity of the west bend. This is a coarse deposit, apparently laid down in water near an ice-front. The height of its level top is 135 feet above the lake or 1,151 feet above sea-level. Other hills around, especially on the west side of Crescent lake, appear to have similar flat-topped deposits on their summits. The upper part of the deposit consists of coarse sand and pebbles. Lower down the size of the stones increases to boulders, and there are some beds of pure sand. The deposit was probably derived directly from an ice-front, which here confined the waters of Lake Algonquin on the north. It is older than the deposit farther south and also older than the stratified deposit to the north, which was formed after the recession of the ice beyond the Lake Superior-Hudson Bay divide and the consequent lowering of the ice-dammed waters. As it is not seen anywhere under either of these deposits, it must have been partly removed by erosion before the later deposit to the south was formed and was never deposited on the north side of the watershed. Only the isolated remnants on the tops of hills near Zigzag lake remain. Probably the wave erosion of the lake waters, which sank as the ice-front retired, removed the rest and redeposited its finer parts at lower levels. Northward from Zigzag lake the superficial deposits are mainly boulder clay, which attains a considerable thickness around the south end of Moule lake (1,042 feet), where its summit reaches a height 30 feet above the level of Zigzag lake. Small deposits of sand appear in two places on the west side of the lake. The shores of Stork lake (1,048 feet) and South Summit lake (1,062 feet) show also a considerable amount of exposed till and little sand. From North Summit lake (1,053 feet) to Mojikit lake (1,060 feet) is largely marsh with a few outcrops of rock and occasional ridges of sand rising above the general level. On Mojikit lake the eastern shores are mainly till-covered, but several of the islands and some hills near the lake are of exposed rock. Near the mouth of the Mojikit river there is a fall of about 20 feet, but the upper part of the river flows through marshy levels.

The Ogoki from the mouth of Mojikit river eastward has banks of sand, which in part have been wind-drifted so that the surface bears a succession of small dunes. Occasional outcrops of gneiss are seen at the rapids. The sand deposits increase in thickness below Waboose falls, where they are exposed in a cut-bank to a height of about 60 feet above the river. The upper surface is here nearly level with the summit of the divide at North Summit lake. From this point eastward the deposits change to white silt and clay. At the next rapid, which has a fall of about 7 feet, boulder clay is exposed beneath the white silt and clay. Occasionally, boulders were noted in the stratified clays that overlie the till. Toward the mouth of the Ottertail river the banks become low, and there is much marshy country on both sides as far as French creek, where the route leaves the Ogoki and passes by a portage to the Kagianagami waters. Mahamo lake is surrounded by high hills of gneiss, but the course of the creek from Mahamo lake to Kagianagami lake passes through extensive marshy flats with sandy ridges emerging here and there. A terminal moraine runs

northward from Kagianagami lake. Many ridges of drift with kettle lakes between are to be seen, especially on the route northward from the west bay of Kagianagami lake, and it is probable that an ice-front once remained for some time in this locality, but the general direction of the morainic deposits could not be determined for a sufficient distance to prove its general trend.



Terminal moraine topography on the divide between the Opichuan river and Kagianagami lake waters on the route from the Portage river to Kagianagami lake.

The ridges observed where it was crossed on the route from Portage river to Kagianagami lake run northeast and southwest. They may mark the northwestern limit of the waters of Lake Ojibway, to whose former existence the sand and clay deposits of the Ogoki river are attributed.[1]

The Pleistocene and post-Pleistocene deposits of the Albany valley will be separately considered.

PRE-CAMBRIAN

Keewatin

On the Little Jackfish route a ban of altered meta-igneous rocks crosses the southern end of Zigzag lake and is also found exposed on Crescent lake immediately to the west. The first outcrops of Keewatin rocks are seen on entering Zigzag lake from the south and consist of schistose ellipsoidal lavas. Farther northward the shores are covered with till, which is partly overlain by light beds of sand and gravel; but where the lake turns westward, the southern shore is occupied by a hill of Keewatin greenstone. On the northern side, the rock is a fine-grained gneiss, which extends east and west parallel to the greenstone and is about half a mile in width. This rock, the strike of which agrees nearly with that of the greenstone and shows a marked divergence from that of the coarse intrusive gneiss immediately north, is, therefore, taken to be a member of the

[1]A. P. Coleman, Lake Ojibway, Last of the Great Glacial Lakes, Ont. Bur. Mines, Vol. XVIII, pt. 1, pp. 284-93.

Keewatin formation or a formation closely associated with it in age. In the field it appears as a fine-grained biotite gneiss, weathering yellow from oxidation of iron. Microscopically it is found to consist of old, much-weathered orthoclase with idiomorphic biotite in parallel agreement. Younger than these are fresh unaltered microline and large optically continuous areas of muscovite embracing the biotite and feldspar. Some old quartzes are present, having crystal outlines in one observed case, and also younger interstitial quartzes. This would appear to be a mashed and recrystallized quartz porphyry older than the surrounding granites. It also appears to have been included in the same orogenic movement which has rendered schistose the adjacent greenstones. Inclusions of it are also found on Moule lake embedded in the later coarse-grained granite gneiss. The folding of the effusives and older granite or quartz porphyry is, therefore, probably to be assigned to a post-Timiskaming age, and the original granite magma, if such it was, from which the finer grained gneiss was derived, may have been Laurentian, although it was not impossibly a felsite or rhyolite porphyry of the same age as the greenstones (Keewatin). The later granite might then be Laurentian. The greenstone formation of Zigzag and Crescent lakes shows ellipsoidal structure in several places, and in one case an obscurely agglomeratic or otherwise fragmental appearance was noted. It has been strongly sheared, so that the ellipsoids are much elongated and narrow and the sharp angular outlines of apparently fragmental parts modified to lenticular forms. The whole has been rendered schistose or gneissic. The prevalent petrographic type is andesite or quartz andesite consisting of green hornblende, andesine, and quartz. In some cases the hornblende occurs in coarse aggregates enclosed in a felty network of feldspar laths, and the rock then presents an ophitic appearance. The greenstones are intruded in several places by dikes of diabase. On the west side of Crescent lake, near a large diabase dike that intrudes the schist, a rusty-weathering mineralized zone parallel to the schistosity was observed. Samples of this on assay yielded a low value in gold.

On the route northward from Ombabika station a somewhat similar but much wider belt of Keewatin rocks is encountered at Toronto lake and apparently extends underneath the drift deposits beyond Summit lake. The northernmost exposure observed was at a fall on the Powitik river near its confluence with the Kapikotongwa. Here the rock appears to be meta-sedimentary injected with granitoid apophyses parallel to the bedding. The bedding is well defined, and the rock is probably greywacké, or greyish quartzite in some beds. This section was not closely examined, but it may be an easterly extension of the belt that crosses the Little Jackfish route at Zigzag lake, as suggested on the accompanying map; it may also be continuous as far west as the Pikitigushi[1] river and beyond toward Caribou lake, where similar measures are known to exist.[2] Another belt of greenstone with some sediment is encountered near the Albany river and will be considered later.

Laurentian and Algoman

As already stated the fine-grained gneiss of Zigzag lake may be altered granite or quartz porphyry of any age older than the coarser gneiss adjacent; it is, therefore, possibly Laurentian, but may represent a still earlier Keewatin rhyolitic effusive. A few inclusions of this material were observed in the later granite. The granite ranges from massive red granular types, through ortho-gneissic types due to flowage of the magma, to hybrid types formed by injection

[1] W. McInnes, Geol. Surv. Can., Vol. XV, 1902-3, p. 212A.
[2] W. H. Collins, Geol. Surv. Can., Sum. Repts., 1906, 1907.

of the granite along the planes of schistosity of older rocks or separation of parallel slabs by a stoping action and their inclusion in the gneiss, often with very slight changes of orientation. In this process they have often undergone partial assimilation, injection, and recrystallization. In the southern part of the Little Jackfish route, which appears to be entirely underlain by granite, an outcrop occurs at the railway a short distance east of Little Jackfish bridge; the next outcrop is seen as the first lake to the north is approached. The general colour here is a light-pink, but a grey variety is found at Zigzag lake. What difference in age there may be between the red and grey types, if any, was not determined there.

North from Zigzag lake the underlying rocks are largely granite and gneiss until the Albany river is approached. On Moule lake a porphyritic phase of the coarse granitoid gneiss is exposed, in which there are phenocrysts as much as two inches in diameter. The country bordering Mojikit lake and river and the Ogoki river as far as French creek[1] is almost completely covered by swamps or sands of recent origin or by the underlying Pleistocene till, but where outcrops of rock occur at rapids they are all of granite or gneiss with the exception of a few basic intrusives of Keweenawan age. On the Ogoki river below the mouth of Mojikit river gneissic outcrops occur at several rapids and falls, and the complex or hybrid nature of these rocks is well illustrated. The rock generally consists of older gneissic or schistose constituents injected by younger granite or included in it. A somewhat uniform granitoid gneiss appears at Waboose falls. It consists, in order of abundance, of pink, non-striated feldspar, much kaolinized; younger microcline, quartz, hornblende, and a little oligoclase. Below Waboose falls the granite has a more or less gneissoid and porphyritic character. At the 3-foot rapid a mile and half above Ogoki (Island) falls a garnetiferous gneiss was seen, possibly meta-sedimentary material further altered by intralaminar injection. At Ogoki falls an older gneissoid member of the complex can be distinguished which is dark-grey in colour and composed of biotite, hornblende, microcline, orthoclase, and plagiclase near oligoclase-andesine, and interstitial quartz. The hornblende has been in part altered to augite. The minerals are mentioned in their order of crystallization. The younger part of the complex appears to be an ordinary acid granite of a pink colour, injected into the older grey gneiss in small amounts. Below this, toward the junction of the Ottertail river, the newer red granite appears penetrating the older grey type in larger amounts and is in general of a porphyritic facies. One section examined consists, in order of age, of oligoclase, orthoclase, microcline, and much quartz, with a very little biotite—practically an alaskite. Accessory pyrite, apatite, and spinel are present. At the junction of the Ogoki and Ottertail rivers there is a rusty fine-grained gneiss, consisting of red, iron-stained biotite, a little orthoclase, and younger microcline and quartz with included bubble-chains. There is accessory apatite and pyrite. Garnet, probably secondary, also occurs. The granite, which is injected into the gneiss, also contains garnets.

From the Ogoki river the route lies through French creek, French lake, and Mahamo lake. The granite-gneiss complex is exposed on the portage from French lake and throughout the length of Mahamo lake. The Kagianagami creek from Mahamo to Kagianagami lake crosses a deposit of sand and marsh with occasional exposures of till in higher hills. At Kagianagami lake the granitoid complex appears again, covered in part by till. Down the Opichuan river,

[1]Also referred to by Robinson as French channel, "Report of the Survey and Exploration of Northern Ontario, 1900," Dept. of Crown Lands, 1901.

the granite becomes more massive and less gneissoid, and the inclusions of gneiss become fewer and smaller. On the Portage river route, from Kagianagami lake to the bay of the Albany river which forms the northern end of the route, the rocks exposed where heavy drift or muskeg does not prevail are all of the granitic or gneissic types. On this bay of the Albany, a band of greenstone schist is exposed which is almost certainly an extension of the Keewatin belt of Petawanga lake and will be described as part of it.

On the Portage river route at the south end of Big Whitefish lake, a hybrid gneiss occurs in which the older element is quartz diorite, composed of hornblende in large equidimensional grains, acid andesine, and a little quartz with accessory sphene and magnetite. Farther north a body of white pegmatite contains included masses of amphibolite much like some found on Eabamet lake. The granite on the Portage bay of the Albany is a grey type in contradistinction to the newer elements of the complex, found farther south, which are light-red.

On the route by way of the Ottertail river from the Albany to Ombabika station, gneiss and granite were observed in comparatively few places, but appear to be mainly of the hybrid character found farther west. The rock is largely covered with drift, principally boulder clay and sand. Some parts of this country suggest good farming possibilities. The same is true of the route from the Portage river to Kagianagami lake.

Structure of the Gneisses

The strikes and dips observed on the routes between the Albany and the railway vary considerably and are too much confined to narrow belts on each side of the route followed to permit of a complete analysis of the structure of the area. The normal strike of the gneiss is east-west or northeast-southwest. The strike varies considerably near the contact of the Keewatin schist synclines, which traverse it in a general east-west direction. A few instances of almost north-south strikes were observed on the Portage river. The least common direction is northwest-southeast. The topography of the country as indicated by water contours involves a predominant but not exclusive control by the northeast-southwest or Appalachian system of folding. In some places the system that parallels the Cordilleran ranges is also in evidence. The east-west and north-south folds and faults are probably due to interaction of the two major systems of stress, and ought normally to result in plunging types of structure whose axes pitch toward or away from the point of interaction. The Keewatin synclinal band that extends from Zigzag lake to the Ombabika river route appears to meet these conditions as it widens, and presumably pitches east.

Keweenawan

Penetrating both the Keewatin and the batholithic complex, a number of dikes and stocks of diabase occur between Lake Nipigon and the Ogoki river. Beyond this none was observed before reaching the Albany river.

On the west side of Crescent lake toward the south end a dike about 100 feet wide cuts the Keewatin schists, on a bearing of 170 degrees. It is a medium-grained diabase containing labradorite laths (Ab 47 per cent., An 53 per cent.) in a latticed intergrowth or, in some cases, in cruciform twins with interstitial augite and a little micropegmatite younger than the augite. The only accessory seen was magnetite in small amounts. The large dike is crossed perpendicularly by shrinkage cracks which terminate at its walls and are in some cases a few inches wide in the centre. These cracks are occupied by a quartz andesite, consisting of andesine (Ab 60 per cent., An 40 per cent.) and quartz,

which together constitute 95 per cent. of the rock, and are traversed by occasional laths of hornblende. This may represent a late phase of the same magma that produced the dike. In that case it is related to the diabase in the same way as aplite to granite, being considerably more acid and not as coarse in texture. Immediately adjacent to this dike there are mineralized zones in the schist, which here strikes nearly at right angles to the dike. These are marked by oxidation of iron on the surface. Examination shows that there has been a considerable injection of quartz with dissemination of pyrite and chalcopyrite. An assay of a sample collected by the writer from one of these zones yielded 40 cents in gold per ton. The dike cuts these mineralized zones and is therefore probably younger, though the juxtaposition of the two suggests at first sight a genetic relationship.

On the east side of Moule lake, toward the north end, is a large hill of diabase. At the south end of the exposure the material is fine-grained, but the main mass is of a medium diabasic texture. Under the microscope it is seen to be porphyritic, due to the presence of large laths of labradorite (Ab 46 per cent., An 54 per cent.). The groundmass consists of labradorite laths ophitically arranged in much larger individuals or aggregations of augite or aegirite-augite, exhibiting a "lustre mottled" effect. These are enclosed by a network of more densely packed feldspars with interstitial pyroxene and iron ore. The fine-grained type is a hyaline or sub-hyaline phase of the coarser part and contains cruciform twins of labradorite and some grains of serpentine, which are probably derived from olivine.

Other dark rocks that have the same relationships as to age are seen at the north end of South Summit lake and between North Summit lake and Mojikit lake. On Mojikit river also exposures occur at two places. The northernmost is at the Mojikit rapids near the junction of the creek with the Ogoki river. Under the microscope a sample of rock from this exposure presents a porphyritic appearance and shows an ophitic arrangement of stout feldspar laths (labradorite, Ab 49 per cent., An 51 per cent.) with interstitial dark pyroxene and masses of magnetite.

Diorite Dikes

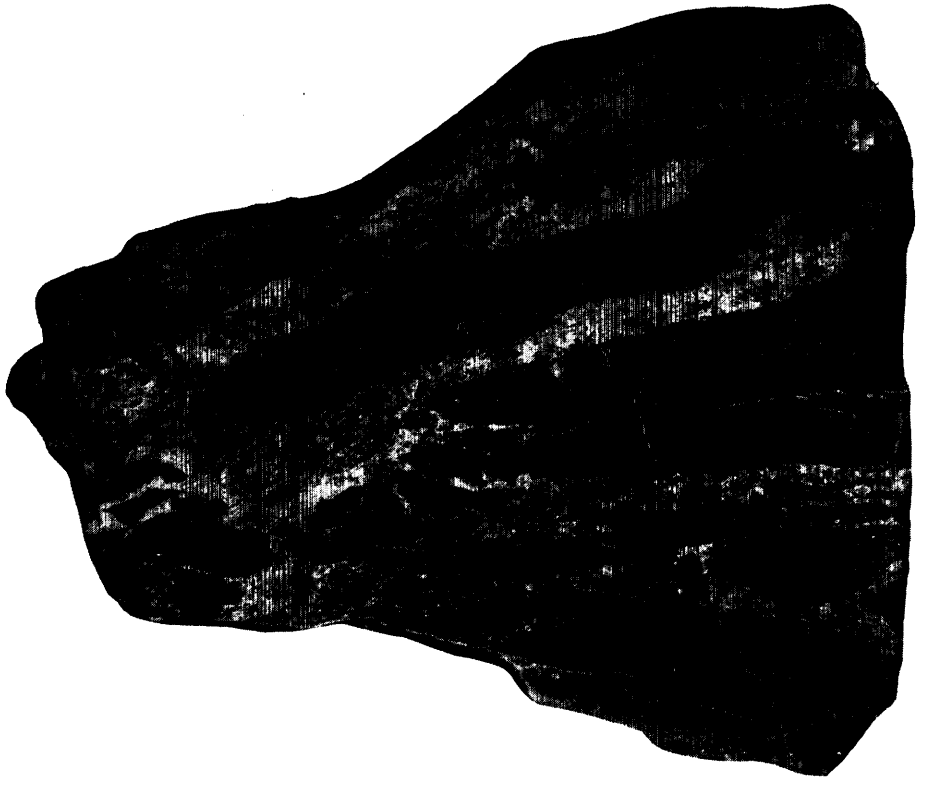
On the third lake on the Little Jackfish river, a basic dike cuts across the lamination of the gneiss in a direction roughly N. 60° E. Similar dikes of almost the same strike are seen on Zigzag lake and on an island in the northeastern part of Crescent lake. That on Crescent lake shows large hornblende aggregates as much as a quarter of an inch in diameter and is in reality an ophitic diorite. The feldspar is andesine (Ab 55 per cent., An 45 per cent.) in idiomorphic laths, which are imbedded in the hornblende aggregates around their margins and form felty meshes in the interstices between the hornblende. There are also crystals and lath-shaped aggregates of iron oxide, probably titaniferous, and occasional grains of pyrite. As it is possible that the feldspar is more basic than any measured in the section, the rock may be a hornblende diabase; but the accessory minerals as well as the hornblende agree rather with a dioritic facies.

Fort Hope Gold Area

Introduction

After our arrival at Fort Hope, attention was given first to the terrain immediately adjacent to the mining operations. A micrometer survey of Opikeigen (Rib) lake was undertaken, but this unfortunately could not be connected

with the traverse of Eabamet lake. The stream which enters Opikeigen lake from southwest was followed up nearly to its source, and the boundaries of the schist area were approximately determined in the vicinity of the ore occurrences. The shores of Opikeigen and Eabamet lakes were found to furnish fairly satisfactory sections of the Keewatin schists and granite complex. The route northward from Opikeigen lake was followed until the outcrop of the batholithic complex was reached on the north side of the schist area, but very little exposure of underlying rock occurs between that point and Opikeigen lake that might assist in determining accurately the northern boundary of the schist area.



Polished specimen (two-thirds natural size) of typical ore from the Fort Hope mine. The fragmented material is andesitic lava, now practically hornblende schist. The gold occurs mainly in the quartz.

A survey of the Albany river and its tributaries as far west as the eastern arm of Miminiska lake occupied the remainder of the time available for work in the Fort Hope area before returning for a brief second visit to the mine and some adjacent properties. Several days were occupied in following the route from the Albany to Kagianagami lake by way of the Portage river, and the geology of the rock exposures on the route was studied. We then proceeded from Kagianagami to the Ogoki and thence by the Ottertail, Kapikotongwa, Powitik, and Ombabika rivers to Ombabika station. Ten days longer might have been spent in the field to good advantage, but the unfortunate loss of some instruments on September 3 rendered this impracticable.

Work in the Fort Hope area was retarded considerably by the lack of detailed maps. It was necessary to make micrometer surveys of all parts out-

side of the routes mapped, on a very small scale (8 miles to 1 inch), by the Geological Survey, and these in part were also resurveyed in order to secure a more detailed mapping, particularly of Opikeigen lake. Photographic detail on a larger scale was available for the routes from Fort Hope south to the railway, which greatly facilitated the work. J. S. Dobie's survey of the Fort Hope Indian Reserve was a help in mapping the north side of Eabamet lake. Miminiska lake, having very strong local magnetic declinations, could not be mapped by micrometer and compass survey, and Mr. Dobie's traverse of that lake and of the Albany river in general was not then available in plotted form, although his pickets, which were still in place, rendered it possible to fix the positions of geological observations quite accurately. His traverse with some sketched data has been incorporated in the accompanying map (No. 38*b*-1) herewith and has afforded a valuable control for the photographic detail available in some other parts of the work. A track survey, with distances estimated, was used on the Cedar river, and pace and compass surveys on the portages of those routes where the micrometer and compass was employed for the navigable reaches.

Climate

Climatic data for Fort Hope and Martins Falls have been kept for nearly thirty years, from 1886 to 1914. The region is one which is especially subject to the passage of high-pressure areas (anticyclones), as it lies near the point where the paths of those from the south and those from the west or northwest converge. It is, therefore, an area of small precipitation and clear skies. Of the total annual precipitation of 16.04 inches, 11.18 falls in the form of rain, and 4.86 in the form of snow. June is the wettest month with 2.41 inches of rain, and 0.01 inches of snow. April is the driest with 0.32 inches, mainly snow. Though scanty, the precipitation is well distributed for the promotion of growth. From December to April there is less than one inch per month, the total for the five months being 3.32 inches. The remaining 12.72 inches are concentrated largely in the growing months, 8.79 inches or more than half the annual rainfall occurring in the four months from June to September, with an early summer maximum in June.

As a result of the prevailing high-pressure conditions, the temperature gradients are also low, and the temperature data available hold nearly true for a considerable part of the Albany valley east of Lake St. Joseph.

The summer season from June to August has a mean average daily temperature of 58.36 degrees, which is rather too low for wheat growing but permits, in most seasons, of the raising of good potatoes and such vegetables as radishes and lettuce. The climate may be fairly classed as extreme, ranging from records of 99 degrees above zero to 54 degrees below, a range of 153 degrees, if the absolute minimum and maximum temperatures are considered. The mean maximum and minimum temperatures are plus 73 degrees for July, and minus 19.6 degrees for January. The mean annual range is therefore 92.6 degrees. The mean annual temperature is undoubtedly low, about 28 degrees. Frost is recorded for every month in the year, and snow for all but July and August, but nevertheless in most seasons all the common garden vegetables are successfully grown, including vegetable marrow and potatoes, though Indian corn failed to fill out.[1]

Up to the present time the Indians have confined their agricultural efforts to potatoes. The country is also reported as favourable for cattle, which have been experimentally introduced at Martins Falls.

[1]W. McInnes, Geol. Surv. Can., Vol. XV, pt. AA, 1902-3, p. 10.

The accompanying table, kindly furnished by the Meteorological Service of Canada, may furnish data for further requirements.

CLIMATE OF THE FORT HOPE AREA

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual mean
TEMPERATURE (degrees F.):													
Mean daily	— 8.7	— 5.4	8.5	29.2	42.6	55.8	61.5	57.8	48	36	18.8	1.5	28.8
Mean daily maximum	2.2	6.8	22	41.3	54.7	68.8	73	69.2	58	44.2	26	11.4	
Mean daily minimum	—19.6	—17.5	— 5	17	30.5	42.9	50	46.4	38	27.9	11.6	— 8.4	
Extremes {High	38	42	55	80	87	95	93	99	89	83	56	42	
Extremes {Low	—54	—53	—49	—27	— 7	24	27	27	16	— 5	—38	—49	
PRECIPITATION (inches):													Mean annual total
Average	0.87	0.45	0.79	0.32	1.45	2.42	2.31	1.99	2.25	1.28	1.02	0.89	16.04
Average snowfall	8.7	4.5	7.9	3	2.4	.1	.....	.....	.6	3.2	9.3	8.9	48.6 (=4.86 inches rain)

Soil

The soil over a great part of the area is sandy. A peculiar white soil is found around Eabamet lake, which on analysis is classified as sandy clay loam or gravelly sandy loam. This soil appears to overlie the boulder clay. Its reaction is alkaline; the carbonate content abundant, but it is very low in organic matter, and consequently in nitrate. In other parts of the area, the upper sandy deposits are wanting, and boulder-clay forms the surface. At such places, notably in the valley of the Albany river and southward along the Portage river route, there is a timber growth of large size and the soil appears to be distinctly good. The only stratified clay seen during the summer was on the Ogoki river from below Waboose falls to French creek. This soil might be expected to yield the most satisfactory results of any of the three types. It also overlies the boulder clay. In general the sand silt and clay deposits are very flat and swampy where they are far from good drainage, such as exists along the banks of the rivers or lakes. Under these conditions their future use depends largely on the possibility of profitable drainage works. Narrow areas along the rivers and lakes may be of immediate use.

Timber

Owing to the swampy character of a large part of the country, the growth of spruce is mostly small and sparse. On the hilly parts and in the immediate vicinity of the main routes where the natural drainage is good, the timber is of good quality, especially where there is a heavy clay soil, as along the Albany between Triangular and Petawanga lakes. In this locality white spruce trees were seen with a diameter as great as a foot, and white birch trees were noted of 15 or 16 inches diameter. The clay country south of the Albany along the Portage river has also some well developed timber. Around Eabamet lake spruce is cut large enough to make boards up to 8 inches wide and square timber of about the same size. The following list includes the principal trees and larger shrubs observed:--

White birch (*Betula alta. var. papyrifera*)
Aspen (*Populus tremuloides*)
Balsam poplar (*Populus balsamifera*)
Birch alder (*Alnus incana*)
Rowan, small (*Pyrus americana*)
Several small species of willow
Black ash (*Fraxinus nigra*)
Wild cherry (*Prunus pennsylvanica*)
Black spruce (*Picea mariana*)
Balsam (*Picea canadensis*)
Tamarac (*Laryx laricina*)
Banksian pine (*Pinus banksiana*)
White cedar (*Thuja occidentalis*)
Raspberry (*Rubus strigosus*)
Blueberry (*Vaccinium pennsylvanicum*)
Labrador tea (*Ledum latifolium*)
Various other shrubs of the heath family.
Cranberry (*Vaccinium* sp. undet.)
Wild rose (probably *Rosa blanda* Ait.)

Burned areas of recent date were encountered along the canoe routes from the railway to the Opichuan river, and two recent fires, which were not of great extent, have occurred near Fort Hope. For the rest the timber appears in its natural condition without many recent burns throughout the area examined.

Fish and Game

The fish of the Albany river system are in general like those of adjoining waters to the south. Summit lake at the head of the Ombabika river discharges also northward by the Powitik river to the Kapikotongwa, and the passage of fish across the divide is quite possible at the present time. During the later stages of Lake Algonquin, whose waters actually crossed the height of land, the distribution of fish on both sides must have been unavoidable, if any fish existed in those waters at that time. The chief varieties noticed in the Albany and its tributaries near Fort Hope are:—

Sturgeon (*Acipenser lucius*)
Pickerel (*Stizostedion vitrium*)
Whitefish (*Coregonus clupeiformis*)
Sucker (*Catostomus catostomus*)
Brook trout (*Salmo fontinalis*)

The sturgeon are of good size, and the trout reach three or four pounds in weight.

No red deer (*Odocoileus virginianus borealis*) or caribou (*Rangifer caribou*) were seen by our party during the summer of 1928. It is probable that not many deer live in this region. Vast numbers of caribou formerly passed along Eabamet lake in their annual migrations. Moose (*Alces americanus*) were encountered in only one or two places. It is said that fisher (*Mustela pennantii*) are the most abundant fur-bearing animals taken by the Indians who trade at Fort Hope. Grouse (*Bonassa umbellus*) were scarce, and wild duck only moderately plentiful.

GENERAL GEOLOGY

Physiography

The area as a whole is a typical part of the Laurentian peneplain and lies on the gradual slope that extends from the divide near the north shore of Lake Superior to the coasts of Hudson and James bays. The rate of slope from the divide north of Lake Nipigon to the shore of James bay near Akimiski island, which is the steepest incline, is about 3.6 feet per mile. From the same point to Lake Superior at the mouth of the Nipigon river it is 4.16 feet. Locally the slopes near the summit are somewhat steeper. From the divide between the Little Jackfish and the Mojikit river headwaters, the slope, taken in a direct line to the Albany at the mouth of the Opichuan river, is 6.3 feet; southward to Ombabika bay at the head of Lake Nipigon, it is 13.26 feet per mile. Measuring along the courses of streams the slopes would be gentler than these, but it is also to be considered that the point on the divide where the measurement for elevation was taken is the lowest col along the watershed in that vicinity. The exceptional steepness of the slope to Lake Nipigon is not due to the very marked concavity of an erosional profile, but to the fact that the basin of the lake is a structural depression.

The Albany river in its passage across the area included in the accompanying map has a fall of 98 feet, which represents an average descent of 2 feet per mile, measuring in a straight line from point to point, but somewhat less along a traverse of the river. This descent is to a large extent concentrated at four points: the outlets of Miminiska, Petawanga, and Kawitoskamigamog lakes, and at Frenchman's rapid. The details are as follows:—

	Elevation	Descent
	feet	feet
Miminiska lake	951.4	.....
Rapid at outlet	.....	3.1
Above the fall below rapid	948.3	.....
Below the fall	938.3	10
Petawanga lake	919.5	18.8
Miminiska lake to Petawanga lake (total)	.....	31.9
Foot of rapid below Petawanga lake	898	21.5
Kawitoskamigamog lake	896	2
Rapid below	878	18
Triangular lake	877.1	.9
Above Frenchman's rapid	877.25	error in level
Below Frenchman's rapid	869.2	8.05
Expansion 1½ miles below rapid	860	9.2
Abazotikichuan lake	853	7
Total descent	.....	98.55
Correction	.15	
Total elevation	98.55	

As the volume of the river is comparable to that of the Ottawa, the amount of water power available within the area is more than ample for any immediate needs of the mining industry. Favourable sites for economic development appear to exist at the outlets of Miminiska and Petawanga lakes, and at Frenchman's rapid, all within a few miles of the present centre of mining operations. Between the rapids the river expands into lakes or lake-like reaches, each of several miles in length.

The surface throughout the area is very flat. This is especially true of the parts underlain by Keewatin schist, which are characterized by wide stretches of muskeg or sand plain, with occasional rocky ridges of no great height rising above the general level. It is to such low ridges that the prospector must look for accessible mineral outcroppings. In the granitic areas much of the surface is almost equally level and covered with muskeg or sand and gravel deposits. This would apply especially to that part of the gneiss which consists of a complex of schist and granite. In a few parts, hills of the more massive types of granite and gneiss reach a height of nearly 200 feet.

Lying upon this surface of low relief, which, apart from shallow sand and swamp deposits, represents the peneplanation of the pre-Cambrian terrain, there are a number of high drift hills or ridges, which reach altitudes as great apparently as 400 feet. They are by far the most prominent topographical features of the country and are visible for long distances from high points or from canoes on the larger lakes. One of these hills rises along the south side of Miminiska lake. The Albany river, a short distance from the point where it issues from the lake, has cut away part of one end of it, exposing a cliff about 80 or 100 feet in height. Viewed from a distance it appears to be partly morainic but is essentially a kame, covered on its upper surface with till about 20 feet in thickness. It shows no cliffs or outcrops of rock and is thickly wooded up to the summit. This hill is elongated in an east-west direction and is one of a series which are noted by Bell[1] as extending westward along the Albany to the junction of the Etowamani river, a distance of about 21 miles in a straight line. A drift ridge, possibly of similar character, forms an island 2 miles in length toward the east end of Kawitoskamigamog lake; an elongated island of sand and gravel

[1]Robt. Bell, Geol. Surv. Can., Rept. of Progress, 1886, pt. G, pp. 14-18.

in the eastern part of Petawanga lake has the same bearing along its main axis, about north-northeast. Similar ridges project through the muskeg in the vicinity of Spence lake.

At the north end of Opikeigen lake there are a series of east-west morainic ridges, and similar topography is seen on the Cedar river north of Miminiska lake near the contact of the granite and schist formations. These two occurrences of morainic ridges may be parts of a continuous series representing a temporary pause of the ice-front during its retreat. Farther north on the route from Opikeigen lake to Attawapiskat lake the country again becomes flat and marshy. The sand deposits east of Miminiska lake, north of Petawanga lake, on the shores of Opikeigen lake, and in the neighbourhood of Fort Hope are probably to be assigned to an outwash apron deposited in front of the ice-margin or possibly to a shallow lake which lay before it. Under the sands a thin sheet of till is in evidence here and there, and occasional thin beds of loam or clay.

South of the Albany river, the till is more in evidence than on the north side and, as one goes south, it gradually assumes again the character of a line of terminal moraine, which passes across the country to the north of Kagianagami lake. This is again followed on its south side by the water-laid sand and clay deposits ascribed to the western end of Lake Ojibway.

List of Glacial Striae

WABOOSE FALLS:

1. Older set, N. 12° E.
2. Later set, N. 41° E.

EABAMET LAKE:

1. Northwest arm, post No. 67, N. 81° E.
2. Snake point, N. 84° E.
3. Point west of entrance to Reserve (Indian) lake, N. 76° E.
4. Same point, lee-side facets, N. 56° E.
5. Island in bay at outlet of Reserve lake, N. 75° E.
6. Same point, lee-side facet, N. 37° E.

OPIKEIGEN LAKE:

1. Islet on southeast side of main beach, N. 60° E.
2. Shore on south side of main body, N. 72° E.
3. Narrows at north end of wide part, N. 77° E.
4. South shore, N. 62° E.

Considerable divergences are noticeable in this list, apart from the cases where two sets of striae were observed at the same point. As an example, Nos. 9 and 10 are within a very short distance of each other and probably represent two distinct sets. Compared with those at the point on Eabamet lake just west of the outlet of Reserve lake, they appear to represent the same two sets of straie:—

EABAMET LAKE	OPIKEIGEN LAKE
(No. 3) 76°	(No. 2) 72°
(No. 4) 56°	(No. 1) 60°

The other two readings on Opikeigen lake, 77 degrees and 62 degrees, are probably explainable in the same way. The difference between these and the two sets at Waboose falls is explained by the distance between the two localities, but appears, even so, to indicate a divergence from not very distant centres to the northeast. If we produce the earlier set at Waboose falls and Reserve lake toward the source of the ice, they converge at points within a few miles to the east and north of Eabamet lake. This is about the locality where Tyrrell has placed the locus of the gathering ground of his Patricia glacier.

Lines of Fracture

As elsewhere in the pre-Cambrian shield, the topography is affected in part by the differential erosion of rocks of different resistant powers, but there are also certain lines of shearing along which fractures, faults, and sheared, sheeted, and crushed zones are produced which form lines of erosional weakness and permit of the formation of topographical depressions, which are strikingly apparent on the map. In some cases these lines correspond with the strikes of metamorphic structures, such as schistosity, or of original bedding or contact lines, and they are then difficult to distinguish on the surface. In other instances they are markedly transverse to such structures, and must always be assigned to a time subsequent to these structures.

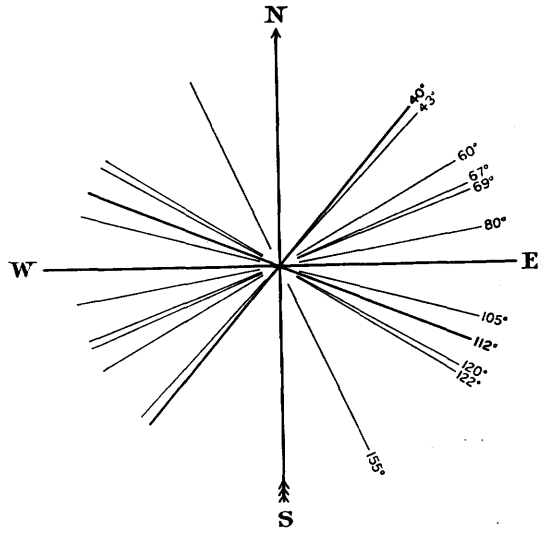


Diagram of lines of fracture in the Fort Hope area. The heavy lines at 40 degrees and 112 degrees indicate two similar readings.

The topographic lines due to such structural lines of weakness lie in two general directions, northeast to southwest and northwest to southeast. These two directions correspond to the two principal lines of folding on the continent, which are represented by its two major mountain systems, the Appalachian and the Cordilleran or Rocky Mountain system. They correspond also to the main directions of the infolded parts of much older mountain systems, which in the form of separated synclinal remnants are embedded in the granite or gneiss and constitute the greater part of the Keewatin and Timiskaming formations of Northern Ontario. There are also intermediate lines of structure due to the interplay of the two principal systems and curvilinear structures connecting the two main types. Within the Fort Hope area as elsewhere, such lines of structural weakness play an important part in the topography. The structure of the Keewatin infolds, shaped like a Y with northeast and southeast branches, represents in its strike one of the oldest periods of strain of which there is any remaining record. Other lines of weakness which cut across these structures must be of later date. The following list, which is also summarized in the accompanying figure, shows that the lines of strain fall into definite groups which can be accordingly assigned to distinct periods.

TABLE OF LINES OF FRACTURE AND OF EROSIONAL WEAKNESS

I.	Northwest-southeast lines:		
1.	(a)	Albany river, Portage bay, and eastward	105°
		Eabamet lake, main traverse	112°
		Kenozhe lake, main axis	112°
	(b)	Albany river, Triangular lake, and southeastward	120°
		Albany river from Abazotikichuan lake northwestward	122°
2.	(c)	Eabamet lake, northwest traverse, including Round lake and transverse bays of Opikeigen lake and Keweenawan dikes	155°
		Average	121°
II.	Northeast-southwest lines:		
1.		Abazotikichuan lake, southwest arm	40°
		Bay and river entering Albany river below Frenchman's rapid	40°
		Petawanga lake, north bay; Spence lake, creek, and Opikeigen lake; Fort Hope gold vein	43°
2.		Lake Kawitoskamigamog and bay of Eabamet lake opposite Fort Hope	60°
		Lake and canoe route northeast from Eabamet lake	67°
		Reserve lake and parallel reaches of the Albany	68°
3.		Rich lake chain and bays of Miminiska lake	80°
		Average	57°

It will easily be apparent that the fracture lines which have a northwest-southeast direction fall into two groups: The first vary from 105 to 122 degrees, with an average of about 114 degrees. They represent the strike of the folded lavas and sediments and of the gneissoid or schistose structures that apparently date from about the same age and belong to the northeast direction. The second set is represented by only one marked topographic depression but corresponds also with the strike of the dikes of diabase and quartz porphyry, which are taken to be of Keweenawan age. Its direction is from + 155° to + 160° east of north. Its marked divergence from the rest of the group agrees well with the undoubtedly great difference in time between the two sets of fractures.

The northeast-southwest lines also fall into two main groups, with a tendency to subordinate grouping in the older of the two sets. Here again the older group lies nearer to an east-west direction than the younger, and in each case the younger lies more nearly parallel to the existing mountain systems of the continent. The older group varies from 60 to 80 degrees, the greater number of lines being not far from 70 degrees, the divergencies being due to local conditions or to differences in direction of stresses at different times. This group in some instances represents the direction of contacts and the strike of schists or gneisses, especially in the region around the west end of Petawanga lake, Miminiska lake, and the country immediately north and east of it, where the northern fork of the schists trends to the northeast. The general direction here is nearly 80 degrees. Eastward as far as Opikeigen lake this band curves to the south of east and the strikes follow the line of the main reach of Eabamet lake, which is 112 degrees. As far as the folded structures are concerned, therefore, the area belongs predominantly to the northwest-southeast type, but it is everywhere crossed by lines of faulting of the older part of the northeast-southwest element, to which the directions of several lakes and river reaches owe their origin. They cut across the areal structure and are therefore of later date; they vary from 60 to 80 degrees. The younger set of the northeast-southwest lines of fracture also cuts across the bands of Keewatin rocks and the intervening granite areas. Its direction is in the neighbourhood of 40 degrees, and this corresponds with the direction of observed quartz veins and of the auriferous fracture zone of the Fort Hope mine. It is, therefore, younger than the structures which it traverses, though not later than all the observed fracture lines. A quartz vein near the mouth of the Reserve Lake river was observed to be

faulted by a shear zone in the diorite, which has a bearing of 100 degrees. The vein at Fort Hope mine was not observed to be faulted greatly, but is cut by quartz porphyry dikes of the Keweenawan period, which have a bearing of about 160 degrees. It is, therefore, older than the Keweenawan, and if it is of the same age as parallel-lying topographical elements, must also be younger than the older granite if not younger than the whole granite complex. If the gold-bearing quartz is genetically attributable to the younger granite intrusions, as is commonly found to be the case throughout Northern Ontario, the 40-degree fracture lines would be referred to the Algoman period.

We have, therefore, in this area topographically and structurally observable shear planes, whose horizontal traces are of northeast-southwest or northwest-southeast strike, belonging to the following periods:—

(1) Laurentian, mainly northwest-southeast, 112°-120°
(2) Laurentian, mainly northeast-southwest, 80°
(3) Post-Laurentian, mainly northeast-southwest, 60°-70°
(4) Algoman, mainly northeast-southwest, 40°-43°
(5) Post-Algoman, mainly northwest-southeast, 100°
(6) Keweenawan, mainly northwest-southeast, 155°-160°

A study of such lines of fracture or weakness is of interest from the point of view of practical mineral discovery, and is also of value as a collateral aid to the determination of the relative ages of various intrusions and earth movements.

Keewatin

Areal Distribution

A series of very ancient schists and gneisses, the oldest rocks in the region, was first described by Bell[1] in 1886 as extending along the valley of the Albany eastward from a point two and a half miles east of the Shabuskwia river junction to the eastern end of Petawanga lake, and again from below the Portage river to Abazotikichuan lake at the mouth of the Opichuan river. Recently reports indicate that similar rocks are found farther east on the Albany. The western boundary, as shown on the map compiled by Collins and Wilson, lies nearly as far west as the Etowamami river. East of the Opichuan river similar rocks are reported on the shores of Makokibatan and Washi lakes, which are expansions of the Albany. On the route northward from Eabamet lake to Attawapiskat (Lansdowne) lake, another band of these rocks was noted commencing at the northwest end of Eabamet lake. Its northern edge is obscured by drift but lies somewhere within three miles of the north end of Opikeigan lake.

The work of the writer during the summer of 1928 included a somewhat more detailed examination of these rocks from the eastern part of Miminiska lake to the mouth of the Opichuan river, which enters the Albany at the expansion known as Abazotikichuan lake. The contacts of the schist with granite of younger age were observed on several of the tributary streams, and while the resulting map is more conjectural in the location of its boundaries than is altogether desirable, it is believed to be substantially correct. The large area of schist which surrounds Miminiska lake appears to divide into two branches to the east. The larger branch extends east by north from Miminiska lake and passes to the north of Eabamet lake with a width of over ten miles. A narrower branch extends south of east along Petawanga lake. From the east end of Petawanga it apparently leaves the river lying to the south of it and crosses the bay into which the Portage river enters; it broadens to the east, where it again crosses the Albany with a width of about five miles. It was not traced eastward beyond the Opichuan river.

[1]Robt. Bell, Geol. Surv. Can., Vol. II, pt. G, 1886, pp. 14-18.

Structure

The schists are in most parts so completely metamorphosed that the original bedding is not easily distinguishable. Here and there, however, banded colorations or other indications of the original structure remain, and in the larger structural units, such as lava flows, the distinct types of lava are so related to each other as to indicate the secondary structural changes which have taken place since their original deposition. As usual throughout the country, the bands of schist appear to be synclinal in structure. Along the granite contacts there are wide belts of the Keewatin which show granitoid injection, silicification, and probably a considerable amount of recrystallization of the original minerals of the schist. The gneisses thus produced consist preponderantly of the materials of the schist and are therefore mapped with the schist in the accompanying map. The principal example of this is the area bordering the north shore of Eabamet lake as far east as Reserve lake, which was mapped by earlier explorers as Laurentian gneiss. The older gneiss is an orthogneiss in which the parallelism of the micas is due to movement prior to final solidification. It is mapped with the batholitic intrusives.

Stratigraphic Succession and Petrology

In all cases where sections have been followed across the schists from north to south, the marginal members of the bands are found to consist of hornblendic rocks, including andesite, andesite gneiss, a coarse variety of amphibolite containing a little andesine, and ophitic diorite. Higher in the series rhyolitic flows occur, some of which, as on Opikeigen lake near its southwestern end, show brecciation at the margin. On Miminiska lake there is a coarse-grained sill of syenite which is a later intrusion. Still higher in the series on the same lake, where the widest extension of the schist area is seen, there is a considerable thickness of iron formation, consisting for the most part of hematite and magnetite in unusually thick bands with siliceous bands correspondingly thick. The ore is rendered fissile by the development of glaucophane needles lying in different directions in the plane of schistosity. Yet higher there is apparently a considerable thickness of sericitic schists, which are in part indeterminate as to origin, but probably represent sediments or sediments and rhyolitic lavas. On Eabamet lake the upper schists are partly sericitic and partly biotitic, and where they are in contact with granite there is a considerable development of red garnet and in some places of staurolite.

The following are more detailed descriptions of the rock sections seen on Miminiska, Petawanga, Eabamet, and Opikeigen lakes, and on the Albany river near Frenchman's rapid. In the last case the observed data are scanty, but in one or two cases important.

Frenchman's Rapid Area

As already stated the southern fork of the schist extends along the basin occupied by Petawanga lake and, leaving the Albany at the east end of the lake, is continued to the south of the river, crossing the bay which forms the mouth of the Portage river. Here the greenstone schists are first seen at the point where the general direction of the narrow bay changes from west-northwest to southwest. A mile farther on, where the bay becomes wider toward its head, a grey granite succeeds the schist. Down the Albany the schists appear again on the shores before the lake expansion above Frenchman's rapid is reached. At the lower end of the main part of the rapid the hornblendic schists give way

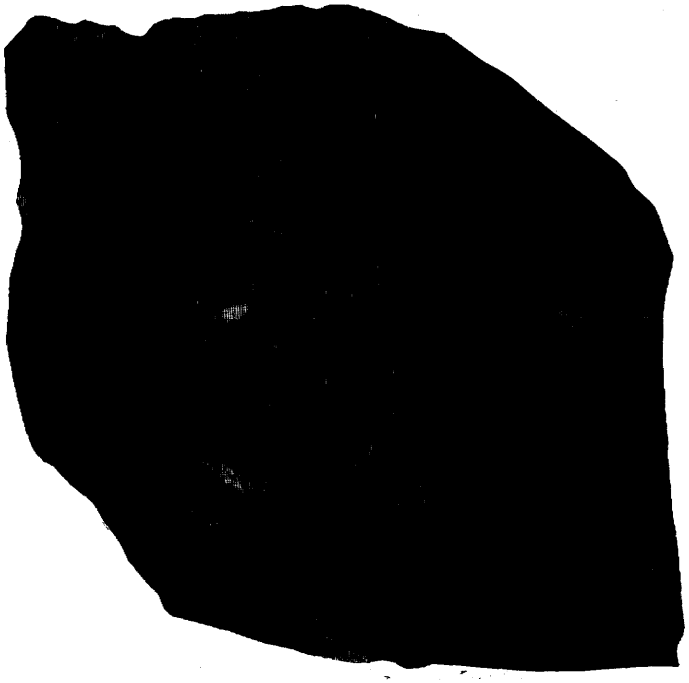
to grey banded schist with large dark inclusions, which appear to be flattened pebbles of the darker schists. They are distinctly different in colour from the matrix in which they occur, and for that reason the rock was taken to be a sheared conglomerate rather than an agglomerate. Time was not taken for the collection of specimens or extended examination. The rock is mapped as an upper sedimentary formation infolded in the lower andesitic lavas. South from Abazotikichuan lake toward the Opichuan river route the rocks are andesitic, but along the south shore of the lake a coarse ophitically developed diorite occurs much like some that were seen on the north side of Eabamet lake. The rock under the microscope reveals a high percentage of idiomorphic hornblende crystals which are largely bleached with separation of magnetite, though in parts green hornblende masses occur which appear to be secondary and include

Injection gneiss of the contact zone between schists and granite occurs on the island at the east point of the bay in the western part of the Indian reserve, Eabamet lake. There are two sets of injections, the earlier (a) across the schistosity and the later (b) parallel to it.

remnants of the older bleached individuals. The feldspar is andesine near oligoclase, representing a compound of albite 70 per cent. and anorthite 30 per cent. It is interstitial between the hornblendes and occurs in large individuals, which penetrate through the felted mass of hornblendes for considerable distances with optical continuity. Much smaller amounts of interstitial quartz are also present. Some brown biotite with few or no inclusions is seen, intergrown in the hornblende, and may be of secondary formation. The rock as it stands is a quartz-mica diorite. Between crossed nicols the bleached hornblende shows the interference colours of epidote. Original accessory magnetite is also seen.

The relation of these dioritic rocks, which are of very coarse texture in some instances, is undoubtedly that of later intrusion into the rocks in which they occur. They are not seen intrusively related to the granite and are known only in the Keewatin measures. Quartz veins, which presumably originated from the granite, are found penetrating the diorite, which is therefore older. Its relation to the Keewatin is that of intrusive sills; it is therefore younger

than the beds with which it is immediately in contact. They are largely andesitic, and the petrological similarity might suggest that the sills were simply intrusions into the lavas which had already been extended from the same dioritic magma. Though younger than the flows, the sills would then be of substantially the same period. As against this consideration the more schistose character of the surrounding lavas might seem to imply that the sills were introduced after folding had succeeded to extrusion, and this is a possibility; but it is also true that the diorite has a coarser and perhaps more massive character that would not lend itself to the development of schistose structure, and also that there has been in fact a very considerable amount of alteration, such as might follow



Hornblende schist with bundles of hornblende needles from the south shore of Eabamet lake. The large crystal of porphyritic secondary feldspar (plagioclase) is marked "P."

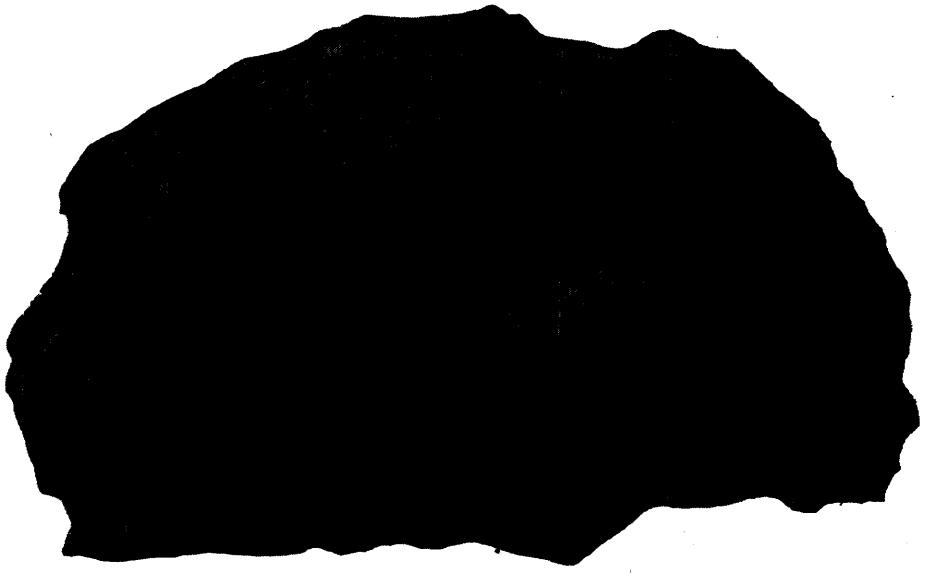
fracturing and the percolation of waters during folding. This problem may require some further investigation in the field.

Eabamet Lake and Round Lake Area

As already stated the rocks which are exposed on the northeastern shore of Eabamet lake from a point about a mile west of the eastern boundary of the Indian reserve to the northwest end of the lake appear to be predominantly of Keewatin origin. They include an injected and altered contact zone, part of which has been assigned on the map to a later period of batholithic intrusion.

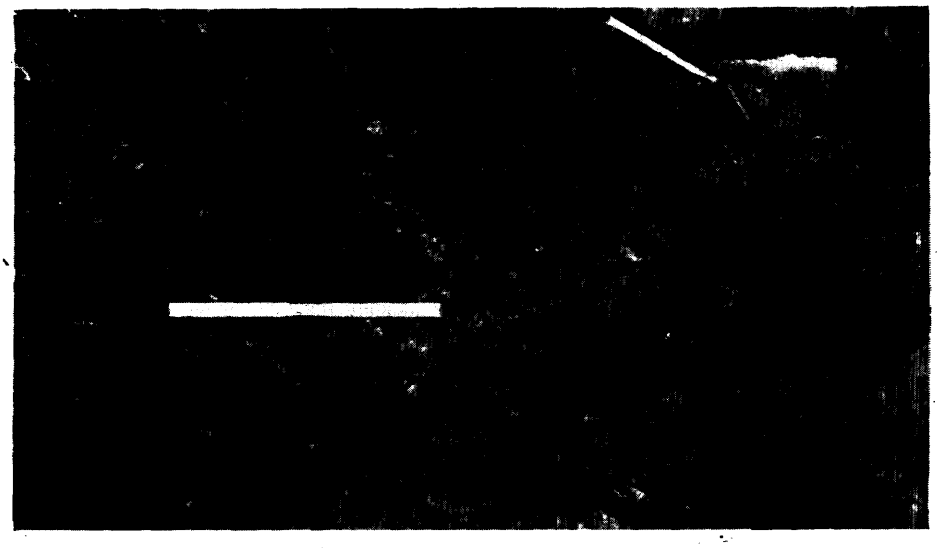
Commencing at the northwest end of the lake a series of hornblende, biotite, muscovite, chlorite, and epidote schists are found as one follows the eastern shore. They are garnetiferous toward the north end, and in two places farther on staurolite was noted. The strike is from 110 to 130 degrees, and the dip to the northeast at steep angles of from 70 to 80 degrees. On the point that

projects opposite to Fort Hope, the schists are much intruded by granite in dikes which contains potash and lime-soda feldspar (oligoclase), biotite, muscovite,



Specimen of biotite schist with staurolites from an island on the east side of the northwest bay of Eabamet lake. The schist carries magnetite and pyrite and possibly apatite and zircon. It is probably derived from rhyolite or greywacké.

and quartz in rather small amounts, while the adjacent schists are largely altered to biotite gneiss. The whole is traversed by pegmatite dikes in which oligoclase

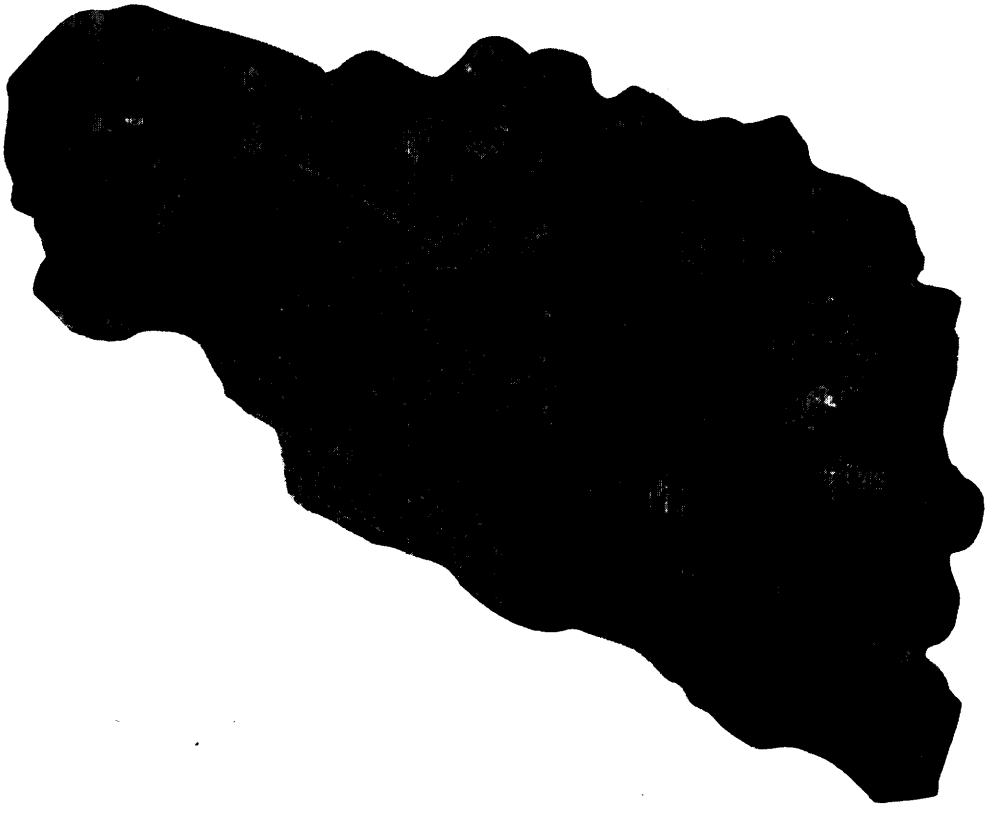


Two types of inclusions in lava, Eabamet lake, at the mouth of the bay leading to Reserve lake. One is lighter coloured than the lava and even with its surface; the other is coarse hornblendic or biotitic material which weathers more rapidly, forming pits, some of which are shown containing water. The scale is one foot long.

is again a prominent constituent, and green apatite appears in larger amounts than usual. The islands which lie about half a mile east-southeast are of much

the same composition and display some dikes of extremely coarse pegmatite. The shores of the bay that opens northeastward between the point and the islands affords good exposures of rock. The southern parts of these shores consist of finely banded grey gneiss, which represents either sheared rhyolite or acidic sediment. These rocks appear on both the east and west sides, and their strike lies across the bay. They appear again on the shore of the lake eastward from the eastern point of the bay for about a mile and three-quarters.

The types of rock included in these grey gneissic or schistose rocks are biotite schists with staurolites, sericitic gneiss, and recrystallized greywacké consisting of quartz grains, mainly original fragments, with some secondary quartz, sericite



Specimen of biotite schist with garnets, from the south shore of the west end of Reserve lake.

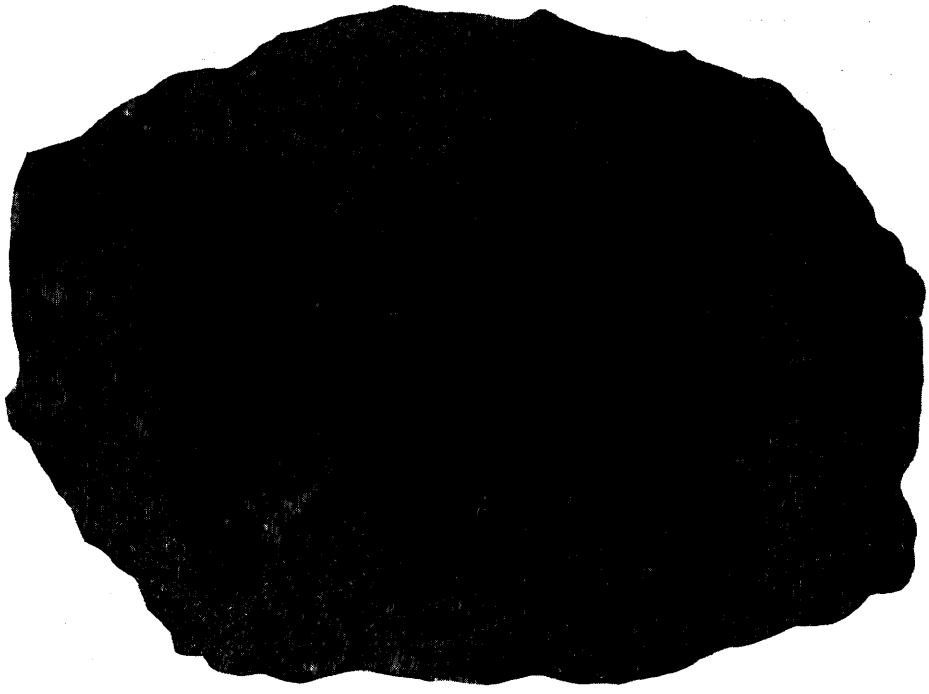
in considerable quantities, not always parallel to the schistosity, and younger biotite which is always parallel to the schistosity, some apatite in prisms and grains, and a little ferrite.

On the northeast side of these acidic schists are darker, greenish hornblende schists, andesite, and amphibolite, the more or less altered representatives of an andesitic series of lavas with some intrusive amphibolite and diorite.

These rocks appear on the shore of the lake in the ends of the two bays which lie opposite Fort Hope, one to the northeast and one directly north. They appear again on the northeast shore of the lake a mile and a half northwest of the point which projects to the west of the mouth of the creek which drains Reserve lake. From that point the basic lavas extend along the shore to within a mile and a quarter of the east boundary of the Indian reserve, where

a contact with the granitoid complex occurs. This contact also crosses Reserve lake, and the southwestern part of the lake lies within the Keewatin. The rocks in this area are chiefly of altered andesitic or dioritic types; staurolitic and garnetiferous biotite schists also occur. A few examples may be of interest.

Amphibolite.—This rock, which was originally a diorite, has undergone considerable alteration. The original hornblende crystals, which were rather short and broad in shape, have been bleached with the development of dusty particles of magnetite throughout. The bleached hornblende crystals between crossed nicols display to a considerable extent the interference colours of epidote. In many cases there has been a secondary growth of fresh green hornblende around and optically parallel to them, which appears macroscopically like large



Specimen of recrystallized diorite from the northwest bay of Eabamet lake. These diorite sills occur in older Keewatin schists and are themselves Laurentian or older.

phenocrysts of hornblende in a much finer groundmass. Under the microscope the finer-grained part between the hornblende individuals consists of epidotized hornblende, with much development of magnetite parallel to the cleavage, and a small amount of interstitial plagioclase. This rock should be compared with that seen in Abazotikichuan lake, which is quite similar. It extends southeast from the northwest bay of Eabamet lake, crossing a creek which flows into the bay opposite Fort Hope, and appearing again on the point and islands at the mouth of the bay into which the Reserve Lake creek discharges. On the creek the amphibolite is somewhat more schistose than that described above: The large hornblende, individuals show ragged edges due to secondary growth, which seems to represent a mashing and recrystallization of the rock. The iron is ilmenite with leucoxenic alteration, and there is a small amount of fine-grained quartz mosaic in the interstices. At the point west of the Reserve Lake creek,

the secondary growth is not so apparent and the rock appears fresher but is essentially a hornblende schist, consisting of short hornblende crystals with some ferrite and interstitial quartz mosaic. Here, as at Abazotikichuan lake, the relations are intrusive in the adjacent schists.

Hornblende Eclogite.—This rock occurs just east of the belt of more acid rocks on the shore of Eabamet lake. It has a gneissoid texture. The oldest mineral present is brown biotite, immediately followed by green hornblende, which is much the most abundant constituent. There is a kaolinized feldspar, which may be orthoclase, and a little sericite and oligoclase with interstitial quartz. Much red garnet has developed among the hornblende crystals, some parts of which are included in it. This corresponds with the hornblende eclogite described by Bonney from Beinn Fyn near Loch Maree in Scotland and regarded by Harker and others as of igneous origin.

Carbonaceous schists at Eabamet lake weathering to pillars and pits. The top represents the original glaciated surface.

Carbonated Schists.—These consist of hornblende, in fibrous clusters or as short thick prisms, and a quartz mosaic filling the interstices, in which carbonate, usually calcite, occurs in considerable aggregates or occasionally in larger optically continuous areas penetrating the interstices of the older minerals. In some cases there is ilmenite and a little andesine; in others biotite has been produced by alteration of the hornblende.

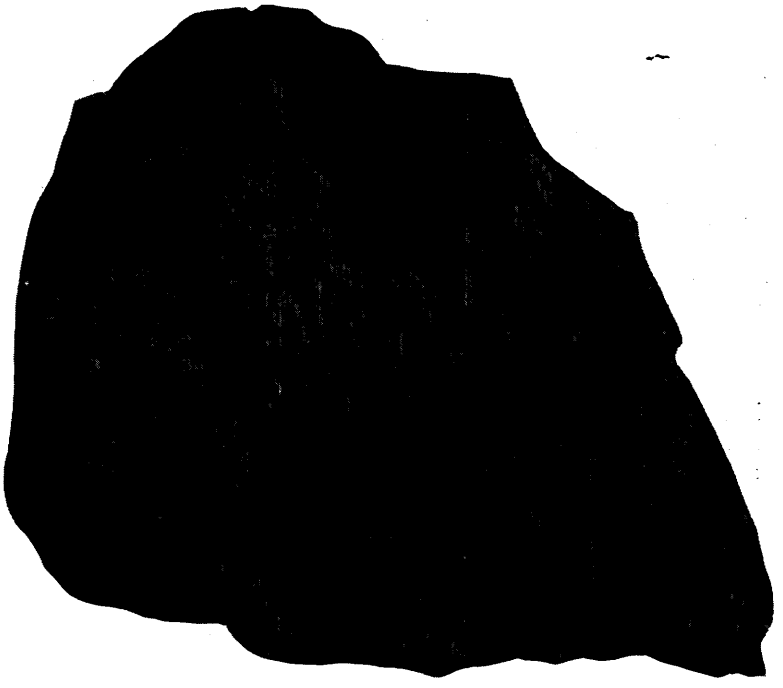
These rocks are altered andesite flows. Their more carbonaceous parts frequently weather out into pits; in some cases the more siliceous parts are left standing as pillars whose tops still show the rounding and grooving of the original glaciated surface (see photograph above). In the contact zone between the schist and granite the hornblende schists develop porphyritic plagioclase individuals as large as an inch square.

Fort Hope Mine, Round Lake, and Opikeigen Lake

This area practically constitutes a section across the northern band of Keewatin schist, except that the north edge is covered with drift from the northern part of Opikeigen lake to the first granitic outcrop, about 3 miles farther north. Possibly two miles of the width of the structural band of schist are hidden by the intervening drift. The lack can, however, be supplied quite

satisfactorily from a section farther west on the Cedar river. Commencing at Fort Hope mine, which is near the southern edge of the Keewatin, the rocks are of the sheared ellipsoidal andesite type. Farther west, on the creek which discharges the overflow of Rich lake into Opikeigen lake, there are chlorite-sericite schists, which appear to be the type that extends to the granite contact. This chlorite-sericite schist has an appreciable amount of leucoxene derived from ilmenite, and is possibly an alteration product of trachyte-andesite.

The Irish-Wording group of claims, which lies to the west of the Fort Hope group, has a variety of effusive rocks including carbonated hornblende schist, biotite schist, sericite schist, rhyolite, quartz porphyry, and greywacké gneiss. The Hargreaves property on the west side of Round lake has gold in the mineralized parts of the more acid meta-sedimentary schists. The mineralization



Specimen of brecciated rhyolite from the northwest shore of Opikeigen lake.

here and on the Irish-Wording property appears to run with the strike of the schists, which is from 60 to 85 degrees, rather than across it at about 40 degrees as at the Fort Hope mine.

At the south end of Opikeigen lake, there is grey hornblende schist with much magnetite, somewhat similar to the iron formation rocks of Miminiska lake, garnetiferous hornblende schist, quartz diorite gneiss, quartz andesite, quartz porphyry or rhyolite, hornblende-mica rhyolite. The rhyolite is in some parts brecciated. Farther north the outcrops are rarer, and those observed include a curious ferruginous soda-gneiss on a small island on the east side at the south end of the large expansion that opens about one-third of the way up the lake from the south end. This consists of large idiomorphic green hornblende crystals embedded in a quartz mosaic with some grains of albite; irregular bands of iron ore particles cross the hornblende and the mosaic indifferently as if older than either. In some cases the hornblende crystals have been fractured,

the fragments drawn apart by shearing movements, and the spaces between filled with secondary quartz. This separation lies in the direction of the magnetite bands. A few pyrite grains are also present. The whole is suggestive of altered iron formation or ferruginous schist as seen in other parts of the field at such places as Pakwash lake and Whitemud lake in the region between Red lake and Clearwater lake. A mile farther east on the same side of the lake hornblende schist occurs with ilmenite older than the hornblende, which forms a felt of needles interstitially filled with quartz mosaic; this is probably an altered andesite. Near this the hornblende schist has calcite aggregates distributed through the quartz mosaic, and magnetite grains are thickly disseminated throughout the whole. Somewhat similar green schists are seen wherever rock is exposed, but for the most part the northern shores of Opikeigen lake are covered with sand, probably a glacial outwash apron, but at one or two points hornblendic schists with some biotite occur. At the north end of the lake an east-west line of terminal moraine is reached, and behind this there is no outcrop until the second lake northward, where a contact complex, mainly of granite, has inclusions which consist of augite diorite, composed of a little augite, much more abundant and younger green hornblende, and andesine-feldspar (Ab 63 per cent., An 37 per cent.), with little or no quartz.

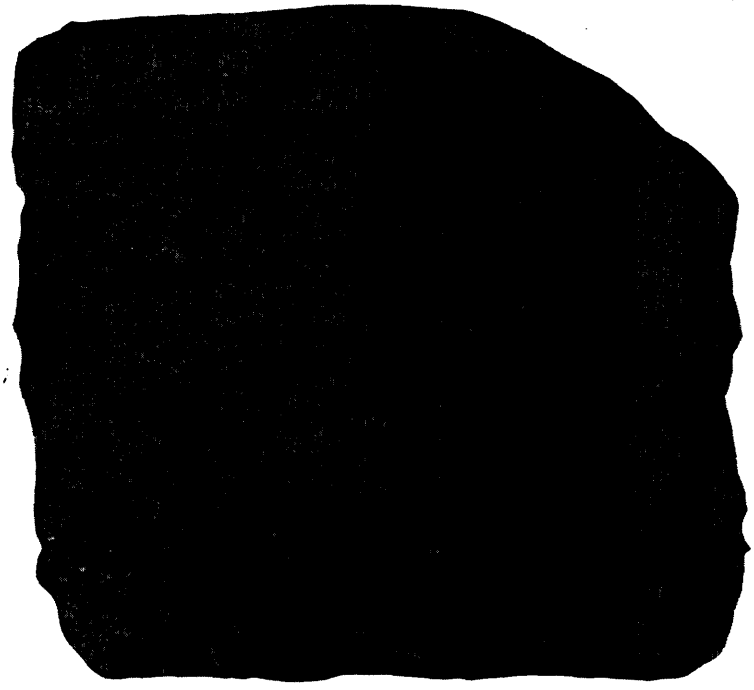
The section as a whole, from the Fort Hope mine north, shows basic lavas typically developed at both edges, rhyolitic lavas and greywackés above, with some ferruginous schists in the centre. The gold discoveries have been made in the andesitic lavas of the southern edge. It would appear from the limited examination made that the northern edge is covered with drift.

Petawanga Lake Area

Up the Albany from Fort Hope, coarse greyish gneisses of the older granitic formation are seen on both sides as far as the east end of Petawanga lake, where the Keewatin rocks are again exposed on the shores. A contact zone of granite with large inclusions is first seen on an island on the south side of the lake. The next outcrop is of grey hornblende-biotite gneiss with old angular quartzes and is probably a recrystallized greywacké. It is penetrated by pegmatite dikes for some distance westward from the contact. The schist is carbonated in part, as evidenced by pitted surfaces. Farther on, near Dobie's post No. 55, an ellipsoidal structure is distinguishable, which marks the rock as volcanic. Much of the shore is covered with glacial till. In the narrows of the lake a granite intrusion through the schist is exposed on some small islands and on the north shore near post No. 49, and again on the south side at the west end of the narrows. At the mouth of Small Cedar river a dark schist again appears, and about half way from that point to the point where the Albany discharges into the western end of the lake there is an exposure of rhyolite.

The north shores of the lake have a slightly different series. In the eastern part a covering of boulder clay permits of few outcrops, and exact contact relations cannot be ascertained. Granite is exposed on the point north of the eastern outlet. Boulder clay hides the shores to and beyond the long bay which projects northward, but a small islet near the eastern outlet is Keewatin. The granite contact crosses the north bay about half way to its end. From that point on, the exposures are of greenstone schist with the exception of the granite intrusion near the middle of the narrows. In the bay on the north side near the west end of the lake, lavas of amygdaloidal structure are to be seen along the south side of the eastern arm. Microscopically the rock consists of a felt of green hornblende needles with occasional laths of younger brown biotite;

here and there larger phenocrysts of hornblende occur. The oldest mineral is ilmenite in skeletal aggregates partly altered to leucoxene. There is an interstitial quartz mosaic and large amygdules of quartz. It is a recrystallized andesite, now hornblende schist. The mica may represent alteration of hornblende or partly the feldspathic part of the original rock. A similar type occurs on the western arm of the bay on the south side and on the islands. On the point which encloses the western arm of the bay, pillow lava is exposed. On the northeastern shore of the bay a light-grey banded rock, which has a vertical dip and strikes N. 80° E., reveals under the microscope a quartz mosaic surrounding small angular fragments of primary quartz and idiomorphic laths of muscovite and chlorite, which also have inclusions of the older quartz grains.



Specimen of rusty-weathering greywacké from the north bay of the east arm of Miminiska lake. The rock contains much magnetite, pyrite, and biotite laths in a matrix of quartz with some feldspar.

A little brownish carbonate is associated with the mica. This chlorite-sericite schist undoubtedly represents a somewhat calcareous arenaceous shale and marks a transition from volcanic to sedimentary measures. The fact that the strike of the sediments lies at an angle of about 30 degrees from that of the contact would appear to indicate a faulted or unconformable relation between the two formations, the line of fault lying along the axis of the bay on a bearing of about N. 110° E., which is also the strike of the meta-igneous schists near the contact.

Up the river to Miminiska lake the rocks exposed on the portage to the lake are meta-igneous, and Bell reports a coarse dioritic rock at the falls on the other side of the river from the portage,[1] which has "concretionary structure," presumably pillow lava.

[1]Robt. Bell, Geol. Surv. Can., Vol. II, pt. G, 1886, pp. 14-18.

Miminiska Lake and Cedar River Area

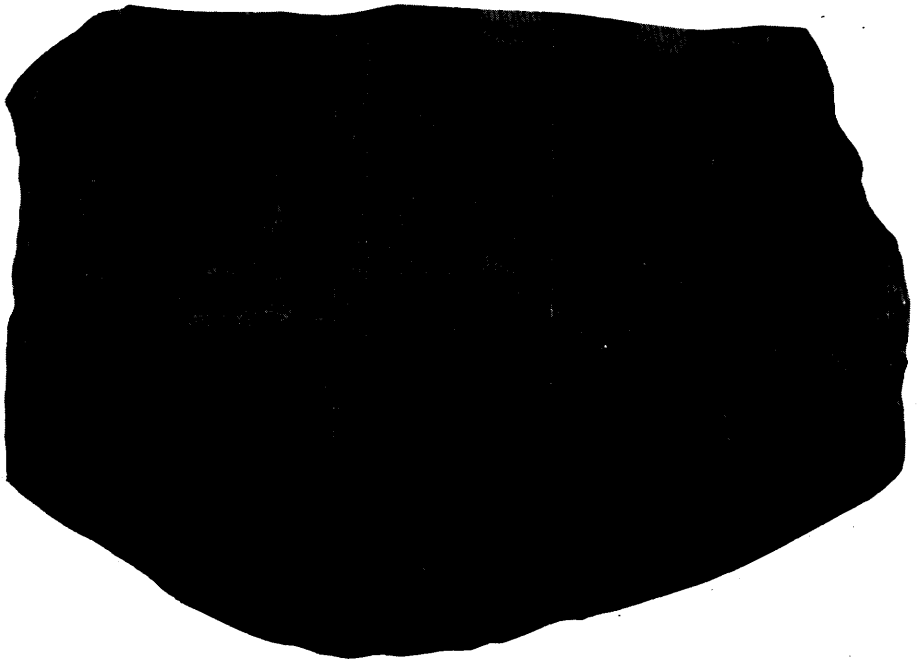
In this area all the rocks observed, with one exception, were of Keewatin age. The rocks around Miminiska lake and Cedar lake, together with those at the west end of Petawanga lake, Small Cedar river, Cedar river, and the part of the Albany which connects the two lakes, afford a tolerably good section across the western part of the schist area, which is about sixteen miles in width. Northward from the outlet of Miminiska lake, where the rock is meta-igneous, the shores and islands for three miles consist mainly of the sedimentary rocks that were seen on the northwestern part of Petawanga lake. The prevailing rocks here are grey, fairly contorted, and schistose and on examination prove to be very quartzose sericite schist, with alternating bands in which iron particles and quartz mosaic predominate. Most of the sericite is irregularly arranged in the quartz bands, but there is a notable proportion in parallel arrangement transverse to the bands. This result might have been produced by alteration

Corrugated sericitic schists on the central peninsula of Miminiska lake.

of a siliceous sediment with some clay and black sand. Farther north on the shores of the northeasterly trending bay there are exposures of grey rock in varve-like bands, transverse to the schistosity. This proves on examination to be andesitic in type. The microscope shows gneissic texture. There are numerous parallel needles of green hornblende in thin bands with some quartz and wider bands where quartz predominates over the hornblende. There appear to be some angular grains of fractured quartz and fine-grained material of low interference, probably feldspar or in part glass. Ilmenite with leucoxene occurs in grains. These rocks may represent a quartz andesite ash or sheared quartz andesite. Farther north toward the end of the bay they are succeeded by highly ferruginous hornblende and glaucophane schists, which are best seen on an island in the marsh in the north part of the bay. The width here exposed is about 150 feet. It varies from thick bands of grey-brown ore, in places two feet across and filled with glaucophane laths, which lie mainly in the plane of cleavage, to green and black banded zones, the green having more of the am-

phibole, the black of the ore. In some parts are streaks of white quartz (see photograph on page 38.)

The section is continued up the Cedar river to the northern edge of the schist area. In the bay that leads to the mouth of the Cedar river, much of the shore is drift-covered, but an outcrop of ophitic diorite is seen toward the south end. Badly weathered laths of andesine or oligoclase andesine are older than the green hornblende which fills in the rest of the space. There are some small inclusions in the hornblende which may be biotite, and also some titaniferous iron in grains. An intrusion of syenite (described on page 43) is seen on some of the small islands. There are no exposures of rock up the river until the outlet of the first lake is reached. Here there is a grey, rusty-weathered, very fissile, apparently sericite schist, somewhat contorted, which strikes near 90 degrees and dips almost vertically. On the second lake, above the fifth



Specimen of andesitic ash rock from the northeastern part of Miminiska lake. The upper part of the surface is weathered indicating a varve-like structure.

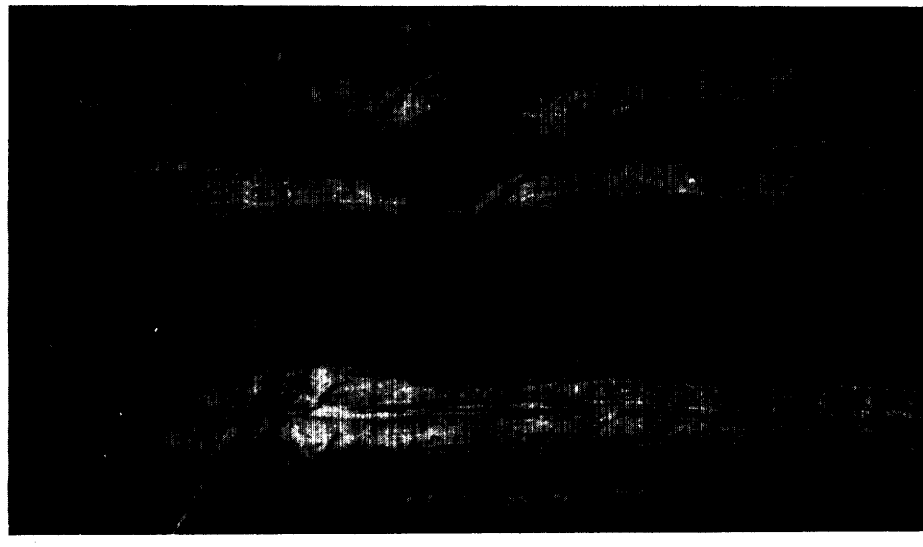
portage, an exposure of dark pillow lava is composed of a felt of tufted or radial hornblende aggregates with some larger single individuals interspersed. Embedded in this are much older ilmenite, altered to leucoxene, fresh pyrite, and a little hematite. A quartz mosaic fills the interstices. This is no doubt an altered andesite. In the contact zone, which lies a mile and three-quarters farther north, the rock that is found embedded in the granite is a quartz diorite or granodiorite, containing a little sericite among the secondary minerals, but no recognizable orthoclase.

The band as a whole shows a schistosity of which the average strike is east and west and the prevailing dips from vertical to south. If the structure is synclinal, as would appear most probable, the zones indicated are: (1) a lower member of andesite and diorite of medium basicity and partly ellipsoidal, interbedded higher up with a little rhyolite; (2) iron formation, apparently

somewhat related to the dioritic effusives, but much more heavily charged with iron; (3) above this, banded deposits which are probably andesitic ash; and finally (4) somewhat siliceous and partly calcareous argillitic sediments.

Specimen of crenulated grey chloritic schist, probably sheared andesitic ash rock, from the large island in the southeastern part of Miminiska lake.

In general it appears that the effusive part of the Keewatin in this locality is not as basic as in many other areas, where basalt is more common. Here the



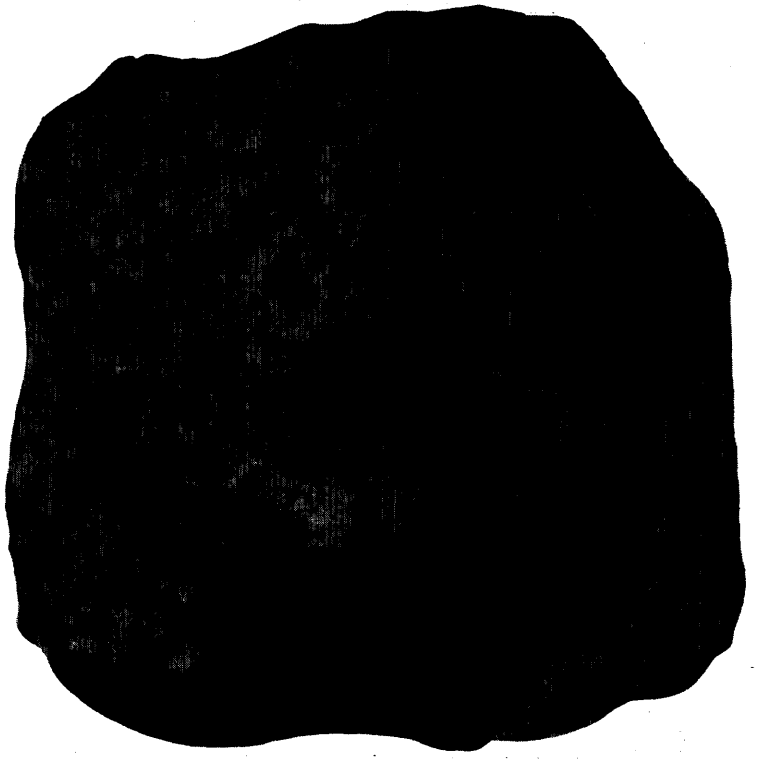
Ferruginous banded schists of the north arm of the east bay of Miminiska lake. There are occasional streaks of nearly pure quartz. The scale is one foot long.

range is from andesite to highly acid rhyolite. The "iron formation" also has a considerable amount of amphibole.

Batholithic Intrusives

The granitoid and gneissic rocks throughout the area around Fort Hope and along the approaches to it from the Canadian National railway present in common a complex or hybrid character. The occurrences along the routes from the railway to the gold-producing area have been described already. In the Fort Hope area proper, the rocks of this complex have been divided into three types, as shown in Tables I, II, and III.

Table I gives details of nine specimens of an older, comparatively coarse-grained granitoid gneiss, in which the gneissic structure may be due to flowage in the liquid condition before cooling. There is no banding except from very



Granodiorite with large biotite aggregates, from the northeast shore of Eabamet lake. Note the coarse grain, gneissic texture, and pitted surface in the weathered (dark) part.

occasional drawn-out inclusions or schlieren; but in general the ferromagnesian elements, especially biotite aggregates, are arranged in parallel. The constituents vary somewhat.

Of the nine specimens studied, all contain quartz and biotite, the latter often in leafy aggregates and generally in a parallel arrangement. The oligoclase and orthoclase are generally much kaolinized, but the microcline is fresh. In one case primary and secondary quartz could be distinguished. The orthoclase was in some cases idiomorphic and large enough to constitute a well-marked porphyritic structure.

Table II gives details of nine specimens of granite which either in their field relationships are clearly seen to be intrusive in and therefore younger

TABLE I—OLDER MEMBERS OF THE GRANITOID COMPLEX, MAINLY GNEISSIC

Specimen No.	Locality	Field relations or description	Mineral constituents											Name
			Quartz	Microcline	Orthoclase	Oligoclase	Muscovite	Biotite	Hornblende	Apatite	Zircorn	Iron oxide	Pyrite	
1	Waboose falls	Medium grain	X	X	X	X	...	X	X	...	...	...	...	Hornblende-biotite granite.
2	Contact north of Opikeigen lake	Coarse granite (oldest part of complex)	X	X	X	X	...	X	X	X	...	X	...	Hornblende-biotite granite.
3	Abazotikichuan lake	Coarse gneiss, biotite aggregates	X	X	X	X	...	X	...	...	...	...	...	Biotite orthogneiss.
4	Contact on Small Cedar river	Coarse porphyritic gneiss	X	X	X	...	...	X	X	...	...	...	...	Biotite-hornblende orthogneiss (porphyry).
5	Post No. 51, Petawanga lake	"Grey gneiss, coarse grain"	X	...	X	X	X	X	X	X	...	X	...	Binary or hornblende-biotite-muscovite orthogneiss.
6	Eabamet lake, station No. 50 (Dobie)	Coarse granite, older type	X	...	...	X	...	X	X	...	...	X	...	Biotite-hornblende granite.
7	Eabamet lake, southeast bay	Older granite	X	X	X	...	...	X	X	X	...	X	...	Biotite-hornblende granite.
8	Eabamet lake, station No. 10	Coarse, older type gneiss, porphyritic	X	X	X	X	...	X	X	X	...	...	...	Hornblende-biotite orthogneiss porphyry.
9	Rich lake	"Coarse cream-coloured granite"	X	X	X	...	X	X	...	?	X	...	X	Binary granite.
	Total mineral occurrences		9	7	8	6	2	9	7	4	1	4	1	

TABLE II—YOUNGER MEMBERS OF THE GRANITOID COMPLEX, MAINLY MASSIVE

Specimen No.	Locality	Field relations or description	Mineral constituents												Name
			Quartz	Microcline	Orthoclase	Oligoclase	Hornblende	Biotite	Muscovite	Zircorn	Apatite	Iron {Magnetite / Ilmenite	Sphene	Epidote	
1	Below outlet of Rich lake	Dike penetrating fine-grained gneiss	X	X	...	X	X	X	...	...	X	X	...	..	Hornblende-biotite granite.
2	South of Opikeigen lake, intruding oldest granite	Aplite?	X	X	...	...	...	X	...	...	...	....	...	..	Microcline-biotite aplite.
3	North of Opikeigen lake, younger of two injections	Aplite?	X	X	X	...	X	...	...	X	X	X	...	..	Hornblende granite.
4	Eabamet lake, east end	Newer granite	X	X	X	X	X	...	X	...	...	....	...	..	Hornblende-muscovite granite.
5	Eabamet lake, Dobie's station, No. 50	Fine granular rock intruding coarse gneiss.	X	...	X	X	X	X	X	...	X	I	X	..	Biotite-hornblende-muscovite granite.
6	Creek east of Graham lake	"Red, fine-grained, later type granite."	X	X	X	X	X	X	...	X	X	I	...	..	Biotite-hornblende granite porphyry.
7	Eabamet lake	Granite dike, intrusive into gneiss.	X	...	...	X	...	X	X	X	X	M	...	..	Binary (biotite-muscovite) granite.
8	Route northeast of Eabamet lake	Granite at first portage	X	X	X	...	X	...	...	...	X	I	X	..	Hornblende gneiss.
9	Reserve lake, southeast side	Pale-grey gneiss, blue quartz, fine-grained.	X	X	...	...	...	X	X	...	...	....	X	X	Binary (biotite-muscovite) gneiss.
	Total mineral occurrences		9	7	5	4	6	6	4	3	6	6	3	1	
	Corresponding total from Table I		9	7	8	6	7	9	2	1	4	4	0	0	

TABLE III—HYBRID OR OTHER DIFFERENTIATES OF GRANITE

Specimen No.	Locality	Field relations	Mineral constituents											Name
			Quartz	Microcline	Orthoclase	Oligoclase	Hornblende	Biotite	Muscovite	Apatite	Iron ore	Sphene	Epidote	
A1	Trail to Fort Hope mine	Near Keewatin contact—coarse	X	...	...	X	X	X	...	X	...	...	...	Soda-lime granite.
A2	Reserve lake, southeast side	Pale-grey gneiss, fine grain (near contact)	X	X	...	...	...	X	X	...	...	X	X	Potash-rich granite.
B	Cedar bay, Miminiska lake	Plutonic intrusive in Keewatin	...	X	X	X	X	X	...	X	X	...	...	Basic syenite.
C1	Eabamet lake, near station No. 14	Pegmatite dike with apatite	?	...	X	X	...	X	...	X	X	...	...	Basic pegmatite.
C2	Eabamet lake, southwest of station No. 23	Pegmatite, flesh-coloured, very coarse	X	...	...	X	...	...	X	...	...	...	...	Basic pegmatite.

A. The occurrence of blue quartz in these contact phases of granite apparently has no relation to rate of cooling or to acidity or basicity.
B. Probably a hybrid type.
C. Notable for the presence of oligoclase in both instances. The localities are within a few hundred yards of one another.

than the oldest granite present, or correspond in appearance much more nearly with the younger than with the older types. In the latter case it is admitted that some of the older type granites may be included here. The younger are of a darker red colour and seldom gnessic in structure; the older are generally of a grey or pinkish-grey colour and often gneissoid.

Drawing a general comparison between the two types of granite, it appears that microcline occurs seven out of nine times in each class. In the newer granites, orthoclase and oligoclase are less frequent, as are also hornblende and biotite; muscovite and the accessories, apatite, zircorn, magnetite, and ilmenite, are more abundant in the younger type. Sphene and epidote, which were not found in the older granites, occur three times and once, respectively, out of nine cases of the younger granites.

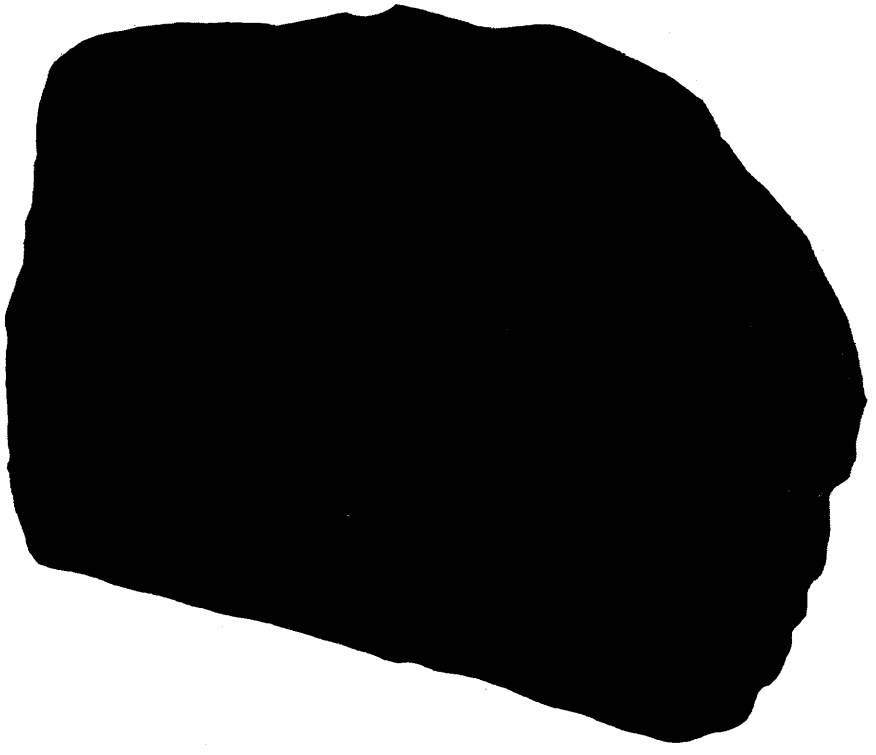
Table III presents certain differentiated types. Those which come under the heads A1 and B are probably to be referred to the older granites. In A, there are grouped two granites whose only common features are the presence of blue quartzes and their position near the Keewatin contact. A suggestion is offered that the blue colour may be due to the presence of dust particles produced during the fracturing of the surface of the Keewatin rocks caused by differential heating and consequent unequal expansion of the parts immediately in contact with the hot magma. Apart from this similarity, their mineralogical composition would assign A1 to the older granites, and A2, which has muscovite, sphene, and epidote, to the younger. B is a syenite, practically identical with the older granite except for the absence of quartz, which might indicate its injection into a cavity in the Keewatin at an early stage in the batholithic action and the subsequent excretion of the portions of the rock which remained liquid before the crystallization of the quartz. The notable thing about the pegmatites of group C, which are found in the contact zone rocks on the north-east side of Eabamet lake immediately opposite Fort Hope, is the extensive occurrence of oligoclase in them. They are, in some cases, very coarse, containing crystals of oligoclase two or three feet in diameter.

Certain features are common to the granitic complex throughout the whole region from Zigzag lake on the Little Jackfish river to the northernmost points visited. Referring to Table I, which deals with the oldest members of the complex, speciments Nos. 1, 2, and 8 were taken respectively in the Ogoki, at Waboose falls; at the northern contact of the Keewatin with granite, on the route from Fort Hope to Attawapiskat lake; and at Eabamet lake. It will be seen that the mineralogical composition is in each case nearly identical. The older rock is everywhere microscopically recognizable by its greyish colour tones, coarse grain, and a pitted appearance caused by the weathering out of the parallel-lying aggregates of biotite, which also render the type gneissic. Hornblende is also a usual constituent. The unaltered state of the microcline, as compared with the somewhat altered orthoclase and oligoclase, and the occasional presence of secondary quartz appear to indicate considerable regional alteration.

The younger granite is confined to the Fort Hope area proper, is generally of a markedly reddish colour and massive granular in texture, and retains a smooth glaciated surface. It has not been found to occur in very large areas, but is confined almost entirely to dikes in the older granite and is nowhere very far from it. Mineralogically it differs more in the proportions of the mineral constituents than in their nature, and is therefore almost certainly to be attributed to the later phases of the same batholithic advance. This holds good also for the differentiates of Table III.

Keweenawan Dikes

Penetrating both the granite and the Keewatin there are at least three sets of dikes, one of diabase and two of porphyry. Both the porphyry and the diabase have nearly the same average strike, from N. 155°E. to N. 160° E. The diabase and porphyry were not observed to intersect one another at any point. This fact, and the general similarity of strike, would indicate that they are of the same age. That the diabase is post-Algoman is certain as it was observed cutting both Keewatin and Algoman rocks; although the porphyry was not observed to cut the granite, it cuts the gold vein near Fort Hope, which is presumably Algoman. The post-Algoman dikes which are known in other parts



Specimen (natural size) from a quartz andesite porphyry dike that intersects the vein at the Fort Hope mine and is itself intersected by a later small dike, which is mineralized along its margin. Both are probably Keweenawan. The vein itself is older, probably Algoman.

of Northern Ontario have been classified as Matachewan (pre-Keweenawan), Nipissing, or Keweenawan, and post-Keweenawan (i.e. post-Nipissing). In the region immediately to the south, around Lake Nipigon, these rocks have been determined as Keweenawan and they also occur in diminishing amounts along the route from that body of water to the Fort Hope area. It is presumably correct, therefore, that they are the same age here. Diabase dikes were observed on Eabamet lake and on the lake which lies just east of it on the route from Eabamet lake to Wabassi lake.

A small island in the bay on the north shore of Eabamet lake, about one and a half miles east of the eastern boundary of the Indian reserve, is traversed

by a dike of diabase about 30 inches in width, with well-marked transverse columnar structure. The dike cuts both the older and later granite. A larger body of coarser grain lies parallel to the small dike at a distance of about 50 feet, and has the same field relations to the granite. Both display a poikilitic texture and are composed of laths of labradorite (Ab 47 per cent., An 53 per cent. to Ab 45 per cent., An 55 per cent.) which are idiomorphic, with younger magnetite grains and interstitial augite. In the smaller dike two generations of crystals are distinguishable, larger laths and zonal individuals of feldspar are embedded in a groundmass of much finer grained diabase in which some interstitial glass appears.

On the south side of the lake there are two diabase dikes almost on the measured strike of those on the other side.

On the first lake on the route to Wabassi river diabase dikes were seen in which the labradorite laths are more basic than in those already described (Ab 40 per cent., An 60 per cent.), and there is hornblende present which is younger than the augite, which in turn is interstitial in its relation to the feldspar.

The quartz porphyry dikes seen at the Fort Hope mine strike in a direction nearly parallel to the diabase dikes already described. They are subsequent to the Algoman, and are therefore included with the presumably Keweenawan diabase. In appearance these are grey or yellowish-grey rocks with a fine-grained groundmass enclosing square feldspars as much as three-sixteenths of an inch across, blue quartz grains, and occasional large hornblende individuals. The feldspar is white and sometimes striated. Under the microscope the groundmass in one case contained quartz, brown biotite, feldspar, and apatite needles. The feldspar phenocrysts were zonally weathered orthoclases. No quartz phenocrysts appeared in the section, but spots of coarsely developed quartz mosaic containing a little mica occur. In another case the dike is andesitic. It has a groundmass of small idiomorphic hornblende needles, feldspar, quartz, and ilmenite grains. The phenocrysts are large twinned feldspars displaying zonal banding, hornblende individuals rounded by resorption, and quartz. The first might be described as a granite porphyry or quartz porphyry, the second as a quartz-andesite porphyry. The relations between the two were not determined definitely in the field, but there are small dikes of porphyry which carry sulphide mineralization and cut the andesite porphyry. They are, therefore, younger. They are of a somewhat darker and yellower colour and show no quartz or hornblende phenocrysts. One is shown in the accompanying illustration but was not microscopically determined. It would appear almost certain, however, that the acid porphyry is the younger. Its mineralization is, of course, in no way connected with that of the gold veins, which are much older than either of the porphyries.

ECONOMIC GEOLOGY

Gold

The economic interest of the Fort Hope region centres for the present in its gold deposits. With the application of improved methods for the electrical treatment of somewhat lean iron ores, it would appear also that justifiable anticipations may be entertained for the future development of the iron deposits of Miminiska lake as soon as transportation conditions in the area are somewhat improved. Abundant water power for electrical development is available close to the deposits.

Fort Hope Mine

The exposure of ellipsoidal Keewatin rock in which the vein occurs is part of a low rounded knoll which rises about 40 feet above the surrounding muskeg. It is several acres in extent, largely covered with soil, and was thickly wooded with spruce. The country rock traversed by the vein is a fine-grained, fairly massive, dark-grey pillow lava, chloritic on sheared faces and displaying to the unaided eye occasional small grains of pyrite. Microscopically it presents an ophitic texture with laths of andesine (Ab 60 per cent., An 40 per cent.) and a few larger crystals altered to kaolin. The interstices are filled with a felt of green hornblende, the fibres mainly parallel, irrespective of the direction of the feldspars. The hornblende is slightly epidotized. Accessory ilmenite, altered to leucoxene, and disseminated pyrite grains complete the list of minerals usually present. Where fractures traverse the rock they are healed with chlorite, epidote, and quartz. The country rock as a whole is, therefore, an ophitic andesite or andesite gneiss rather than a hornblende schist, as at first supposed.

The strike of the gneissic and ellipsoidal structure is nearly east and west. It has been much fractured and faulted after the deposition of the ore. The vein is a fractured zone of age long subsequent to the folding of the rocks, whose strike it traverses at an angle of about 45 degrees in a northeast to southwest direction. The fragments of the andesite gneiss have been altered by the hydrothermal action accompanying the intrusion of the vein matter, which has produced a recrystallization of the hornblende in somewhat coarser individuals than before. Small fragments are reduced to hornblende schist. The vein matter between the fragments consists of quartz and calcite. The sulphide mineralization includes pyrrhotite, pyrite, and chalcopyrite in decreasing order of abundance, and in some places native gold. The sulphides are to some extent disseminated in the fractured country rock, but the gold is said to be mainly in the quartz. Sampling in 21 places over a length of about 575 feet showed widths varying from 8 to 78 inches, averaging 34.5 inches. The values found ranged from $311.00 to 40 cents per ton, the average being $20.81. These values were those reported by the company from assays made by them up to November 11, 1927. A grab sample taken by the writer of good-looking ore assayed $193.60. The average of $20.81 given above omits the extreme high value of $311.00.

Hargreaves Property, Round Lake

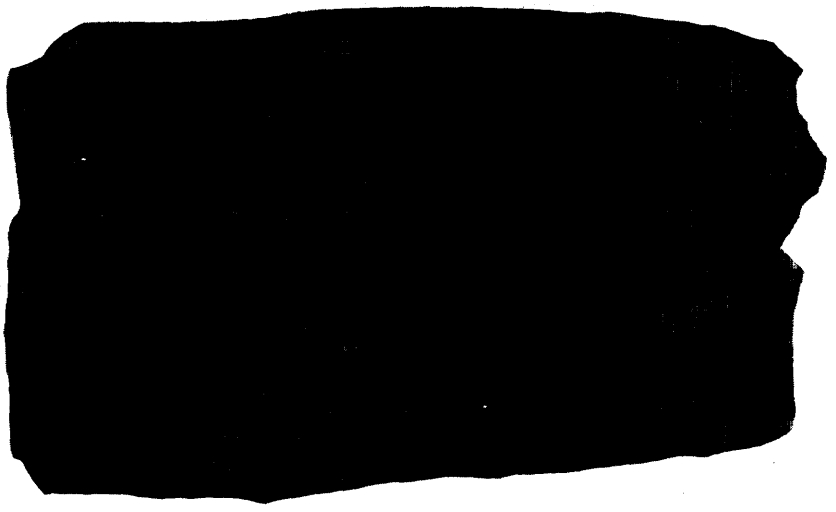
On an islet near the west side of the lake, sheared greywacké, mineralized with pyrites, shows low values in gold over a width of several feet. There is no fracture zone as at the Fort Hope mine, but the deposit extends apparently along the strike of the sheared greywacké, which is N. 80° E.

Near the landing from which the trail led to the Fort Hope mine, a mineralized shear zone in the greenstone having a strike of 70 degrees is said to carry gold, but an assay of a sample collected by the writer failed to indicate its presence. The direction of these permeable zones probably indicates that their formation took place at a much earlier period than that of the fracture zone at the Fort Hope mine, and they were undoubtedly less accessible to the mineralizing waters than the fractured zone at the time when mineralization took place. This would account for their much lower values.

Irish-Wording Claims

This property lies to the west of the Fort Hope mine in a separate claim group, which is reached by ascending a creek from the southwest end of Opikeigen lake. About half a mile up the creek, the claims lie mainly on the north (right

hand) side, where the gold discovery was made. The country rock includes andesitic lava and interbedded altered sediments, which are well exposed across a width of about 60 feet at the vein. The strike is from N. 95° E. to N. 100° E., and the dip southward at steep angles. An irregular quartz vein follows the strike for about 500 feet, breaking across toward the southwest at its western end, where the quartz reaches a width of over 4 feet. For the most part there are only a few inches of quartz. An assay of the quartz from a sample taken by the writer at the widest part indicates a value of $3.00 over a width of 3 feet on the hanging-wall side. The schist on the hanging wall for a foot in width yielded $1.20 and on the footwall about 40 cents. Here, as at Round lake, the conditions for mineralization in zones parallel to the strike appear to be not so good as in the fracture zone, transverse to the strike, at Fort Hope mine.



Specimen (three-quarters natural size) from the interbedded green and black banded beds of iron formation at Miminiska lake, showing amphibole needles (visible in light-coloured bands).

Northern Aerial Minerals Exploration Company

This company's claims, which are located on a body of massive pyrrhotite on Lily Pad creek, which enters Opikeigen lake from the west, about half way along its length, were staked by the Mosher brothers during the summer of 1929. They were not visited by the writer, and no assays have been reported.

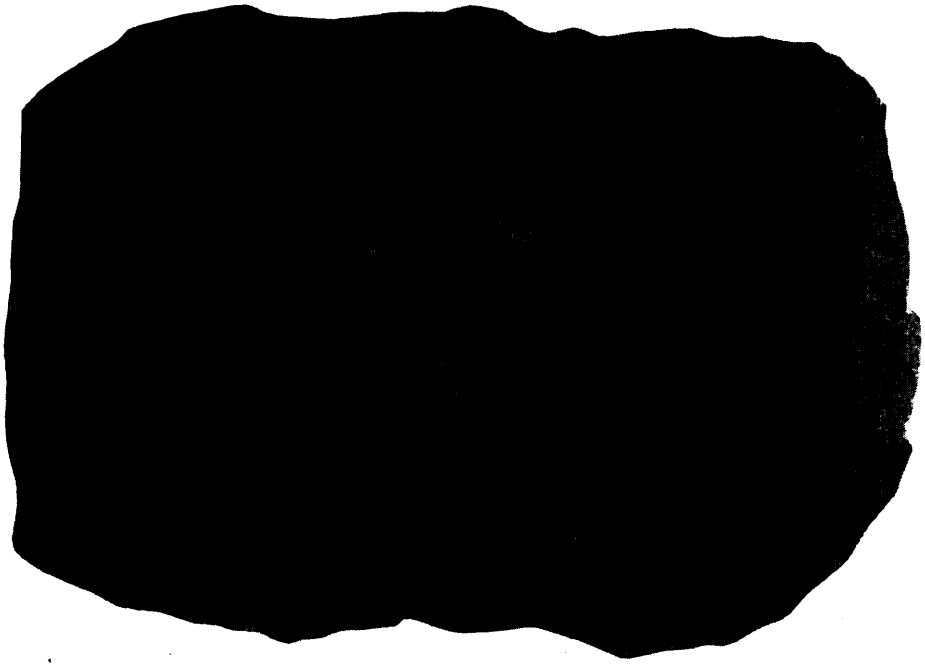
Iron Formation of Miminiska Lake

At the head of the northeastern bay of Miminiska lake, an island partly surrounded by marsh is made up of banded ferruginous rock. The banding is much wider than is usually seen in the field, but in hand specimens smaller bands of about the usual thickness, half an inch or less, are to be seen. The coarse banding arises from beds of almost pure ore, as much as a foot across, interbedded with green and black banded beds. There are also some beds of white quartz. The coarser bands or beds range from 4 inches to more than a foot in thickness. An assay across the coarser banding indicates an iron content of 37.5 per cent.

The more ferruginous bands are seen microscopically to consist of magnetite grains with interstitial quartz mosaic. The percentage of iron is high, probably

at least 40 per cent. of metallic iron in these bands. The ore is itself divided into smaller bands of thick-set magnetite grains with small quartz content, alternating with others richer in quartz and poorer in iron. In both, there are distributed single crystals and radiating aggregates of glaucophane, but these are more common in the more ferruginous part.

The less ferruginous green and black banded beds consist in some cases of alternating bands of (1) epidote in prisms parallel to the banding, and (2) epidote highly charged with magnetite grains and larger glaucophane crystals. The glaucophane appears to be of late formation, as it is found developed on sheared and fractured planes later than the banding.



Iron ore (ferruginous glaucophane schist) from the north side of the east arm of Miminiska lake. A magnetite and quartz mosaic with about 40 per cent. metallic iron alternates with bands containing more quartz and less iron ore. Glaucophane laths (black) are abundant parallel to the banding and more so in the ferruginous than in the more quartzose parts.

In another instance the successive bands are as follows: (1) feldspar band penetrated along cracks by brown iron ore, which in part replaces the feldspar; (2) a schistose band, having a fine mosaic of quartz and apparently feldspar with glaucophane and pargasite in parallel laths, also thickly interspersed crystals of magnetite; (3) very pargasitic, but not so much iron, the hornblende much epidotized in some parts; (4) similar to (2) but with more quartz mosaic and less iron and amphibole.

In some of the green and black banded beds there is a sort of cross-bedding traversing the green and black bands diagonally in opposite directions alternately. The exposure on the island is about 150 feet in width, but the magnetic disturbance indicates that ferruginous rocks occupy a much greater width under the waters of the lake.

Geology of the Area between Favourable Lake and Sandy Lake, District of Kenora (Patricia Portion)

By M. E. Hurst

INTRODUCTION

In 1926, the Ontario Department of Mines published the results of a geological reconnaissance by G. V. Douglas along the principal water route between Red lake and Favourable lake. In this report[1] the attention of prospectors was directed to the indications of mineralization which had been observed in a belt of greenstones in the vicinity of Favourable lake. Subsequent prospecting of these formations led to the discovery, in the fall of 1927, of native gold and later of deposits carrying gold, silver, lead, and zinc. The announcement of these "finds" was followed by an influx of prospectors who, during the winter months, staked several hundred claims covering the most promising ground. In response to the interest aroused by these discoveries, the writer was instructed to examine the deposits and prepare a reconnaissance map of the mineral-bearing area. In view of the remoteness of the region and the loss of time involved in reaching it by canoe, advantage was taken of the airplane service operated by Western Canada Airways, Limited, to transport the party to and from the field. Thus, in spite of a late start, two and a half months were devoted, during the summer of 1928, to field work in the area.

Acknowledgments

Throughout the field season the party was entirely dependent on the transportation facilities provided by Western Canada Airways, Limited, and the writer wishes to take this opportunity of thanking the pilots and officials of the company for the timely and reliable service rendered, for the prompt delivery of additional supplies and mail, and for their hearty co-operation in many other ways.

Able assistance was rendered throughout the field season by H. C. Laird, C. H. Hopper, Jr., and H. P. Hermance, Jr. Mr. Laird, as senior assistant, carried on a considerable part of the mapping while the writer was engaged in other parts of the area.

The writer wishes to express his appreciation of the assistance, information, and hospitality tendered the members of the party by those engaged in prospecting in the area, particularly to Walter H. Woods, resident engineer of the Favourable Lake Mining and Exploration Company, D. G. Oliver, Cyril Knight, K. Murray, J. Zione, L. G. Springer, J. Wright, C. F. Rice, and J. Dawson.

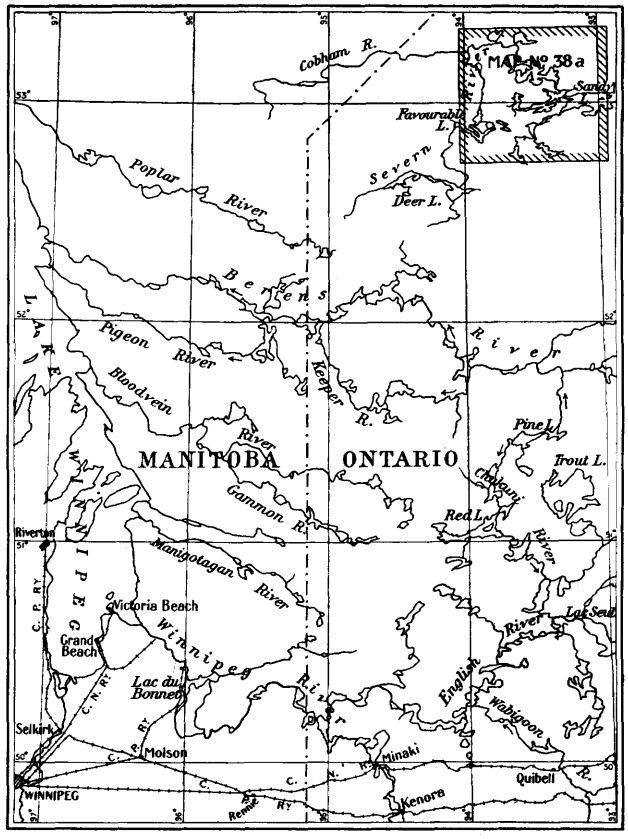
Access

The area dealt with in this report lies in the district of Kenora (Patricia portion) about 230 miles north of Hudson or Sioux Lookout on the Canadian National railway, 120 miles north of Red lake, and 60 miles east of the Manitoba

[1]Ont. Dept. Mines, Vol. XXXV, pt. 4, 1926.

boundary. It comprises an area of roughly 800 square miles contained within the bend made by the Severn river in its course from Favourable lake on the west to Sandy lake on the east. With the exception of the Severn river between Favourable lake and Opasquia lake, none of the territory has been accurately surveyed.

The area may be reached by canoe or, more conveniently, by airplane. The route taken by Douglas in 1925 begins at Red lake and follows the Chukuni, Dowling, Berens, Crooked-mouth, Little Trout, and Severn rivers northward to



Key map showing position of and water routes into the Favourable-Sandy Lakes area. Scale, 60 miles to the inch.

Favourable lake. Shorter and less arduous routes, requiring from two to three weeks travel, are available from Lake Winnipeg via Norway House, Berens river, or Poplar river. Of these, the route via Norway House is much longer, requires more time, but has fewer portages than either of the others. The Berens river, owing to its swifter water and short portages, is the quickest and most travelled route from the area to Lake Winnipeg. The Poplar river is said by prospectors to afford the easiest route for the eastbound trip, particularly when the water levels are high. This route is less frequently used for the westward journey, as steamers plying on Lake Winnipeg do not make regular stops at the mouth of the Poplar river.

The most travelled route from Norway House follows the McLaughlin river and a series of lakes and connecting streams into Island lake, a distance of 175 miles with 32 portages. From the east end of the lake the route, involving 12 more portages, continues up the Sagawitchewan river to its source, across the 4-mile divide into Opasquia lake, and thence by the Severn river into Rat House bay of Sandy lake. This route requires about three weeks of travel.

The Berens river route leads from Lake Winnipeg eastward to Stout lake and thence by the Crooked-mouth, Little Trout, and Severn rivers to Favourable lake. There are 52 portages between Lake Winnipeg and Little Grand rapids on the Berens river and 22 short portages from that point to Favourable lake. The swiftest and most difficult stretch can be avoided by taking the 80-mile wagon road which runs from the mouth of the Bloodvein river on Lake Winnipeg to Little Grand rapids.

The Poplar river route involves 52 portages and, with two men in a canoe, can be covered in ten days from Lake Winnipeg. The river is followed to its source, the divide is crossed into Deer lake, and the Severn river is then taken to Favourable lake.

According to estimates furnished by prospectors, supplies and equipment can be taken into the area by any of the above water routes for about 25 cents per pound.

The area may be reached most quickly and conveniently by taking advantage of the organized boat and airplane services. A daily boat service is maintained by the Red Lake Transportation Company between Hudson and Goldpines during the summer months. This trip requires about 12 hours. From Goldpines or Sioux Lookout, airplanes operated by the Western Canada Airways, Limited, can be taken to the area. The 188-mile hop from Goldpines takes about two hours. The rates charged by this company during the summer of 1928 were as follows:—

CHARTER RATE:
$50.00 per day for use of plane, plus $1.00 per mile travelled. As the distance from Goldpines to Favourable lake and return is 376 miles, the cost of one trip taking one day would be $50+$376=$426.

PASSENGER RATES:
Single fare, Goldpines to Favourable lake, $145.
Single fare, Favourable lake to Goldpines, $75.

EXPRESS RATES AND EXCESS BAGGAGE:
Goldpines to Favourable lake, 50 cents per pound.
Favourable lake to Goldpines, 30 cents per pound.

Previous Work

The first reliable information concerning the Favourable-Sandy Lakes area is contained in a report by A. P. Low[1] who, in 1886, made a reconnaissance survey of the Berens and Severn rivers waterway between Lake Winnipeg and Hudson bay. In this report, Low called attention to the physical and economic features of the territory traversed and also to the occurrence of what he presumed to be a continuous belt of Huronian (now called Keewatin) rocks exposed in the vicinity of Favourable and Sandy lakes and along the Severn river to the east.

No further investigations were made in the area until 1925, when G. V. Douglas examined and mapped more closely the belt of Keewatin rocks on Favourable lake and called attention to the frequent evidence of mineralization occurring in these formations.

[1]Geol. Surv. Can., Vol. II, pt. F. Reprint, Ont. Bur. Mines, Vol. XXI, pt. 2, 1912, pp. 94-106.

The nearest areas in which detailed geological work has been done are: the Red Lake area[1] and the Woman and Narrow Lakes area[2] of Ontario, both situated about 125 miles to the south; and the Island Lake area[3] of Manitoba, which lies about 60 miles to the northwest.

Scope of the Work

As the new "finds" occur some five or six miles east of Favourable lake in hitherto unmapped territory, it was found necessary to construct by compass, micrometer, and pacing a sketch map on which to plot the geology in the vicinity of the deposits. This map extends eastward from Favourable lake to North Wind lake, a distance of 15 miles, and includes the territory adjoining North and South Trout lakes, Setting Net lake, and Rat House bay of Sandy lake.

Owing to the shortness of the field season it was not possible to examine the whole area with the same amount of detail; nor was it feasible, in the limited time, to attempt a separation of the sedimentary and volcanic members comprising the Keewatin-Timiskaming complex. In the vicinity of Setting Net lake, the mapping was done in sufficient detail to distinguish post-Timiskaming intrusions of gabbro-diorite from Keewatin-Timiskaming greenstones and sediments, but elsewhere in the area no such differentiation was attempted.

Several weeks were devoted by the writer to a reconnaissance of the Severn river between Favourable and Sandy lakes. A recent airplane map, compiled by the Topographic Survey of Canada, made it possible to plot the geology along this water route with fair detail and to amplify considerably the observations made by A. P. Low in 1886.

Topography and Drainage

The topography of the area is similar to that in other parts of the pre-Cambrian shield. More or less continuous rocky ridges, with here and there isolated hills, whose concordant crests give evidence of widespread peneplanation, rise from 100 to 250 feet above intervening plains, lakes, or muskeg. The batholithic masses of granite which occupy so much of the area are exposed as ridges and elongated hills having no uniform trend. In the northern part of the area, only occasional bare hills of granite rise above the otherwise monotonously flat terrain intersected by the Severn river. Toward the south the ruggedness of the topography increases and conspicuous ranges of hills mark the skyline in all directions. In the bands of Keewatin-Timiskaming rocks outcropping between Favourable lake and Sandy lake, the intense folding to which these formations have been subjected is reflected in an east-west linear arrangement of the hills. Some of the most prominent elevations in the greenstone belts owe their origin to stocks or dike-like intrusions of gabbro-diorite. Aneroid readings place the average elevation of the area at slightly under 1,000 feet.

The area is drained by the Severn river and its tributaries. After emerging from Favourable lake the Severn flows northward, passing over three small chutes or falls in the first ten miles and then continuing its course between low banks of clay and without perceptible current to the junction with the Cobham river. From this point it turns eastward; after passing the outlets of Angekum (Lost) and Opasquia lakes, it bends sharply to the south and enters Muskrat Dam lake. From the southern extremity of Muskrat Dam lake the river flows

[1]E. L. Bruce and J. E. Hawley, Ont. Dept. Mines, Vol. XXXVI, pt. 3, 1927, pp. 1-72.
[2]J. W. Greig, ibid, pp. 85-110.
[3]J. F. Wright, Geol. Surv. Can., Sum. Rept., 1927, pt. B.

with appreciable current but without rapids or waterfalls into Sandy lake. From Favourable lake to Sandy lake, which lies only 8 miles to the east, the river makes a horse-shoe bend of 60 miles. From the last rapids, ten miles north of Favourable lake, it is navigable for small boats as far as Sandy lake. Below the rapids the water of the river and tributary lakes is turbid with finely divided particles of clay eroded from the banks and shores.

Duck river is the largest tributary of the Severn within the area investigated. It empties into Rat House bay of Sandy lake and drains North Wind, Duck, and many other lakes stretching for miles to the south and east. This is the route most commonly followed by prospectors in reaching the area of greenstones which outcrop in the vicinity of Spirit (Fairy) lake, some 40 or 50 miles southeast of Setting Net lake.

Setting Net lake and several smaller bodies of water to the east are drained by Setting Net creek which flows into the head of Rat House bay. The clear, spring-fed waters of South Trout lake drain into North Trout lake, which in turn empties into the west arm of Sandy lake.

Inhabitants

The area provides hunting and fishing grounds for ten or twelve families of Indians who winter in the vicinity of the Hudson's Bay Company's outpost on the south side of Sandy lake near the entrance to Rat House bay. This outpost is only kept open during the trapping season; hence the nearest point at which supplies can be obtained during the summer months is the Hudson's Bay post and Indian settlement on Deer lake, some 25 miles to the southwest. Owing to the ravages of forest fires in recent years and the consequent depletion of game in the Deer lake region, it is reported that the Hudson's Bay Company will move its post to Favourable lake.

The natives are descendents of Cree and Saulteaux stock and speak a language which is a mixture of both dialects. They make no attempt at agriculture and are content to live in teepees or tents as best befits their roving existence. In common with Indians living farther south and in spite of their slender build, they have the ability to carry enormous loads. Their services are utilized to some extent by the trading companies in transporting freight.

The white population resident in the area during the summer of 1928 consisted of some 30 people engaged in the development of claims or in prospecting. Most of these were transported to and from the area by airplane.

Natural Resources

Climate and Soil

Field work was carried on in the area from the last week in June to the first week in September. During this time the weather was comfortably warm and dry, no severe thunder storms occurred, and frosts did not appear until late in August. During July and August clouds of smoke from forest fires in the vicinity of Favourable, Deer, and Island lakes hung over the district at times. The barometric pressure ranged from a high of 29.3 inches to a low of 28.6 inches, fluctuations of from three to four-tenths of an inch within 24 hours being not infrequent. Occasional heavy rains, lasting from a few hours to two days, normally accompanied a low barometer. The approach of high-pressure areas from the west was marked by strong, steady west and northwest winds, while oncoming low-pressure areas were indicated by prevailing east or southeast

winds. The shallow lakes warm up appreciably during the summer. The temperature of the surface water in the West arm of Sandy lake reached 64° F. on August 16. The normal summer temperature of most of the lakes ranges between 50° and 60° F.

The Severn river intersects an extensive clay belt in its course from Favourable lake to Sandy lake. While much of the belt is low and swampy, considerable stretches of flat, well-drained land suitable for agriculture occur near the outlet of Favourable lake, around the shores of Angekum, Opasquia, and Muskrat Dam lakes, and along the north shore of Sandy lake. The soil has been largely derived from the weathering of stratified glacial clays. It is grey to buff in colour, contains considerable calcium carbonate, and is usually deficient in sand. A dense growth of spruce, poplar, and birch covers most of the arable land. The

Gravel rampart due to pressure of lake ice, Setting Net lake.

growing season is short and subject to summer frosts. The ground within ten inches of the surface of the muskegs is frozen the year round to depths of several feet. The few Indians who live in the area do not plant gardens; hence no information is available concerning the growth of crops in the region. Small fruits such as raspberries and blueberries are native to the area but are poorly developed and do not mature until the middle of August.

Forests

Timber is not particularly abundant in the area. The flat stretches of clay land bordering the Severn river between Favourable and Sandy lakes support a dense growth of spruce, poplar, and birch. Stunted spruce and, more rarely, tamarac grow in the muskeg areas. Alder and willow border the small creeks. The rocky portions of the region are usually bare or sparsely covered with jackpine and a sprinkling of spruce or balsam. The growth on the sand plains and ridges is typically jackpine and poplar and on the burned areas, birch and poplar. Only occasionally does the spruce exceed 10 inches and is usually not more than 4 or 5 inches in diameter. Much of the territory has been burned over, and

large stretches are covered by windfalls. Very little timber suitable for mining purposes is to be found in the immediate vicinity of the prospect workings, although small patches of fair-sized spruce occur along the north shore of South Trout lake and on the large island in the south half of Setting Net lake.

Fish and Game

The waters of the Severn river and lakes lying within the clay belt are turbid and yellowish in colour; hence fishing is best done with nets. In Sandy lake, whitefish, gold eyes, pickerel, pike, and sturgeon are said to be plentiful. In Setting Net lake, pickerel and pike abound and can be readily caught by trolling along the rocky shores. Lake trout are obtained in abundance by migrant bands of Indians from the clear waters of North and South Trout lakes.

Twenty-foot clay bank, Opasquia lake.

No moose and deer were seen in the area by members of the party and, judging by the scarcity of tracks, these animals are comparatively rare. Black bears occasionally appeared in the vicinity of the camps. Rabbits are very scarce. Although no signs of beaver were observed, small fur-bearing animals such as the mink, muskrat, and weasel are said to be quite abundant. The marshy stretches along the Severn river afford excellent breeding grounds for ducks of all kinds, Spruce partridge and ruffed grouse are fairly plentiful.

Water Powers

There are three falls or chutes of 6, 25, and 15 feet, respectively, on the Severn river within ten miles of the outlet of Favourable lake, but for the rest of its course of 50 miles into Sandy lake, the river has no appreciable current or rapids.

The most promising source of power in the area is the Duck river, which has a fairly large and uniform volume and drains a string of lakes stretching far to the southeast. Within a distance of one and a half miles it drops, in two

falls of 50 and 30 feet, from North Wind lake into Rat House bay of Sandy lake. This source of power is only about 6 miles distant from the properties on Setting Net lake.

Between Setting Net lake and the head of Rat House bay, a distance of two miles, the course of Setting Net creek is marked by a series of six short rapids or cascades having a total drop of 60 to 70 feet. Although close at hand, the stream is comparatively small and would not furnish much power.

GENERAL GEOLOGY

The consolidated rocks of the Favourable–Sandy Lakes area are all pre-Cambrian in age. They consist essentially of remnants of a basement complex (Keewatin-Timiskaming?) resting upon and partly surrounded by batholithic intrusions of granite (Algoman?). The bed rock is covered in part by a mantle of unconsolidated material consisting of glacial till, stratified lake clays, and plant remains.

Table of Geological Formations

QUATERNARY

RECENT: Beach deposits, river silts, peat.

PLEISTOCENE: Glacial deposits (boulder clay, outwash sands and silts, stratified or varved clays).

Great unconformity

PRE-CAMBRIAN

POST-TIMISKAMING:

Granite (Algoman?).

Intrusive contact

Gabbro-diorite.

Intrusive contact

KEEWATIN-TIMISKAMING(?):

Igneous-sedimentary complex composed of conglomerate, quartzite, argillite, rhyolite, basalt, pillow lavas, tuffs, amphibolite, chlorite and talc schists, serpentine, iron formation, etc.

Keewatin-Timiskaming(?)

The rocks grouped under this heading comprise the oldest formations in the area. They consist of volcanic rocks and their metamorphic derivatives together with a considerable thickness of sediments. In areas where similar formations occur it has been possible, in some cases, to differentiate between an older, dominantly volcanic group (Keewatin) and a younger sedimentary group (Timiskaming). No such distinction could be made in this area owing to the complex structural and lithological relationships of the rocks and the brief time available for studying them.

The various members of the basement complex have been steeply tilted and, in places, intricately folded and sheared. The general direction of strike is roughly east and west and the prevailing dips are northward at angles of 65 to 80 degrees. That the folding of the Keewatin-Timiskaming rocks had been accomplished prior to the intrusion of gabbro and granite is indicated by the presence of highly contorted inclusions of greenstones and sediments within these intrusives and by the abrupt severing of stretched pebbles at conglomerate-granite contacts.

The Keewatin-Timiskaming rocks occur in two well-defined but comparatively narrow belts separated by 3 to 4 miles of granite. These are referred to hereafter as the Sandy Lake belt and the Favourable Lake belt.

Sandy Lake Belt

The Sandy Lake or more northerly belt of Keewatin-Timiskaming rocks extends eastward from the West arm of Sandy lake along the north shore at least as far as the east end of the lake, a total distance of over 40 miles. It ranges in width from 1 to 4 miles at the west end of the lake and is reported to widen somewhat toward the east. The rocks are well exposed along the steep shores and on the islands in the West arm. Toward the east the bed-rock surface is largely covered by a mantle of stratified clay, and outcrops away from the lakeshore are relatively scarce.

In the time available it was not possible to map the western limit of this belt, but sufficient information was obtained to indicate that it does not form a part of the Favourable Lake belt as was suggested by A. P. Low. As no greenstones were found on the Severn river to the west, it seems probable that these rocks are cut off by granite intrusions just beyond the West arm of Sandy lake. According to prospectors the northern greenstone-granite contact lies from one to two miles inland from the north shore of Sandy lake and the southern contact passes through the middle of the lake. The south shore of Sandy lake is reported to be composed entirely of granite.

In the West arm of Sandy lake, massive basaltic greenstones and pillow lavas occupy the central part of the belt. A band of sediments with conspicuous beds of conglomerate and some iron formation occurs near the southern granite contact. Remnants of sedimentary formations also outcrop along the northern margin of the belt. Rusty streaks and patches, due to weathering of pyrite or pyrrhotite, occur in some of the conglomerate or quartzitic horizons. Such evidence of mineralization was seen at several points along the shore of the large bay opening to the south off the West arm of Sandy lake. Prospectors working on this belt report that the formations on the whole appear to be "tight" and unpromising.

Two isolated patches of greenstone were found to the north of the Sandy Lake belt: one on the Severn river about 4 miles east of the junction with the Cobham river, the other on the south shore of Muskrat Dam lake about a mile west of the outlet.

Favourable Lake Belt

This belt of Keewatin-Timiskaming rocks has been traced from Favourable lake west for 7 miles and east for more than 20 miles. Its ultimate extent is not known, as it continues beyond the limits of the area examined. West of Favourable lake it has a width of 2 to 4 miles. Between North and South Trout lakes it narrows to 1½ miles, widens again to 5 or 6 miles to the east of Setting Net lake, and then narrows perceptibly as it passes out of the area to the southeast.

In the vicinity of Favourable lake the belt consists of fine-grained arkosic or quartzitic sediments together with frequent bands of schistose greenstones and dark fragmental rocks of indefinite origin. At the west end of North Trout lake a wide band of conglomerate terminates sharply at the granite contact. Between North and South Trout lakes the belt is composed largely of dense, massive greenstones together with some black tuffaceous rocks. The area lying between South Trout lake and Setting New creek contains highly metamorphosed sediments, both rhyolite and basic greenstones, and a variety of schists composed

chiefly of mica, chlorite, talc, or serpentine. These rocks are intruded by irregular bodies of gabbro-diorite or hornblendite. To the east of Setting Net creek, massive greenstones, amphibolite, and hornblendic intrusives occupy most of the belt.

Basaltic pillow lava, West arm of Sandy lake.

Volcanic Rocks

Volcanic rocks form an important part of the Keewatin-Timiskaming complex. They are predominatingly dark in colour and basaltic in composition. Acid types, such as rhyolite and quartz porphyry, are more restricted in their

Quartz vein in drag-folded amygdaloid,
Rat House bay, Sandy lake.

distribution and in some cases could not be readily distinguished in the field from dense, siliceous sediments. The basic lavas or typical greenstones occur chiefly as massive flows without conspicuous structure. In some exposures a

pillow or ellipsoidal structure, usually accentuated by weathering, was well developed, while in others scoriaceous or slaggy flow tops were observed. Typical pillow lavas or "snowshoe basalts," as the prospectors call them, occur along the south shore of the West arm of Sandy lake and on some of the nearby islands. Amygdaloidal structure was observed in only a few small outcrops. Tuffs and other fragmental rocks are also represented.

Practically all the volcanic rocks are highly metamorphosed and are now represented by a complex variety of schistose derivatives. This metamorphism appears to be due in part to the intense folding that the formations have undergone and in part to the contact effects that accompanied the intrusions of gabbro and granite. Hornblende schists occupy much of the area to the east of Setting Net lake; talc-carbonate schist outcrops at several points along Setting Net creek and at the head of Rat House bay; irregular bands of serpentine schist

Iron formation, south side of Rat House bay.

occur near the margins of gabbro intrusions between South Trout lake and Rat House bay; and areas of chloritic schists are particularly abundant.

Iron Formation

In many areas of Keewatin rocks, iron formation is a frequent and characteristic member. In the Favourable-Sandy Lakes area its occurrence was noted in two outcrops: one on the south side of Rat House bay about one and a half miles from its head, the other along the shore of the large bay which opens southward from the West arm of Sandy lake. In both instances the outcrops consist of magnetite and silica in alternating bands, which range from one-eighth to three-quarters of an inch in thickness.

Magnetic attraction is particularly strong along the north shore of South Trout lake, especially toward the east end of the lake. The shore line is composed of black tuffs having a slaty cleavage but without the interbedded structure of typical iron formation. The rocks contain an abundance of magnetite, which occurs to some extent in bands but chiefly as disseminated grains.

Sediments

Sedimentary rocks form an important part of the basement complex, remnants of which comprise the so-called greenstone belts that pass through the basins of Sandy and Favourable lakes. Insufficient evidence was obtained in the field to warrant a separation of the sedimentary formations on the basis of relative age. Hence, it is not known just what proportion of these rocks are Keewatin and what, if any, should be considered as Timiskaming in age. The scarcity or absence of greenstone pebbles in the various conglomerate members strongly suggests that they, at least, are not post-Keewatin in age.

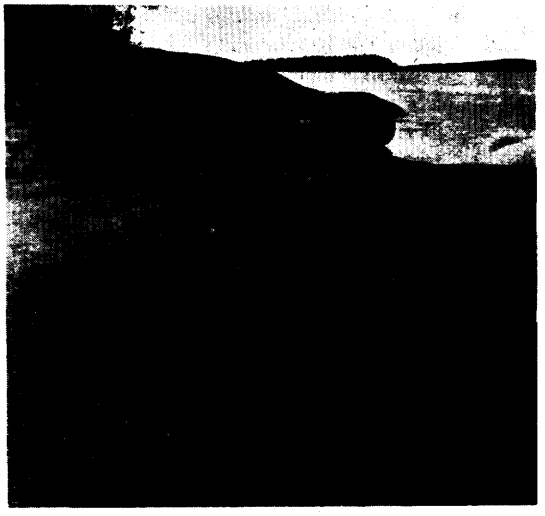
It was especially difficult in the field, in view of the intense metamorphism that has affected all members of the basement complex, to distinguish with any degree of certainty arkosic quartzites and similar sedimentary rocks from rhyolites and allied rocks of volcanic origin. The most conspicuous and easily

Stretched conglomerate, west end of North Trout lake.

recognized members are the conglomerates. These rocks occur in fairly continuous bands or lenses ranging from a few feet to several hundred feet in width. The principal occurrences are briefly described below.

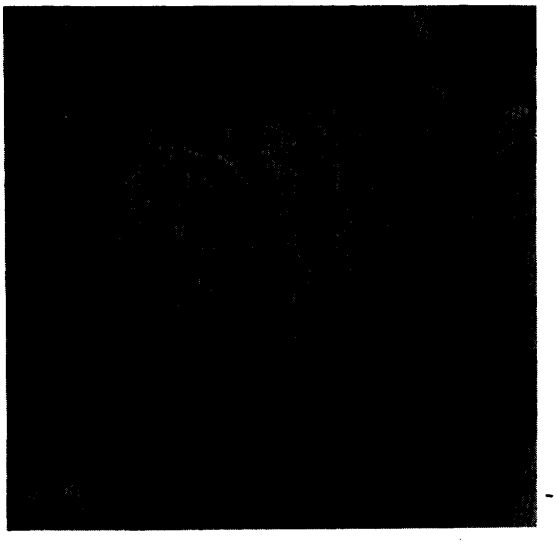
Several bands of conglomerate, reaching a width of 300 feet in places, outcrop between the west end of North Trout lake and the portage leading from South Trout lake to Favourable lake. These beds strike roughly east and west and dip steeply to the north. They grade into finer sediments toward the east and are cut off abruptly by granite toward the west. The pebbles are composed chiefly of granite, quartz, and chert embedded in a dark, sandy matrix. They reach a length of 10 inches and a diameter of 4 to 6 inches, are closely packed, and are usually well rounded. The granite pebbles are characteristically light-coloured and contain only inconspicuous amounts of biotite or hornblende. In this respect they differ noticeably from the types of granite now found in the area, a fact which suggests that they must have been derived from pre-existing granite highlands of which no trace remains. As a consequence of the squeezing

and folding that these formations have undergone, the pebbles have become elongated and ellipsoidal in shape and are aligned with their long axes vertically rather than horizontally parallel to one another. Not infrequently such stretched



Etched conglomerate, south side of West arm, Sandy lake.

pebbles are cut off sharply by granite; hence it is assumed that much of the folding and deformation that the conglomerate and other members of the basement complex have undergone antedated the granite intrusions.



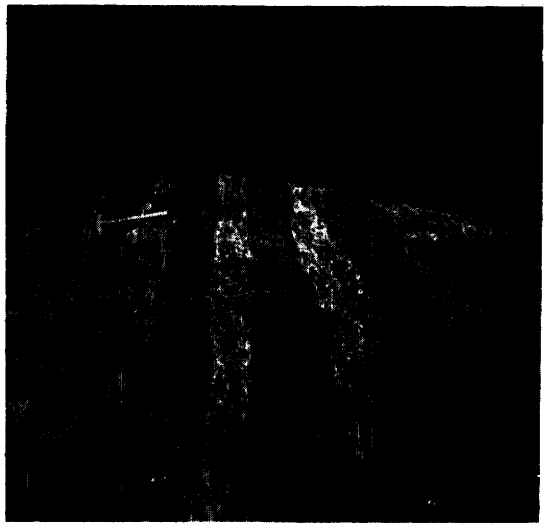
Banded sediments, north side of West arm, Sandy lake.

A narrow band or series of lenses of conglomerate runs north and south near the east margin of the gabbro-diorite intrusion extending from Borthwick

lake across claims Pa. 117 and 120. This band is closely associated with beds of argillite and quartzite; the pebbles are composed chiefly of granite and chert.

A conspicuous band of conglomerate, in places 200 feet wide, outcrops in the large bay that opens to the south off the West arm of Sandy lake. This bed can be traced for a mile or more, through occasional islands, from east to west across the bay. It stands vertically or dips steeply to the north. The pebbles are usually less than 2 inches in length and are not greatly squeezed or elongated. They consist chiefly of chert and granite. Rusty patches and zones, due to the weathering of pyrite or pyrrhotite, occur at several points along this belt.

It is thought that fine-grained sediments form an important part of the greenstone belts, but their identification is rendered uncertain and difficult owing to the intense metamorphism that has changed or even obliterated the original characteristics of such rocks. When coarse sediments were lacking it was often impossible to decide, in the field, whether dense, siliceous members



Lit par lit injections of gabbro in sediments, north side of West arm, Sandy lake.

were sedimentary or volcanic in origin. Bands of fine-grained sediments, chiefly arkosic and micaceous quartzites, greywackés, and argillites occur in the vicinity of Favourable lake; near the west end of South Trout lake, between South Trout lake and Setting Net lake, and at various points along the north and south shores of the West arm of Sandy lake.

A small outcrop of grey, crystalline limestone is exposed on the west side of Setting Net creek at the head of the second rapids below Setting Net lake. It is not known whether this represents a distinct calcareous sediment or simply an alteration product of metamorphosed greenstone. The presence of considerable talc-carbonate schist farther north on the creek suggests that the latter explanation is the more plausible one.

Basic Intrusives

The belts of Keewatin-Timiskaming greenstones and sediments include many stocks and dike-like bodies of later intrusives. These consist chiefly of coarse-grained basic rocks, such as gabbro, diorite, and hornblendite. That these

bodies are intrusive is indicated by the following characteristics: (1) remnants or xenoliths of greenstones and sediments "floating" within them, (2) *lit par lit* injections into older rocks, (3) chilled or fine-grained contacts, (4) contactmetamorphism of adjoining rocks, (5) mineralization of adjoining or included rocks.

That the gabbro-diorite intrusions antedated the batholithic invasions of granite seems evident from the following facts: (1) Fragments of brecciated gabbro occur in the granite where these rocks are in contact; (2) in places, tongues of granite penetrate the basic intrusives; (3) the granite at contacts is fine-grained or chilled; (4) numerous gash veins consisting of quartz, thought to have been derived from the granite, occupy tension cracks in the basic intrusives.

It is not known whether the intrusions represent an early basic differentiate of the granitic magma or whether they belong to a much older and unrelated period of irruption.

Gabbro fragments in granite near contact, west of Setting Net lake.

In the field, some difficulty was experienced in differentiating intrusive bodies of gabbro-diorite from older metamorphosed greenstones or amphibolites of similar appearance. Such a distinction has only been attempted in the area about the north end of Setting Net lake. In this area the gabbro-diorite bodies form prominent hills and ridges, the most conspicuous being Diabase hill situated about a mile north of the camp of the Favourable Lake Mines.

The basic intrusives are typically massive, dark-green in colour, and medium to coarse in texture. Microscopically they show considerable variation. In the dioritic types, the dominant dark-coloured constituent is hornblende which, in some cases, is present in such abundance that feldspar is scarce or lacking and the rocks are more properly called hornblendites.

Intrusions of highly altered gabbro occur near the Favourable Lake Mines and on the adjoining Zione property. A sample from an exposure at the northwest corner of claim Pa. 117 was examined in thin section. The microscope shows the rock to be composed essentially of plagioclase feldspar hornblende secondary after augite, and calcite filling cracks traversing the feldspar.

A sample from the body of slightly sheared hornblendite which forms Diabase hill was examined microscopically. It consists of coarsely crystalline hornblende and shreds of actinolite. Feldspar is absent. The hornblende contains here and there cores of augite and, where sheared, has itself given rise to a fibrous network of actinolite.

Comparatively unaltered gabbro occurs in a sill-like body in the vicinity of the Oliver showings near the east end of South Trout lake. Examination under a microscope shows that the rock is composed of augite, labradorite, biotite, chlorite, and magnetite.

Intrusions of hornblende diabase or diorite occur on the Oliver claims at the northeast end of Setting Net lake. The microscope shows the rock to consist chiefly of hornblende and basic plagioclase with minor quantities of quartz, biotite, magnetite, and pyrrhotite.

Granite-conglomerate contact, west end of North Trout lake.

In places sufficient magnetite and pyrrhotite are present in the gabbro-diorite bodies to render compass readings unreliable. These minerals, together with pyrite and chalcopyrite, are occasionally concentrated in small patches or zones along contacts with the older greenstones or sediments.

Granites

The volcanic and sedimentary rocks comprising the Favourable lake and Sandy lake belts are bordered on the north and south by granite. These rocks appear to occupy longitudinal depressions on the surface of the underlying granite. They represent remnants of once more extensive formations which have been partially engulfed by the granite intrusions and partially removed by erosion. The hybrid character of the granitic rocks in many places, the presence of greenstone inclusions within the granite, and contacts marked by *lit par lit* injections, all confirm the idea that the older rocks have been extensively assimilated and are now "floating" on a sea of granite.

Here and there small bosses of granite occur within the greenstone belts. The largest of these extends southeast from the outlet of Setting Net lake and is roughly two miles in diameter. A much smaller body outcrops about half a mile north of the Favourable Lake Mines. The presence of such bodies is evidence of the uneven surface of the underlying batholithic mass of granite and suggests that the mantle of greenstones is comparatively thin.

The granitic rocks vary somewhat in colour, texture, and structure. The predominating type is a rather dark grey, medium to coarse grained, biotite granite showing a faint gneissic structure. Quartz is not abundant and is usually grey, bluish, or smoky in colour. This rock forms conspicuous ridges along the south shore of Setting Net lake, along the north shore of North Trout lake, and in the vicinity of Opasquia and Muskrat Dam lakes.

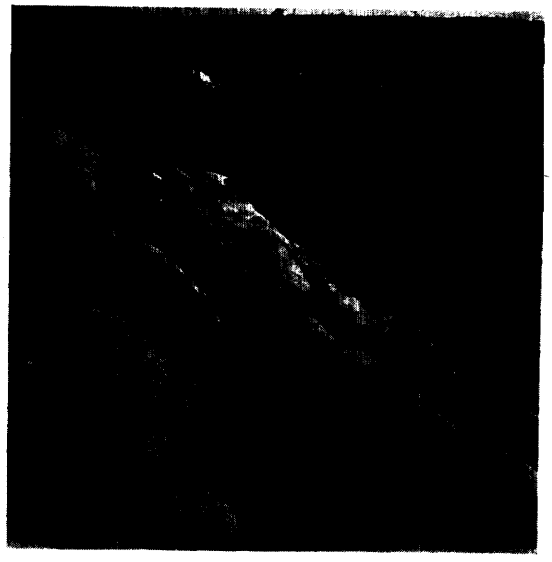
The grey granite has been cut by bodies of pink granite and associated dikes of pegmatite. This can be observed in a number of places but particularly along the north shore of North Trout lake and in the ridges to the west and

Pegmatite dike (P) cutting grey granite, north side of North Trout lake.

south of Setting Net lake. The granite is light in colour and medium to coarse in texture. It shows no gneissic structure and consists chiefly of pink orthoclase and quartz with subordinate amounts of biotite. Pegmatite dikes, usually from 4 inches to 2 feet in width, are frequently associated with the larger bodies of pink granite from which they extend like tongues into the surrounding grey granite. They are composed of coarsely crystalline orthoclase or microcline along the margins, grey quartz in the centre, and occasional scattered flakes of muscovite.

It is thought that the intrusions of grey and pink granite belong to the same general period of igneous activity but represent separate phases of it. Presumably differentiation of the parent magma resulted in the formation of two fractions: a major relatively basic portion, represented by the earlier intrusions of grey granite; and a minor acidic portion or residue intruded later and represented by the bodies of pink granite and pegmatite dikes. It is thought that the gnessic structure of the grey granite is due largely to flowage just prior to consolidation rather than to subsequent regional metamorphism. Furthermore, it is thought that the later and more acid intrusions of granite are respon-

sible for much of the mineralization in the area, particularly where extensive silicification has taken place.



Lit par lit injections of granite in greenstone, northeast side of the peninsula, Favourable lake.

The greenstone-granite contacts are frequently marked by the development of hybrid granitic rocks, amphibolites, gneissic banding, and *lit par lit* injections. Such features are well developed to the west of the narrows of Setting Net lake and along the northeast side of the long peninsula in Favourable lake. Con-

Inclusion of greenstone in granite, Rat House bay, Sandy lake.

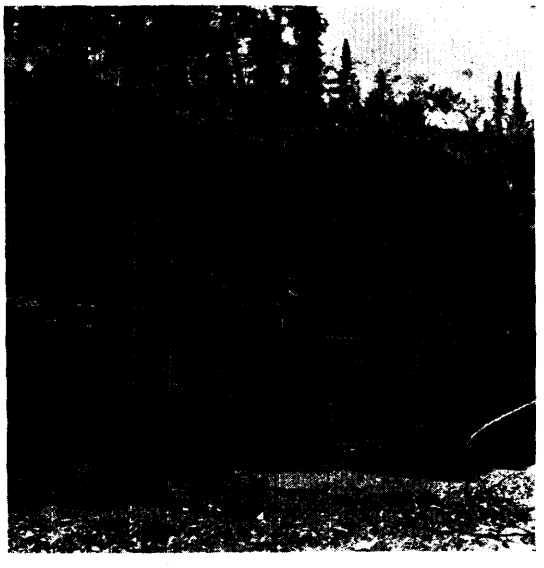
siderable areas of hybrid granite with partially assimilated inclusions of greenstone occur along the shores of Opasquia and Muskrat Dam lakes and in Rat House bay of Sandy lake.

Pleistocene

The movement of ice over the area as shown by glacial striae was roughly S. 45° W. (mag.). Rock ridges and hummocks have been rounded, striated,

Glacial striae in chlorite schist, West arm of Sandy lake.

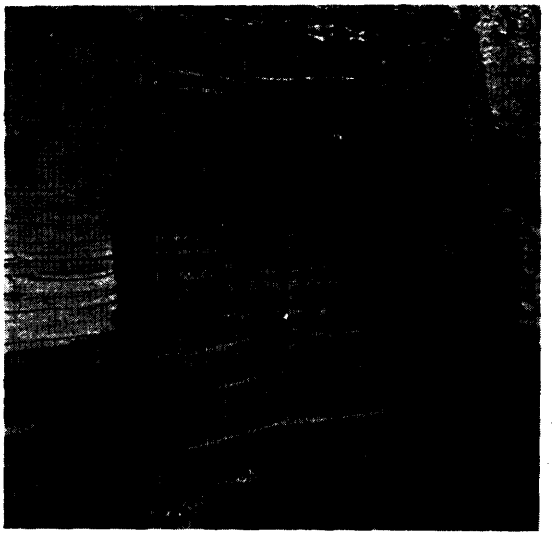
and denuded of soil on their northeast slopes. On the lee or protected southwest slopes, the bed rock is usually covered with deposits of boulder clay or till, which



Stratified glacial lake clay, west side of Angekum lake.

tail out in the direction of glacial advance. Such slopes afford the best sites for springs or wells. Morainal deposits are confined to low knolls rising here and there above outwash plains of sand and silt.

In the northern part of the area, especially along the Severn river north of Favourable lake and surrounding Angekum, Opasquia, Muskrat Dam, and Sandy lakes, extensive deposits of stratified clays cover the low ground and occupy the depressions between the rock ridges. These deposits range in thickness from a few feet to 30 feet, the thickness increasing toward the east or more deeply submerged portion of the area. Where the clay banks have been freshly eroded by wave action, the banded or varved character of the material is at once apparent. The light and dark bands together have an average thickness of about an inch, although the seasonal layers diminish to paper-like thinness near the top of the deposits. In some exposures more than 100 yearly bands could be counted. It is thought that these clays were laid down in a large glacial lake which covered most of the Favourable-Sandy Lakes area and the territory



Varved clay, west side of Angekum lake.

adjoining the Severn river to the east. As varved clays, according to J. F. Wright,[1] do not occur in the vicinity of Island lake, it is believed that the glacial lake did not extend far to the northwest of Angekum lake but probably followed the retreating ice-front to the northeast. Whether these clays were laid down in an arm of glacial lake Agassiz or in a separate body of water has not been determined as yet.

A sample of these clays was examined by R. J. Montgomery, of the Ceramics Department, University of Toronto, whose report is given on another page.

ECONOMIC GEOLOGY

Mineralization in the Favourable-Sandy Lakes area is confined to the belts of Keewatin-Timiskaming rocks described above. The surrounding masses of granite appear to be barren. Mineral deposition is usually indicated by rusty patches or zones due to the weathering of pyrite or pyrrhotite. Mineralization was observed (a) at or near greenstone-gabbro contacts, (b) in inclusions of

[1]Personal communication.

greenstones or sediments in gabbro-diorite, (c) at greenstone-granite contacts, (d) in quartz veins in gabbro or greenstone, (e) along fracture zones in acidic volcanics.

The last type, represented by the mineralized zones on the property of the Favourable Lake Mining and Exploration Company, has so far proved of most importance. Most of the deposits owe their origin to a combination of fissure filling and replacement.

It is thought that the later and more siliceous intrusions of granite rather than the bodies of post-Keewatin gabbro-diorite were the principal source of mineralization in the area. This conclusion is suggested by the observations cited below:—

1. With the exception of the granite there are no rocks in the area which are acidic enough to be the source of the silicification usually associated with the mineral deposits. Of the granites present, the later pink variety is more highly siliceous than the older grey granite.

2. A gold-quartz vein containing galena and other sulphides was found on the Zione property filling a fracture within a body of gabbro-diorite. The fracturing and mineralization obviously took place after the basic intrusive had solidified.

3. On the Oliver claims, the granite-greenstone contact is silicified and contains molybdenite, a mineral characteristically associated with granitic rocks.

4. Zones containing contact-metamorphic silicates, such as garnet and epidote, as well as molybdenite and other sulphides, were found in the greenstones at several points within a short distance of the granite contact.

It is thought that some of the pyrrhotite-chalcopyrite zones in which silicification is lacking may owe their origin to gabbro-diorite intrusives, especially as pyrrhotite is an original and frequent constituent of these rocks.

After an active season of prospecting, the gold-silver-lead-zinc-bearing zones on the property of the Favourable Lake Mining and Exploration Company appear to be the most promising deposits so far discovered in the area. While indications of mineralization occur at many points, none of these has proved large enough or rich enough to have any economic significance at the present time. Native gold has been found in at least two places, on Gold hill and on the Zione property west of Borthwick lake, but these occurrences are only of mineralogical interest. Argentiferous galena occurs in narrow veins to the west of Favourable lake. Zones containing pyrite and pyrrhotite, often with some chalcopyrite or sphalerite, have been found in a number of places, but the deposits are low-grade and erratic. Other mineral occurrences of minor importance are as follows: asbestos in narrow veinlets in greenstone between Rat House bay and North Trout lake; molybdenite in scattered flakes at the granite-greenstone contact on the Oliver claims; black tourmaline in a zone traversing hornblendite half a mile east of Gold hill; allanite in a quartz vein in greenstone on the east side of Setting Net creek; tetradymite associated with native gold in a quartz vein on the Zione property; and small outcrops of iron formation on Rat House bay and the West arm of Sandy lake.

Immense deposits of stratified glacial clays occur in the northern part of the area. These offer the most favourable agricultural possibilities within the region. Tests show that the material is suitable for the manufacture of common buff or possibly face brick and drain tile; but owing to its remoteness, it has no economic value at the present time.

Description of Properties

Favourable Lake Mining and Exploration Company

The discovery that is chiefly responsible for the recent interest in the Favourable-Sandy Lakes area was made by K. Murray, who, in December, 1927, staked nine claims in the vicinity of the deposit. The ground was optioned to F. M. Connell, J. H. C. Waite, and associates, who later organized the Favourable Lake Mining and Exploration Company to take over and develop the property. Work was carried on under the direction of Walter H. Woods, resident engineer.

The property lies about two miles northwest of Setting Net lake and about three-quarters of a mile south of the head of Rat House bay of Sandy lake. Men, supplies, and equipment were brought from Goldpines in planes operated by the Western Canada Airways, Limited, and landed at the north end of Setting

Camp at the Favourable Lake Mines.

Net lake. From this point all freight was taken by canoe two miles down Setting Net creek and then packed over a trail for a third of a mile to the camp.

Four mineralized zones have been discovered on the property so far. The best showings occur in low ground where outcrops are relatively scarce and where the bed rock is covered by several feet of frozen muskeg. As excavations in this material soon become filled with water, it was decided that further information concerning the character and continuity of the deposits could best be obtained by diamond-drilling. By July 20, 1928, a gasoline drill (Sullivan Bravo 300) was in operation, and 18 holes, for a total of 2,145 feet, were put down on the No. 1 zone before work for the season was discontinued about the end of September. In April, 1929, drilling operations were resumed with two machines, and 17 holes, for a total of 3,244 feet, were put down on No. 1 and No. 3 zones. On completion of this work in July, the claims were surveyed and operations on the property were again discontinued.

Transportation charges on all supplies and equipment landed on the property amounted to 54 cents per pound. The gasoline consumed cost $6 per gallon.

The following itemized statement of drilling costs was supplied by the company:—

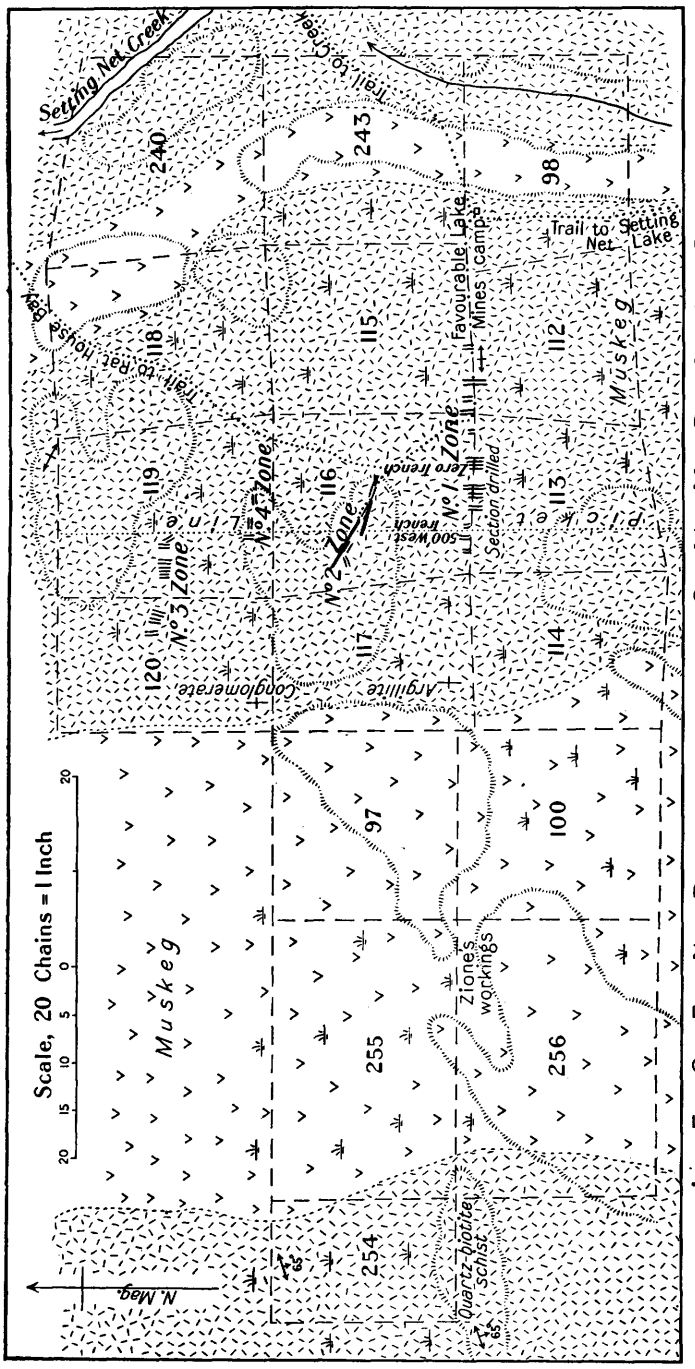
Labour	$1.39
Carbon	1.24
Gasoline	1.34
Oil and grease	.07
Transportation of crew from steel and return	.67
Cookhouse loss	.24
Total operating cost per foot	$4.95
Office, overhead and depreciation	1.54
Drill bits	.02
Complete cost per foot	$6.51

The operating cost of $4.95 per foot compares very favourably with the expense of similar exploration in more accessible areas. The complete cost of $6.51 per foot includes a liberal allowance for depreciation, which is based on a life for the drill of 15,000 feet.

The areal geology in the vicinity of the property consists essentially of a band of highly altered Keewatin rocks, about half a mile wide, lying between parallel intrusions of gabbro-diorite. These relationships are shown on the accompanying map. A small body of granite or granodiorite outcrops about half a mile north of the showings, and the main granite intrusions lie about one and a half miles to the west. The prevalence and magnitude of the gabbro-diorite and granite intrusions in the area suggest that the Keewatin rocks do not extend to great depths.

The Keewatin formations appear to strike north and south although the conspicuous and prevailing direction of schistosity is east and west. Along the eastern gabbro-diorite contact the rocks consist of black argillite and quartzite with occasional patches of conglomerate. In the vicinity of the workings the formations are highly silicified and altered. They consist of fine-grained, slightly schistose rocks, which resemble impure quartzite or metamorphosed rhyolite in appearance. They are light to dark grey, yellow-green, or black in colour. Thin sections of these rocks were made from drill cores and chip samples. Under the microscope they show a mosaic of fine quartz grains which constitute from 75 to 90 per cent. of the whole. Feldspars are conspicuously scarce or absent. Biotite is the principal ferromagnesian constituent and occurs in disseminated brown flakes. Sericite, chlorite, calcite, and pyrite are present in varying but minor amounts. Only occasional grains of garnet, formed probably during an earlier period of metamorphism, have survived the intense silicification that has so affected all the rocks. While very little evidence of porphyritic texture can be discerned in the thin sections, it is thought that occasional nests of clear quartz grains mark the site of former phenocrysts. The feldspathic and femic minerals have been replaced by quartz, biotite, sericite, chlorite, and calcite, an association which suggests that the original rocks were probably rhyolite or quartz porphyry.

Mineralization occurs along fracture zones intersecting the silicified and altered rocks described above. These zones are, for the most part, without definite walls and are subject to considerable variation along the strike. The mineralized portions are marked by increased silicification, prevalence of sulphides, and in places by the development of actinolite, garnet, and calcite. The ore values consist chiefly of gold and silver associated with pyrite, galena, sphalerite, and chalcopyrite. In general, the silver content exceeds in value that of the gold. Diamond-drilling on the No. 1 zone indicated that the mineralization is not uniform throughout but occurs rather in lens-shaped concentra-



SKETCH MAP OF WORKINGS AND GEOLOGY ON THE PROPERTY OF THE FAVOURABLE LAKE MINING COMPANY.

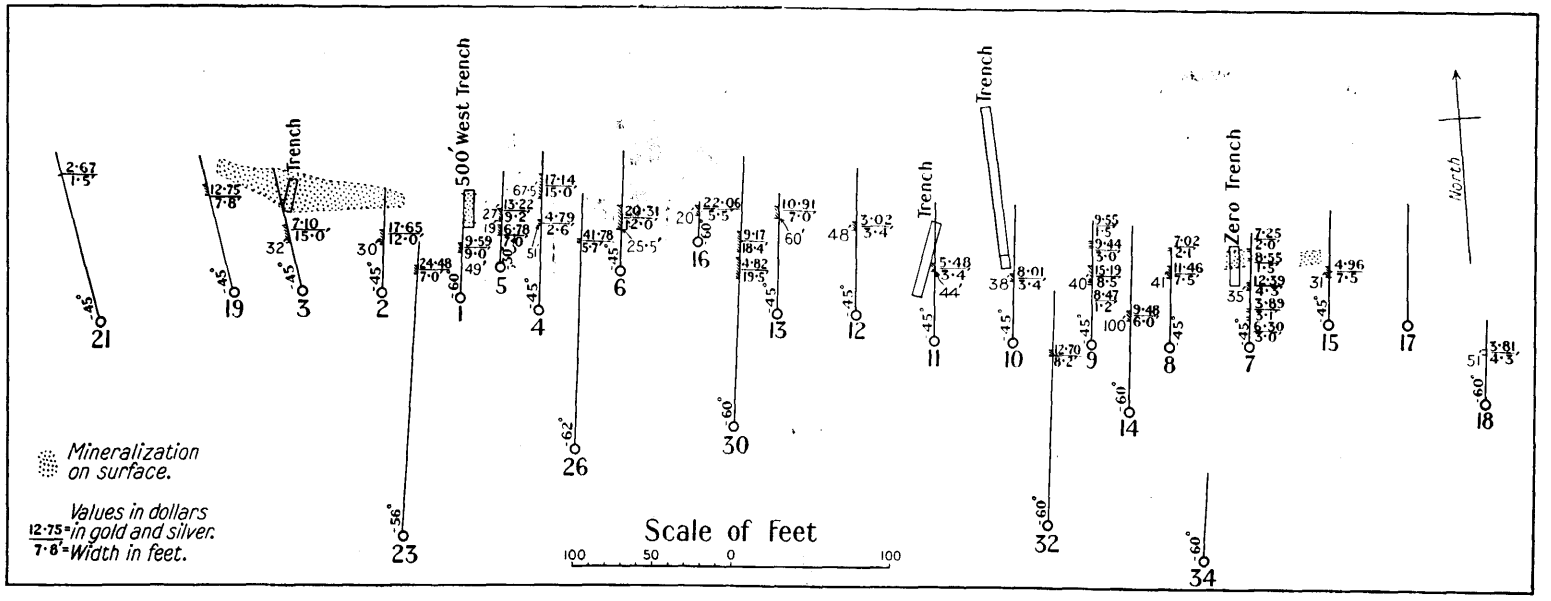
tions. The four mineralized zones so far discovered on the property are briefly described below.

No. 1 Zone.—Development work to date has been largely concentrated on this zone. As indicated in the surface workings and by diamond-drilling, the mineralization is not continuous throughout the zone but occurs in lens-like patches along an east-west line of fracturing in silicified rhyolite or quartz porphyry. As the mineralization dips to the south, drill-holes were driven northward at angles of 30, 45, and 60 degrees to intersect the vein matter at depths of 30 to 240 feet below the surface. Twenty-five holes, spaced at intervals of 50 feet or less, were put down within a length of 900 feet. The vein widths and corresponding values in gold and silver obtained from drill-core assays are shown on the accompanying plan furnished by Walter H. Woods, resident engineer of the Favourable Lake Mining and Exploration Company.

Diamond-drill in operation on No. 1 zone, Favourable Lake Mines.

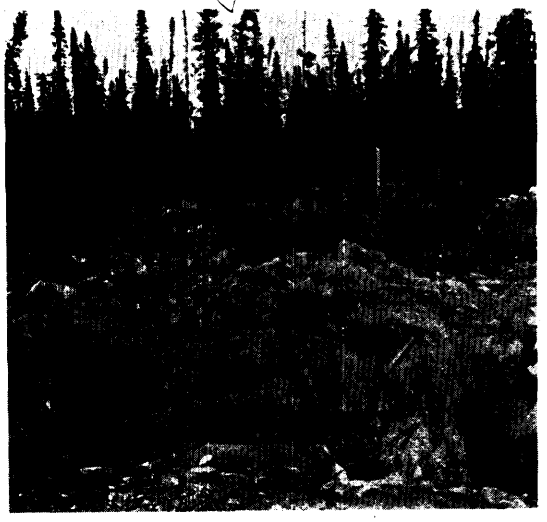
At the "zero" trench, a brecciated zone about 8 feet wide intersects black rhyolite or silicified greenstone. It strikes N. 75° E. (mag.) and appears to dip steeply to the southeast. The zone consists of white, sugary quartz in a plexus of veinlets, dark fragments and streaks of country rock, and disseminated grains or patches of sulphides. Definite walls are lacking. The mineralization consists essentially of the following, in order of abundance: pyrite, sphalerite, galena, chalcopyrite, actinolite, and garnet. The following surface assays, furnished by Walter H. Woods, were secured from this trench: $15.08 in gold and silver across 6 feet 8 inches, or $10.54 across 8 feet 10 inches. A check sample yielded $19.32 in gold and silver across 6 feet 8 inches, or $13.03 across 8 feet 10 inches. The combined lead and zinc values were 4.1 per cent. across 6 feet 8 inches.

At the "500 west" trench, a mineralized zone about 20 feet in width has been exposed by trenching through muskeg. It occurs in grey, silicified rhyolite or altered porphyry. There is less evidence of fracturing at this point, and quartz stringers are relatively scarce. Sulphides form only a small percentage



PLAN SHOWING RESULTS OF DIAMOND-DRILLING ON NO. 1 ZONE, FAVOURABLE LAKE MINES.

of the zone. They occur as patches, streaks, or disseminated grains, due to replacement of the country rock, or as veinlets and stringers occupying fractures in it. In order of abundance they are: sphalerite, galena, pyrite, pyrrhotite, and chalcopyrite. The development of actinolite and garnet is less marked at this point than at the "zero" trench. Surface assays, furnished by Walter H. Woods, were obtained from this trench as follows: $14.45 in gold and silver across 18 feet 11 inches; with two sections carrying 1.44 per cent. lead and 8.84 per cent. zinc across 30 inches, and 2.61 per cent. lead and 7.95 per cent. zinc across 50 inches, respectively.



"Zero" trench, No. 1 zone, Favourable Lake Mines.
This marks the original discovery.

Diamond-drilling done in 1928 indicated the presence of three mineralized lenses. The following composite estimate of the length, width, and assay values of each of these lenses was furnished by Walter H. Woods.

	Length	Width	Gold and silver
	feet	feet	
West end	350	10.6	$14.45
Centre	100	3.4	4.25
East end	250	6.2	10.40

In the spring of 1929, additional drilling (holes Nos. 19, 21, 23, 26, 30, 32, 34) was done on this zone. Two holes put down at the west end of the deposit showed that the mineralization did not extend much farther in that direction than the previous work had indicated. In the deeper holes spaced at intervals along the zone, the vein matter was found to be contained in sericite schist, whereas near the surface the wall rock is chiefly rhyolite. In the schist formation the mineralization showed a sharp contraction in width, a condition which was offset, in part, by greater concentration of values.

No. 2 Zone.—This zone lies about 12 chains north of the No. 1 zone. Stripping and trenching have exposed two lens-like bodies of quartzose material lying between walls of dark greenstone. The more easterly lens has an average width of about 4 feet and can be traced for 25 feet in an east-west direction. Some 50 feet to the west, a second lens, about 5 feet in width, is exposed for 35 feet. In both cases the vein matter is composed of white sugary quartz, actinolite in streaks and radiating needles, some carbonate, and a sprinkling of sulphides, chiefly pyrite, sphalerite, galena, and chalcopyrite. Native silver was found in a veinlet occupying a cross-fracture in the more westerly lens. This veinlet is composed of drusy quartz and crystals of pyrite, and was evidently formed after

West end of No. 2 zone, Favourable Lake Mines.
The hammer marks the cross-fracture
containing native silver.

the main mineralization. The occurrence is chiefly of mineralogical interest, as no native silver was found elsewhere on the property.

Sampling was done at two points, 95 feet apart, on the zone. The assay returns, according to Walter H. Woods, were as follows:—

East end, $19.74 in gold and silver, across 50 inches.
West end, $9.56 in gold and silver, across 45 inches.

No. 3 Zone.—This is the northernmost showing on the property and lies about 33 chains north of the No. 1 zone. It intersects a dark-coloured silicified greenstone of rhyolitic composition. The country rock along the line of fracturing is brecciated and altered to a yellowish-grey silicified material. The principal showings occur in two trenches 65 feet apart (see plan). In the East trench, a mineralized zone 8 to 10 feet in width, striking N. 60°-70° E. (mag.), has been exposed. In the West trench similar mineralization extends across 12 to 15 feet. While these concentrations lie along the same "break," they do not appear to be continuous along the strike and hence are thought to represent separate lenses. The vein matter in both cases consists of streaks and bands of bleached country rock separated and cut by numerous patches and veinlets of white

sugary quartz. Sulphides, in streaks and occasional solid patches, considerable chlorite, and some garnet are also present. Sphalerite is the most abundant of the sulphides. Pyrite, chalcopyrite, pyrrhotite, and galena occur only in minor amounts.

The following assays, obtained from sampling the trenches referred to above, were supplied by Walter H. Woods:—

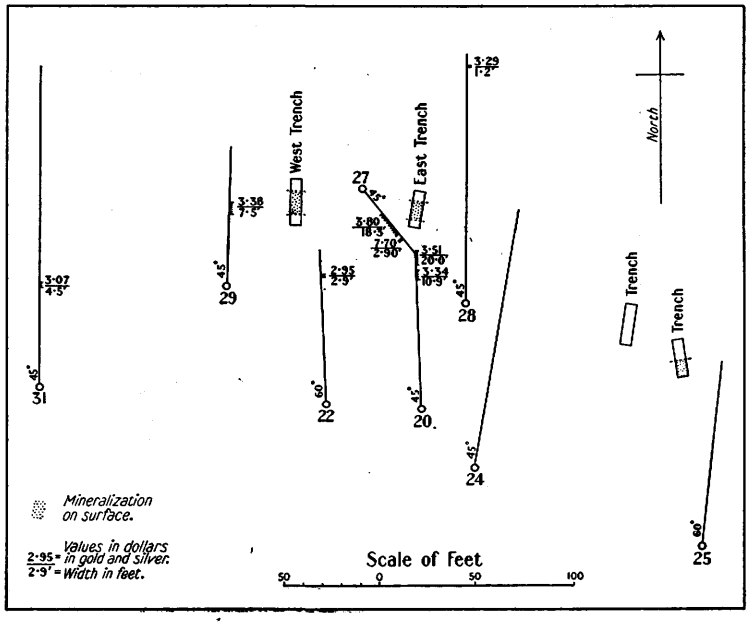
EAST TRENCH:

$9.79 in gold and silver, 2.97 per cent. lead, and 8.54 per cent. zinc, across 8 feet 3 inches. A check sample on the above gave $6.43 in gold and silver, 3.11 per cent. lead, 10 per cent. zinc, across 8 feet 3 inches.

WEST TRENCH:

$4.01 in gold and silver, 0.3 per cent. lead, 6.59 per cent. zinc, across 11 feet.

During the spring of 1929, this zone was further investigated by diamond-drilling. Eight holes were put down in the vicinity of the surface showings, seven being directed toward the north and one toward the south. The vein widths and corresponding values in gold and silver are shown on the accompany-



Plans showing results of diamond-drilling on No. 3 zone, Favourable Lake Mines.

ing plan furnished by the Favourable Lake Mining and Exploration Company. The drilling indicated that the mineralization at the surface had little extension in length or depth. Moreover, the vein matter, where intersected at depth, was of low grade.

No. 4 Zone.—This zone lies about 22 chains north of the No. 1 zone. Stripping and trenching have exposed mineralization ranging in width from a few inches to 7 feet over a distance of 60 feet. The zone runs N. 85° E. (mag.) and intersects a dark-green to black volcanic flow, which is brecciated and intensely silicified. The vein matter has a streaked appearance and consists of a plexus of quartz veinlets, patches and bands of country rock, some actinolite, garnet, and calcite, and occasional patches of sulphides. The sulphides are

chiefly sphalerite and pyrite, with minor amounts of galena and chalcopyrite. This zone was not sampled.

Summary.—Four parallel, mineralized zones, situated about 10 chains apart, have been discovered so far on the property. They lie along lines of fracture which trend roughly east and west and intersect Keewatin rocks consisting chiefly of highly altered and silicified rhyolite. Brecciation of the country rock has occurred along the lines of fracturing, and the spaces so formed have been filled by irregular patches and veinlets of white sugary quartz. Silicification has been accompanied or preceded in places by recrystallization of the rock constituents to form actinolite, garnet, and calcite. Mineralization is not continuous throughout the zones but occurs in lens-shaped concentrations, which are erratic both in occurrence and extent. In the mineralized portions, the ore minerals occur as

No. 4 zone, Favourable Lake Mines.

patches, streaks, or scattered grains replacing the silicified country rock or enclosed in veinlets of quartz. They are usually intimately mixed, although sphalerite predominates; galena and pyrite are less abundant; chalcopyrite and pyrrhotite occur more sparingly still.

Taken as a whole, the percentages of zinc and lead are low. No native gold has been definitely identified in any of the showings. It is thought that the gold values are either contained in pyrite or chalcopyrite, or that the metal is present in a very finely disseminated state. Native silver occurs in a narrow cross-fracture in the No. 2 zone but has not been found in any of the other showings. It is believed that the silver content of the ores is associated with galena. Although tellurides have not been identified in the ore, it is possible that they occur, especially since bismuth telluride (tetradymite) and native gold are associated on the nearby Zione claims.

Oliver Properties

The interests represented by D. G. Oliver carried on intensive prospecting on two groups of claims, one on Setting Net and the other on South Trout lake.

Setting Net Lake.—This group, consisting of 26 unsurveyed claims, is situated on the east side and at the north end of Setting Net lake. About 2,000 feet of stripping and trenching were done on the property during the summer. The location of this work and the areal geology in the vicinity of the claims are shown on the accompanying sketch map. Owing to the similarity in appearance of metamorphosed greenstones (amphibolites) and basic intrusives, the formation boundaries as shown must be considered largely tentative.

The claims embrace an area of basic greenstones and hornblende schists (Keewatin) which have been intruded by irregular bodies of diorite and hornblendite. These rocks lie along the western margin of a still later intrusive mass of granite, roughly two miles in diameter. Metamorphism induced by this intrusion is thought to have played a part in the development of the hornblende schists.

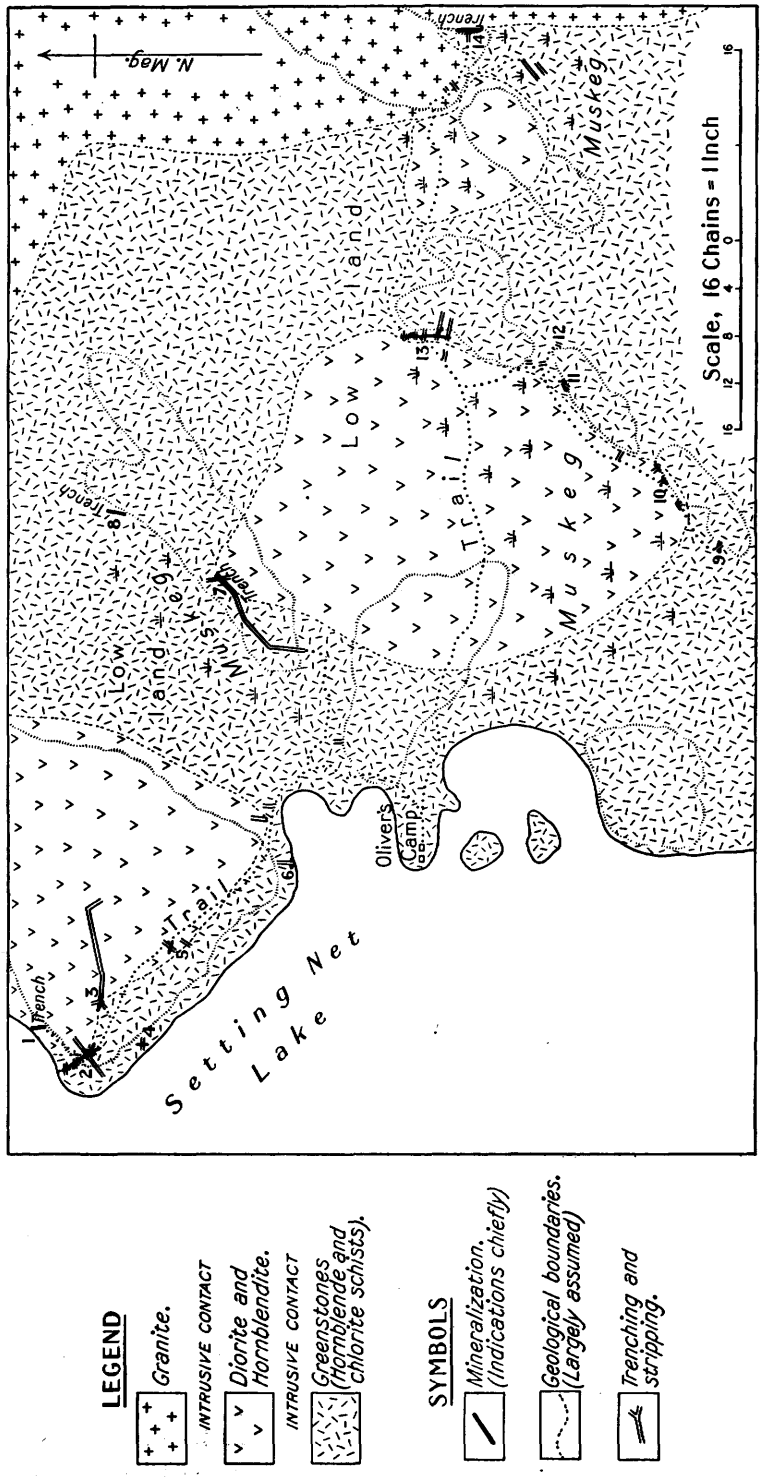
The Oliver camp, Setting Net lake.

Rusty patches or zones sparsely mineralized with pyrite, pyrrhotite, and chalcopyrite have been uncovered in various parts of the property. This mineralization occurs chiefly at or near contacts between greenstones and basic intrusives or between greenstones and granite. The principal showings are indicated on the accompanying map and are briefly described below.

At 1, a silicified zone 10 to 15 feet wide, striking N. 15° E. (mag.), occurs along a greenstone-diorite contact. It has been stripped for about 100 feet. The mineralization consists chiefly of pyrite with minor amounts of pyrrhotite and chalcopyrite.

At 2, a silicified zone 5 to 18 feet wide, striking N. 30° W. (mag.), has been crosscut by several trenches over a length of about 300 feet. As much as 8 feet of glacial drift covers the bed rock in places. The zone consists of sheared greenstone with several feet of quartz and occasional streaks of epidote. Pyrite, chalcopyrite, and pyrrhotite occur disseminated throughout the zone.

At 3, a mineralized patch about 20 feet in diameter occurs near a greenstone-diorite contact. The rocks have been partially replaced by sulphides, which are, in order of abundance, pyrrhotite, pyrite, chalcopyrite, and sphalerite.



SKETCH MAP OF GEOLOGY AND WORKINGS ON OLIVER PROPERTY.

At 4, a rusty zone 15 feet wide, containing 2 to 3 feet of quartz and some pyrite, has been exposed by trenching.

At 5, a 20-foot silicified zone occurs in the diorite. Pyrrhotite and some chalcopyrite are present.

At 6, 15 to 20 feet of silicified greenstone outcrop on the shore of the lake. The mineralization consists chiefly of pyrite and pyrrhotite with some chalcopyrite and garnet.

At 7 and 8, rusty patches containing scattered grains of pyrite have been uncovered.

At 9, pyrite together with epidote, garnet, calcite, and quartz occur along a narrow shear zone in greenstone.

At 10, a rusty shear zone, 7 to 8 feet wide, striking N. 72° E. (mag.), and dipping south, occurs at or near a greenstone-diorite contact. It is exposed in several trenches along the face of an escarpment. Pyrite and pyrrhotite are present in small amounts.

At 11, a silicified shear zone, striking east and dipping south, intersects some black tuffaceous rocks. Seams of pyrrhotite and chalcopyrite penetrate and partially replace the shattered tuffs. A small amount of sphalerite is also present. A selected sample, well mineralized with pyrrhotite and chalcopyrite, was assayed at the Provincial Assay Office and yielded: gold, trace; silver, none; nickel, trace.

At 12, minerals typical of contact-metamorphism occur in a shear zone intersecting a calcareous patch in the greenstones. These are, in order of abunddance, garnet, epidote, calcite, quartz, pyrrhotite, molybdenite, pyrite, magnetite, and chalcopyrite.

At 13, a rusty silicified zone, striking N. 15° E. (mag.) and dipping south, has been traced in a series of trenches for several hundred feet along the west side of a greenstone ridge. The mineralization consists chiefly of pyrrhotite and some chalcopyrite in patches, streaks, and disseminated grains. This is probably the most attractive showing on the property.

At 14, the greenstone-granite contact is marked by a silicified zone 10 to 15 feet wide. The contact strikes N. 30° E. (mag.) and appears to be vertical. The zone is sparsely mineralized with molybdenite, pyrite, sphalerite, pyrrhotite, and chalcopyrite. The outcrop is rusty and streaked with molybdite, the yellow oxide of molybdenum.

Trout Lake.—This group consists of 6 unsurveyed claims located near the east end of South Trout lake. The showings lie about a quarter of a mile northeast of the lake. Prospecting has uncovered a band of phyllite or slaty schist about 25 feet wide, contained within or lying between sill-like bodies of gabbro. This band strikes N. 65° W. (mag.) and dips north. It has been traced by trenching for about 200 feet. Both rocks have been affected by shearing. The phyllite-gabbro contacts are marked by considerable silification in the form of veinlets or irregular patches of quartz and by the development of biotite and some tourmaline. Mineralization, consisting chiefly of pyrrhotite and chalcopyrite with minor amounts of pyrite, is found at or near these contacts and extends over a width of 4 to 5 feet in places. The sulphides occur as streaks or disseminated grains and are best developed in the silicified portions of the zone.

Zione Property

This property, consisting of 9 unsurveyed claims, lying about a quarter of a mile west of the Favourable Lake Mines, was staked early in 1928 by Jack

Zione. The ground covers an area underlain by highly metamorphased sediments and greenstones into which masses of gabbro-diorite have been intruded. The bed rock is well exposed on the ridges but is covered by 5 to 6 feet of glacial drift in the low ground.

Stripping and trenching have exposed several widely scattered mineralized patches or zones, locally referred to as "iron dikes," on various parts of the property. These patches range in width from a few inches to 20 feet and can be traced, in some cases, for several hundred feet. They occur along zones of shearing or in remnants of greenstones and sediments that have been intruded by or caught up in bodies of gabbro-diorite. The mineralization is due to the partial replacement of the older rocks by sulphides, especially at or near gabbro-diorite contacts. The sulphides occur as streaks, patches, or disseminated grains aligned roughly parallel to the schistosity. They consist chiefly of pyrrhotite

Principal showing, claim Pa. 256, Zione property.

and pyrite with minor amounts of chalcopyrite and sphalerite. A little arsenopyrite occurs in some of the showings. The gangue is composed essentially of silicified country rock or, where the gabbro-diorite has been sheared, of actinolite and calcite.

A 4-inch quartz vein carrying native gold in conspicuous amounts was found within an area of gabbro-diorite about a quarter of a mile west of Borthwick lake. The vein is of the gash or fissure type and can be traced for about 30 feet. It strikes N. 30° W. (mag.) and stands vertically. The vein-filling consists essentially of grey quartz, which has also permeated and silicified the adjoining wall rocks to some extent. Pyrrhotite, chalcopyrite, pyrite, and galena occur along the walls of the vein in disseminated grains or streaks. Specks or grains of native gold are found occasionally alone in the quartz, more frequently in silicified portions of the vein walls, and often in streaks or patches of sheared country rock caught up in the vein. In most cases, the gold is intimately associated with a tin-white mineral, which occurs as soft, sectile flakes and responds to the tests for tetradymite, the telluride of bismuth.

Severn Mines, Limited

The Severn Mines, Limited, was organized by the Waite-Connell interests to acquire control of some 98 claims surrounding the property of the Favourable Lake Mining and Exploration Company. This ground was examined and prospected under the direction of Walter H. Woods. A few stringers of galena and several rusty zones were opened up, but no mineralization of importance was uncovered.

Springer Claims

One group of 15 claims covers ground lying to the east and south of the narrows in Setting Net lake. The area is underlain by basic greenstones intruded by small bodies of gabbro-diorite. The principal showing occurs near a gabbro-greenstone contact exposed on a ridge about three-quarters of a mile by trail east of the lake. Here, a zone several feet wide, mineralized with disseminated chalcopyrite and pyrrhotite, has been uncovered for 90 feet.

A similar zone containing considerable pyrrhotite occurs in the vicinity of a gabbro body farther south on the property.

Another group of 12 claims located near the east end of South Trout lake covers an area of massive greenstones on the north side of the lake and a granite-greenstone contact on the south side of the lake. With the exception of small patches of magnetite, little evidence of mineralization was found.

Keist Syndicate

This syndicate controls a number of claims situated near the head of Rat House bay and east of Setting Net creek. The rocks in the vicinity consist chiefly of greenstones and various schists intruded by small bodies of gabbro-diorite. Granite outcrops a short distance to the south of the claims. Prospecting was carried on under the direction of John Dawson. With the exception of a few small quartz veins, little evidence of mineralization was found on the property.

Cockeram Claims

Nine claims covering ground in the area of granite to the west of Setting Net lake were prospected by A. Cockeram, but no mineralization of interest was found.

Murray-Stewart

Narrow veins containing argentiferous galena were found during the past summer by K. Murray and H. R. Stewart in the belt of Keewatin rocks on the northwest side of Favourable lake. The showings lie on a bare ridge about three-quarters of a mile north of the portage across the long peninsula in Favourable lake. The veins are associated with bands of slightly sheared rhyolite and feldspar porphyry. They follow the direction of schistosity, which is N. 70° W. (mag.). The Keewatin rocks have been intruded by several sills of gabbro, which also show evidence of shearing. The nearest body of granite lies about half a mile to the south.

The principal vein can be traced for about 35 feet. It consists of several lenses, which swell to a maximum width of 8 to 10 inches and, within a length of 3 feet, pinch out to faint stringers. The mineralization consists chiefly of galena with some chalcopyrite and pyrite. The sulphides are disseminated through a gangue of partially replaced wall rock and quartz. Grab samples are reported to have yielded assays as high as 89 ounces of silver per ton.

Clay Deposits

The course of the Severn river between Favourable lake and Sandy lake intersects an extensive belt of stratified clays. It is thought that these deposits were laid down in a glacial lake formed at the margin of the ice-sheet during its final recession. Remnants of these lacustrine clays still cover to varying depths the areas of low ground and the depressions between rock ridges. The deposits range in thickness from a few feet to 30 feet, the average being about 10 feet.

A sample of varved clay from a typical exposure on the north side of the West arm of Sandy lake was submitted to R. J. Montgomery, of the Ceramics Department, University of Toronto, who reports as follows:—

This clay is grey in the dry state and fine-grained, and contains no stones. Water required for plasticity is 34 per cent., giving a very smooth plastic mass, rather sticky if a slight excess of water is used, and so fine grained that it dries with difficulty. It would probably give trouble in rapid commercial drying.

A sieve test gave a residue of only 0.15 per cent. on a 200-mesh screen. This residue was composed mostly of roots and plant remains with a little silica sand and miscellaneous rock fragments. The fusion temperature or pyrometric cone equivalent is 2,138° F. or cone 2, giving a dark-brown fused mass. Test with acid indicates a rather high percentage of lime. The drying shrinkage is 11.1 per cent., which is quite high. A normal shrinkage for this type of clay is from 6 to 8 per cent. This means that in working, a non-plastic, such as sand, would probably be necessary to reduce the shrinkage and allow safe drying. The clay burns to a buff colour because of the high lime content, and at cone 6 or 1,900° F. the burning shrinkage is 0.8 per cent. The low burning shrinkage is due to the lime.

This clay is probably of glacial origin as suggested. It would be classed as a young, impure surface clay. It could probably be manufactured into buff common or possibly face brick and drain tile. It would require sand or other non-plastic to give a suitable body. Unless it is near some centre of population it would have very little economic value.

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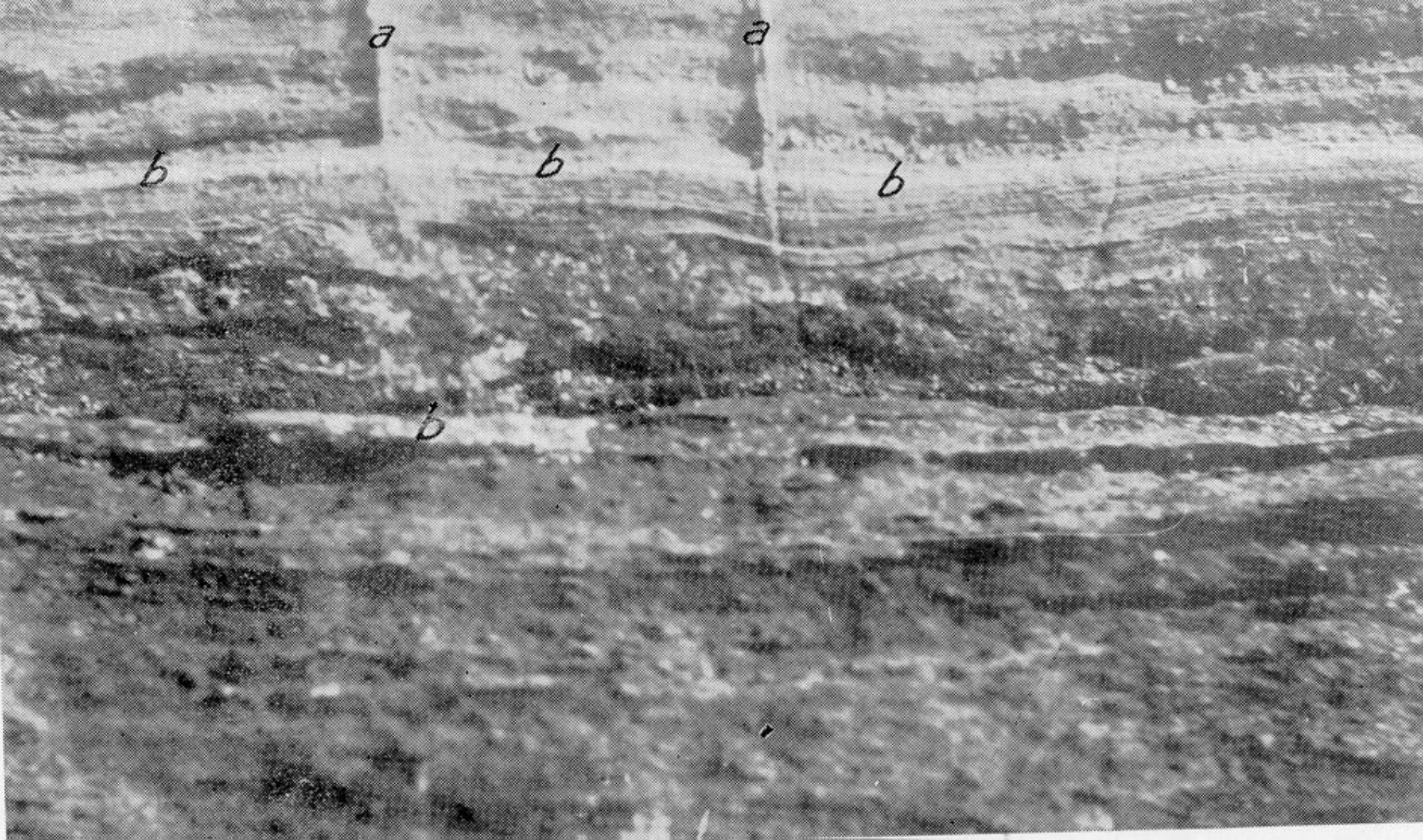
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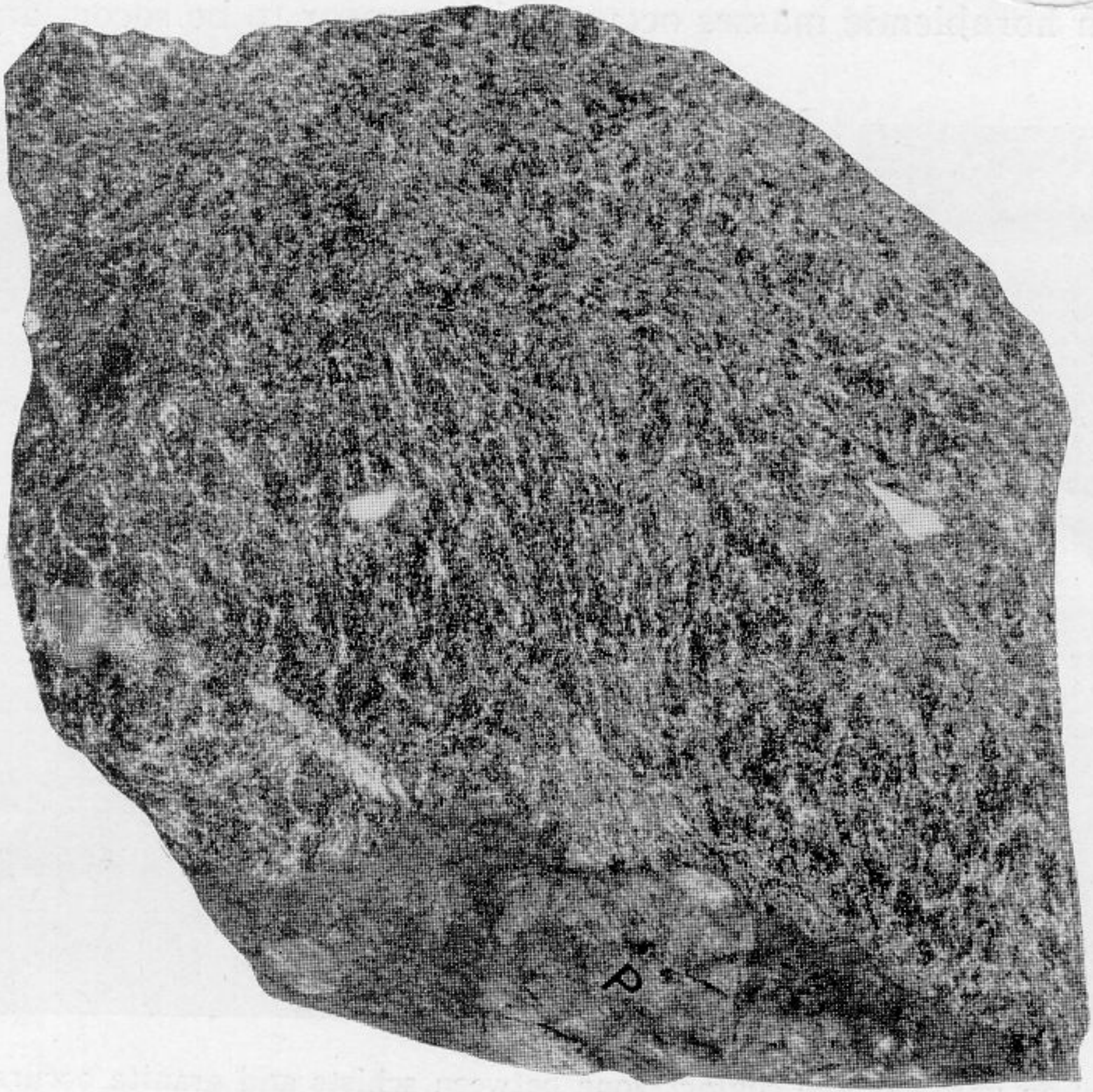
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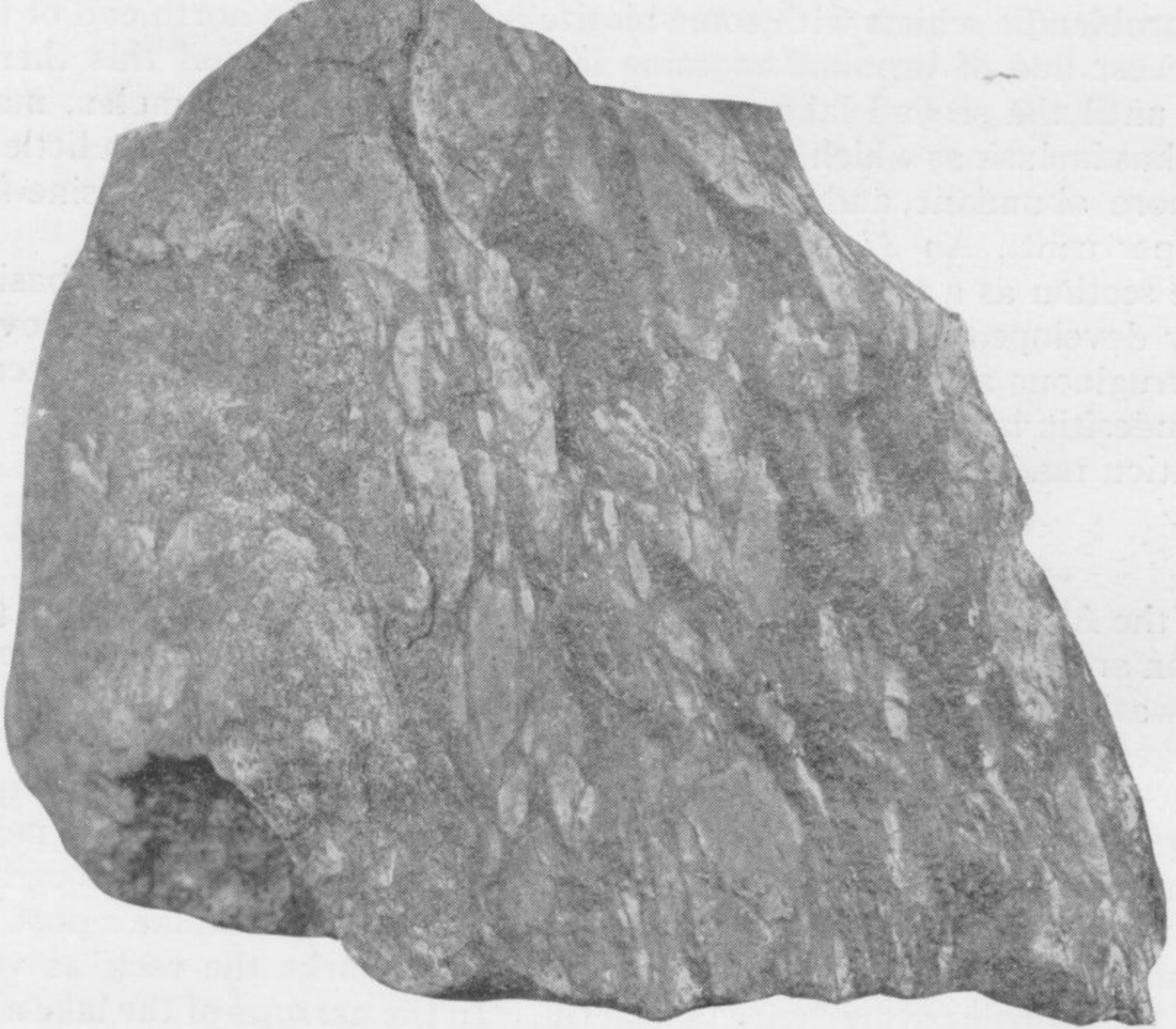

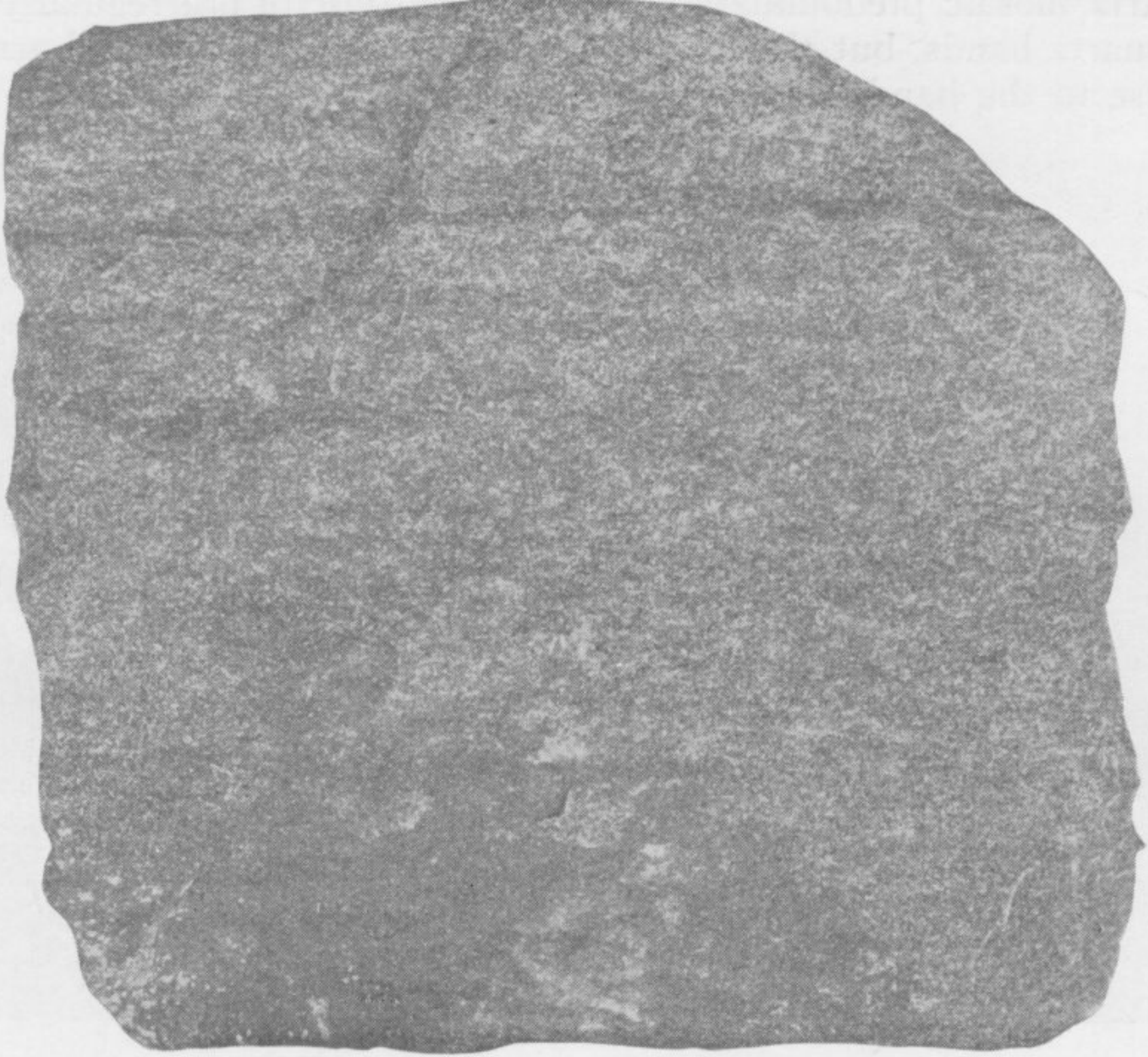

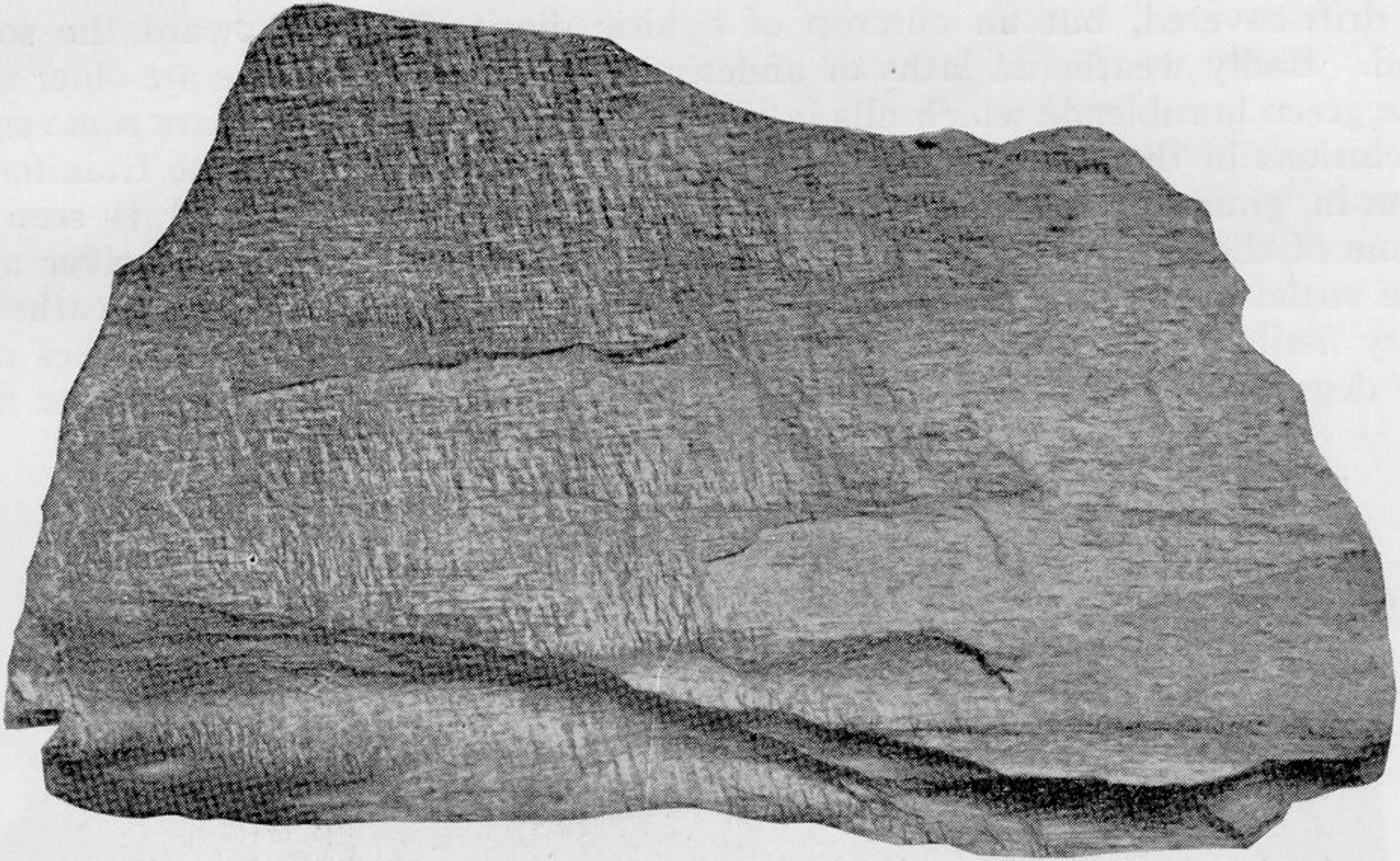

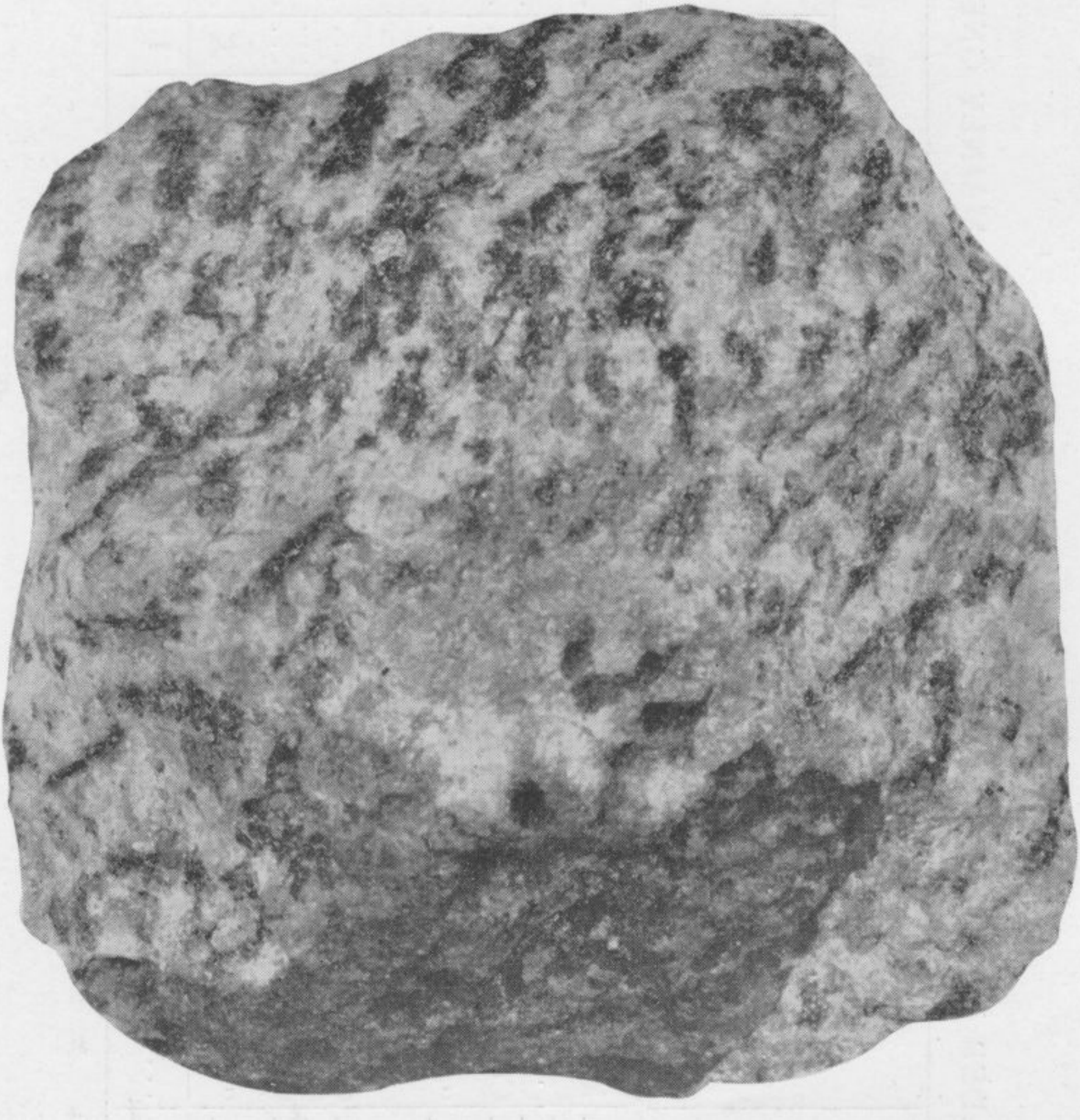

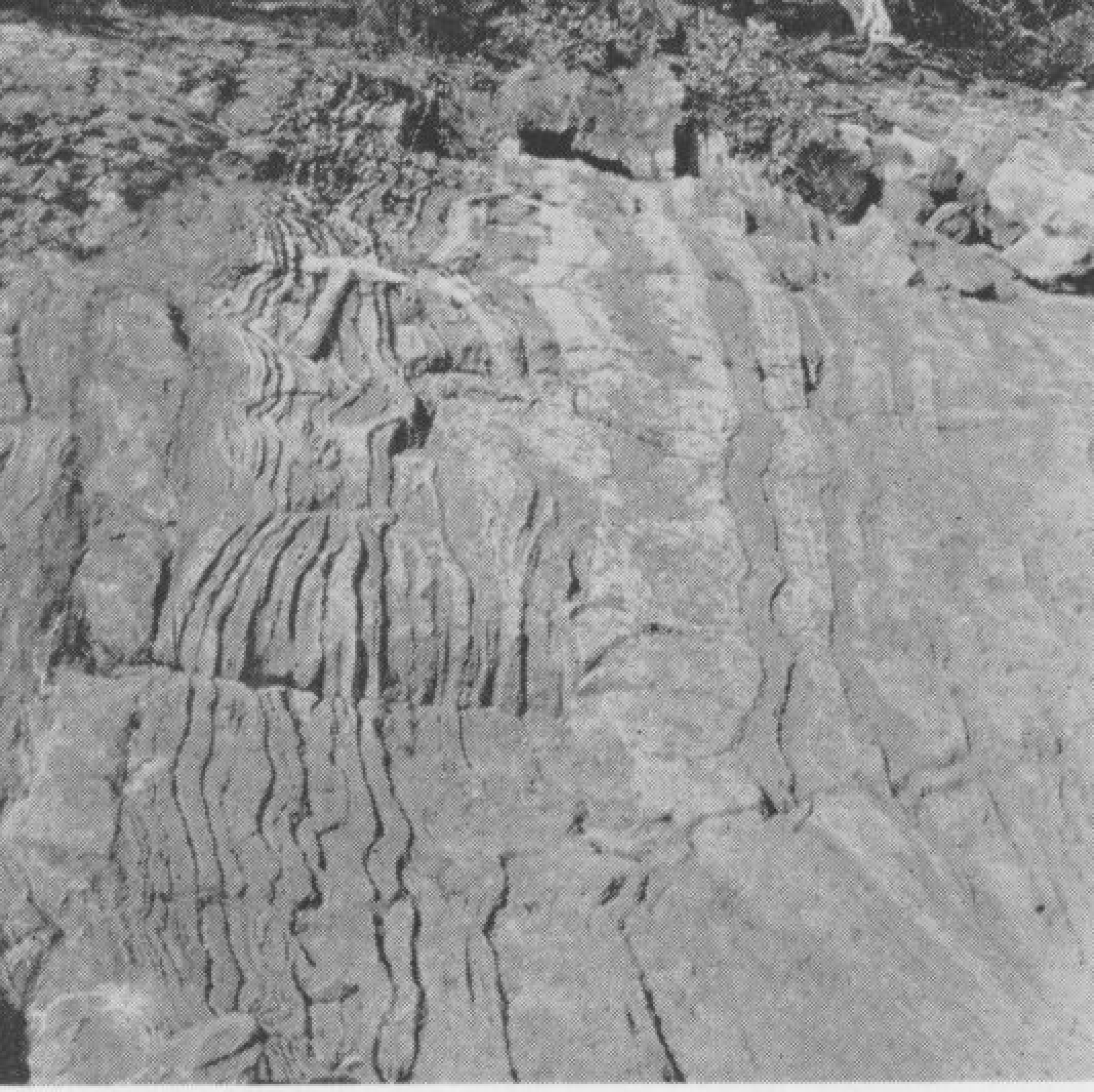

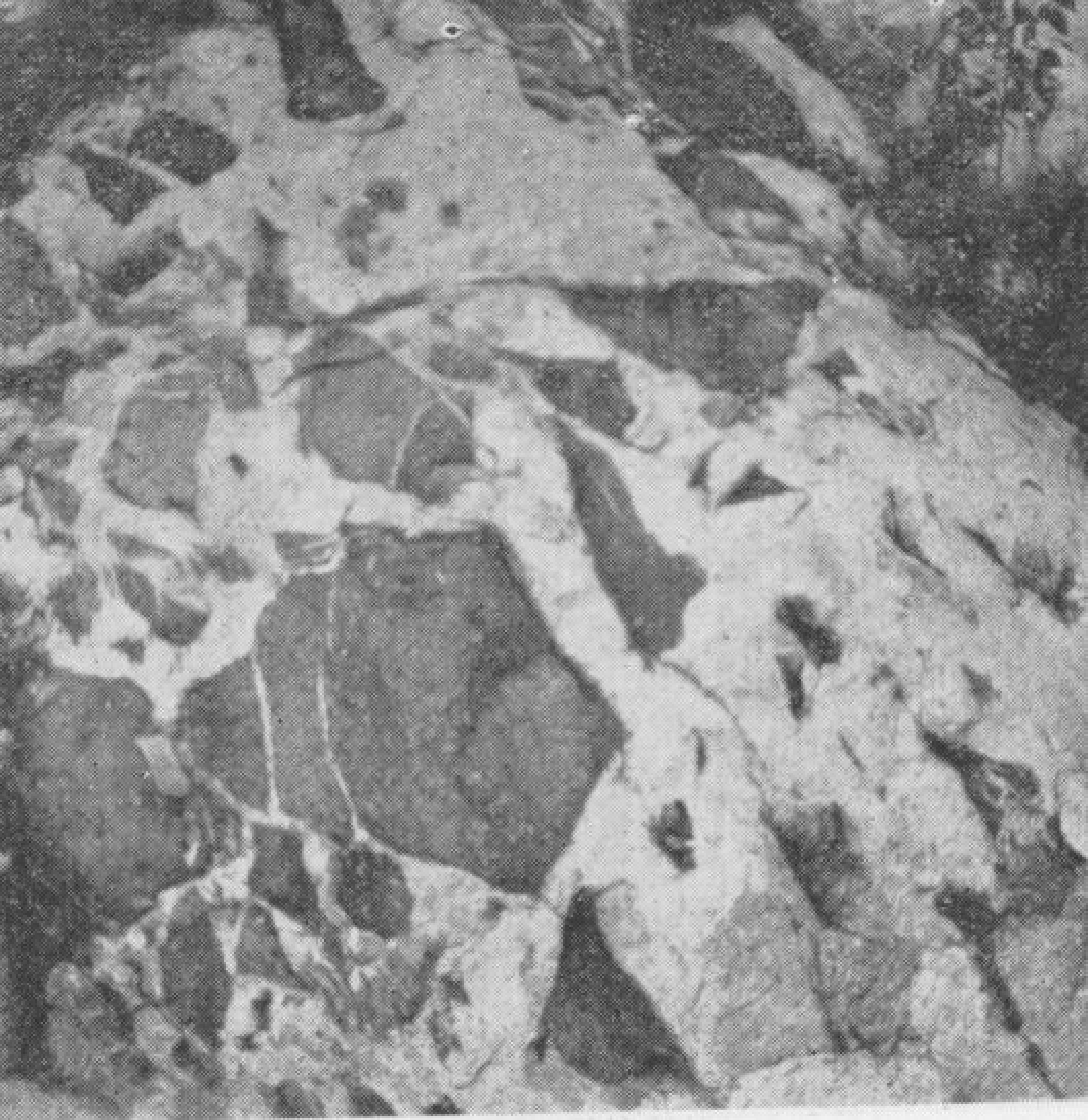

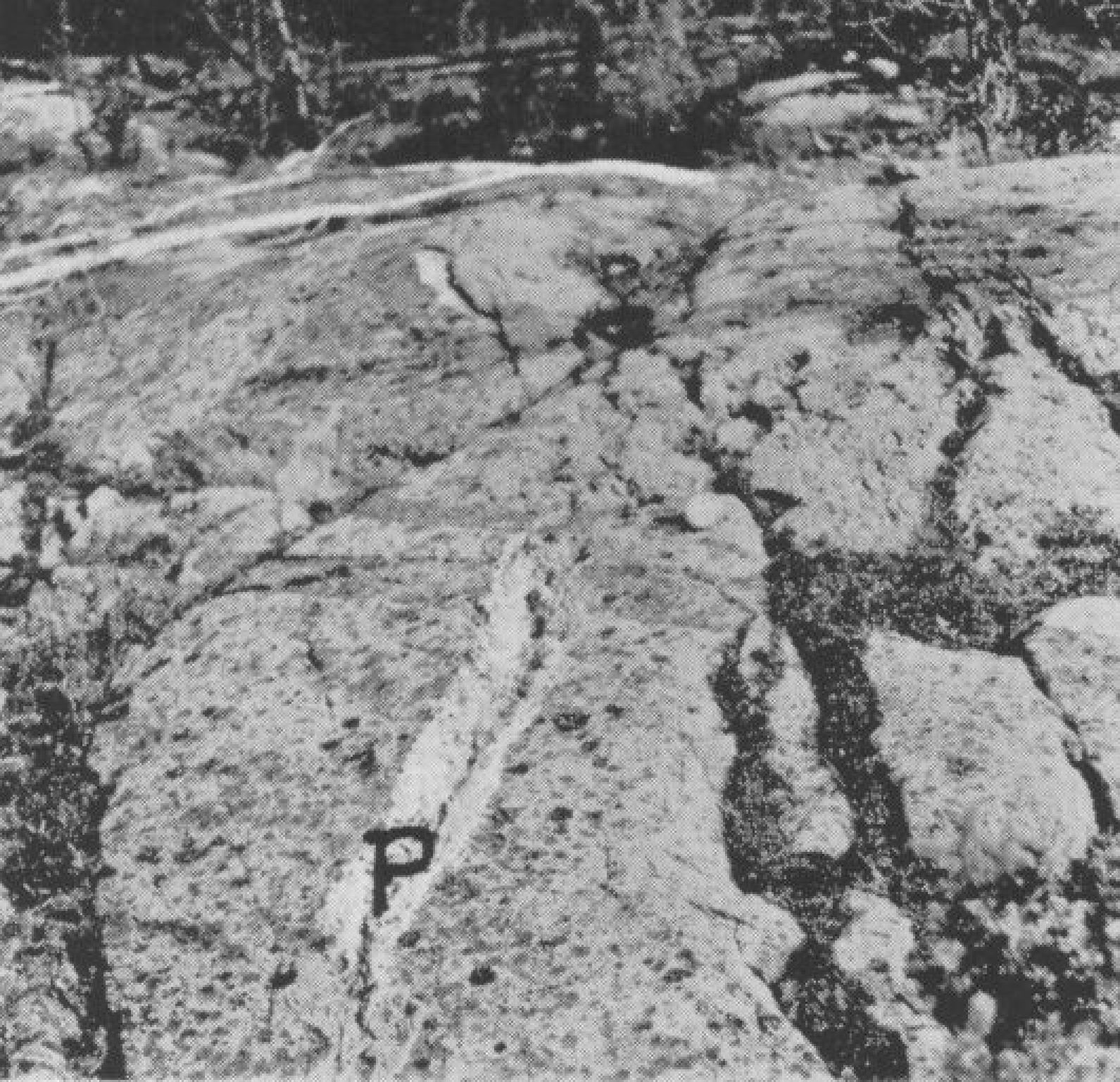
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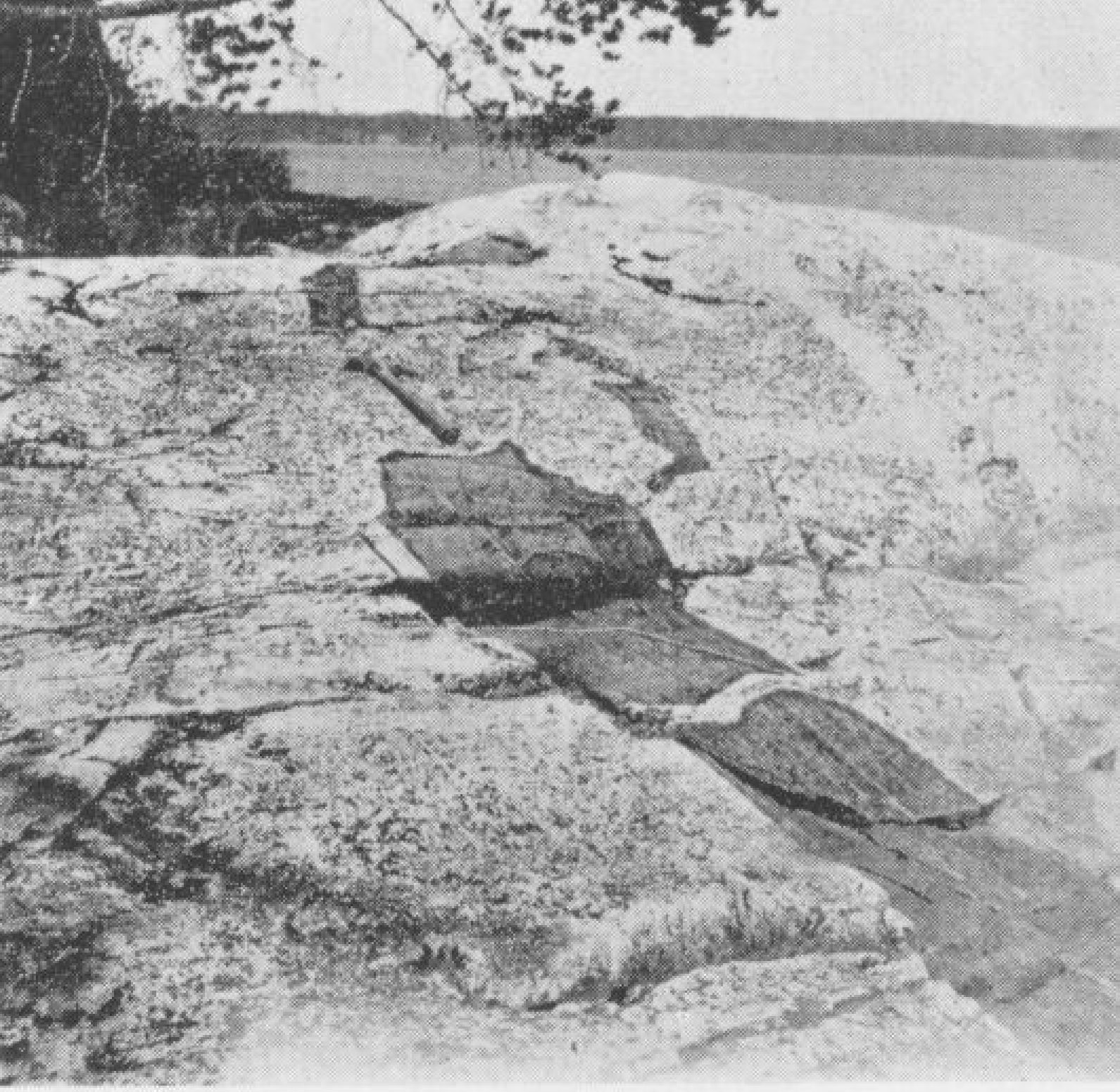

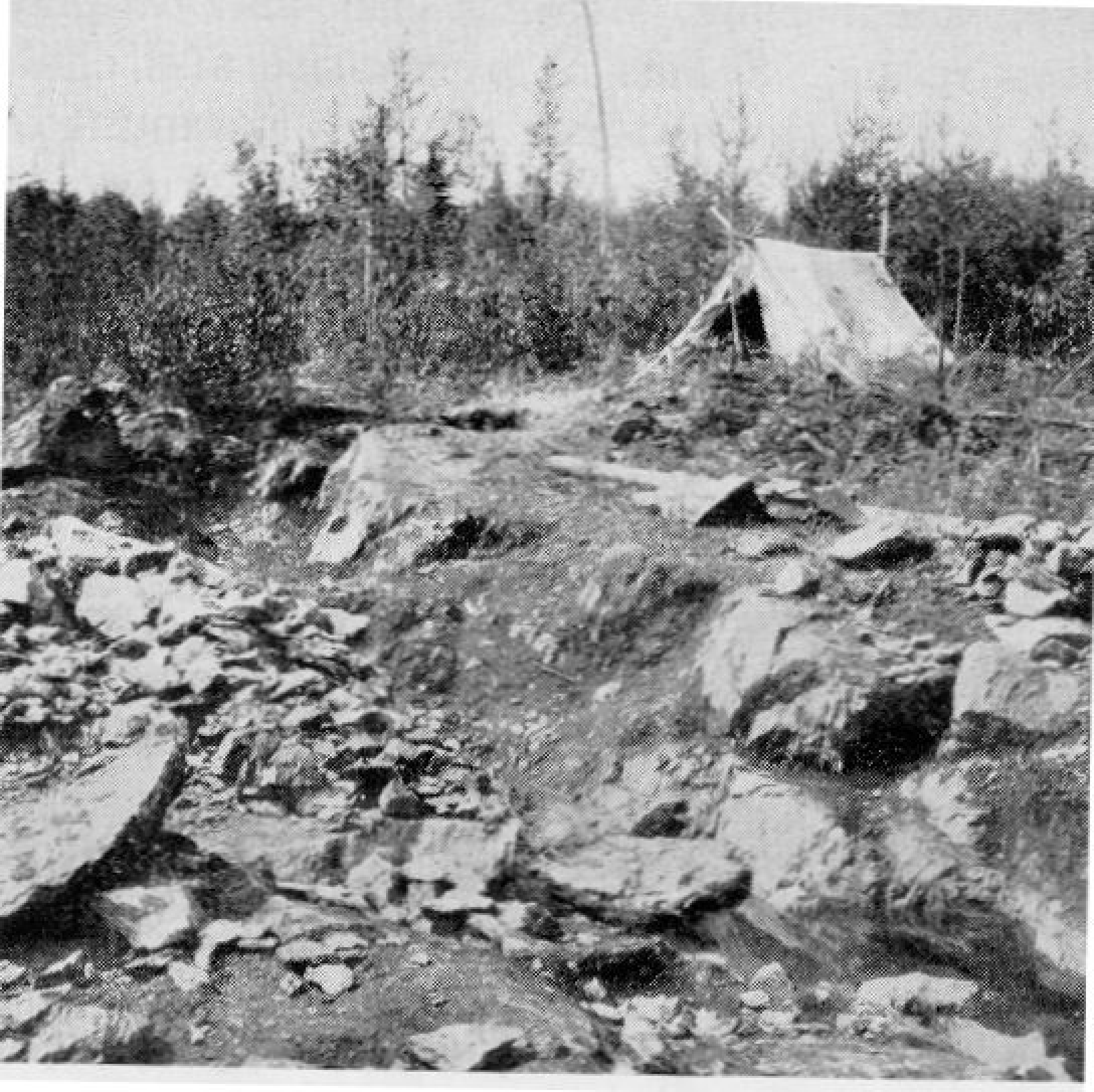

North end
Eabamet
Lake
Fort Hope

Box #2

PROVINCE OF ONTARIO

DEPARTMENT OF MINES

HON. CHAS. McCREA, *Minister of Mines* — THOS. W. GIBSON, *Deputy Minister*

THIRTY-EIGHTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXVIII, PART III, 1929

Sudbury Basin Area

By

A. G. BURROWS and H. C. RICKABY

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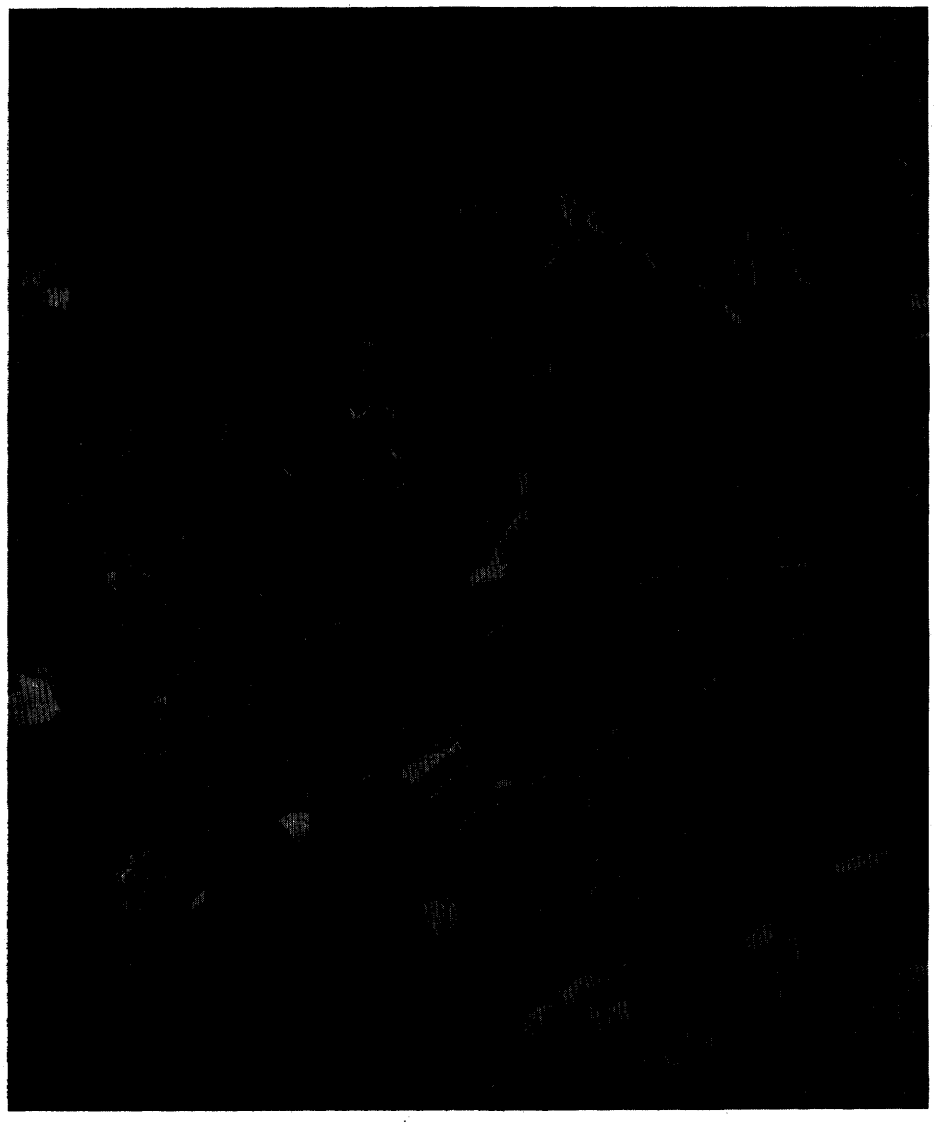
COLOURED GEOLOGICAL MAP

(In pocket at back of report)

Map No. 38*g*—Sudbury Basin Area, District of Sudbury. Scale, 1½ miles to the inch.

Photo by Topographical Survey, Ottawa.



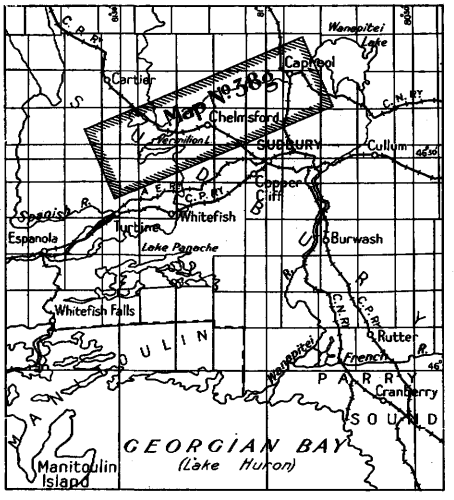
Parts of lots 10 and 11, concession V, Balfour township, showing meanderings and cut-offs of Vermilion river with sandstone ridges and intervening farm lands.

SUDBURY BASIN AREA

By A. G. Burrows and H. C. Rickaby

INTRODUCTION

Because of the interest taken in the occurrence of certain zinc-lead-copper deposits near the Vermilion river, about 13 miles northwest of Sudbury, and the effort to find similar deposits along a fault zone, it was decided by the Department of Mines in 1927 to make an examination of the area. The deposits occur in what is commonly referred to as the Sudbury basin, an area of low relief, surrounded by rather high hills composed of a hardened volcanic fragmental rock and micropegmatite.



Key map showing location of the Sudbury Basin area. Scale, 32 miles to the inch.

The area of the basin is well shown on A. P. Coleman's "Geological Map of Sudbury Nickel Region" (map No. 171), published in 1913 by the Mines Branch, Department of Mines, Ottawa. The rocks within the basin have been called Animikie by Dr. Coleman, whereas the name Whitewater series has been used by W. H. Collins. The basin is about 35 miles long from northeast to southwest and about 10½ miles wide in its central portion. This report deals with the zinc-lead-copper deposits lying within the basin and not with the nickel-copper deposits, which have been the subject of numerous reports and papers. Certain deposits containing lead and associated metals of a different type occur in the volcanic fragmental rocks and the micropegmatite on the rim of the basin.

Since the greater part of the zone of major faulting along which efforts have been made to find ore deposits lies in an area of low relief and is largely drift-covered, much of the information about it has been obtained by means of

diamond-drilling. Nowhere in northeastern Ontario has so much drilling been done in an effort to determine the location of a mineralized fault zone.

Acknowledgments

Parts of the years 1927 and 1928 were spent in examining the area. Most of the field work was carried on under the direction of the junior author. During 1928, Archibald M. Bell and Bertrand Robinson, students of Toronto University, were employed as assistants and rendered efficient service.

The Errington mine served as headquarters for a part of the time, and the writers wish to express their indebtedness to the officials of the company for the hospitality extended to the members of the party.

Plans of the surface and of the underground workings of the Errington mine, from which sketches appearing in the report have been prepared, were kindly furnished by V. C. Clauson, general superintendent of the Treadwell Yukon Company.

To the Department of Mineralogy, University of Toronto, acknowledgment is made for assistance in the preparation of photographs of thin sections and polished sections, and the junior author wishes to express to Dr. T. L. Walker his appreciation of assistance and suggestions on the petrographic studies of the volcanic fragmentals.

Records of diamond-drilling and the cores from numerous holes were available through the courtesy of various mining companies. Diamond-drilling was the principal method by which exploration was carried on owing to the overburden of drift.

A number of analyses of rocks were made by W. K. McNeill and T. E. Rothwell at the Provincial Assay Office.

History and Access

The Sudbury area, which includes the basin, has been the subject of many reports dealing chiefly with the nickel-copper deposits, since such deposits have been found practically all around the basin, which is elliptical in shape. The basin has been described briefly in reports by Bell, Barlow, and Coleman. Some of the townships in the basin were surveyed as early as 1884 and divided into concessions and lots. The township lines are now obliterated and only a few old posts can be found at corners, so that the geological survey is based largely on the location of roads, most of which are on concession and lot lines. Some of the old lines in the vicinity of mining operations have been re-run.

The construction of the Canadian Pacific railway in 1883 gave access to the agricultural lands, which were settled largely by French-Canadians. Most of the farms are on the flat clay land which covers the Onwatin slate. The airplane photographs of the Department of the Interior, Ottawa, show very finely the pattern of the farming lands.

The Canadian Pacific railway runs nearly east and west across the southwest portion, and the Canadian National north and south across the northeast portion. In addition, good roads traverse all the farming area. The rim of the basin is less accessible, with only occasional bush roads and trails away from the railway and trunk lines.

The peculiar geological structure of the basin, with its agricultural land surrounded by a rocky rim, is unique in the pre-Cambrian of Northern Ontario.

Robert Bell gave the first description of the geological and other features of the basin in his report on the Sudbury mining area.[1] He described the tuffs,

[1]Geol. Surv. Can., Vol. V, pt. F, 1890-91.

slates, and sandstones that occur along the course of the Vermilion river which, with its lake expansions, gives a section across the basin and rim from Bass lake in the northeast to below Stobie falls at the southwest end. Bell noted the occurrence of galena and zinc blende at several places, particularly one on lot 10, concession VI, Creighton township, which is now part of the property of the Errington mine. Numerous veins of quartz, some of them of large size, were noted in the northeastern part of Fairbank township and the northwestern part of Creighton township near the Vermilion river. Later a shaft was sunk on a property known as the Creighton gold mine where gold was reported to occur.

A. E. Barlow made a report on the nickel and copper deposits of Sudbury,[1] in which brief attention is given to the rocks that overlie the micropegmatite-norite sill. The basin rocks are shown on Barlow's map and described by him as follows:[2]—

> They comprise, at the base, certain breccias and agglomerates, most of which, at least, are of pyroclastic origin, these rocks passing upward into black bituminous slates, while they are, in turn, overlaid by a comparatively coarse greywacké or feldspathic sandstone.

Barlow's report refers to specimens of breccia from Onaping falls being examined by G. H. Williams, who determined them definitely as of volcanic origin. The location of the specimens was at some distance from the micropegmatite with a light-coloured fragmental rock intervening. This rock has larger inclusions than the typical tuff and has been called Trout Lake conglomerate by Coleman. The writers believe that this rock is also of volcanic origin.

The most extensive study of the geology of the Sudbury area, and of the rocks of the Sudbury basin in particular, has been made by A. P. Coleman, the account of which is given in three reports[3] of the Ontario Bureau of Mines and one[4] of the Mines Branch, Department of Mines, Ottawa. Coleman's invaluable 1913 map has been in wide use by those interested in the ore deposits and rock structures of this area. The map shows an orderly succession of the rocks overlying the micropegmatite, to which the names Trout Lake conglomerate, Onaping tuff, Onwatin slate, and Chelmsford sandstone have been applied, from the bottom upward.

The mineral deposits then known in the overlying rocks did not appear to be important, so that this part of the area was never so closely examined geologically as that where the important nickel deposits occurred.

Topography

The basin is a depressed area surrounded by moderately high hills of rugged appearance, particularly when viewed from the central plain. A series of broken ridges of sandstone, of lower elevation than the rocks on the rim, occurs in the central portion of the basin. This is entirely surrounded by a fairly flat drift-covered area, which almost entirely conceals the easily weathered slate that extends under the sandstone.

Outside the slate is the beginning of the ridge of tuff, the outcrops of which entirely surround the slate. The tuff is a member of a series of volcanic rocks that extends to the micropegmatite and, as shown by Coleman, completely encloses the basin.

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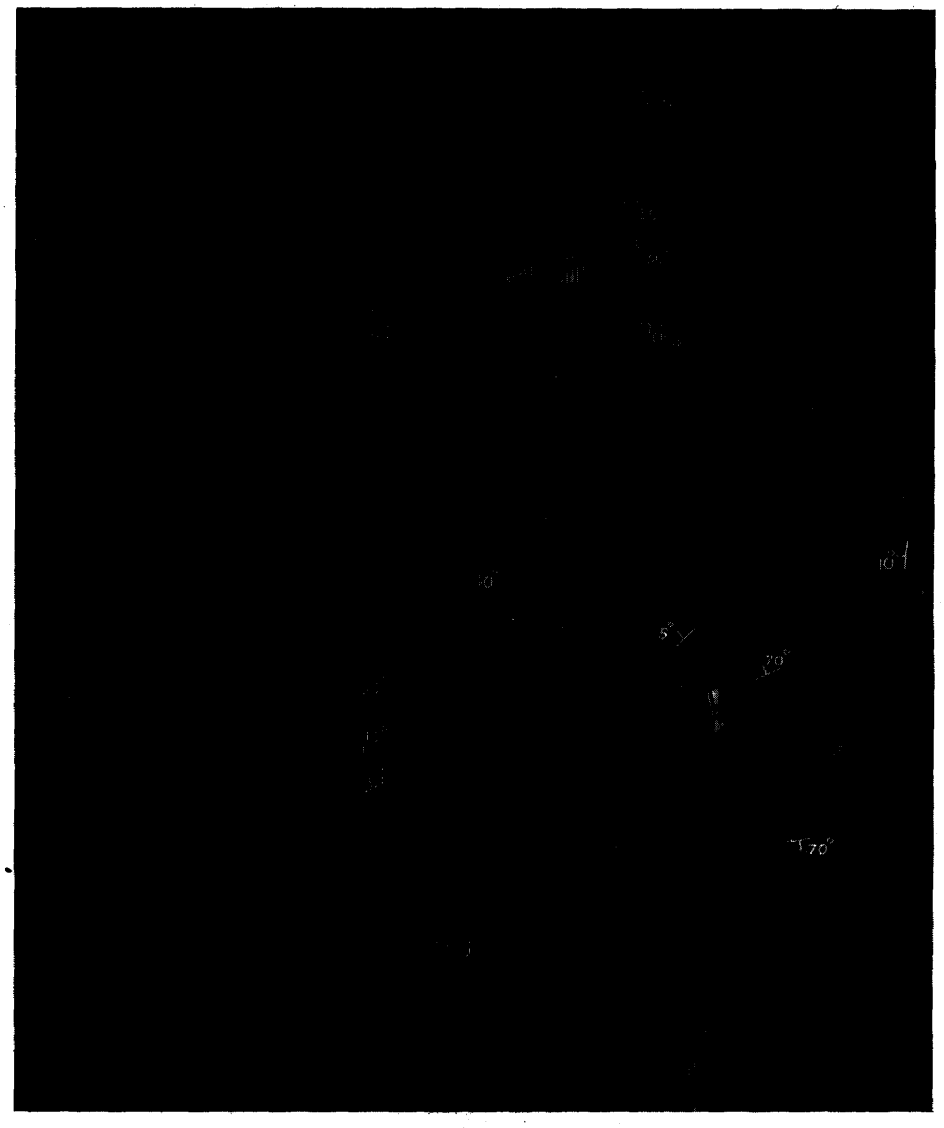
[1]Geol. Surv. Can., Vol. XIV, pt. H, 1906.
[2]Ibid, p. 73.
[3]Ont. Bur. Mines, Vol. XII, 1903; Vol. XIII, pt. 1, 1904, Vol. XIV; pt. 3, 1905.
[4]The Nickel Industry, with Special Reference to the Sudbury Region, Ontario, Mines Branch, Dept. Mines, Can., No. 170, 1913.

Some of the sandstone ridges are from 50 to 100 feet above the plain. Azilda station has an elevation of 881 feet above sea-level, and the general elevation of the farming area does not vary greatly from this. There is a general slope of

Photo by Topographical Survey, Ottawa.



Parts of lots 6 and 7, concessions V and VI, Balfour township, showing anticlinal and synclinal structures of Chelmsford sandstone. An olivine diabase dike cutting the sandstone may be seen running diagonally across the upper part of the photograph. At the top (north) is a meandering stream and a road. The light-coloured rectangular areas are cultivated fields.

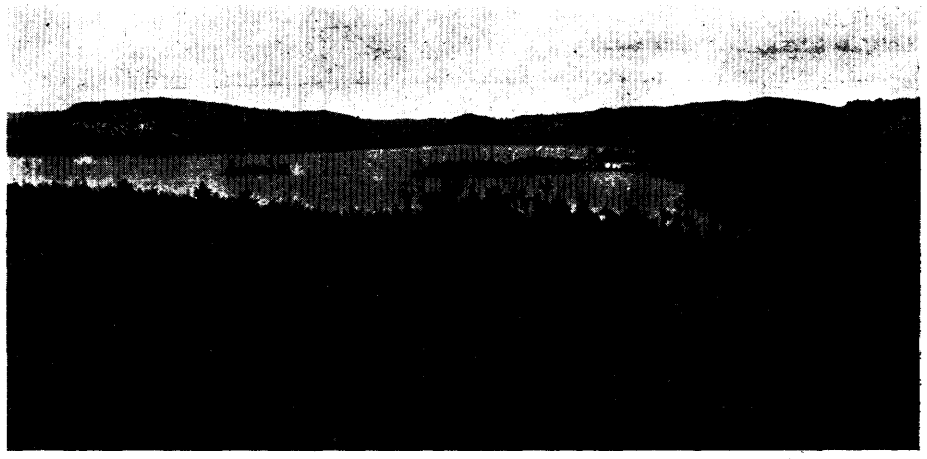
the land from the northeast to the southwest, the area being drained by the Vermilion river and its tributary streams, of which Whitson river is the largest. The direction of flow is southwest, the waters draining from the basin below Stobie falls, where the Vermilion river flows through a fault depression in the rim.

The rocky rim has an average elevation of about 1,050 feet above sea-level, an unusually high elevation for this part of Ontario.

The few lakes of the area are mostly scattered along the contact of the volcanic fragmentals and the micropegmatite. An excellent description of the topography of the basin and its marked connection with the geology is given by Coleman.[1]

Aerial Mapping

Part of the Sudbury district has been photographed by the Royal Air Force, and a map is in preparation by the Department of the Interior, Ottawa. A number of the photographs covering the basin area were procured from the Dominion Survey for use in the field and were of great assistance in mapping. The photographs bring out distinctive geological structures in the several forma-



Scene on Trout lake, Bowell township, showing the topography of the rim of the basin.

tions. For instance, the Chelmsford sandstone is most strikingly shown, and the synclinal and anticlinal folding is clearly indicated in the curving strata (see photograph opposite). Dikes of olivine diabase cutting across the folded strata can be clearly seen in the photographs.

One photograph (see page 34) gives an excellent view of the fault at Cameron creek.

The continuous stretch of agricultural land covering the Onwatin slate and valleys in the sandstone and part of the tuff is in sharp contrast to the hilly country. The rim of the tuff and micropegmatite is shown in the broken and irregular ridges distinct from the interior basin.

The physiographic history of the courses of the Vermilion and Whitson rivers with the windings and frequent changes of channel are shown in some of these photographs. Numerous oxbow lakes in several stages of filling, some of which are dried up, form an interesting pattern (see frontispiece).

Where some scale, like a mile of road, is shown on the photographs it is possible to map the boundaries of rock outcrops more accurately than by pacing on the ground.

[1]Ont. Bur. Mines, Vol. XIV, pt. 3, 1905, p. 114.

GENERAL GEOLOGY

The following is a classification of the formations of the Sudbury Basin area:—

QUATERNARY
Boulder clay, stratified clays, sands, gravel, peat.

PRE-CAMBRIAN
WHITEWATER SERIES:
Chelmsford sandstone.
Onwatin slate.
Onaping volcanic fragmental rocks.
INTRUSIVES:
Olivine diabase, quartz diabase, brown-weathering dikes of basic to intermediate composition.
Micropegmatite dikes in Whitewater series.
Micropegmatite, i.e., part of the norite-micropegmatite laccolith.
Norite.

The Chelmsford sandstone overlies the Onwatin slate conformably. The contact is a gradational one with increasing coarseness of grain and thickness of beds upward from the typical thinly bedded slate. There are a number of good exposures of the rocks in contact showing the gradual change. The best exposures are on the north halves of lots 11 and 12, concession I, and on the south half of lot 7, concession VI, Balfour township, on opposite sides of the sandstone area. The sandstone is composed mostly of angular fragments of quartz, feldspars, and so on, indicating slight transportation of material. Owing to the great extent to which the slate is covered by drift on its outer margin, contacts with tuff are extremely scarce. In fact, none have been observed except along the southern margin and in the zone of faulting, so that relationships are obscure. It is assumed that the tuff underlies the slates. Some of the bedded slates at Errington mine dip toward the tuff at one place and gently away from it at another. Bedding has not been recognized in the black fine-grained tuff, which always occurs near the slate. Otherwise the formations are very similar and difficult to distinguish when bedding planes in the slate are indistinct. There may be a gradational change from tuff to slate, or it is possible that the formations are unconformable. There is not sufficient evidence to be sure of the relationship.

The volcanic rocks, which occur in large volume completely surrounding the basin of slate and sandstone, form in most parts the rim of the basin. The highest parts of the area are usually the coarse volcanic fragmental or the micropegmatite in contact with it. The volcanics form a complex mixture of rocks from the inner edge to the micropegmatite and in most places show an increasing coarseness of fragments from the inner to the outer edge, or in section from the top to the bottom. Ash, tuff, ropy and scoraceous lavas, pillow lava, amygdaloidal and spherulitic lava, rhyolite, gneiss, and coarse breccia are all present.

These rocks represent a period of great vulcanism, during which time volcanic debris, mostly of the explosive type, piled up to form a great thickness of material over a region the extent of which is not now known. No drilling has yet penetrated below the slate formation at any considerable distance from its contact with the tuff, so that it is not certain that the volcanic rock entirely underlies the slate. One drill-hole was put down in the centre of the basin many years ago to a vertical depth of 2,700 feet and is reported to have been in black slate at the bottom.

The general elliptical structure of the basin, which has been described as due to the collapse of underlying rocks with consequent sagging of the basin area,

could also be explained by the theory of a ring of volcanoes which built up a huge structure with a central basin area which was subsequently filled with shales and sandstone. These materials could readily be derived by erosion of the volcanic fragmentals and deposited under water in stratified formations.

The volcanic rocks do not show much evidence of having been deposited in water, since stratification is not apparent even in the finest ash. Erosion has, of course, removed a tremendous quantity of the volcanics and exposed the micropegmatite-norite[1] all around the basin, and there is no means of knowing how much larger the volcanic area and laccolith were.

Some of the breccias which occur below the norite, as, for example, that near Little Stobie mine, if subjected to silicification by micropegmatite would resemble some of the coarser fragmentals of the Onaping series. It is possible that the micropegmatite-norite laccolith may have penetrated into the volcanic fragmental rocks, leaving a remnant of the series below the laccolith. Much of the volcanic rock has been altered to schist, particularly in its southern portion, from Trill township to Capreol township. The general strike is east-northeast to west-southwest, and the dip is southeast at varying angles. The adjacent micropegmatite on the south side, especially at Fairbank and Moore lakes, is highly sheared, the rock along the south shore of Moore lake being gneissoid.

Generally the volcanics have an older appearance than the micropegmatite. The contact between them is not always easy to find, owing to the partial assimilation of the overlying rock. However, in places there is a sharp contact between the rocks where the two are readily recognized. On the east-west line between Trill and Cascaden townships there is a clear contact, with the fine-grained micropegmatite in eruptive relations with the fragmental rock. In Capreol township, lot 2, concession I, there is a hybrid rock with characteristics of the micropegmatite, which has been produced by assimilation of the volcanic fragmental.

LITHOLOGY

Onaping Volcanic Fragmentals

In order to study this remarkable series of volcanic fragmentals and lavas it is necessary to make complete sections across it, and this was done at a number of points around the basin rim. Particularly good sections are to be seen in the area south and west of Vermilion lake and northeast of the Onaping river. Much of the rock on the north and east side of the basin is drift-covered, but the outer contact of the volcanics with the micropegmatite is almost everywhere observable, whereas the inner contact with the Onwatin slate is apparently covered with drift except in the faulted zones. Careful examination of the numerous diamond-drill cores failed to throw much light on the actual relations between the tuffs and the overlying slate.

Beginning at the base or the contact of the volcanics with the micropegmatite and travelling in towards the centre of the basin there is a marked gradation in the rock, expressed chiefly by a decrease in the size of the included fragments. First, there is a coarse breccia, which contains fragments as much as 3 feet in diameter, then in succession there are finer breccias, coarse tuffs, and finally very fine tuffs indistinguishable in the field from the overlying slates

[1]The micropegmatite and norite are a portion of the same eruptive mass, but on the map (No. 38g) accompanying this report only the micropegmatite is shown in contact with the overlying rocks of the Whitewater series.

except for the absence of bedding planes. There are, of course, some irregularities in the presence of lavas and unusually coarse or fine bands, but the above gradation is generally true for almost any section across the Onaping volcanics. A petrographical description of some of the common types of these volcanics is given below.

Onaping Tuff, Type Specimen

This rock, owing to its unique character, has attracted the attention of a number of writers, who have described it with considerable detail. It was first noticed and described by T. G. Bonney.[1] It has also been described by Robt. Bell, who sent specimens for microscopical examination to G. H. Williams,[2] by

Photomicrograph of Onaping tuff from a point near Onaping falls. (×35.)

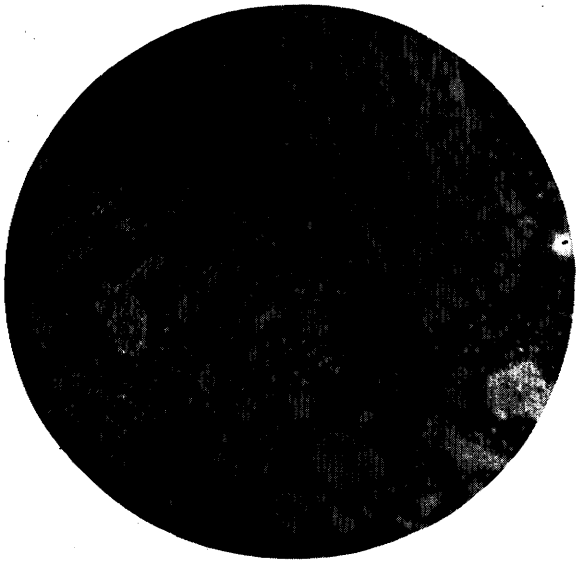
T. L. Walker,[3] and finally by A. P. Coleman[4] in his extensive report on the Sudbury region. The locality from which the tuff was first described and named is in the neighbourhood of Onaping falls in Dowling township on the Canadian Pacific railway, and a specimen from that area is taken as the type specimen, partly for that reason but also because the rock is perfectly massive and shows the least alteration effects.

Macroscopically, the rock appears to be made of angular fragments, the largest of which are about one centimetre in diameter, embedded in a black fine-grained cement. The fragments are, for the most part, lighter in colour than the cement. Pyrrhotite is quite plentifully scattered throughout the rock and, with occasional small specks of pyrite, makes up roughly 2 per cent. of the

[1]Quart. Jour., Geol. Soc. London, Vol. 44, 1888, p. 40.
[2]Geol. Surv. Can., Vol. V, pt. F, 1890-91, p. 74.
[3]Quart. Jour., Geol. Soc. London, Vol. 53, 1897, p. 45.
[4]Ont. Bur. Mines, Vol. XIV, pt. 3, 1905, pp. 131-133.

constituents. Under the microscope the sharp angular nature of the fragments, characteristic of volcanic material, shows up prominently. The matrix surrounding these fragments is dense and almost opaque, and this is probably owing in part to its content of carbonaceous material, as shown by chemical analyses.

The fragmental material retains for the most part its original boundaries, which show up distinctly against the dark cement. Prominent in these edges are rounded bay-like indentations, which are represented in the interior by circular aggregates of later minerals (see photomicrograph opposite). They represent vesicles and indicate the original pumiceous character of the glass. Though devitrification has proceeded extensively, yet the original flow structure is still to be seen in the lines of what were microlites extending in parallel bands through-



Photomicrograph of Onaping tuff from a point near Onaping falls. (×20.)

out the fragments. The large fragment in the photomicrograph illustrates this banded arrangement.

Scattered throughout the matrix are a number of small fragments, up to half a millimetre in diameter, of clear quartz, sometimes composite but generally of a single individual. In shape they may be described as subangular, though many of them, particularly the larger ones, have well rounded edges (see photomicrograph above). Occasional grains of granite similar in shape are also to be seen. A possible explanation of the presence of these rounded grains is that they represent water-worn material laid down with the tuff. This implies, of course, as suggested by Coleman, that the material was deposited in water. However, in view of the lack of any definite evidence of the presence of water at the time of the eruption, they may represent shattered material of the crust through which the eruption took place, some of the particles having become rounded through friction in their passage through the air.

The original glass fragments are entirely devitrified and recrystallized, with the consequent development of new minerals. T. G. Bonney has mentioned

the marked zonal arrangement of many of the devitrified fragments, which is well illustrated by some fragments in the photomicrographs. The most prominent mineral developed is a pale-green substance with a circular radiating structure; where the zonal arrangement is shown it usually occupies the outer rim of the original glass. It is pleochroic, pale-green to bluish-green, with moderately low birefringence. Examination with the refractive index liquids gives indices from 1.635 to 1.655; it appears to belong to the amphibole group. Besides the acicular mineral there is present another green substance with tabular structure. It is pleochroic, green to pale-green, with very low birefringence and a refractive index of approximately 1.608; it is probably a member of the chlorite group. The rest of the material of the fragments consists of a mosaic of quartz and feldspar, mostly fine-grained. The feldspar shows the plagioclase twinning and has extinction angles corresponding to albite. Small amounts of calcite and leucoxene are present as accessory minerals.

Analyses of a sample of the above rock and of one from the C.P.R. east of Levack[1] are given below:—

	Onaping falls	C.P.R. east of Levack
	per cent.	per cent.
SiO_2	59.02	61.43
TiO_2	.45	.49
Al_2O_3	10.84	10.11
Fe_2O_3	2.56	3.27
FeO	5.83	7.15
Fe (pyrrhotite)	1.32	.....
CaO	4.09	3.09
MgO	5.50	5.13
Na_2O	3.60	2.94
K_2O	2.72	2.87
MnO	.35	.21
P_2O_5	.12	.12
CO_2	.36	.05
H_2O	2.00 (ignition)	2.02
C	.58	.48
S	.96	.91
Total	100.30	100.21

The above analyses are probably representative of the composition of the typical tuff that makes up much the larger part of the Onaping volcanics. They show a rock of intermediate composition corresponding to an andesite or diorite. The tuff is rather remarkable in the inclusion among its constituents of pyrrhotite and carbonaceous material, both of which are uniformly distributed throughout the rock.

The pyrrhotite occurring in small particles and blebs can usually be seen quite readily with the naked eye and forms one of the commonest of the accessory constituents.

As previously mentioned, the dark colour of the rock and the opaque material of the matrix is probably partly due to the carbonaceous material present. The carbon content of the tuff was determined on ten different samples taken from various localities and ranged in quantity from 0.20 to 0.58 per cent., with an average of 0.39 per cent. It is made up of very fine, dust-like grains

[1]A. P. Coleman, E. S. Moore, and T. L. Walker, "The Sudbury Nickel Intrusion," Contributions to Canadian Mineralogy, 1929, University of Toronto Press, p. 39.

scattered throughout the matrix and appears to have more of the nature of an amorphous carbon than of graphite. Its wide distribution in this rock precludes an organic origin but strongly suggests an inorganic one, possibly due to gaseous emanations attending the volcanic outburst. Incidentally it might be mentioned here that one of the spherulitic lavas described later on, containing some small patches of opaque material, showed a carbon content of 0.14 per cent. Carbon dioxide and carbon monoxide have been proved to be constituents of the gaseous emanations from volcanoes, and their reduction to carbon or graphite is generally considered possible under certain circumstances.

Massive Tuff from Trout Lake

Thin sections of the massive tuff from Lumsden township, half a mile south of Trout lake, differ from the Onaping falls sections in the nature of the minerals

Photomicrograph of sheared tuff from lot 5, concession VI, Creighton township. (×20.)

resulting from recrystallization of the glass fragments. Prominent in this tuff is a colourless to faint-green or brownish mineral occurring as columnar crystals with high relief. It has a specific gravity higher than 3.30, and its indices of refraction are in the neighbourhood of 1.74. Its pleochroism, pale-brown to colourless with moderate birefringence, straight extinction, and large optic angle identify it as epidote. Titanite is also present as a fine-grained mineral associated with the chlorite. In most other respects these sections are similar to the Onaping type specimen.

Sheared Tuff

Specimens of the tuff from along the sheared zone extending from Vermilion lake northeastward to Whitson lake and beyond show a pronounced cataclastic structure. A thin section of one of these sheared tuffs taken from a point approximately one mile north of Moore lake in Creighton township is shown in the photomicrograph above. The parallel arrangement of the constituents

can be seen both in the hand specimen and under the microscope. The original structures of the massive tuff are somewhat obliterated, and there is a marked development of considerable biotite. The lenticular form of some of the uncrushed fragments affords an example of augen structure. Apparently the fine material of the cement with the carbonaceous substance has not been altered except to assume the general schistose relationship.

Fine Tuff

Near the inner or upper limit of the tuff the rock becomes quite fine-grained with a slight slaty cleavage, making it difficult to distinguish in the field from the Onwatin slate except for the absence of bedding planes. Good exposures

Photomicrograph of fine tuff from the west end of Vermilion lake. (×20.)

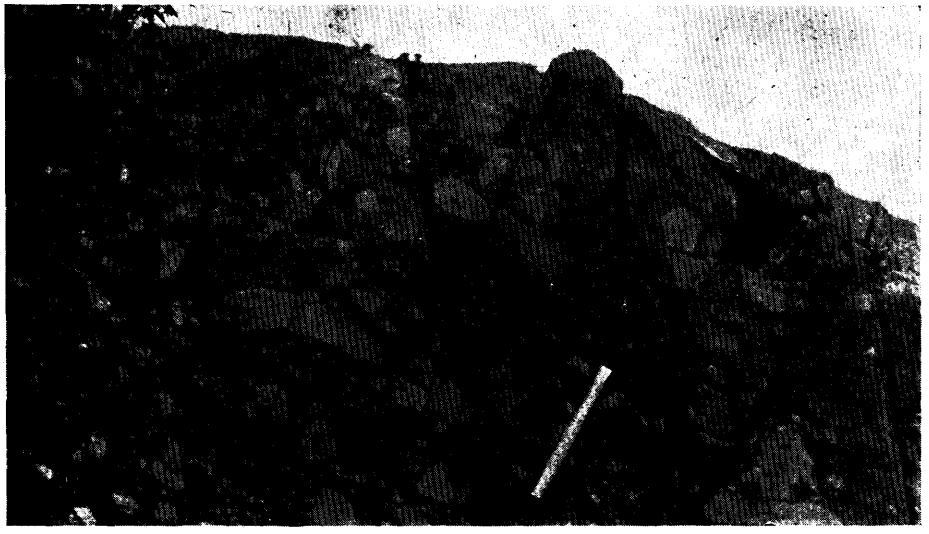
of this fine-grained phase of the tuff may be seen at the west end of Vermilion lake (see photomicrograph above), at the east end of Onwatin lake, and at a number of intervening points.

Apparently the rock does not resist weathering as well as the coarser phases, and actual outcrops are scarce. Its weathered surface is quite rusty and breaks up easily. Under the microscope it is seen to consist of angular fragments, up to one millimetre in diameter, of quartz with chlorite and calcite. The quartz fragments make up a considerably higher proportion of the constituents than in the coarse tuffs. The calcite and chlorite are, of course, secondary. The photomicrograph shows in faint outline a large fragment of volcanic glass with a marked perlitic structure.

Volcanic Breccia and Lavas

Volcanic breccia, along with some agglomeratic rocks and lavas, forms the outer rim of the Onaping volcanics, corresponding roughly to the "Trout Lake conglomerate" of Coleman. The actual contact of this rock with the micropegmatite, with the exception of one or two places where faulting has taken

place, as, for example, in the vicinity of Cameron lake, could hardly be more accurately mapped than has been done by Coleman. The breccia has been metamorphosed by the micropegmatite to such an extent that its original structures have been destroyed or considerably altered near the contact, but away from it, at distances ranging up to 1,000 feet, it has been only slightly altered. It may be studied almost anywhere around the rim, but special mention might be made of the north shore of Whitewater lake and southwestward along Levey creek to its junction with the Vermilion river, which is, incidentally, an excellent canoe route. It has been found somewhat difficult to decide the actual origin of some of the rocks seen, particularly the coarse breccias and lavas, owing to their great age and the proximity of the nickel eruptive, which has profoundly altered the rocks immediately overlying it. Coleman designated most of the rock included in this group of breccias as conglomerate. The



Explosive breccia, west of the narrows on the north shore of Whitewater lake.

authors of this report could find no evidence of the presence of water-worn boulders or local sedimentary beds, such as should characterize a conglomerate, either in the metamorphosed outer rim or amongst the less altered rocks of definite volcanic origin. Moreover, none of the highly altered rocks present any features which cannot be explained as due to metamorphic effects on the volcanic breccia.

The volcanic breccias include two main types: a purely explosive variety in which the fragments of volcanic material have cooled and hardened before being covered and another which shows evidence of flowage subsequent to its deposition. These two varieties grade into each other and into other rocks that were probably lavas, giving rise to intermediate types.

Explosive Breccia.—This purely explosive type makes up much the largest part of the coarser breccias. Except for the size of its fragments, it is much like the typical tuff in structure and may be said to represent the coarse phase of the ejected fragmental volcanics. The fragments, which commonly reach two feet in diameter with occasional ones as much as five feet, show a great variety of shapes. Some are fairly well rounded, but most of them are very

irregular, with sharp angles. None of them show the smoothly rounded edges which distinguish the rolled boulders of a conglomerate. They consist of granite, quartzite, schist, and many other varieties, representing the original crust through which the eruption took place, as well as glassy and pumiceous fragments of purely volcanic origin. The cement surrounding the fragments is commonly the dense, black, fine-grained material of the typical tuffs. The photograph on page 13 shows a rock of this type, which has been but slightly altered. The photographs on pages 14 and 15 show outcrops of the explosive breccia lying near the contact with the micropegmatite and show the metamorphic effects of the intrusive. The fragments, though somewhat altered, have retained their original shapes, while the cement has been silicified and recrystallized with the development of secondary quartz, feldspar, etc.

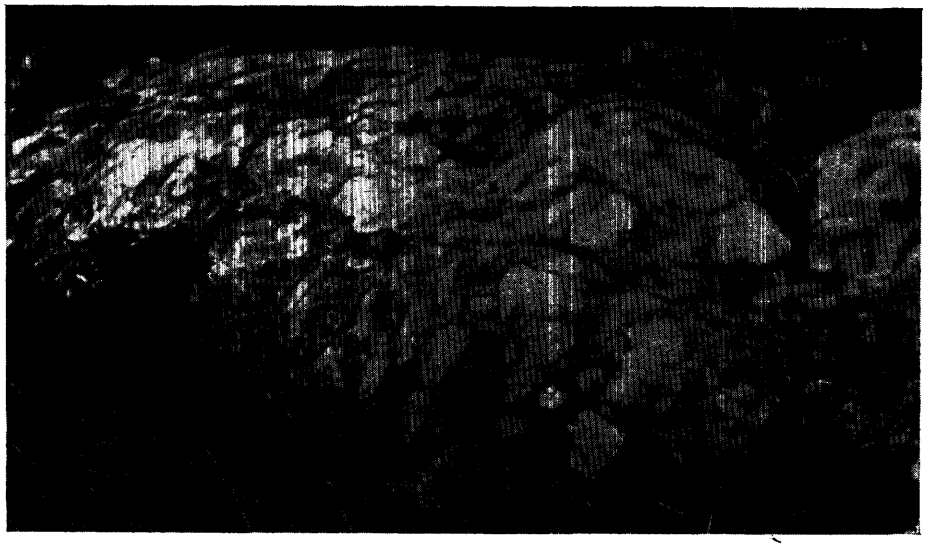
Explosive breccia, north shore of Moore lake, Creighton township.

A chemical analysis of a sample,[1] probably included under the type described above, is given below:—

	Per cent.
SiO_2	69.66
TiO_2	.42
Al_2O_3	12.86
Fe_2O_3	1.40
FeO	2.40
CaO	1.16
MgO	1.44
MnO	.05
Na_2O	4.86
K_2O	3.36
H_2O	1.73
CO_2	.13
P_2O_5	.19
S	....
C	....
Total	99.66

[1]Coleman, Moore, and Walker, op. cit., p. 39.

Spherulitic Lava.—On a small point near the southwest end of Whitewater lake on the north side there is a small outcrop of lava, about 25 feet wide, which



Silicified breccia, north end of lot 2, concession III, Rayside township. Note the peculiar shape of the inclusions.

dips to the southeast and is overlain and underlain by breccia (see photograph on page 16). The weathered surface of the rock, which is dark-grey in colour,

Silicified breccia near the contact with micropegmatite, Morgan township.

is covered with spheroidal nodules, up to one centimetre in diameter, packed closely together with a few amygdules of glassy quartz scattered through it. In thin section it is seen to be composed of biotite, muscovite, and feldspar. The feldspar

occurs in very fine lath-shaped prisms with a pronounced radiating structure (see photomicrograph on page 17) and, along with some fine-grained biotite

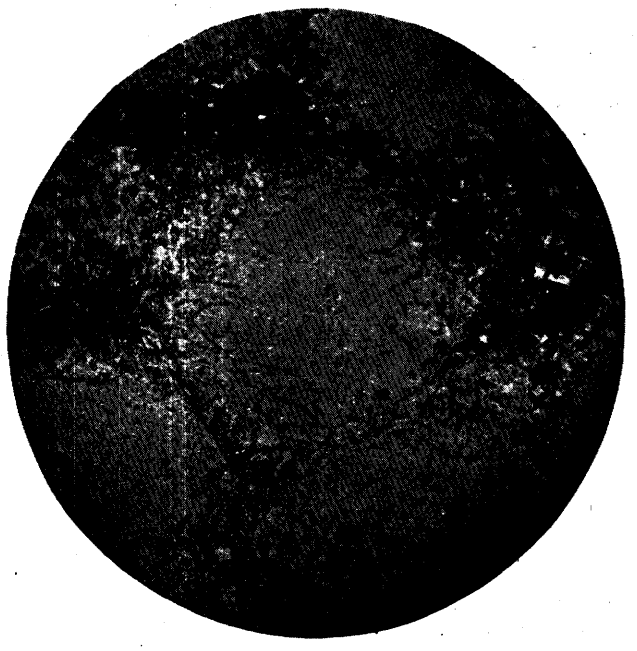
Specimen (two-thirds natural size) of spherulitic lava with amygdules, from Whitewater lake.

and muscovite, makes up the centres of the nodules. It is difficult to identify the variety of the feldspar, but its refractive index, approximatly 1.535, seems to indicate albite. The borders and interstices of the nodules are occupied by

Spherulitic lava west of the narrows on the north shore of Whitewater lake.

fine-grained biotite and muscovite with minor quantities of quartz, leucoxene, and carbonates. This rock is evidently a spherulitic lava. Its analysis is as follows:—

	Per cent.
SiO_2	60.44
TiO_2	.68
Al_2O_3	16.10
Fe_2O_3	.80
FeO	6.84
CaO	trace
MgO	5.48
Na_2O	4.23
K_2O	3.97
MnO	.26
H_2O	1.40
CO_2	.07
Total	100.27



Photomicrograph of spherulitic lava from the north shore of Whitewater lake. (×16.)

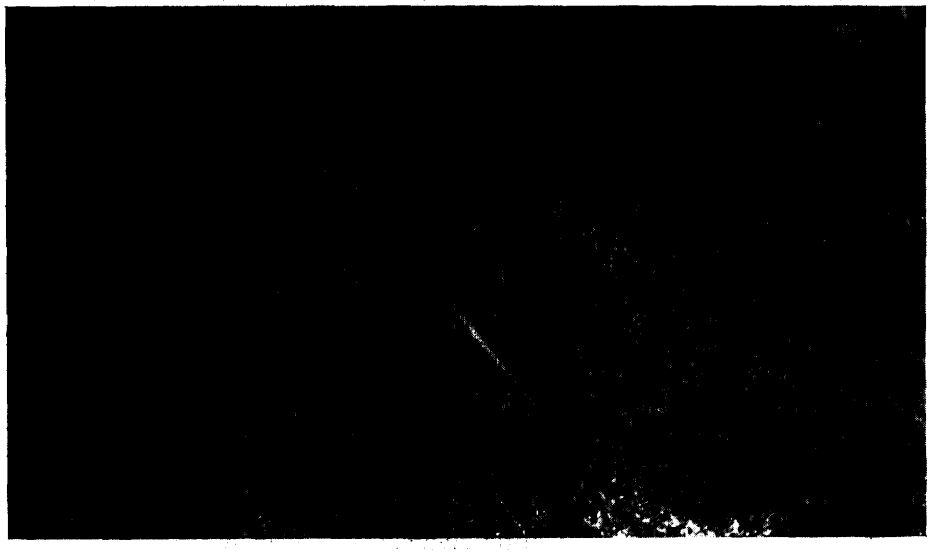
Approximately 300 yards west of this point the spherulitic lava outcrops again in a dike-like mass about 30 feet wide and 100 feet long. In this case the nodular lava forms the matrix of a breccia containing fragments up to two feet in length, very angular in shape, and otherwise similar to the fragments occurring in the explosive type previously described (see upper photograph, page 18). The nodules of the spherulitic matrix are larger than those of the lava described above, in some cases reaching an inch in diameter, but otherwise quite similar to it. The origin of this rock is probably due to the penetration of fluid lava upward through the interstitial spaces between the breccia fragments.

Two other outcrops of spherulitic lava similar to the above were observed south of Vermilion lake. The first one, which occurs near the corner between lots 9 and 10, concessions IV and V of the township of Fairbank, shows a rough pillow structure (see lower photograph, page 18). In thin section it differs from the Whitewater outcrop in the fact that the centres of some of the spherulites show cavities filled with calcite. Moreover, chlorite largely takes the place of

the biotite and muscovite as interstitial material. The feldspar, probably albite, shows the same radiating structure (see photomicrograph on page 19).

Volcanic breccia with a matrix of spherulitic lava, north shore of Whitewater lake.

The rest of the outcrop consists of a fine-grained lava showing rough pillow structure in places. In thin section it is seen to consist of fine-grained feldspar including orthoclase and plagioclase with chlorite and sericite. An opaque substance, probably magnetite and ilmenite with some leucoxene, is scattered



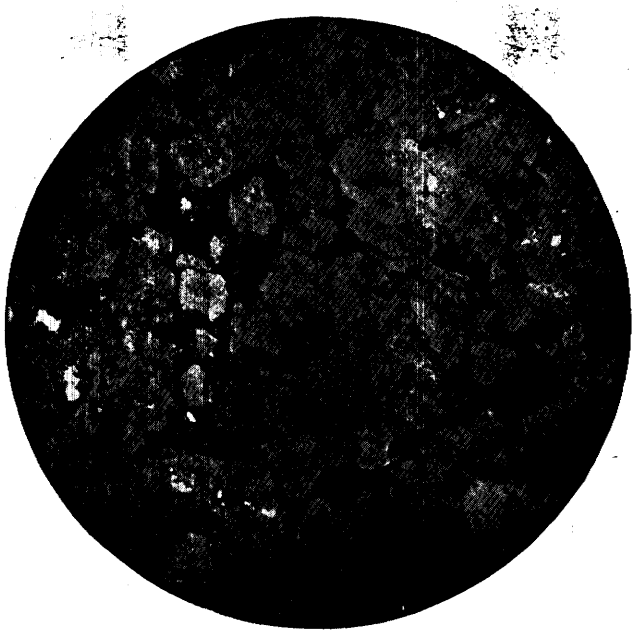
Spherulitic lava showing pillow structure, south of Vermilion lake.

throughout the chlorite. Half a mile south of this point is another outcrop of lava similar to the above.[1]

[1]J. P. Iddings, Igneous Rocks, Vol. II, 1st edit., p. 331.

Flow Breccia.—This term is defined by J. P. Iddings as follows:—

When exploded fragments of molten magma, large or small, fall together in a still heated condition, as may readily happen within the crater of a volcano or in the mouth of a fissure,



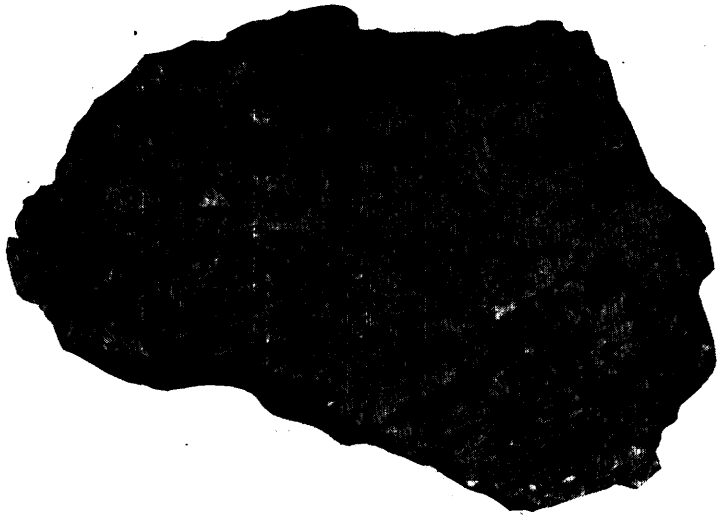
Photomicrograph of spherulitic lava, south of Vermilion lake. (×16.)

they may be plastic enough to weld together in a more or less compact, coherent mass. This may subsequently flow like other lava and is known as "flow breccia."

Flow breccia, lot 5, concession IV, Capreol township.

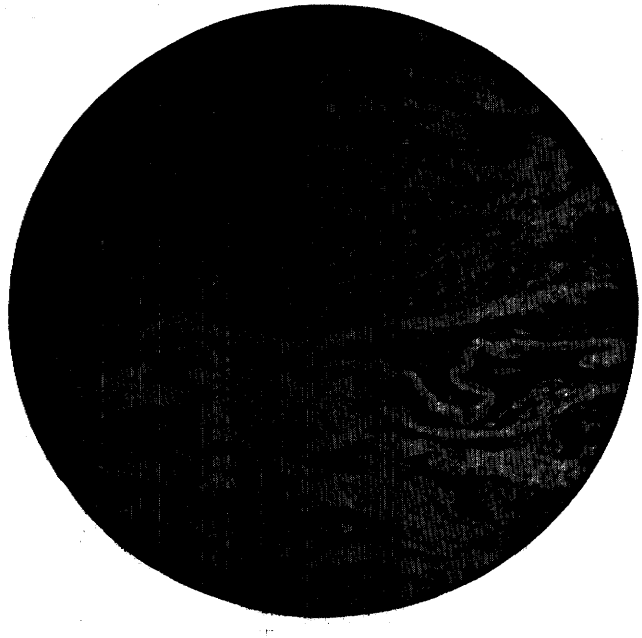
This type of breccia occurs extensively in the outer band of volcanics. Particularly good examples are seen on the south shore of the small lake, in lot 5, concession IV of the township of Capreol (see photographs on pages 19 and 20),

and at the southwest end of the rim in Trill township. The rock is very hard and cherty-looking and weathers to a light-grey with a rough uneven surface.



Specimen (one-third natural size) of flow breccia from lot 5, concession IV, Capreol township.

The fragments, consisting of glass, pumice, etc., show marked flow structures, some of the flowage having taken place after it was deposited. In thin section



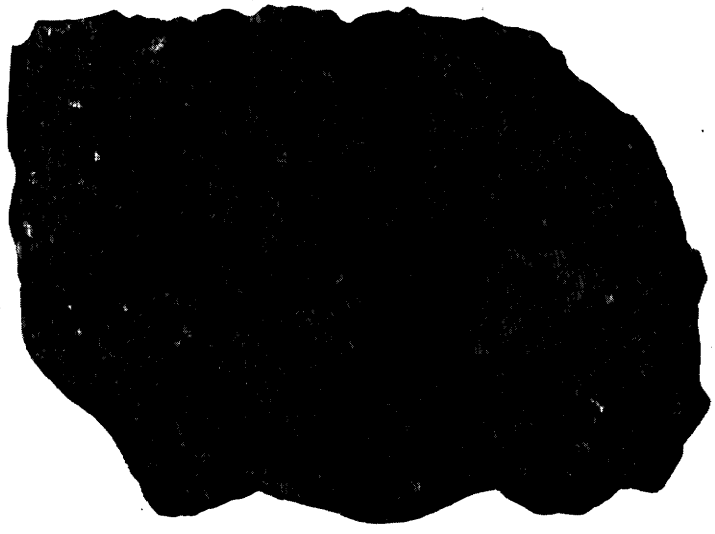
Photomicrograph of a thin section of flow breccia, lot 5, concession IV, Capreol township. (×16.)

(see photomicrograph above), the rock exhibits the usual variety of textures typical of rhyolite lavas. A few small phenocrysts of quartz and feldspar are

to be seen, but the texture for the most part is distinctly glassy with alternating bands of a spherulitic and pumiceous nature. It is difficult to identify the

Photomicrograph of a thin section of contorted lava, lot 11, concession V, Creighton township. (×16.)

minerals that make up the groundmass of the rock, but quartz, feldspar, and sericite are distinguishable.



Specimen (one-half natural size) of pumiceous breccia from Whitewater lake.

Rhyolite.--At a number of points in the outer part of the basin rim there are to be seen bands of a dense cherty-looking rock with the composition of a

rhyolite; sometimes it contains fragments and merges into breccias. It is to be seen at the southwest end of the basin in Trill township, in the southeastern part of Bowell township near Trout lake, and at other points. Some of the very highly altered rocks near the micropegmatite show features that suggest that they were originally rhyolite. These bands are usually narrow and discontinuous; there do not appear to be any extensive areas of acid lavas. The rock frequently contains quartz eyes and has a conchoidal fracture. It is light-grey on its weathered surface, but a fresh surface shows a grey to dark-grey colour. Under the microscope it is seen to be entirely crystalline though the crystals are extremely fine. Quartz, feldspar, and sericite are recognizable among the non-opaque minerals. Pyrite is present in very fine grains. Phenocrysts occur very rarely, the quartz eyes mentioned above apparently representing vesicles.

An analysis of a specimen from Trill township shows the following composition:—

	Per cent.
SiO_2	74.00
TiO_2	.43
Al_2O_3	11.35
Fe_2O_3	.36
FeO	3.24
CaO	1.31
MgO	1.99
Na_2O	1.81
K_2O	3.74
MnO	.06
H_2O (−100)	.02
H_2O (+100)	1.58
P_2O_5	.08
CO_2	.05
FeS_2	.21
Total	100.23

Other Volcanics.—Most of the rocks observed and mapped as belonging to the Onaping volcanics may be included under the various types already described. Special mention might be made of certain agglomeratic rocks occurring at the southwest end of Emma lake, the west end of Whitewater lake, and other points. Some of these weather out with a marked slaggy appearance, others appear to be pumiceous, but most of them show fragments and are undoubtedly of pyroclastic origin.

The outcrop on the southwest shore of Emma lake is especially striking in appearance, as shown by the photograph opposite. The rock, which weathers to a light-grey, is composed of two sorts of material: a dark-grey matrix of fine pumiceous fragmental material and a more acid quartzose rock in the form of narrow oblong inclusions, also pumiceous. The inclusions are all similarly orientated with a steep dip to the southeast, and the rock has been much sheared, which probably accounts for the shapes and orientation. Being quite near the contact with the micropegmatite, the rock has been altered to a gneiss consisting chiefly of quartz, biotite, and feldspar.

Metamorphic Effects of the Micropegmatite on the Onaping Volcanics

The acid edge of the nickel eruptive and its metamorphic effects on the overlying Onaping volcanics have been very fully and completely described by A. P. Coleman in his Sudbury reports. In his 1913 report,[1] "The Nickel Industry," he says:—

[1]Mines Branch, Dept. Mines, Can., No. 170, 1913, p. 97.

In mapping the acid edge unexpected difficulties were encountered. It was found that the edge was often overrun, even for a hundred yards or more, because of the great resemblance of the micropegmatite to the overlying Trout Lake conglomerate, which was often so completely metamorphosed by hot fluids emanating from the eruptive as to be itself largely transformed into micropegmatite of a somewhat ruder sort, near the eruptive margin. Only the larger granite pebbles and boulders of the conglomerate resisted this process and remained as cloudy patches of coarser or redder granitoid material.

In one of his earlier reports for the Ontario Bureau of Mines,[1] Coleman says:—

Thin sections of the matrix of the conglomerate near the acid edge of the eruptive have quite the appearance of a massive rock of the same composition as the acid edge itself, but with little or none of the micropegmatitic structure so characteristic of that rock. In fact every

Sheared agglomeratic rock, southwest shore of Emma lake, Creighton township.

transition can be found between micropegmatitic granodiorite of the typical acid edge and the matrix of the conglomerate, containing undoubted but vaguely edged granite boulders, so that the boundary between the eruptive and the sedimentary rock is no more sharp in thin sections than in the field. . . .

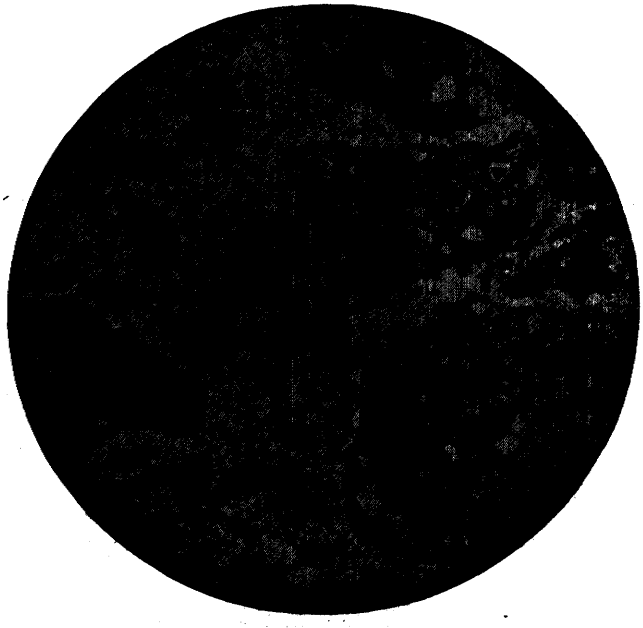
In a general way it may be stated that the Trout Lake conglomerate has been greatly metamorphosed near the acid edge of the nickel eruptive, the process often going so far that the matrix, probably arkose in the beginning, is completely recrystallized into a rock containing the minerals of the acid eruptive, even the micropegmatitic structure being produced to some extent. The enclosed pebbles, being of crystalline rock such as granite and quartzite, have undergone less change, but their boundaries have been blended with the matrix to a considerable degree.

In the opinion of the authors of this report the above excerpts give a very admirable description of the metamorphic effects of the micropegmatite on the Onaping volcanics with the substitution of the terms "breccias and their related types" and "fragments" where the terms "conglomerate" and "boulders," respectively, have been used. No matrix of arkose was ever observed in any phase of the coarser fragmentals. Actual evidence of the above effects may

[1]Ont. Bur. Mines, Vol. XIV, 1905, pt. 3, pp. 130, 131.

be seen at almost any part of the contact, but special mention might be made of lots 2 and 3 in the first concession of Capreol township on the west side of the road, where the rock shows every gradation from a typical micropegmatite to a typical breccia.

A. P. Coleman has also mentioned the occurrence of acid dike-like offshoots of the micropegmatite in the overlying volcanics, some of which will be described later. Veins and lenses of quartz, some of which have been mineralized by sulphides, are also quite common along the contact, the strike of which corresponds with the strike of the schistosity of the rocks in which they occur. The breccias and tuffs have been rendered quite schistose along certain horizons, the strike being generally northeast. At least some of the movement resulting in this schistosity has taken place subsequent to the intrusion of the nickel eruptive, since it is affected as well as the volcanics.



Photomicrograph of Onaping tuff, from a point near the contact, showing recrystallization. (×16)

Origin and Extent of the Onaping Volcanics

In discussing the former extent of the Onaping tuff in his second report for the Bureau of Mines, Coleman says:[1]—

> The thickness of the tuff, estimated at 3,800 feet, and the area of about 200 square miles covered by it, if continuous beneath the slate and sandstone, indicate a total amount of perhaps 130 cubic miles of material still preserved, and this would be increased greatly if we imagine the tuff extended so as to cover the whole area of the laccolithic sheet, which was no doubt the case in the beginning.

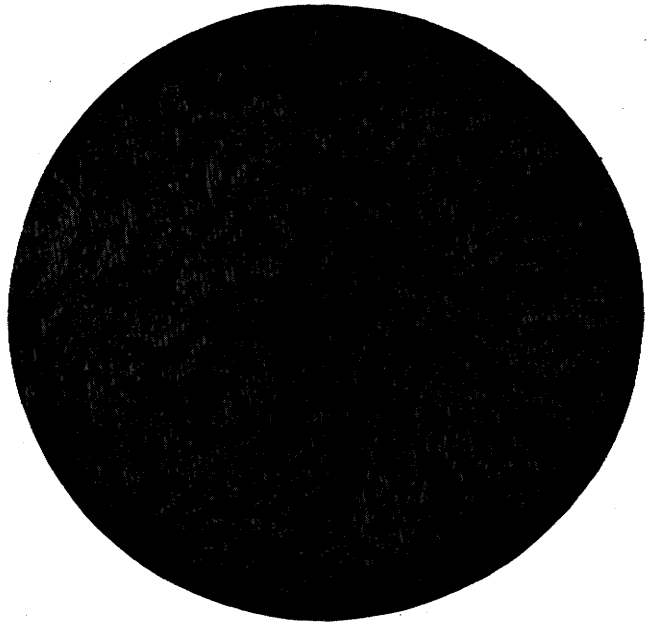
Nor does there seem to be any reason for limiting the extent of the volcanics to the original limits of the nickel eruptive sheet. Although no undoubted remnants of the tuffs have been found outside the basin, they may have been

[1]Ont. Bur. Mines, Vol. XIV, pt. 3, 1905, p. 100.

weathered away. Only under exceptionally favourable circumstances would such an unstable rock be preserved. The various writers who have studied this series of volcanic rocks are in agreement that the evidence indicates explosive volcanic activity on an enormous scale. For example, G. H. Williams in his description of the vitrophyre tuffs, states:[1]—

> The rarity of such rocks in the earth's oldest formations is readily intelligible, but for this very reason the exceptional preservation of a rock like this is all the more welcome proof that explosive volcanic activity took place at the surface, then as now, and on a scale, if possible, even greater than that with which we are familiar.

It is evident, moreover, that the actual eruption was continuous and took place in a comparatively short space of time. There are no marked variations of texture or local bedding such as would result from alternate periods of quies-



Photomicrograph of contorted schist from Levey creek, lot 11, concession IV, Creighton township. (×16.)

cence and discharge. Robert Bell and A. P. Coleman both favoured the idea that the tuffs were deposited in the sea, and this would certainly appear to be the most reasonable explanation of the remarkable preservation of the rock. Yet if such were the case, it would seem that there should be some evidence of bedding due to local currents or other causes. No bedding is to be seen, and it is not impossible that the eruption was entirely aerial and that the preservation of the rock is due to subsidence immediately following the discharge. The overlying slates were certainly deposited under water, but here again the evidence that the two rocks are conformable is not conclusive.

It was thought that a careful study of the various types of the volcanic *ejectamenta* might give some clue as to the location of some of the ancient volcanic

[1]Geol. Surv. Can., Vol. V, pt. 1, 1890-91, pt. F, p. 76.

vents from which the discharges took place. No certain evidence of this kind was seen. Traverses across the Onaping volcanics show a rather uniform arrangement around the basin, with the coarser breccias at the lower or outer rim and fine tuffs at the upper or inner side. This suggests that the volcanic focus was in the nature of a fissure, or row of vents along a fissure extending in a direction parallel to the longer axis of the oval. In this connection some observations made by Sir Archibald Geikie[1] in his work "The Ancient Volcanoes of Great Britain" seem to have an important bearing on the Onaping volcanics. Under "Vents of Eruption" he states:—

> It is the general belief that the first stage in the formation of a volcano of the Vesuvian type by the efforts of subterranean energy is the rending of the terrestrial crust in a line of fissure. Some of the most remarkable groups of active volcanoes on the face of the globe are certainly placed in rows, as if they had risen along such great rents. The actual fissure, however, is not there seen, and its existence is only a matter of probable inference.

Discussing volcanic agglomerates, breccia, and tuffs, he says:[2]—

> Although these various forms of pyroclastic detritus consist as a rule of thoroughly volcanic material, they may include fragments of non-volcanic rocks. This is especially the case among those which represent the earliest explosions of a volcano. The first efforts to establish an eruptive vent lead to the shattering of the terrestrial crust, and the consequent discharge of abundant debris of that crust. The breccias or agglomerates thus produced may contain, indeed, little or no truly volcanic material, but may be made up of fragments of granite, gneiss, sandstone, limestone, shale, or whatever may happen to be the rocks through which the eruptive orifice has been drilled.

Herein lies the explanation of the coarser breccias at the outer ring which contain such a high proportion of fragments of granite, quartzite, etc.

Discussing the arrangement of the volcanic *ejectamenta*, Geikie makes the following statement:[3]—

> Thrown out promiscuously from active vents, the materials that form tuffs arrange themselves, on the whole, according to relative size over the surface on which they come to rest, the largest being generally grouped nearest the focus of discharge, and the finest extending farthest from it. As the volcanoes of which records have been preserved among the geological formations were chiefly subaqueous, the fragmentary substances, as they fell into water, would naturally be to some extent spread out by the action of currents or waves. They would thus tend to take a more or less distinctly stratified arrangement.

Geikie also remarks on the general tendency of the rocks around volcanic vents to dip toward the vent owing to subsidence.[4] In the Sudbury basin, subsidence has taken place again following the laying down of the slate and sandstone and probably contemporaneous with or immediately following the intrusion of the nickel eruptive, since all the rocks apparently dip inward toward the centre.

The possibility of a connection between the Onaping volcanics and the nickel eruptive, in that the former may represent an earlier eruption from the same magma, has been referred to by Coleman.[5] The field relations of the two rocks certainly favour this possibility.

A close approach to the chemical composition of the magma from which the norite-micropegmatite crystallized may be found by taking the average of 48 analyses, Nos. 37 to 74 and 82 to 92, given by Coleman, Moore, and Walker.[6] This would give a rock of the following composition:—

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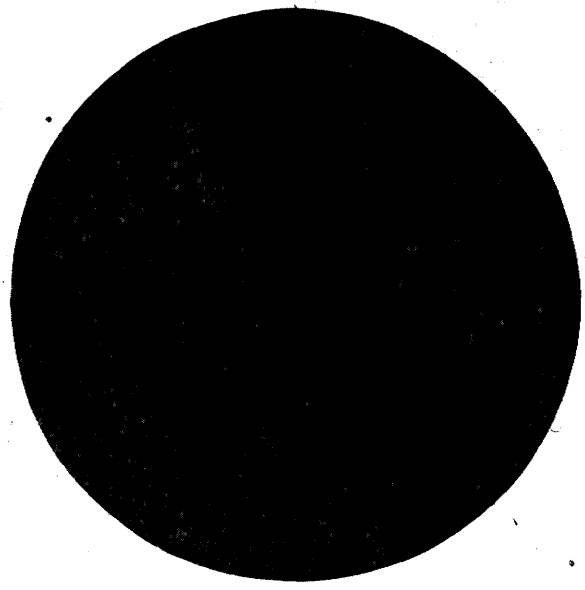
[1]Archibald Geikie, The Ancient Volcanoes of Great Britain, Vol. I, p. 53.
[2]Ibid, p. 31.
[3]Ibid, p. 34.
[4]Ibid, p. 73.
[5]Ont. Bur. Mines, Vol. XIV, pt. 3, 1905, p. 100.
[6]Coleman, Moore, and Walker, op. cit.

	Per cent.
SiO_2	61.23
TiO_2	.90
Al_2O_3	14.69
Fe_2O_3	1.68
FeO	5.81
CaO	4.99
MgO	3.58
M_2O	.10
Na_2O	3.05
K_2O	2.62
H_2O	1.30
CO_2	.14
P_2O_5	.34
S	.08
Total	100.51



Photomicrograph of Onwatin slate showing bedding planes, south shore of Vermilion lake. (×35.)

Comparing this with the analysis of the tuff given previously, it is seen that, with the exception of the alumina, the two rocks are quite similar in composition, Coleman's suggestion of a connection between the norite-micropegmatite and the Onaping volcanics seems, therefore, quite reasonable in the Sudbury basin.

Onwatin Slate

Good descriptions of the Onwatin slate have been given by Barlow,[1] and by Coleman.[2] As previously mentioned the slate is presumed to form a continuous bed between the Onaping volcanics and the Chelmsford sandstone and underlies the belt of level farm land between these two formations. Small remnants of it are to be seen on the south shore of Vermilion lake, and it outcrops as a low ridge on the north side of the lake and as small hills at various points around the basin. Actual undisturbed contacts with the underlying tuff

[1]Geol. Surv. Can., No. 961, 1908, p. 74.
[2]Ont. Bur. Mines, Vol. XIV, pt. 3, 1905.

were not observed, and except for the fact that the tuff becomes very fine grained where it outcrops near the slate, there is no definite evidence that the slate lies conformably on the volcanics. Its actual contact with the overlying sandstone may be observed at a number of places, for example, along the northwest side of the sandstone in the townships of Balfour and Dowling where the interbedding of the two rocks shows them to be conformable. Assuming an average dip toward the centre of the basin of 30 degrees Coleman has estimated an average thickness of 3,700 feet.

The slate is a dark-grey to black, well-bedded rock with good cleavage at high angles to the bedding planes. In thin sections it is seen to consist of minute fragments of quartz, chlorite, sericite, and carbonates, along with small, black, opaque particles, probably of a graphitic or other carbonaceous material. The slate has been considerably sheared, particularly in the vicinity of the Errington mine and southwestward with the development of graphitic slickensides. An analysis of a sample of the slate from the south shore of Vermilion lake, lot 8, concession V, of Fairbank township, shows the following composition:

	Per cent.
SiO_2	58.62
TiO_2	.70
Al_2O_3	15.30
Fe_2O_3	2.32
FeO	9.43
CaO	.28
MgO	2.78
MnO	.40
Na_2O	1.20
K_2O	3.50
CO_2	2.38
H_2O	2.90
C	.30
Total	100.11

It is interesting to compare the chemical compositions of the slate and the tuff. The slate shows an increase in alumina and a decrease in soda, lime, and magnesia. This is the normal change that would be expected in the leaching action of water on the tuff and its subsequent deposition and consolidation as slate. The slate is probably composed of the finer material of the Onaping volcanics.

The carbon content of the slate is somewhat higher than that of the tuff and much more variable. Dr. Coleman states that determinations made in Dr. Ellis's laboratory in the School of Science showed from 6.8 to 10 per cent. of carbon. Four samples of typical black slate were carefully analysed for carbon in the Provincial Assay Office. The results were as follows:—

Locality	Per cent.
Lot 10, con. II, Balfour tp.	3.35
Lumsden tp.	2.03
Errington mine	.73
Lot 8, con. V, Fairbank tp.	.30

The first two are higher than the average, which would probably be not over 1 per cent.

The veins of anthraxolite occurring in the slate have been fully described by Coleman. Efforts to find coal in connection with these persisted up to the summer of 1927, when some further work was done on the deposit on lot 10, concession II of Balfour township. These, however, have only served to bear out Dr. Coleman's ideas on the nature and economic significance of the deposits.

The carbon content of the slate he ascribes to organic matter due to the presence of marine plants or animals in the waters in which the slates were deposited. Of the anthraxolite deposits, he says:[1]—

It is likely that the Onwatin slate was highly charged with bituminous matter in the beginning, like the oil shales of Scotland and other places, and that the heat of the nickel eruptive when it spread out beneath, first drove part of the petroleum or pitch into fissures in the slate and then volatilized the hydrocarbons, leaving only the fixed carbon.

Chelmsford Sandstone

The Chelmsford sandstone occupies the centre of the synclinal trough and has an average width of from 2½ to 3 miles. Commencing at a point near the junction between lots 6 and 7 on the boundary between the township of Fairbank and Balfour, it extends for 20 miles in a direction approximately N. 60° E. to a point near the corner of lots 4 and 5, concessions IV and V, of the township of Hanmer. The general and detailed features of the sandstone have been admirably described by Dr. Coleman:[2]—

Outcrop of Chelmsford sandstone showing bedding, west side of the road, lot 4, concession V, Balfour township.

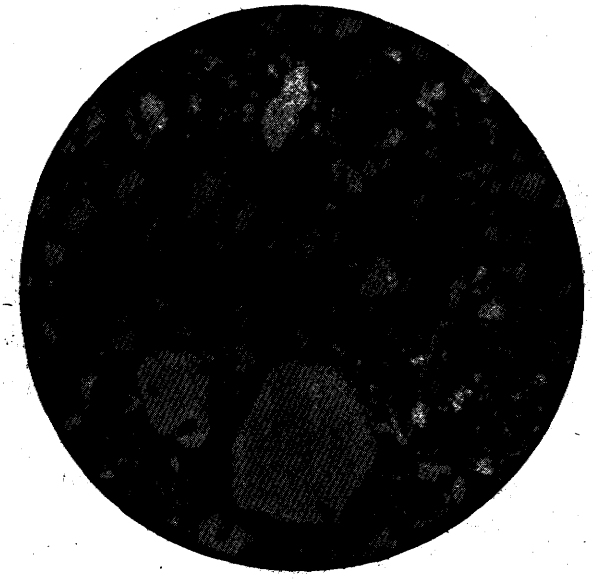
The uppermost rock of the series is distinctly marked off from the slate below, though a few bands of slate part the thick beds of sandstone and bring out prominently the bedding of the formation. The sandstone, where it rises above the plain, forms a succession of gentle anticlines, usually four in number, running parallel to the axis of the main syncline, i.e. about 50° to 80° east of north. The synclines between the anticlinal hills are always buried under stratified lacustrine deposits or under swamps, so that a complete fold is never seen. In almost all cases the top of the anticline has been destroyed, and often narrow, sharp, outlying ridges run parallel to the central hill, ruins of former upper beds of the anticline. In size the anticlines vary considerably, the longest mapped having a length of 2½ miles and a width of about a quarter of a mile, while the next to the northwest is only a mile long and 760 feet wide. The slopes of the folds vary from 20° or 25° to 45° or 50°, and the present height of the hills is seldom more than 150 feet above the plain formed by the old lake deposits. However, in crossing these anticlines one usually finds a more or less steep hill following the bedding and then a sharp break with a nearly vertical cliff of 5 to 15 feet where the stratum has been destroyed. Then comes another ascent of gentler slope along the next stratum with perhaps a smaller cliff; and at last a gently rounded surface on top of the arch; the opposite side being of the same nature but reversed. . . .

The sandstone is medium-grained with particles of quartz and of mica visible, as well as some feldspar, so that it might be called arkose. It is not very strongly cemented, is dark-grey on fresh surfaces and paler grey on weathered ones, and frequently contains large oval concre-

[1]Mines Branch, Dept. Mines, Ottawa, No. 170, 1912, p. 103.
[2]Ont. Bur. Mines, Vol. XIV, pt. 3, 1905, pp. 96-98.

tions richer in lime and iron than the rest of the rock, so that they might be called impure, ferruginous limestone. The large concretions weather out and leave shallow holes, which give a characteristic look to some of the flanks of the anticlines. The beds are from two to seven or eight feet thick, and often a thin seam of slate, less carbonaceous than the slate below, occupies the break between two strata. Occasionally this slaty part of the rock has been greatly crumpled and thickened at some points, probably while the harder sandstone underwent folding.

The quartz grains seldom make up more than 50 per cent. of the rock, the remaining constituents consisting of feldspars, mica, chlorite, and carbonates. Occasional grains show micrographic intergrowth typical of the surrounding micropegmatite. The quartz and feldspar grains are decidedly angular to subangular in shape and are quite fresh-looking. These features indicate a very rapid deposition, probably under shallow lake conditions, the material being gathered from the surrounding micropegmatite and volcanic rocks. An



Photomicrograph of Chelmsford sandstone, lot 4, concession IV, Balfour township. (×20.)

analysis of a specimen taken from the quarry on lot 4, concession IV, of Balfour township, shows the following composition:—

	Per cent.
SiO_2	72.40
TiO_2	.48
Al_2O_3	14.62
FeO_3	.24
FeO	3.67
CaO	.72
MgO	1.99
Na_2O	1.82
K_2O	1.75
MnO	trace
H_2O	1.86
CO_2	.40
C	.27
Total	100.22

As with the tuffs and slates the sandstone also contains carbon in small quantities, which accounts for its very dark colour.

Basic Intrusives

A series of small bodies of intrusive of a highly altered basic rock occurs at several points in the slate near its contact with the Chelmsford sandstone. An outcrop 75 feet wide and 800 feet long, striking N. 70° E. is to be seen on lots 10 and 11, concession I, of Balfour township, about 500 feet south of the anthraxolite deposit. It outcrops again near the north end of the line between lots 2 and 3, concession VI, of Fairbank township, in a series of small short dikes or bosses, which may be followed in a direction approximately W. 15° S. as far as the centre of lot 8, concession VI, of the same township. Finally it is to be seen again in the same form crossing lots 5, 6, and 7, concession VI, of Balfour township. The separate outcrops of the intrusive are not continuous, though their general position and strike correspond closely to the bedding of the slate and its contact with the overlying sandstone. Like the sediments, the dip of the intrusive appears to be toward the centre of the basin; and this, taken in conjunction with the strike, strongly suggests a sill-like arrangement.

Examination of most of the intrusive rock shows it to be very highly altered to carbonates, chlorite, etc., with proportionately little of its original mineral constituents remaining. The least altered specimens were secured from a boss-like outcrop occurring in the northeast corner of lot 3, concession II, of Fairbank township. The hand specimen from this locality shows a coarse-grained holocrystalline rock, dark-grey on a fresh surface and weathering to a rusty-grey. It consists mainly of pyroxene and hornblende with coarse bunches of pyrite scattered throughout. Under the microscope the pyroxene is seen to consist of a brownish pleochroic augite considerably altered to hornblende, epidote, and chlorite. Hornblende makes up most of the remaining constituents with minor amounts of plagioclase and quartz. The hornblende appears to be largely secondary. Thin sections of specimens from the same outcrop but nearer the margin show much greater alteration. Augite is entirely absent and has been replaced by secondary hornblende, chlorite, quartz, and carbonates. This condition is typical of the other outcrops of the intrusive south of the sandstone. Primary quartz and plagioclase of an oligoclase-andesine type are present in varying amounts.

Thin sections of specimens from the intrusive in the northern part of Balfour township show a marked development of granophyric structure approaching the micrographic intergrowth that characterizes the norite-micropegmatite. The original ferromagnesian constitutents have been entirely altered to carbonates, quartz, etc., and the feldspar and quartz intergrowths are the only remaining primary constituents.

Analyses of three specimens of the intrusive are given on page 32. No. 1 is a sample of the least altered specimen from the boss mentioned above; it is the most basic one of the series, approaching a pyroxenite or gabbro in composition. No. 2 is from one of the smaller masses north of Vermilion lake and is probably an altered dike equivalent of No. 1; No. 3 is from the outcrop in lot 7, concession VI, of Balfour township, and is probably an altered granophyre.

The slate adjoining the intrusive has been baked, but the alteration does not extend beyond a few inches. As to the age relationships of this rock nothing can be said except that it is later than the sediments but earlier than the olivine diabase dikes, one of which cuts it just south of the point from which the unaltered specimen was obtained on lot 3, concession VI, of Fairbank township. Its composition is in rather strong contrast to that of the rest of the intrusives in the area, but it is probably a basic differentiate of the magma from which the norite-micropegmatite was derived.

Analyses of Basic Intrusive, Balfour Township

	No. 1	No. 2	No. 3
	per cent.	per cent.	per cent.
SiO_2	49.95	52.44	52.49
TiO_2	.54	.51	1.13
Al_2O_3	9.20	12.19	14.03
Fe_2O_3	1.11	.74	.73
FeO	8.42	7.35	7.73
CaO	9.18	6.74	5.31
MgO	16.24	7.79	3.41
MnO	.08	.14	.15
Na_2O	1.00	1.60	3.12
K_2O	.85	.49	1.38
$H_2O(-100)$	.09	.04	.04
$H_2O(+100)$	2.73	4.78	2.39
CO_2	.18	5.04	7.04
P_2O_5	.10	.13	.25
FeS_2	.26	.23	.71
Total	99.93	100.21	99.91

The specific gravity of No. 1 is 3.00; that of No. 2 is 2.82; and that of No. 3 is 2.76.

Weathered olivine diabase dike, south side of the road, lot 6, concession VI, Balfour township.

Acid Dikes

At a number of points near the contact with the micropegmatite the breccias and tuffs are intruded by narrow dikes, generally not over a few feet wide, with which are associated veins and lenses of quartz carrying some sulphides. The largest of these seen occurs at the southwest end of lot 7, concession V, of Blezard township; it has a width of 30 feet and strikes N. 80° E.

Microscopically the rock is fine-grained and dark-grey in colour. In thin section it is seen to be an even fine-grained rock consisting almost entirely of biotite and plagioclase. The plagioclase of the albite variety occurs as small lath-shaped crystals showing polysynthetic twinning. The biotite is brown in

colour and strongly pleochroic, with a marked development of pleochroic haloes; chlorite, apatite, and leucoxene make up the accessory constituents. An analysis of a specimen of this rock is given below (No. 4). Petrographically it might be called a kersantite. Somewhat similar dikes occur at the northeast corner of lot 2, concession III, of Rayside township, and at other points, generally quite close to the micropegmatite.

A dike of a somewhat more acid type cuts the breccias on the north shore of Whitewater lake west of the narrows. It is a dark-grey rock somewhat coarser in grain than the dikes described above. In thin section it is seen to consist of feldspar, chiefly plagioclase, and considerable quartz showing micrographic intergrowth. Biotite is the chief ferromagnesian constituent and occurs as scattered flakes also showing pleochroic haloes. An analysis of a sample is given below (No. 5).

	No. 4	No. 5
	per cent.	per cent.
SiO_2	63.18	72.65
TiO_2	.69	.45
Al_2O_3	15.65	12.23
Fe_2O_3	.96	.83
FeO	5.14	2.98
CaO	.58	.94
MgO	3.77	2.36
MnO	.14	.16
Na_2O	4.66	3.49
K_2O	3.02	2.30
$H_2O(-100)$	.03	.02
$H^2O(+100)$	1.44	1.08
P_2O_5	.14	.08
CO_2	.17	.58
FeS_2	.47	.13
Total	100.04	100.28

The specific gravity of No. 4 is 2.71; that of No. 5 is 2.82.

The occurrence of these intrusives in the outer part of the tuffs and breccia and their composition point to the probability of their close connection in origin with the norite-micropegmatite sheet.

Olivine Diabase Dikes

The latest rocks of the area are the olivine diabase dikes, which cut all the rocks of the Sudbury basin. The dikes range in width from a few inches to 200 feet or more. Dr. Coleman has mapped and described a number of them in the Sudbury area outside of the Whitewater series. In his description of them he says:[1]—

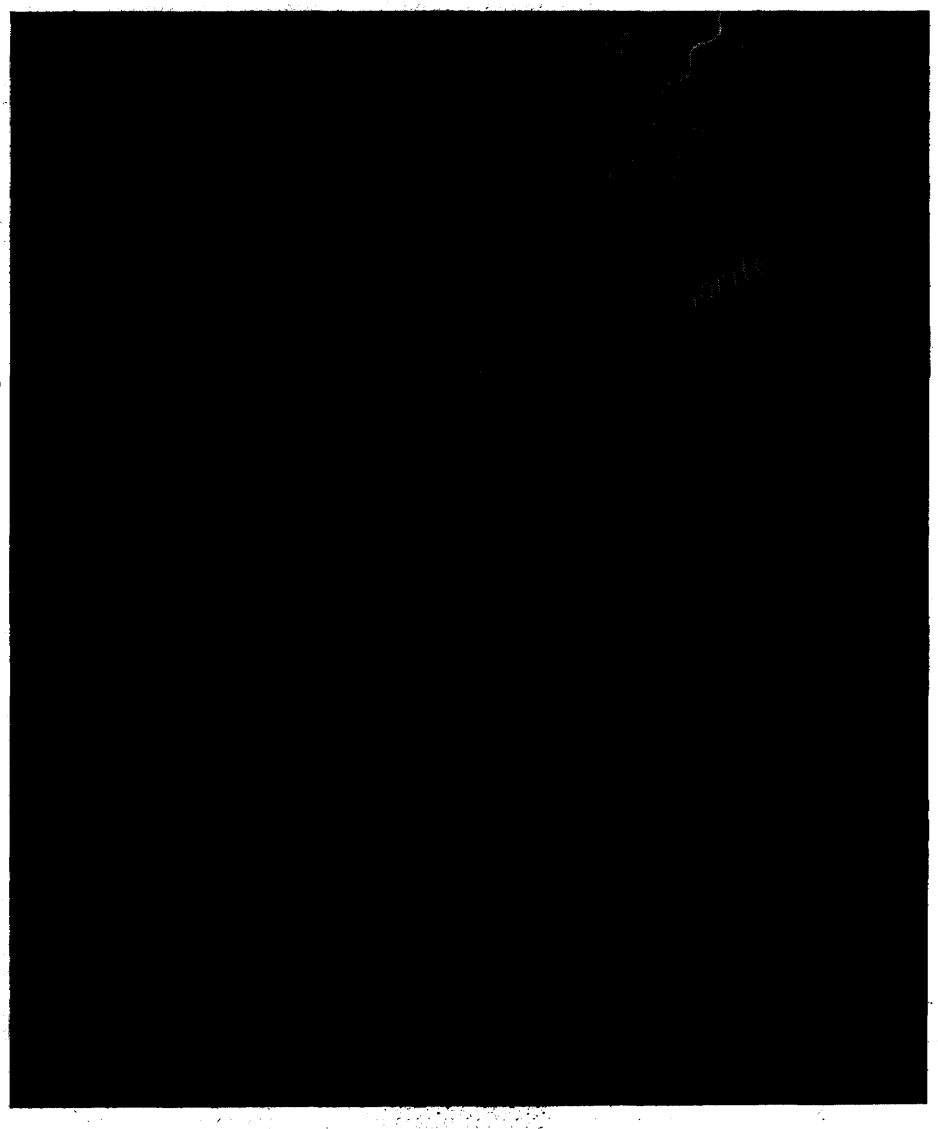
> The rock varies from fine-grained or compact to coarse-grained in the middle of large dikes, and in many cases it is highly porphyritic, flat plates of plagioclase sometimes two inches in longest diameter being embedded in a fine-grained ground. The colour is grey, weathering brown, and the rock is specially apt to form spherical shells and boulder-like masses on exposed surfaces. Thin sections show that the rock is an admirably fresh olivine diabase.

The map (No. 38*g*) accompanying this report shows four of these dikes, each from 100 to 200 feet wide, crossing the sediments with strikes from E. 20° S. to E. 40° S. The dike farthest east outcrops at intervals from a point just

[1]Ont. Bur. Mines, Vol. XIV, pt. 3, 1905, p. 84.

north of Bass lake southeastward to the southeast corner of Capreol township. Another one crosses the northern part of Hanmer township as far as Hanmer station. A third one crosses the northern part of Balfour township; and the fourth one crosses the southern part of Dowling township and was followed as

Photo by Topographical Survey, Ottawa.



Aerial photograph showing the fault (wavy line) at Cameron creek in Trill township.

far as Emma lake to the southeast. This last dike has been faulted at the road between Fairbank and Dowling townships and possibly again at Vermilion river south of Stobie falls. No attempt was made to trace these dikes into or across the norite-micropegmatite, but it is possible that they may connect with similar dikes known to occur in the nickel eruptive.

STRUCTURE

The Fault Zone

Dr. Coleman's map, No. 171, which accompanies his 1913 report on the Sudbury nickel region, suggests a major fault to the southwest of Cameron lake.

C. H. Hitchcock, in a short article with accompanying geological sketch, describes a great fault, which probably extends through the basin from rim to rim, in a general northeast-southwest direction. Hitchcock was the first to mention the possible economic importance of the fault in connection with the occurrence of zinc deposits in the basin.[1] Owing to the great amount of drift cover along the strike of the fault, or branching faults, most of the information obtained has been by means of diamond-drilling. Many holes at places far apart have been drilled by various companies in an endeavour to prove up ore bodies.

Rock exposures are more abundant at the southwest and northeast ends of the basin, and here the evidence, as mentioned by Hitchcock, points to distinct faulting. In the vicinity of Cameron lake, norite is faulted against its acid phase (micropegmatite), and micropegmatite against volcanic fragmental (see photograph on page 34). The offset here is probably 11,000 feet. Near Clear lake at the northeast end of the area a northeast-southwest fault shows norite against greenstone. The offset is here about 2,600 feet. In these cases the north side of the fault has been displaced to the southwest. Where most of the exploratory drilling has been done, along or near the south shore of Vermilion lake, Vermilion river east of the lake, and near the valley of Whitson river on the Treadwell Yukon property and to the northeast, the fault zone is along the contact of black slate and tuff. In this section the fine-grained tuff rises as a ridge on the south side of the zone, the slate being usually concealed by drift or by the waters of the lake or river near the contact. Secondary faults have displaced the continuity of the fault zone at Vermilion lake and near Stobie falls. Exploratory work has indicated that the fault zone has a steep dip to the south, whereas contacts of slate and tuff, where recognizable in cores and underground, appear to indicate a varying dip to the north. Consequently, at depth the deposits would enter the tuffs. In fact, some of the deposits being developed at Errington mine are in the slaty tuffs. The compositions of the slates and fine-grained tuffs are much the same, and as wall rocks for ore deposition should have similar influence.

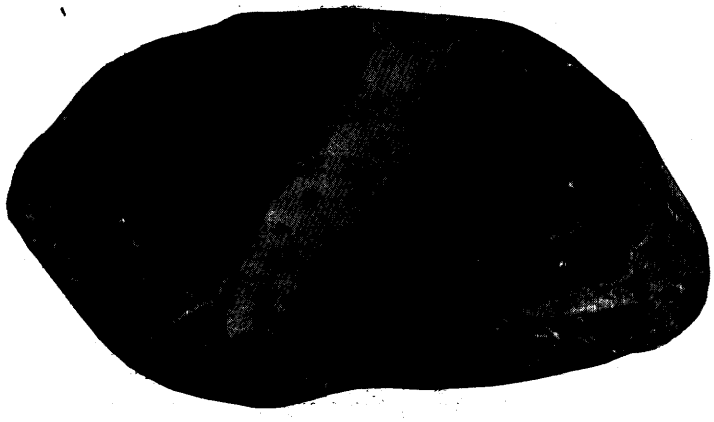
The northeast-southwest strike of the strong fault near Cameron lake is in line with the drift valley of the Vermilion river, above Vermilion lake. In concessions V and VI, Balfour township, there outcrops a narrow mineralized dike, also along the line of strike, which may represent a filling of the fracture. This line of weakness would probably be continued at Onwatin lake, where the fine-grained tuffs are greatly sheared and somewhat mineralized.

The occurrence of the ore-bearing fault on Vermilion lake and river, and near Whitson river is difficult to trace with certainty. The fault under Vermilion lake is probably displaced at intervals. The strike of the section of fault which is ore-bearing at Sudbury Basin Mines if produced southwestward would continue on the land south of the lake. However, drilling off the points of the south shore of the lake on lots 8 and 9, concession V, Fairbank township, indicates a strong breccia zone with the characteristic quartz and carbonate filling. Drilling by Sudbury Contact Mines east from the shore of the southwest bay of Vermilion

[1]Can. Min. Jour., Vol. 42, 1921, p. 215.

lake showed tuff overlying slate, suggesting a strong thrust fault from the southeast, which may have displaced the ore zone fault to the north in the west part of the lake. This fault would continue west-southwest along Cameron creek to the Cameron lake fault. A subsidiary fault structure would explain the occurrence of several small mineralized showings which occur north of Vermilion lake, from a point on lot 8, concession VI, Fairbank township, to the anthraxolite on lot 10, concession I, Balfour township.

The fault zone near Stobie falls has been displaced by a cross-fault with a displacement of approximately 2,000 feet, the portion to the east of the fault being moved to the south. The contact between the fine-grained tuffs and slates is seen in the bend below Stobie falls near an old shaft on the Treadwell Yukon property. The rock at Stobie falls is entirely fine-grained tuff, and the



Polished cross-section (one-half natural size) of concretion.

slate lies some distance to the north concealed by a heavy mantle of drift. Drilling at the Creighton Fairbank property, along the river, revealed the fault zone under the river bed, the strike of which would be to the north of Stobie falls. The rock on the north side of the falls is rusty-weathering and shows a little zinc blende, so the zone is not far north of this point.

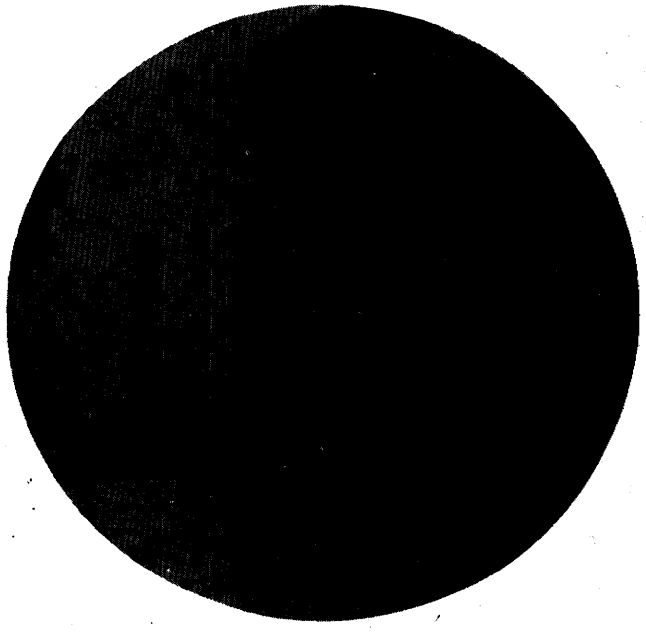
Concretions

In the course of underground examination at the Errington mine, some peculiar rock structures were observed which merit description. They are to be seen on the 300-foot level in the drift about 400 feet east of the crosscut from No. 1 shaft, as well as in some of the crosscuts to the south. Most of them are cylindrical in shape, though roughly ovoid shapes were also observed. They have diameters of from 5 to 10 inches, or more, and varying lengths. Owing to their great hardness in comparison with the rocks in which they occur and to the graphitic slickensides which cover most of them, they separate quite easily and cleanly from the rock. The more pipelike ones for the most part stand in an upright position, dipping with the schistosity of the rock at high angles to the south; they are apparently confined to the fine tuffs. About 2,000 feet W. 30° S. from No. 1 shaft, a small outcrop of fine tuffs shows several of these cylindrical structures protruding slightly above the surrounding rock.

The cylindrical structure from which the specimen shown in the accompanying photograph was taken, hung down about two feet from the roof of one of the

crosscuts, part of it having been removed in blasting. On the wall of this same crosscut another was partly exposed, coming in at the bottom and going out at the top with a perfectly smooth surface.

The general appearance of many of these structures is suggestive of tree trunks. The material composing them is fine-grained and black in colour. They show three marked zones, concentrically arranged. The inner zone consists of a fine-grained mosaic of quartz and carbonates and a small quantity of a faint-green mineral, probably amphibole, with small flakes of carbonaceous material scattered throughout. Surrounding this is a band, about three-



Photomicrograph of ore from the Errington mine, showing mainly chalcopyrite with inclusions of iron pyrites, also pyrrhotite containing blebs of chalcopyrite. A little zinc blende shows on the margin. (×150.)

quarters of an inch thick, of extremely fine grained material, in which quartz and carbon are the only constituents that can be distinguished. It is very hard and cherty and its outer edge is corrugated, the corrugations being filled by veinlets of quartz and carbonates carrying some pyrite. The veinlets extend into and across the fine black cherty layer. Surrounding this band is a third one with an average thickness of one-eighth of an inch of very dense, black graphitic material with pyrite; this band forms the slickensides.

It will be noted in the photograph that a small quartz vein cuts the two inner zones, but is cut off by the outer one. Coarse pyrite occurs in the quartz, and small particles of zinc blende and galena are seen replacing the pyrite. Except for the minor fractures shown by the presence of quartz veinlets, the structures did not appear to be much broken up by the faulting that caused the marked schistosity of the enclosing tuffs.

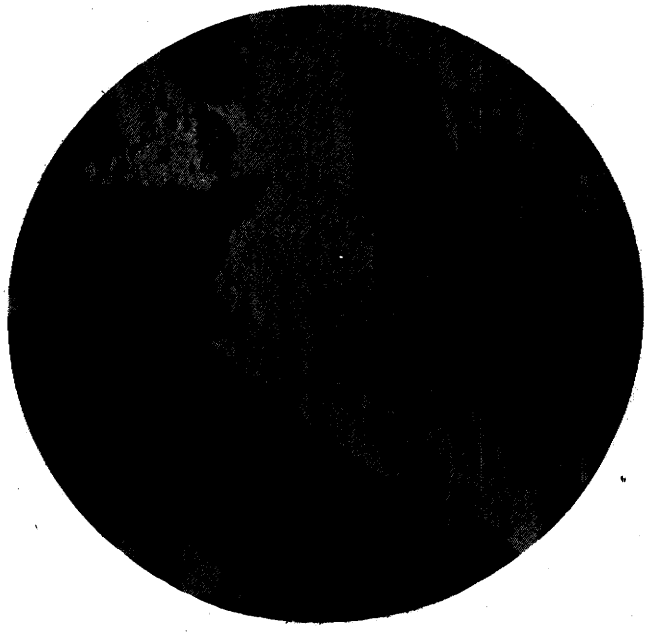
The above is merely a description of the structures as they appear underground and on the surface. It is suggested that they are concretionary in

origin, though they have also some similarity to the "fossil lava tubes" described by H. S. Palmer.[1]

ECONOMIC GEOLOGY

General Description of Deposits and Origin

Deposits carrying zinc, lead, and copper-bearing minerals occur at a number of places in the area. The deposits are not all of the same general character and are not in the same rock formation. The principal deposits, such as those being developed at the Treadwell Yukon and Sudbury Basin properties, are in



Photomicrograph of marcasite, zinc blende, and gangue, with a few small inclusions of chalcopyrite, Errington mine. (×150.)

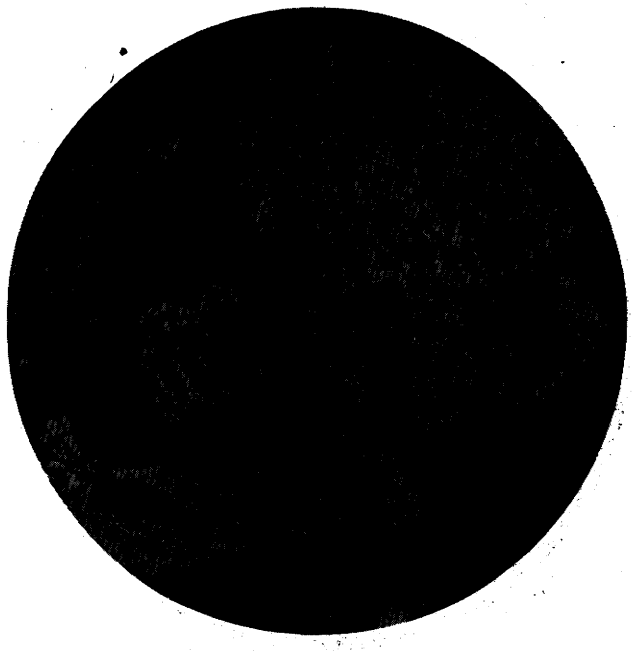
a major fault zone, which extends along the southern margin of the basin. So far the important deposits appear to be in the southwestern part of the area, in the vicinity of Vermilion lake and Whitson river, although the structure of the fault zone has been located by diamond-drilling at a number of places to the northeast. The deposits first mentioned occur in the black slates and tuffs. Certain mineral deposits occur in the hard siliceous volcanic fragmental that is near the contact with the micropegmatite, and these show a preponderance of quartz in narrow veins with galena as the prominent sulphide. Such deposits occur at the Proulx property, near Trout lake; at the Foisey, 2 miles northeast of Azilda station; and on the northeast shore of Moore lake.

A similar mineralization has been observed at several places in the micropegmatite or acid edge of the nickel eruptive. One of these is about 2 miles east of Fairbank lake on the property of the Fairbanks Lake Mining Company. Within the basin there are several narrow dikes which have a rusty-weathered surface and carry quartz in veinlets and lenses. These dikes intrude the slates

[1]Jour. Geol., Vol. XXXVII, No. 3, 1929.

or tuff and may be differentiates from the micropegmatite. One such dike occurs south of Vermilion river on lot 7, concession VI, Balfour township. The quartz carries a small quantity of galena, zinc blende, copper pyrites, and pyrite. Pits have been dug at intervals along the dike for a distance of 2 miles. Again on lot 7, concession V, Blezard township, there is a narrow dike which carries some quartz in lenses and veinlets, in which small showings of galena and related minerals are occasionally observed.

The occurrence of ore minerals with these dikes suggests some genetic relationship between rock and ore minerals.



Photomicrograph of chalcopyrite with rests of iron pyrites and zinc blende, showing a little galena along the border of chalcopyrite and zinc blende, Errington mine. (×150.)

No intrusives that might have some bearing on the origin of the major deposits near Vermilion lake have been observed with the deposits.

A few diabase dikes cut the ore zone at Vermilion lake, but none have been noted in the Errington mine workings. An olivine diabase dike cuts across a mineralized deposit at the Creighton Fairbank property immediately east of Vermilion lake, but this occurrence of ore near a diabase dike is fortuitous. It is a reasonable supposition that the ore along the major fault has been derived from mineral-bearing solutions which emanated from the micropegmatite-norite laccolith at a lower temperature than the nickel-copper ores that occur at the bottom of the norite. No diagnostic high-temperature minerals have been noted in ore from the basin fault zone.

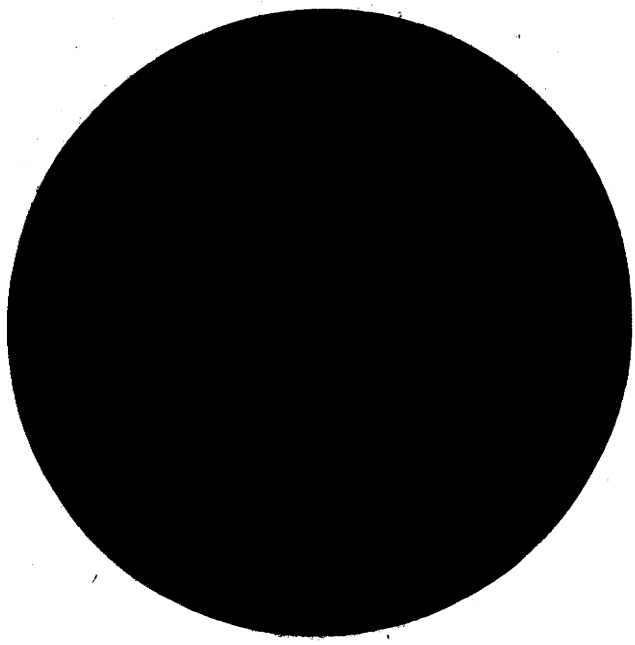
Vein Minerals

The earliest vein minerals in the fault zone are quartz and carbonate, which replaced and included masses of black slate and tuff. Outcrops of the vein structure occur infrequently on the north edge of the ridge on which the plant

at Errington mine is located. Outcrops also occur in the valley to the north. In drilling, this structure is an indicator of ore, since it always accompanies the sulphides, although it may occur without ore being present.

Massive iron pyrites is the earliest of the sulphides, and it is also the most abundant. Masses of pyrite, sometimes nearly free from other sulphides, may occur along the zone.

The massive iron pyrites has been replaced in part by the ore mineral zinc blende, carrying with it galena, copper pyrites, pyrite in cube form, and pyrrhotite. Zinc blende is frequently the host for other sulphides. The replacement of



Photomicrograph of zinc blende with irregular patches of galena, a little pyrrhotite, and cubes and small patches of iron pyrites, Errington mine. (×150.)

pyrite by zinc blende and other sulphides is readily observed in polished hand specimens and by means of the reflecting microscope. Galena occurs with the zinc blende as irregular inclusions, sometimes approaching a minute vein character. At times it is present as a minute, dust-like inclusion, hardly, identifiable. The copper pyrites may occur in the zinc blende as irregular inclusions and as veinlets. A lattice structure of copper pyrites along cleavage planes in zinc blende is at times observed in polished specimens. Sometimes copper pyrites replaces iron pyrites, and rests of pyrite are to be seen in it.

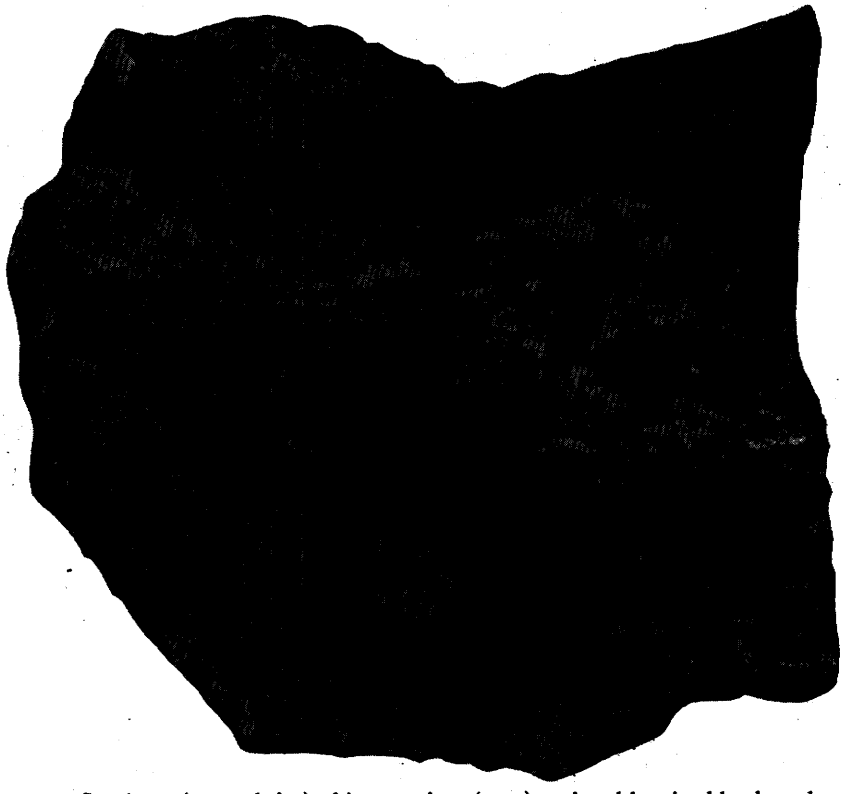
Scattered through the zinc blende there are cubes of iron pyrites of a younger generation than the massive pyrite. Veinlets of copper pyrites and galena cut the zinc blende, which must, therefore, be the older mineral. Lath-like crystals of arsenical pyrites occur in the gangue minerals, and a white mineral, probably also arsenical pyrites or marcasite accompanies the iron pyrites.

For the commoner minerals the order of succession appears to be as follows: massive iron pyrites, zinc blende, pyrrhotite, copper pyrites, and galena. The

relationship of the cubical pyrites in the zinc blende to copper pyrites and galena has not been observed.

Ore Zone

The crushed zone may be several hundred feet in width as indicated by diamond-drilling or underground exploration. It consists of black to grey altered slate and tuff, quartz, carbonate, and in places sulphides of iron, zinc,



Specimen (natural size) of iron pyrites (grey) replaced by zinc blende and associated minerals (black), from the Ollier pit, Errington mine. The quartz (white) is brecciated.

copper, and lead. The slate and tuff contain considerable carbon, and the carbonate is so impregnated with carbon that it appears black.

Underground operations at the Errington mine have shown that the quartz carbonate occurs in a broad lens-like form, with repetitions along the strike of the zone, and not in a continuous body. These lenses also occur across the strike of the fault zone.

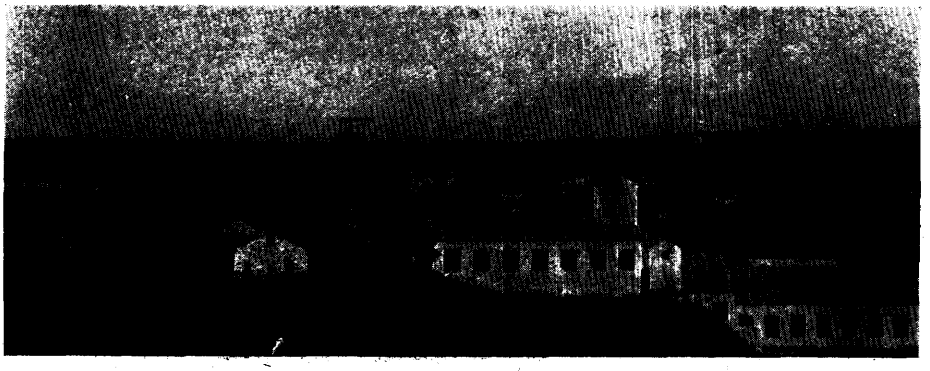
Properties

Treadwell Yukon

The Treadwell Yukon Company is operating the Errington mine, situated in Creighton and Balfour townships. The property covers approximately 3,920 acres in a block, including some flat farming land and adjacent ridges on the south side. The lower part of Whitson river flows across the property close

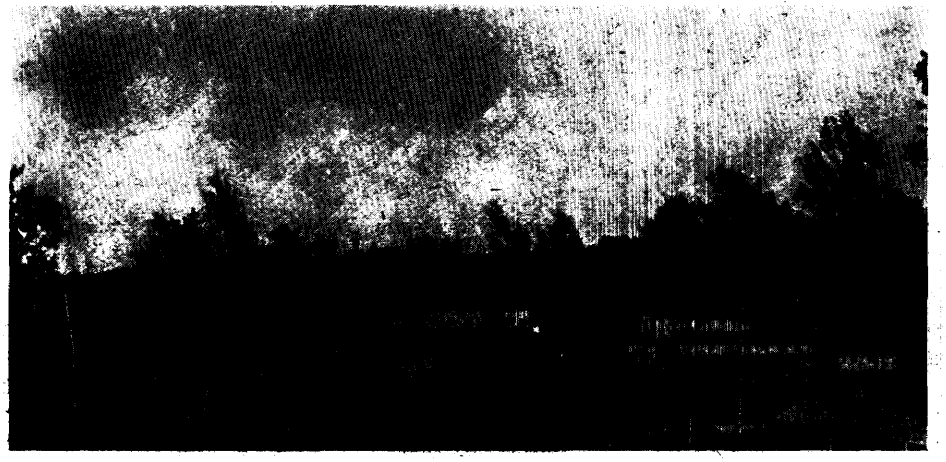
to the line of faulting. The high ground has afforded an excellent location for the mining plants, and the levels near the river have made a convenient and picturesque setting for the homes of the community.

The selection of the area included in the property depended on a diamond-drilling exploration of the fault zone over a length of 3 miles, which had been



Plant at No. 1 shaft, Errington mine.

conducted by Joseph Errington and his associates previous to the property being taken over by the Treadwell Yukon. Diamond-drill holes were put down at 100-foot intervals along a strike of N. 70° E., and usually two holes were drilled from one set-up at angles of 45° and 70° N., indicating a southerly dip to the zone. In all, some 48,000 feet of drilling was done before underground operations



Camp buildings, Errington mine. No. 2 shaft is seen in the background.

were undertaken on several mineralized areas with higher assays in zinc, lead, and copper than elsewhere.

The presence of zinc ore was known some years previous to the present undertaking, for there are four old shafts and a tunnel on the property, besides a number of old pits, near which there are dumps of material, now much rusted, taken from the workings. Owing to the amount of gossan on the outcrops, the

early examination was difficult, and the complex character of the ore made the earlier investigation a disappointment.

In the old workings there are several products of alteration, including limonite, malachite, azurite, and iron and zinc sulphates. Several vugs show beautiful acicular crystals of aragonite, coloured greenish with copper carbonate.

Underground Work.—No. 1 shaft, the first sunk, is located on a tuffaceous ridge towards the southwestern part of the property, and a level was established at 300 feet where a crosscut was run north to the fracture zone between the tuff and the slate.

From an exploratory drift east and west of the main crosscut from the shaft, crosscuts were run at intervals to determine the mineralized areas in the fault zone. From this work and diamond-drill intersections, it was possible to locate several ore shoots along the strike.

The Ollier ore shoot was located by raises a short distance east of the main crosscut. Some of the raises were started in ore that had been located in the drift, the main body of ore being above the level.

The 1928 annual report of the Treadwell Yukon Company states:—

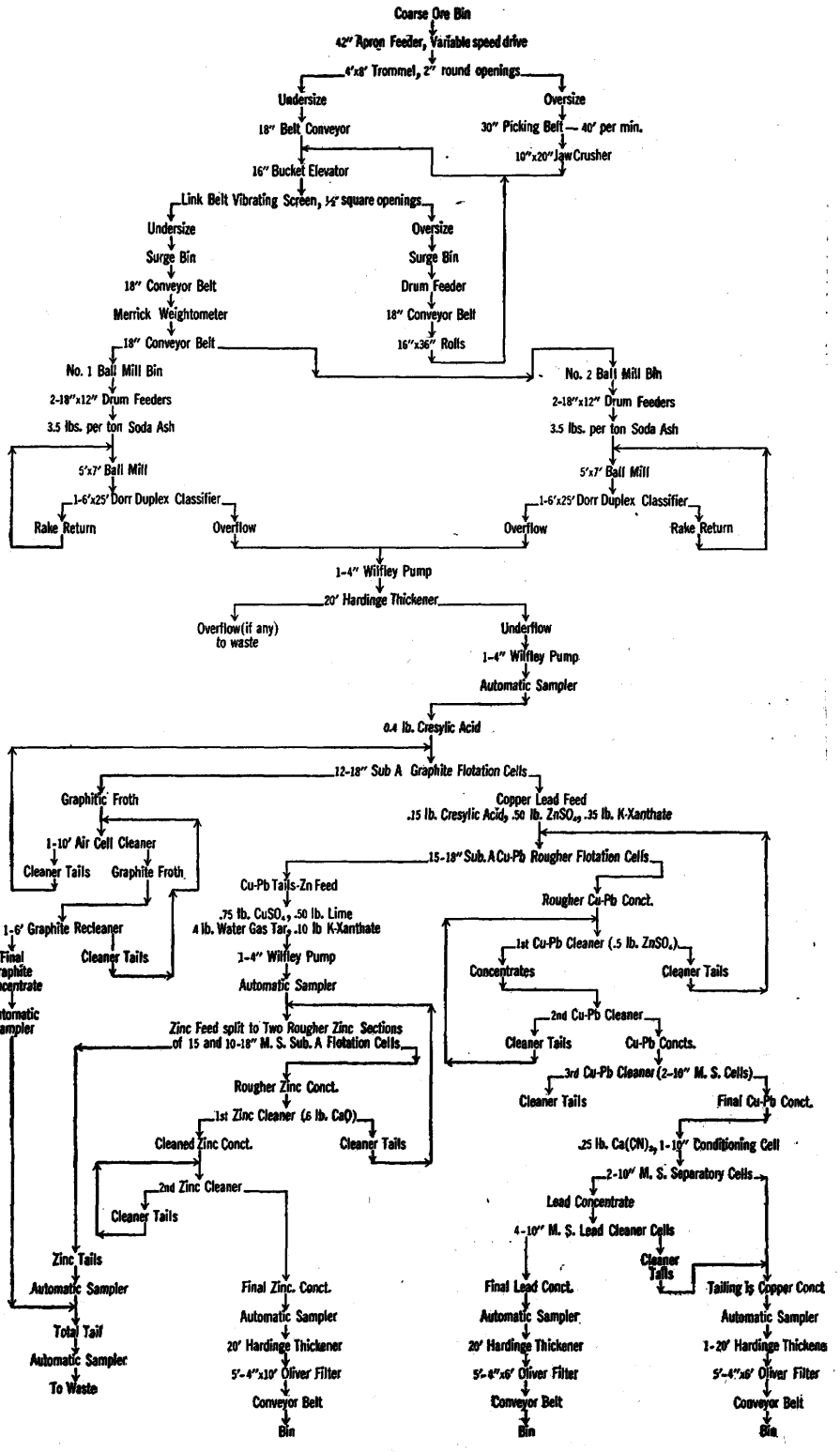
> The Ollier stope at the end of the year had a proven horizontal cross-section of 14,500 square feet, and the average assay of all samples of ore drawn from this stope was 0.033 ounces gold, 2.08 ounces silver, 1.08 per cent. copper, 1.20 per cent. lead, and 6.4 per cent. zinc. The Larson stope had a proven area of 4,000 square feet in horizontal cross-section and the average assay of ore drawn from this stope was 0.03 ounces gold, 1.55 ounces silver, 0.91 per cent. copper, 1.1 per cent. lead, and 5.4 per cent. zinc. The Pit ore body proved to be but 120 feet long by 4 feet wide, although the average width of the outcrop of this ore body is 20 feet. Samples taken of the ore drawn from this stope averaged 0.045 ounces gold, 2.15 ounces silver, 1.05 per cent. copper, 1.5 per cent. lead, and 6.9 per cent. zinc. . . . The Hargraft ore body . . . as far as known . . . has a length of 120 feet and a width of 15 feet.

No. 2 shaft was sunk 3,600 feet east of No. 1, and connection was made with the long 300-foot level drive from No. 1 shaft. A northwest crosscut was run from the 500-foot level and intersected four vein structures called Romig, Christie, Rheaume, and North. The first, near the contact of slate and tuff, shows a little sulphide mineralization; the others in the slate area have shown commercial ore.

Lengths and values of these ore bodies are also given in the annual statement:—

> The east and west drifts on the Christie vein have opened up an ore body 550 feet long without the easterly limit having yet been reached. So far the average width is 12 feet, and the average assays are 0.038 ounces gold, 2.03 ounces silver, 0.60 per cent. copper, 1.0 per cent. lead, and 4.6 per cent. zinc.
>
> The Rheaume vein, east and west drifts, have disclosed ore over a length of 475 feet, with an average width of 12 feet; this ore still continues beyond the face of the east drift. The average assay results from all samples so far taken from this ore body are 0.038 ounces gold, 2.3 ounces silver, 1.70 per cent. copper, 1.0 per cent. lead, and 3.5 per cent. zinc.
>
> Three ore bodies with an aggregate length of 175 feet and an average width of 12 feet have been found by the North vein drifts, and the averages of all assays taken in this area are 0.038 ounces gold, 2.3 ounces silver, 0.36 per cent. copper, 1.0 per cent. lead, and 6.0 per cent. zinc. . . .
>
> The crosscut from this shaft [No. 3] on the 400-foot level has been advanced 1,475 feet, at which point the vein was struck. The vein proved to be 114 feet thick, but at the point cut does not contain commercial values. A raise is now being driven on the vein to intersect the ore cut by diamond-drill hole A.28. . . .
>
> It is planned to sink to the 1,500-foot level and to have that horizon become the next prospecting and working level for all shafts. Intermediate levels between this level and the 500-foot level will subsequently be driven as required for economic extraction of ore.

Development indicates that the ore occurs in a number of separate shoots along the fault zone, some of the shoots being parallel, as in the 500-foot level crosscut. Sufficient work has not been done to determine the vertical extent of the ore in the several ore shoots so far being stoped. A drill-hole below the Christie vein on the 500-foot level penetrated ore at the 700-foot horizon.



Errington mill flow-sheet

The quartz carbonate so commonly observed in different parts of the development work occurs with the ore. In some places it lies between the ore and the slate or tuff, and in others it occurs within the ore and as part of it. Some of the wall rock has a grey colour, due to carbonate; but most of it is black, due to an admixture of carbon. A black, fine-grained calcite containing carbon is also frequently observed with the slate or tuff along the faulted area.

Veinlets of calcite and quartz, carrying more coarsely crystallized zinc blende, galena, and copper pyrites, may be observed cutting across the more massive ore.

A number of narrow quartz veins and also a ribbon structure of quartz veinlets occur in the mine workings. These are commonly devoid of ore minerals and are believed to be later than the masses of zinc-lead-copper ore and quartz carbonate.

Several strong graphitic faults with gouge, striking somewhat north of east, are encountered in the workings. These do not appear to have any bearing on the location of the ore and are probably subsequent to it.

Recent Development.—No. 1 shaft has been sunk to the 500-foot level and a crosscut made in a northwest direction to the slate-tuff contact, which is considerably farther north than on the 300-foot level and at the surface. In this part of the property the contact has a flatter dip to the north than in the workings at No. 2 shaft, where it is almost vertical. In October, 1929, shafts Nos. 1 and 2 were being connected on the 500-foot level, so that the ore from the 500-foot level stopes could be hauled directly to the ore pocket at No. 1 shaft. After the connection is made, No. 2 shaft will be sunk to the 1,500-foot level to explore the ore zone at that horizon.

A third shaft (No. 3) located near the east end of the property was sunk to the 400-foot level, and some exploratory work was carried on; but operations were discontinued, and work was concentrated in the vicinity of No. 2 shaft.

After considerable experimental work on the complex ores of the Errington mine, both at Kellogg, Idaho, and at the property, a treatment was evolved which has been excellently described by *The Northern Miner*,[1] as follows:—

The Errington ore is treated by differential flotation to concentrate the metallic minerals and to separate them from one another.

The ore must first be pulverized so fine that the individual mineral particles will be freed from one another.

The ore as it comes from the mine is first screened through a trommel, or revolving cylindrical screen, which has circular openings two inches in diameter.

The oversize from the trommel travels on a picking belt, which moves 40 feet per minute, to a 10- by 20-inch crusher.

The product from the crusher joins the undersize from the trommel. This material is all conveyed to a bucket elevator and then passed over a Link-Belt vibrating screen which has one-half inch square openings.

The oversize from the one-half inch screen is conveyed on a belt to 16- by 36-inch rolls and the product returns in closed circuit to the screen.

The undersize from the one-half inch screen travels by belt conveyor to the ball mill bins. En route it is weighed by a Merrick weightometer.

From the ball mill bins the crushed ore passses over 18- by 12-inch drum feeders. There is here added 3.5 pounds per ton soda ash. The 5- by 7-foot ball mills are in closed circuit with 6- by 25-foot Dorr Duplex classifiers. The rake returns sands to the ball mill. The overflow, carrying the finely ground product, is raised by a 4-inch Wilfley pump to a 20-foot Hardinge thickener. Any overflow from the thickener goes to waste. The underflow is pumped by a 4-inch Wilfley and automatically sampled.

The underflow from the Dorr thickeners, to which there is added 0.4 pounds cresylic acid, goes to twelve 18-foot subaeration graphite flotation cells. These separate a graphitic froth from the metallic minerals. The removal of this graphitic material is a necessary preliminary to the treatment of the valuable minerals.

[1]Issue of Nov. 7, 1929.

After the removal of the graphitic material the separation of the metallic minerals begins. The first treatment is the addition of chemicals.

To the copper-lead feed there is added 0.15 pounds of cresylic acid, 0.5 pounds of zinc sulphate, and 0.35 pounds of potassium xanthate. Treatment in fifteen 18-inch subaeration copper-lead flotation cells gives a rougher concentrate and tails, which are treated as follows:—

The rougher copper-lead concentrate goes to the first cleaner cell, with 0.5 pounds zinc sulphate added. The products are a concentrate and cleaner tails. These tails go back to the rougher cells. The concentrate goes on to the second cleaner. The tails from the second go back to the first cleaner.

The copper-lead concentrate from the second cleaner cells is treated again in two 10-inch Minerals Separation cells. To the concentrate from these there is added 0.25 pounds calcium cyanide in a 10-inch conditioning cell. Then the lead and copper minerals are separated in two 10-inch Minerals Separation separatory cells.

The lead concentrate goes to four 10-inch Minerals Separation lead cleaner cells. The tails from these machines join the tails from the separatory cells. The final lead concentrate is automatically sampled, then thickened in a 20-foot Hardinge thickener and filtered in a 5-foot 4-inch by 6-foot Oliver filter. The concentrate is then conveyed on a belt to the bin for shipment.

The tailings from the separatory and cleaner cells carry the copper. This concentrate is thickened and filtered and conveyed to the copper concentrate bin.

For the recovery of the zinc there is added to the tails from the rougher flotation cells 0.75 pounds copper sulphate, 0.50 pounds lime, 0.10 pounds potassium xanthate, and 0.4 pounds water gas tar. This zinc feed is pumped to a sampler and then split to two rougher zinc sections of 15 and ten 18-inch Minerals Separation sub-A flotation cells.

The zinc tails from these cells are sampled and then join the graphite concentrate and go to waste.

The rougher zinc concentrate goes to the first cleaner cell with 0.6 pounds of lime, CaO. The cleaner tails are returned to the rougher cells.

The cleaned zinc concentrate goes to a second cleaner. The final zinc concentrate is sampled, thickened, filtered and conveyed by belt to the zinc bin.

The gold and silver are contained about equally in the lead and copper concentrates. The mill is handling 300 tons daily. Feed varies considerably day by day, being high in copper one day and high in zinc the next, and the task of solving the metallurgical problem is not made easier by the fact that the ore comes from a score of different working places. In a few weeks tests will be made on ore drawn from one ore body for a month at a time. The extraction is said to be fairly high, the management not being prepared to give figures yet. No penalties have been paid. Pyrite is to be sold shortly. The present task in front of the management is the reduction of costs, chiefly in the cutting down of reagents, which run 40 per cent. of the $1.50 per ton milling costs, all overhead and depreciation included.

Production.—During 1928, ore milled totalled 32,092 tons, from which were recovered concentrates as follows: 354.4605 tons of lead, 2,744.61 tons of zinc, and 715.823 tons of copper. The lead concentrate, which was shipped to Antwerp, totalled 350.54 tons containing 67.20 ounces of gold, 4,804.71 ounces of silver, and 187,513 pounds of lead. Zinc concentrate shipped totalled 77.051 tons, of which 37.201 went to Trail, B.C., and 39.85 to Kellogg, Idaho. The total metal contents of these two consignments were 2.98 ounces of gold, 249.22 ounces of silver, and 71,052 pounds of zinc. The copper concentrate, totalling 715.823 tons, was consigned to the American Smelting and Refining Company and contained 121.51 ounces of gold, 7,045.33 ounces of silver, and 180,546 pounds of copper. For statistical purposes the proper deductions should be made from the above figures to cover smelter losses.

For 1929, final figures were not available, and the following is an estimate of production by this company: copper concentrate 3,246.172 tons, containing 850.95 ounces of gold, 39,279.13 ounces of silver, and 987,849 pounds of copper; lead concentrate 7,006.575 tons, containing 222.21 ounces of gold, 13,921.4 ounces of silver, 457,270 pounds of lead, and 43,988 pounds of copper; zinc concentrate 5,028.1 tons, containing 4,462,940 pounds of zinc. No gold or silver was reported in the zinc concentrate.

Sudbury Basin Mines

This property, as shown by the map, comprises practically all of the bed of Vermilion lake, together with considerable ground on the south side. The surface indications consist of a band of highly sheared tuffs and slates, striking

from N. 60° E. to N. 70° E. and dipping steeply to the south. It appears to be part of the main sheared zone which passes through the Treadwell Yukon property to the east. Outcrops of the schist in the zone show considerable rust from the oxidation of the sulphides, and contain quartz and carbonates in the form of small stringers and lenses. The mineralized zone, most of which appears to underlie the lake bed, is being systematically prospected by diamond-drilling from the south shore and from the ice during the winter. Drilling to date has indicated mineralization over a length of approximately 5,000 feet, with possible extension both east and west. From information given by the management, one section, which has been drilled at intervals of 100 feet, shows sulphides, quartz, and carbonates fairly continuously over a length of 1,500 feet. The sulphides consist of pyrite, zinc blende, chalcopyrite, and galena, and their association with the gangue minerals as well as the general structural relationships of the bodies intersected by the drills shows much similarity to conditions at the Errington mine.

The following assays of drill sections have been obtained from the management:—

No. of hole	Dip	Strike	Footage	Cu	Pb	Zn
				per cent.	per cent.	per cent.
29.....	70°	N. 30° W.	444.5–462	4.68	0.05	0.86
			473 –507.5	.26	1.61	13.81
			668 –677.5	.05	2.09	9.80
34.....	50°	N. 30° W.	495 –515.4	3.49	0.63	4.84
			519.8–535	.40	.95	5.33
43.....	80°	N. 30° W.	310 –355	5.17	2.32	9.46

The sections carry silver, for the most part from 1 to 3 ounces, and gold values of 40 to 50 cents per ton.

McPherson Property

Several efforts have been made to explore the property, which is located along the Vermilion river between the Sudbury Basin and Treadwell Yukon holdings. While under option to the National Lead Company in 1927, a number of drill-holes were put down along the south shore of the river, and the strike of the fault zone was determined along the bed of the river. Drilling indicated a steep dip to the south. One hole (No. 9), located just east of an olivine diabase dike, showed in places, over a length of 200 feet, a mineralization of iron pyrites, zinc blende, galena, and copper pyrites. A few other holes showed slight mineralization, and several only the crushed zone with no sulphide minerals. The results were not sufficiently satisfactory, and the option lapsed. Again, in 1928, the Creighton Fairbank Company did considerable extra drilling, but this work was also discontinued.

Lot 7, Concession VI, Balfour Township

On the southern part of this lot in a low ridge, there is an exposure of a rusty-weathering dike, 50 feet in width and 500 feet in length. It intrudes nearly horizontally bedded slate, and is cut by quartz veins and veinlets in a reticulated structure. The mass is scantily mineralized with zinc blende, galena, copper pyrites, and iron pyrites, and some specimens were reported to carry low values in gold. At one place a trench has been blasted out transverse to the dike. Two drill-holes have also intersected the dike.

To the southwest, on lot 8, concession V, and to the northeast, on lot 4, concession VI, the same dike outcrops through the drift. Small showings of similar minerals occur at these outcrops and are associated with the quartz stringers in the intrusive rock. Some massive arsenopyrite was also observed at the outcrop on lot 4, concession VI. On the several outcrops there are old pits, sunk many years ago.

Foisey

This property is located on the northern half of lot 2, concession III, Rayside township. Zinc blende and galena were discovered here years ago, and the location is shown on Coleman's map of the Sudbury region. Some trenching and blasting have been done over a period of years, and a number of narrow veins showing sulphide mineralization have been exposed along the south flank of a ridge of volcanic fragmental rock. The gangue mineral of the veins is quartz, with which are spotty and lens-like showings of zinc blende, galena, and copper pyrites. The veins are narrow parallel structures, which strike N. 75° E., mag., and dip 50° to 70° S. One pit shows quartz, 2½ feet wide, with 2 inches of sulphides on the north wall. In most of the pits specimens of galena and zinc blende can be obtained, but the work so far has not revealed any tonnage of the sulphides. In the easternmost pit, near the base of the ridge, there is a mass of quartz 10 feet wide, where a rock dump of dark micropegmatite shows a little galena, zinc blende, arsenopyrite, and pyrite.

Gordon Lake Mining Syndicate

This company controls a group of claims in concessions III, IV, and V of the western part of Creighton and the eastern part of Fairbank. The group includes the property of the Creighton gold mine, which was prospected about the year 1891.[1] The rocks consist of tuffs, breccias, and agglomerates cut by dikes of a lamprophyric nature and probably genetically connected with the micropegmatite. The showings consist of large quartz masses with a little sulphide mineralization and were reported to give values in gold.

During the summer of 1929 this ground was carefully prospected under the direction of E. S. Moore. The work consisted of a detailed geological survey, combined with surface trenching, and an electrical survey. Following this, some diamond-drilling was done, but no ore of commercial value was indicated.

Deposits in Hanmer Township

A number of rock outcrops showing considerable shearing and capped by gossan occur on lots 1 and 2, concession II, of Hanmer township, and some drilling has been done at the north end by the Dome Mines and at the south end by the McIntyre Mines and the Sudbury Basin Company to investigate the sulphides connected with the gossan. A small outcrop of slate, with its beds dipping to the northwest, is to be seen at the north end of lot 2, but the remaining outcrops of tuff indicate that the slate is probably confined to the northwestern part of these two lots. All the rock shows pronounced shearing, the strike of the schistosity being N. 75° E. and the dip about 85° S.E.

The largest surface showing occurs near the line between lots 1 and 2, about half way between the concession roads. At this point considerable trenching has been done to uncover the gossan zone, which is in places 150 feet wide and has been trenched over a distance of about 400 feet. The schist is highly mineralized with pyrite and contains small quartz stringers showing a little chalcopyrite and other sulphides. At one place in the trench a lens of quartz

[1]Ont. Bur. Mines, Vol. III, 1893, pp. 45-47.

5 feet wide is to be seen. The quartz is quite glassy and contains pyrite, a little coarse sphalerite, some galena, chalcopyrite, and graphite. A number of diamond-drills were put down by the Sudbury Basin Company to the south of this showing, one of which is reported to have shown 30 feet of core, assaying 3 per cent. of zinc and lead.

Papineau Claims, Blezard Township

Several short veins and lenses of quartz occur on the northeast shore of Whitson lake in the volcanic breccia near its contact with the micropegmatite. They appear to be associated with dike-like offshoots of the micropegmatite, which extends for short distances into the volcanics. On one of these lenses near the centre of the northwest quarter of the south half of lot 3, concession V, of Blezard township, a shaft was sunk some years ago to a depth of 40 feet. It was full of water at the time of the writer's visit. The quartz lens is 8 feet wide at the shaft and strikes N. 75° E. It is mineralized with chalcopyrite, arsenopyrite, and galena, the mineralization being heaviest near the walls. Two grab samples of the quartz, one carrying chalcopyrite and the other arsenopyrite, were assayed with the following results:—

Sample	Gold	Silver
		ounces
No. 1	$4.40	0.78
No. 2	1.60	nil

A number of other veins in the vicinity have been trenched but showed very little sulphides.

Dowling Township

Near the south end of the boundary between lots 12 and 13, concession II, Dowling township, there is a showing of sulphides on which some surface trenching has been done. The coarse volcanic breccia in which the deposit occurs shows considerable gossan in the neighbourhood, but there is little sign of fractures on shearing. The showings consist of small stringers or lenses, up to 2 inches in width, of sphalerite and galena, with some pyrite, pyrrhotite, and chalcopyrite, but the surface work up to the time of the visit had given no indication of any bodies of considerable size.

Lot 4, Concession V, Creighton Township

A little work, consisting of trenching and shallow pits, has been done on the northeast shore of Moore lake. The rock is a light-coloured silicified fragmental, which has been sheared in a general north-south direction. The veins of quartz have a maximum width of 6 inches and occasionally carry some zinc blende, galena, and iron pyrites.

Proulx

This property, mining location W.D. 252, is situated on the southwest shore of Trout lake in the silicified volcanic fragmental rock near its contact with micropegmatite. A narrow quartz vein carrying galena, zinc blende, and chalcopyrite was discovered many years ago, and a shaft was sunk and some drifting done. At present there is no exposure of the vein on the surface. The property was under option for a time in 1928, and the workings were dewatered. Charles Bracken, who had charge of this work, reports that on the 65-foot level a vein structure was exposed, in which there are two well mineralized veins 8 feet and

5 feet wide with a brecciated zone of 5 feet between the structures, striking northwest and southeast. Specimens on the dump show many of the sulphide minerals in quartz veins. The mineralization has followed definite open fractures in the breccia with well-defined walls. A comb structure of quartz near the walls indicates a slow filling at only moderate temperature.

Fairbanks Lake Mining Company, Limited

The property is located about a mile and a half northeast of Fairbank lake near a small lake in concession II, Fairbank township. The country rock here is a dark-coloured micropegmatite, which has in places a gneissoid texture. A

Specimen (two-thirds natural size) of zinc blende, galena, and copper pyrites in a quartz vein with silicified breccia wall rock, Proulx mine, Trout lake.

low ridge of micropegmatite shows a lenticular mass of quartz and quartz stringers on its east side where the rock dips into low land. The vein structure strikes N. 27° E. and shows for 100 feet along the edge of the ridge, the quartz reaching in places a width of 10 feet and narrowing to 2 feet. At the north end there are minor inclusions of galena and copper pyrites; at the south end where the quartz is rusty-weathered, there are better showings of the sulphides.

Anthraxolite

A deposit of anthraxolite or anthracitic carbon was found on lot 10, concession I, Balfour township, in 1896. Interesting descriptions of the deposit are given by Dr. Coleman[1] in early reports of the Ontario Bureau of Mines.

[1]Ont. Bur. Mines, Vol. VI, 1896, pp. 159-161; Vol. XIV, pt. 3, 1905, pp. 95, 96.

He states that the coaly material occurs in an irregular vein in black fissileslates and not as a bed or seam, as coal ordinarily is found. The length of the exposed vein is given as 70 feet, the south end of the outcrop disappearing under the drift.

The anthraxolite is mixed with considerable quartz, which has penetrated the deposit and cemented fragments of the coaly substance like a breccia. In addition, there is a subordinate amount of iron pyrites, which usually occurs along the margins of the vein or near horses of rock in the vein structure. The anthraxolite has a lustrous black colour and is harder than anthracite. It shows shiny curved and flat faces in broken pieces much resembling cubes.

An analysis of anthraxolite quoted from Coleman's report is as follows:—

	Per cent.
Carbon	94.92
Hydrogen	.52
Nitrogen	1.04
Sulphur	.31
Ash	1.51
Oxygen	1.89

The substance will burn, although with more difficulty than anthracite coal, so that attempts have been made to prove up a good body of the material that might be mined. A number of drill-holes were put down, and an inclined shaft was sunk at a low angle to 300 feet, or about 120 feet vertically. Some of the material from the shaft was shipped for burning tests in furnaces. Owing to its being mixed with quartz, the ash from the fuel is around 50 per cent. When the deposit was visited by the writers, work had been discontinued. The vein was exposed near the shaft entry, being here about 5 feet wide and of mixed material, but about 50 feet in the shaft the structure was narrower and appeared quite irregular.

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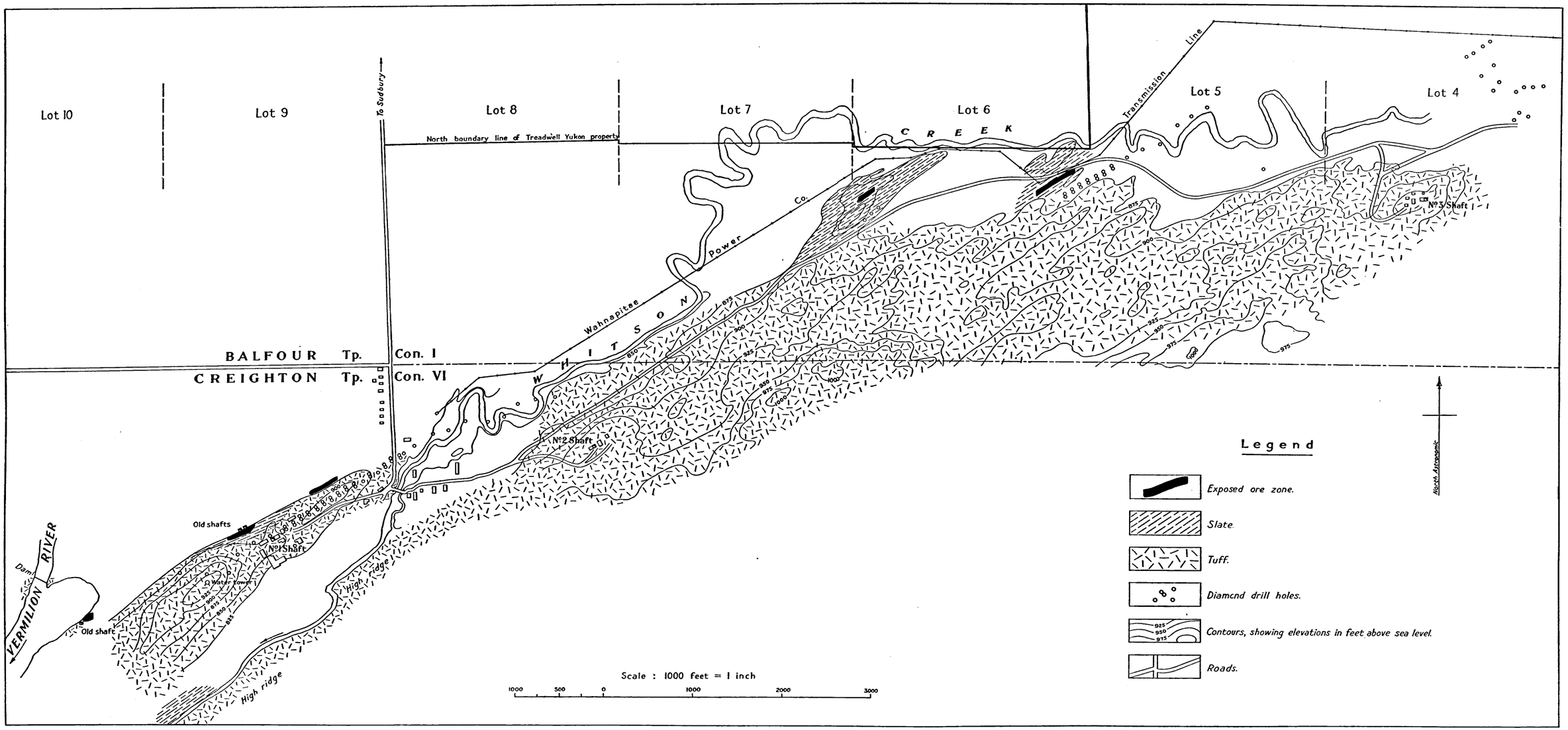

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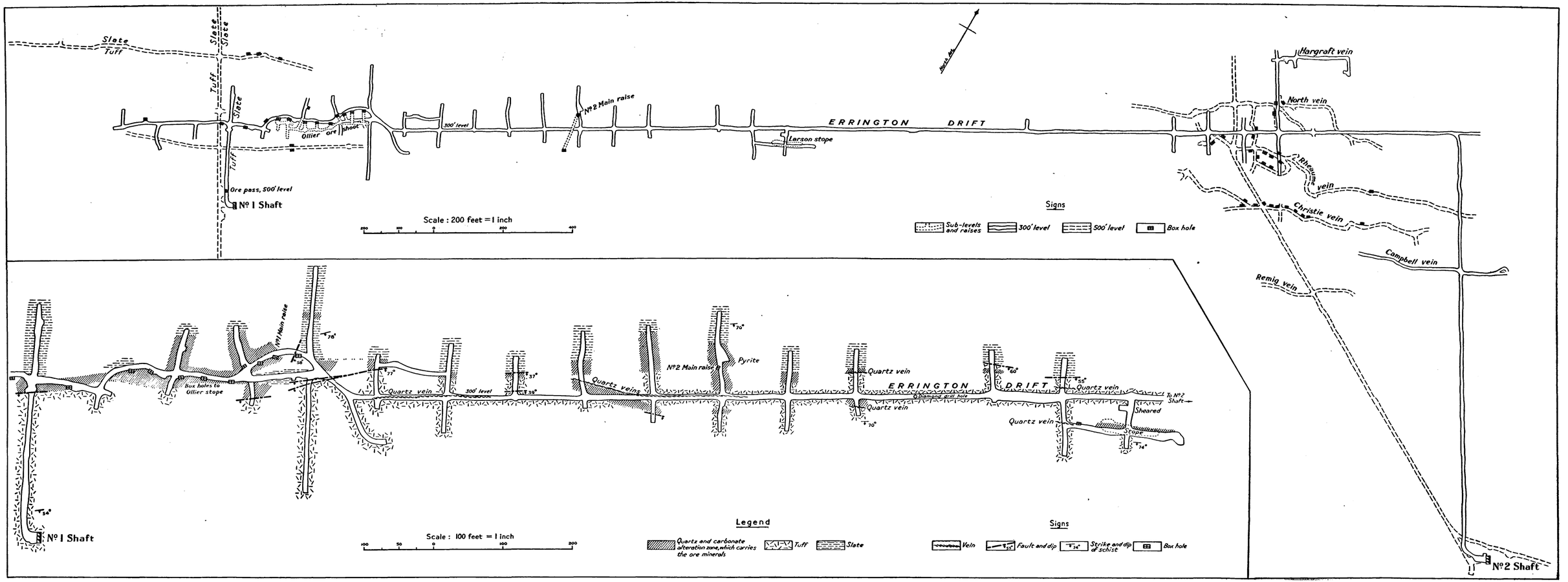

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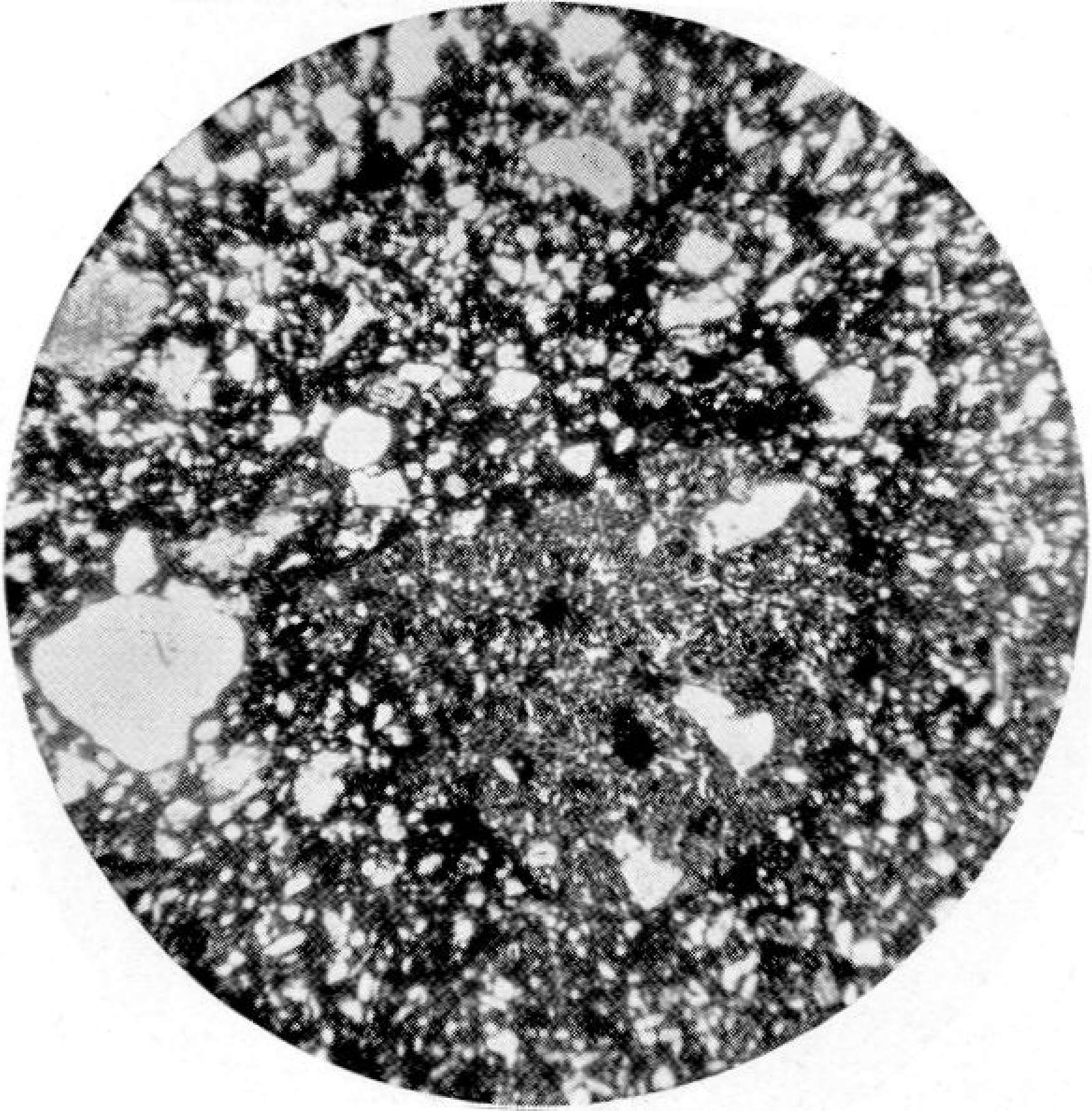

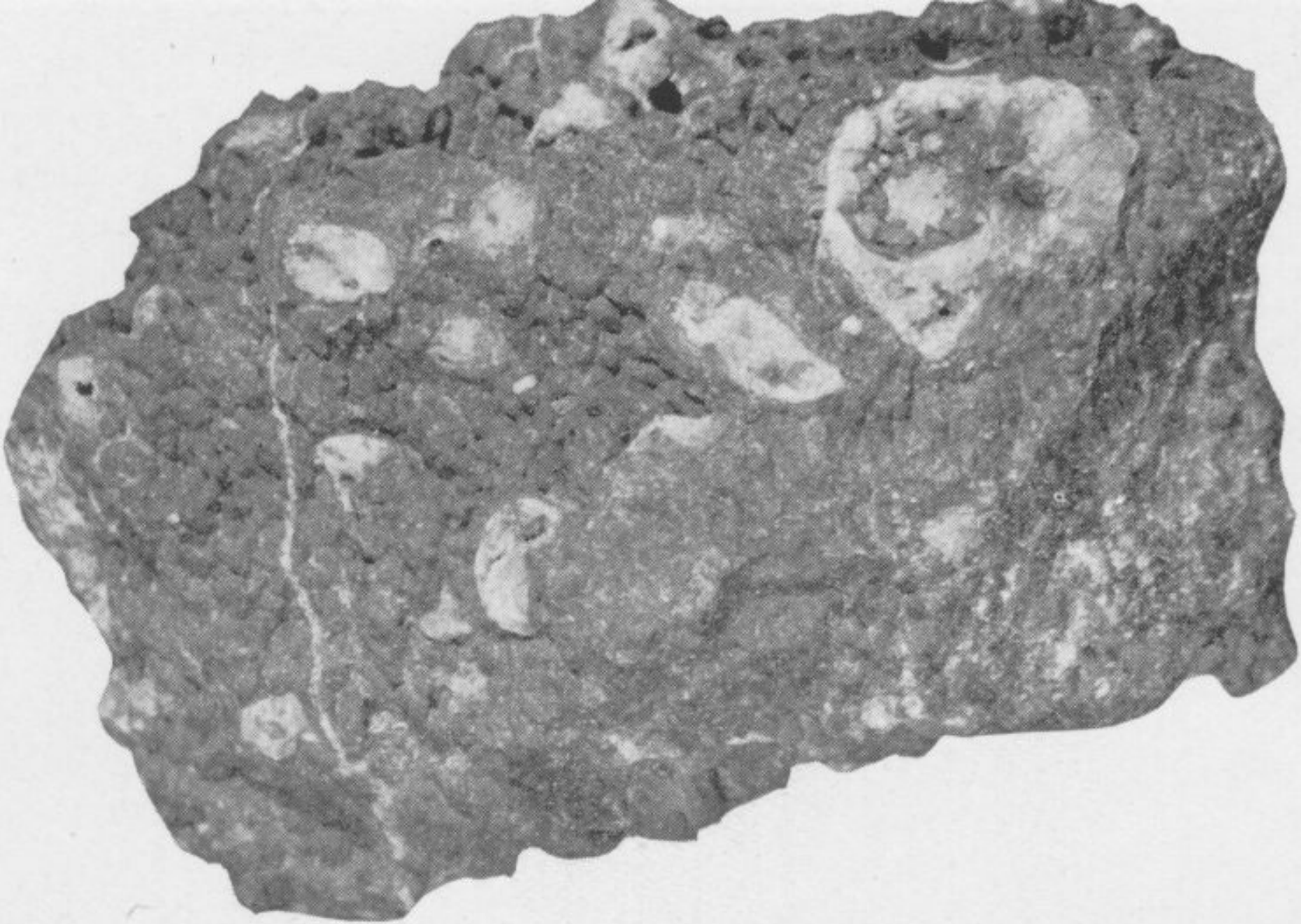

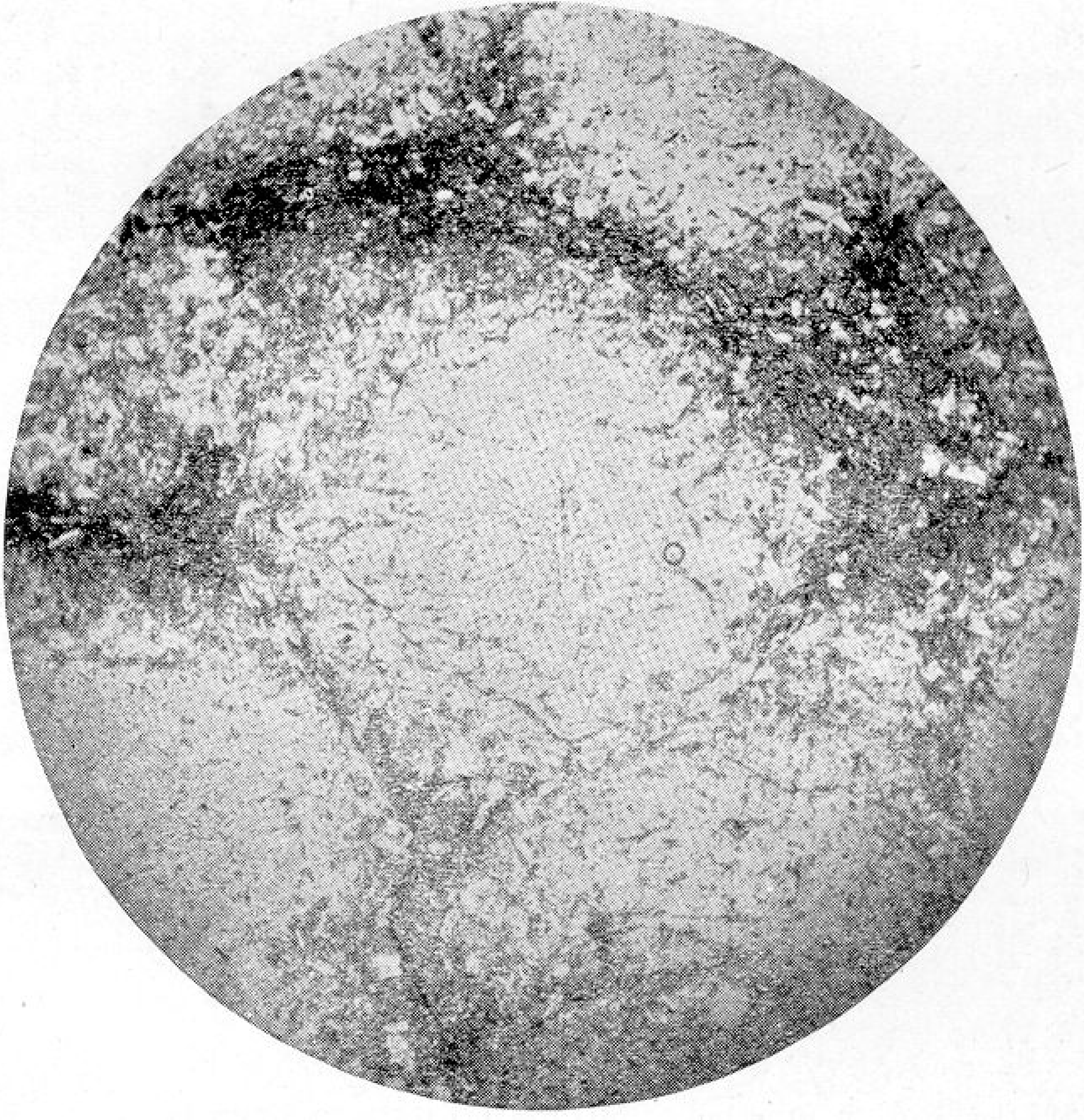

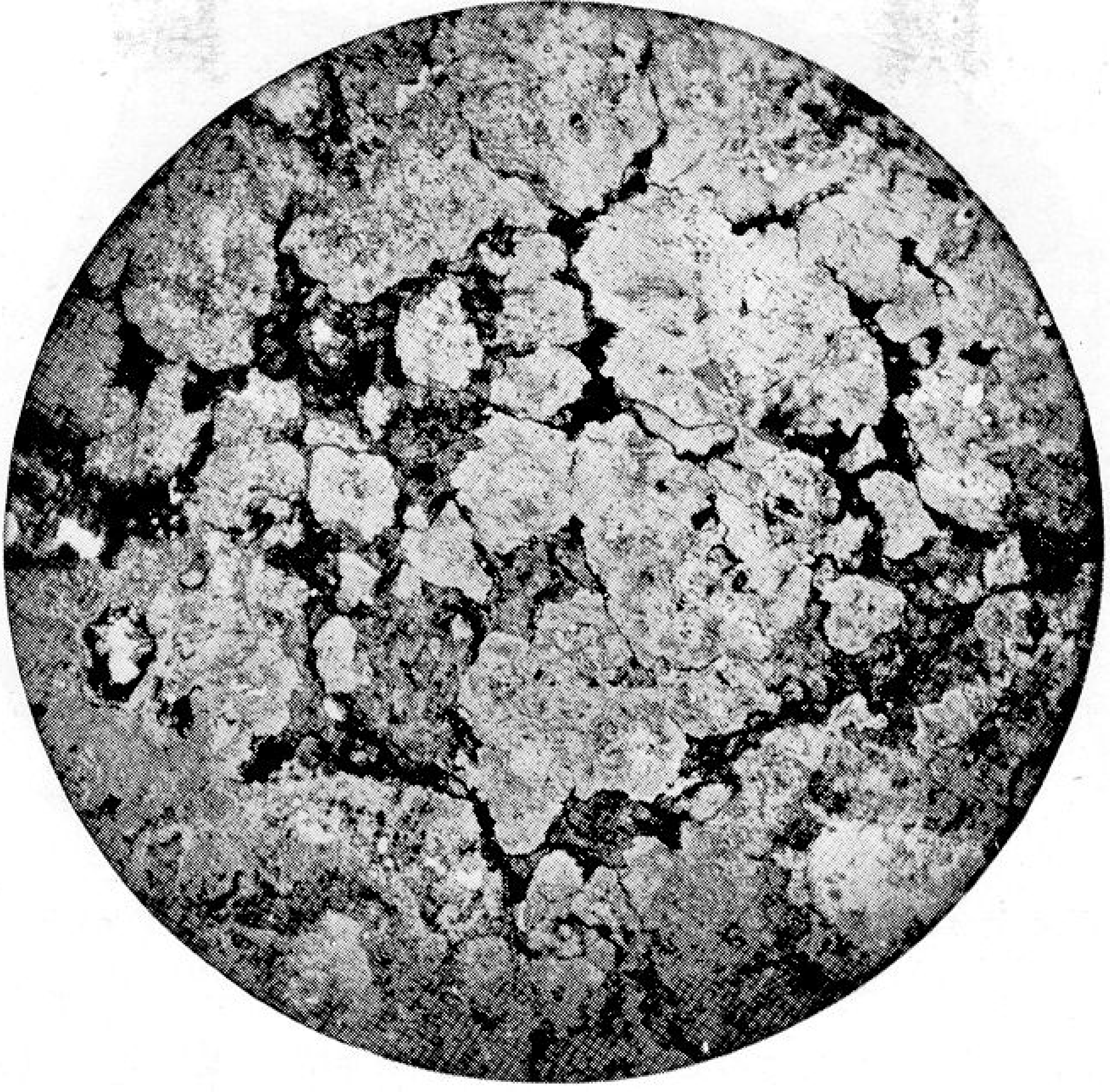

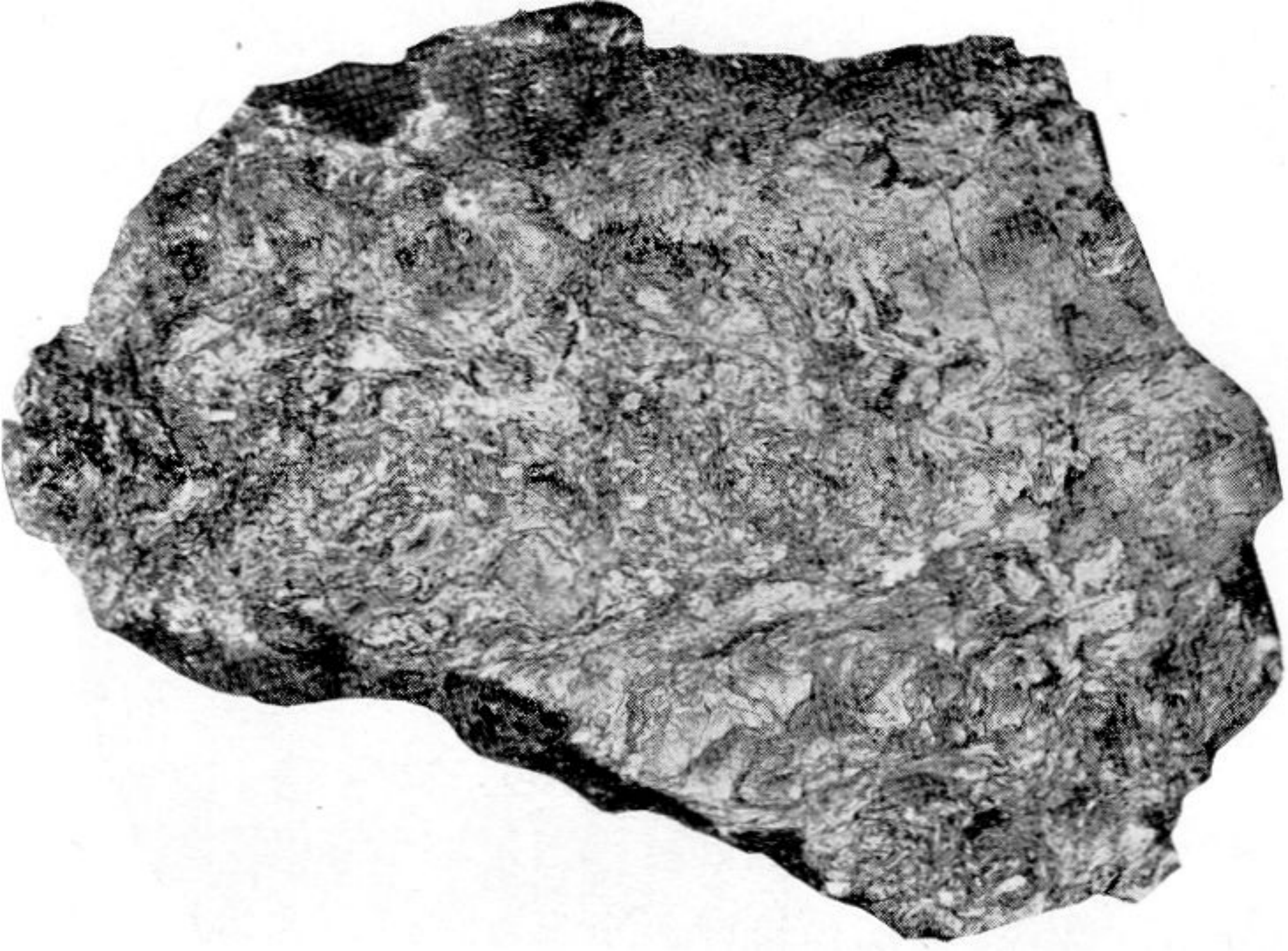

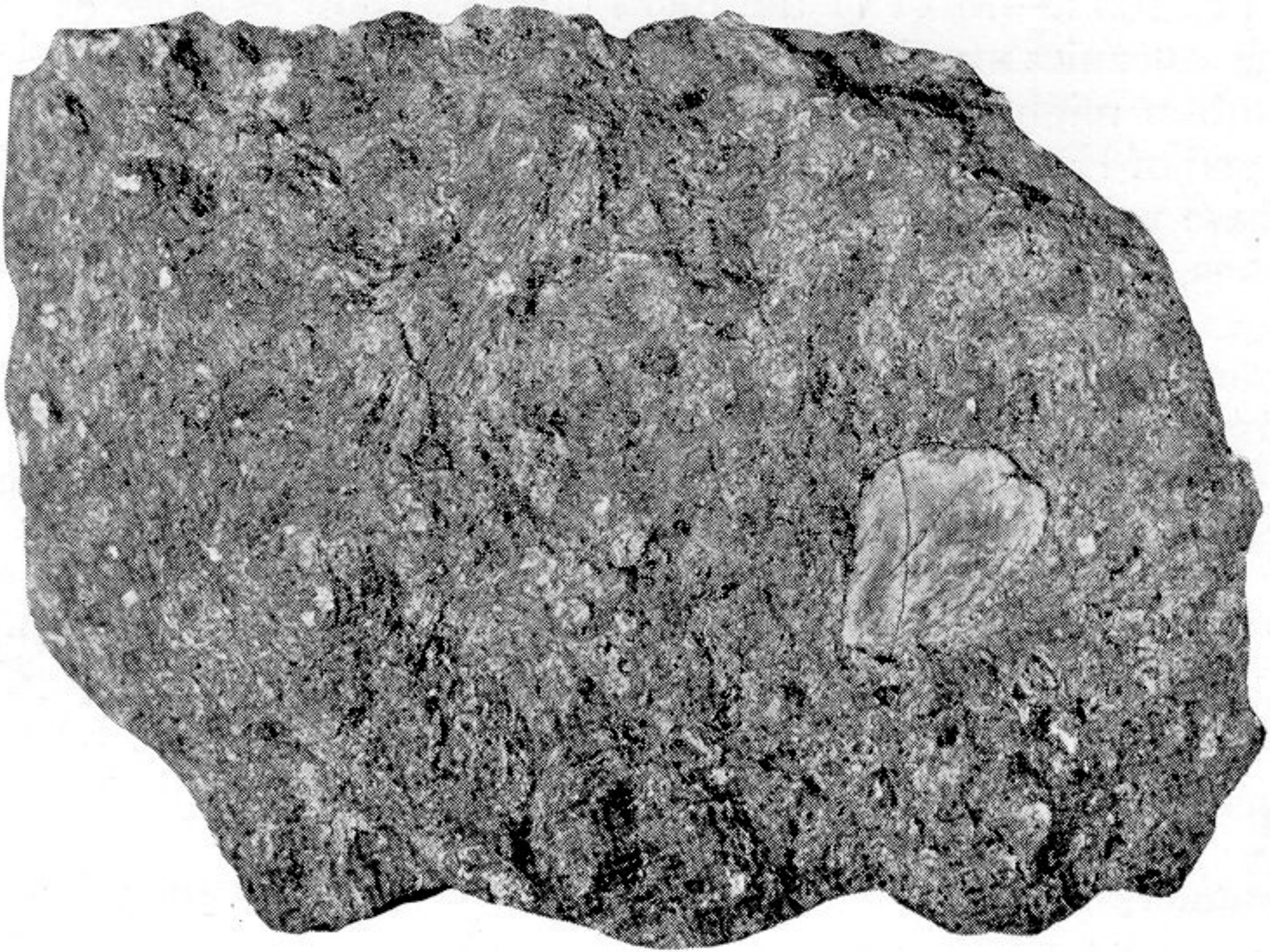

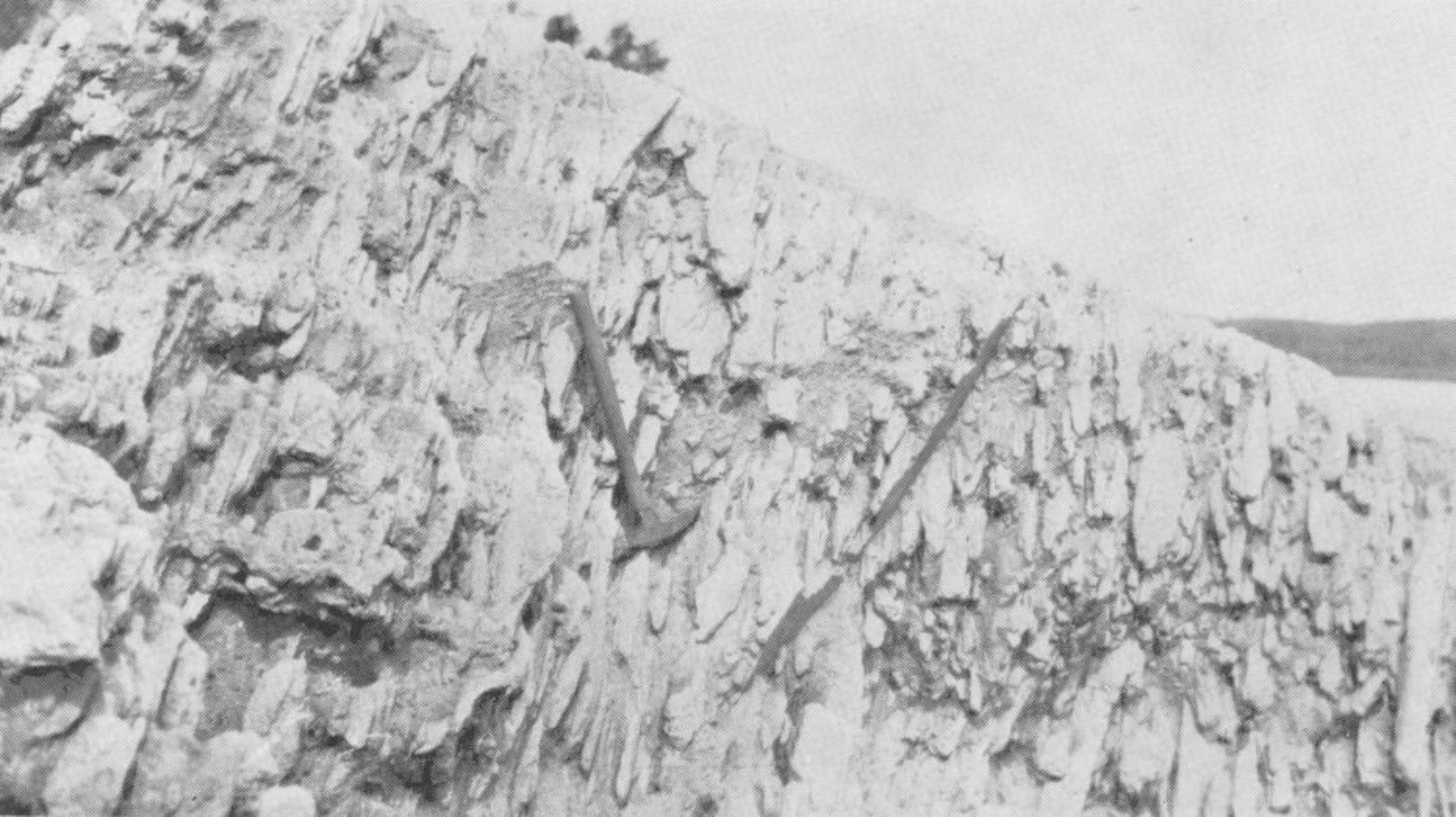

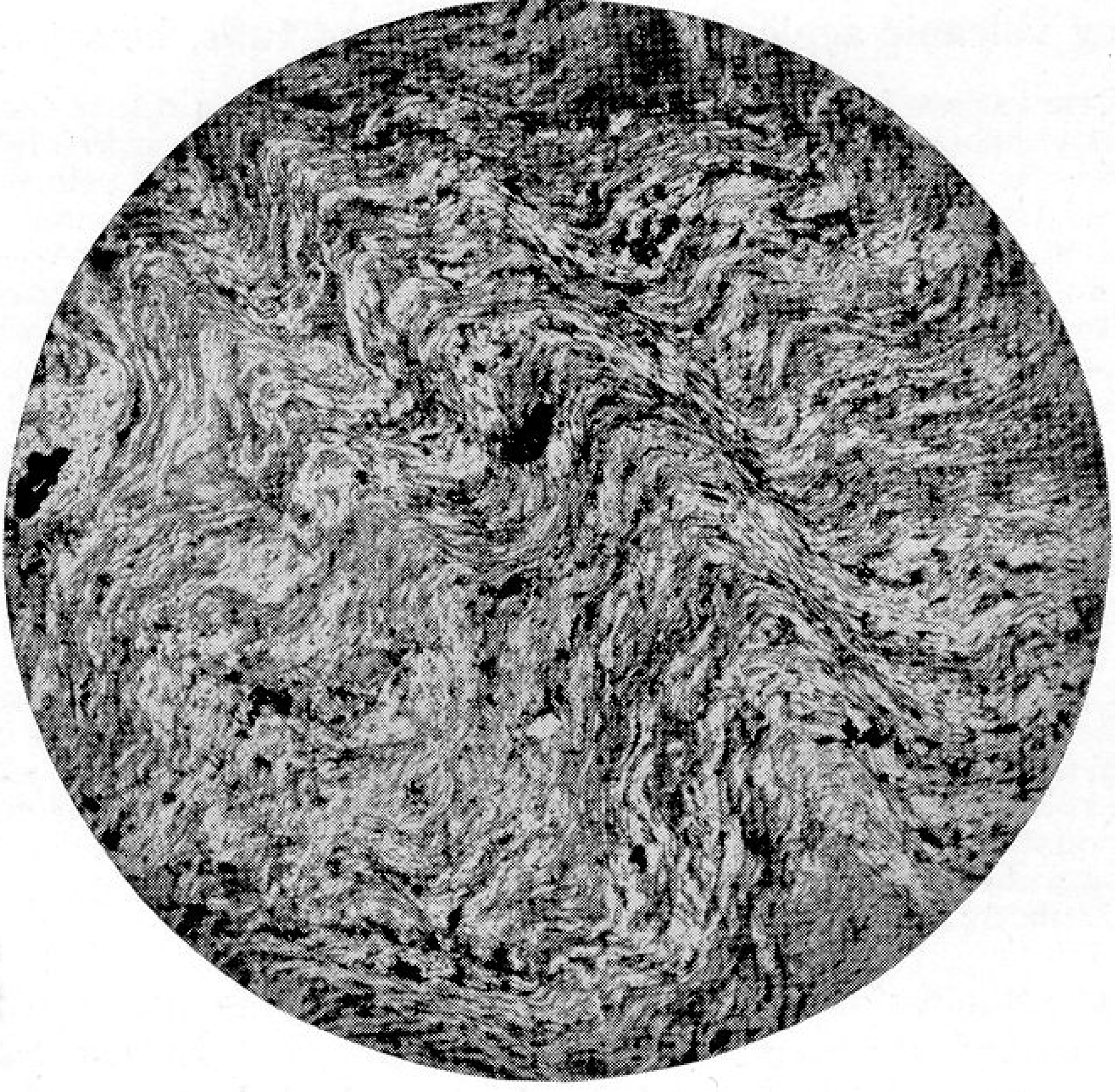

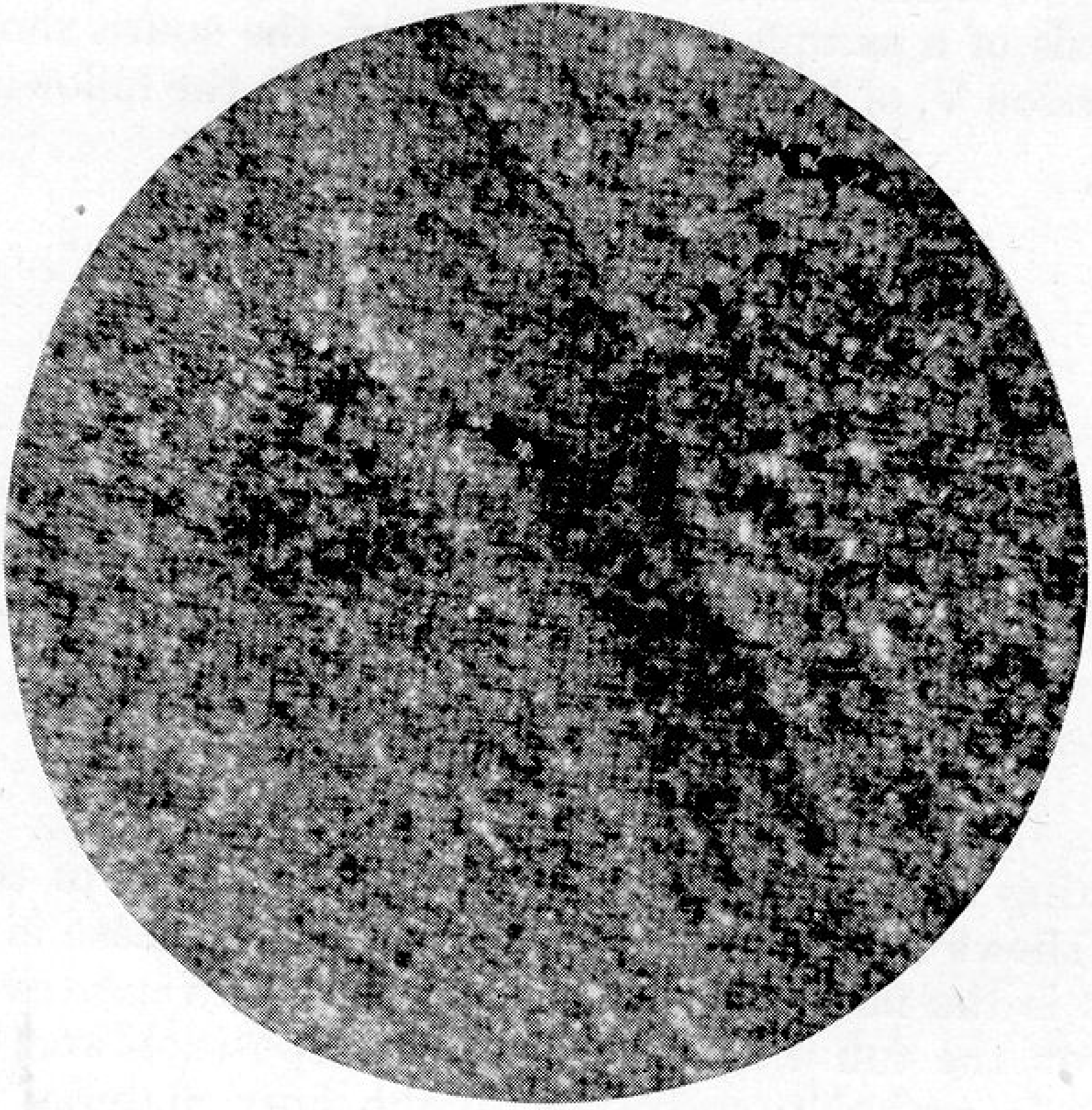

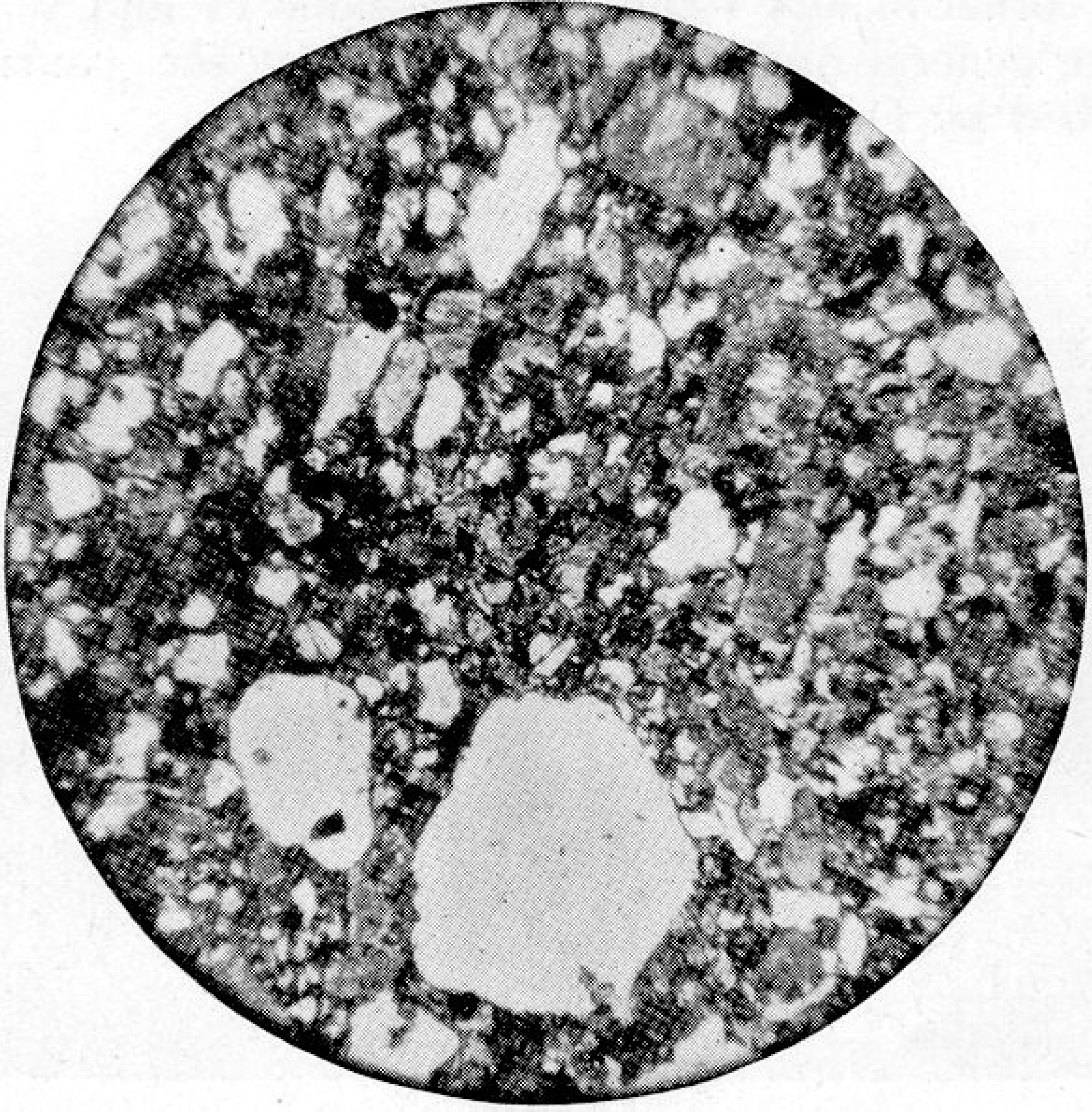

Tuff
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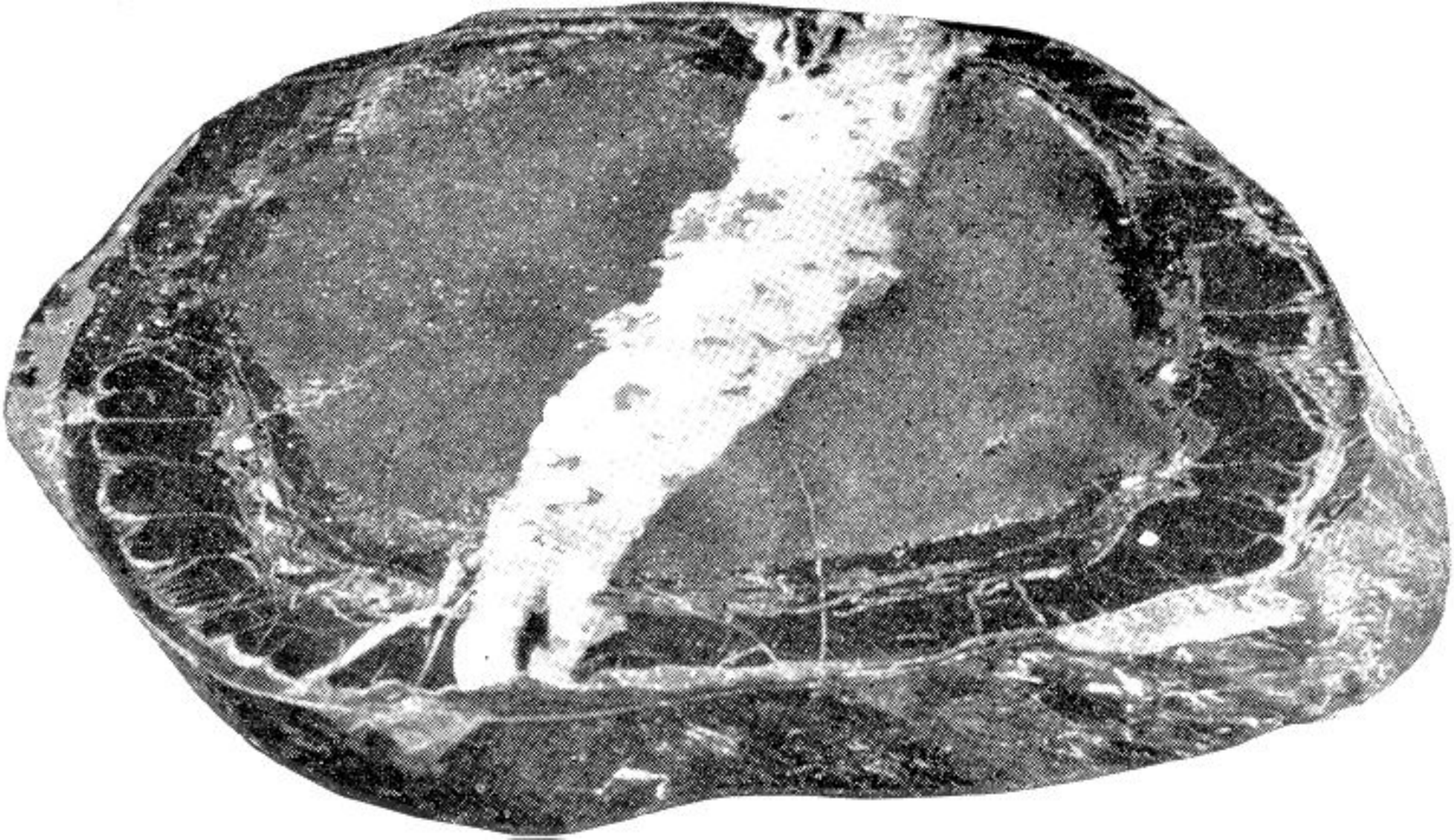
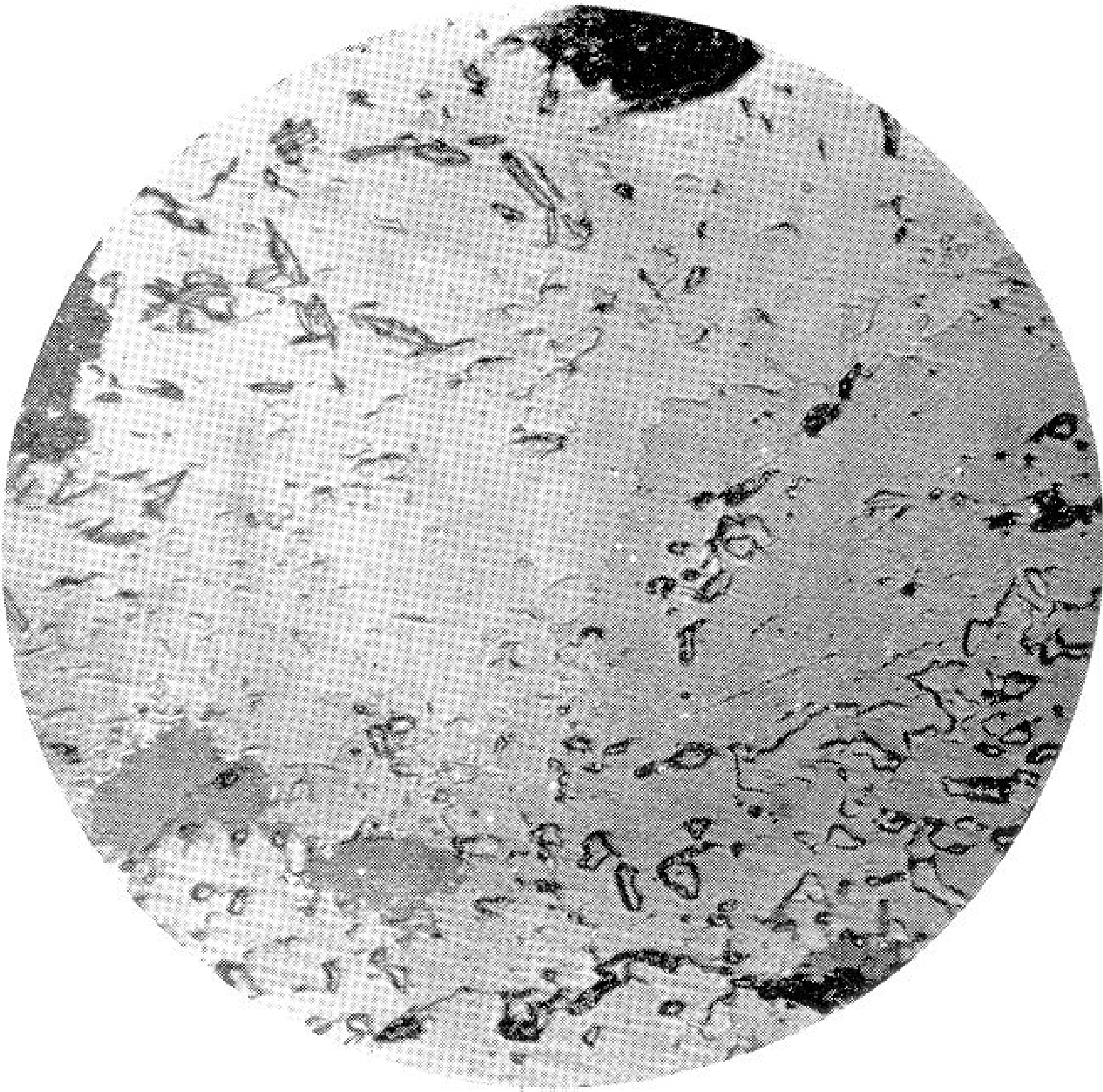
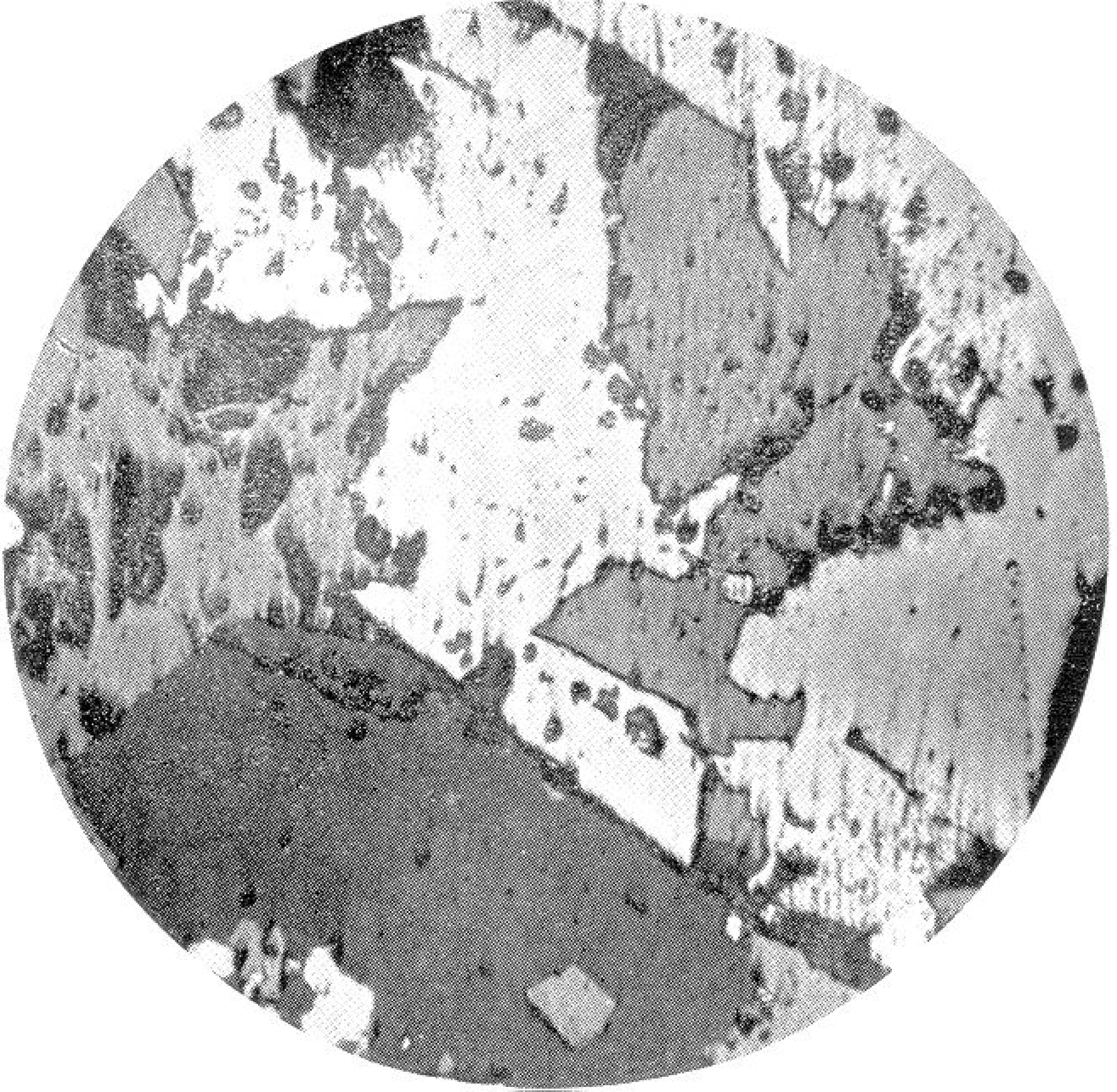
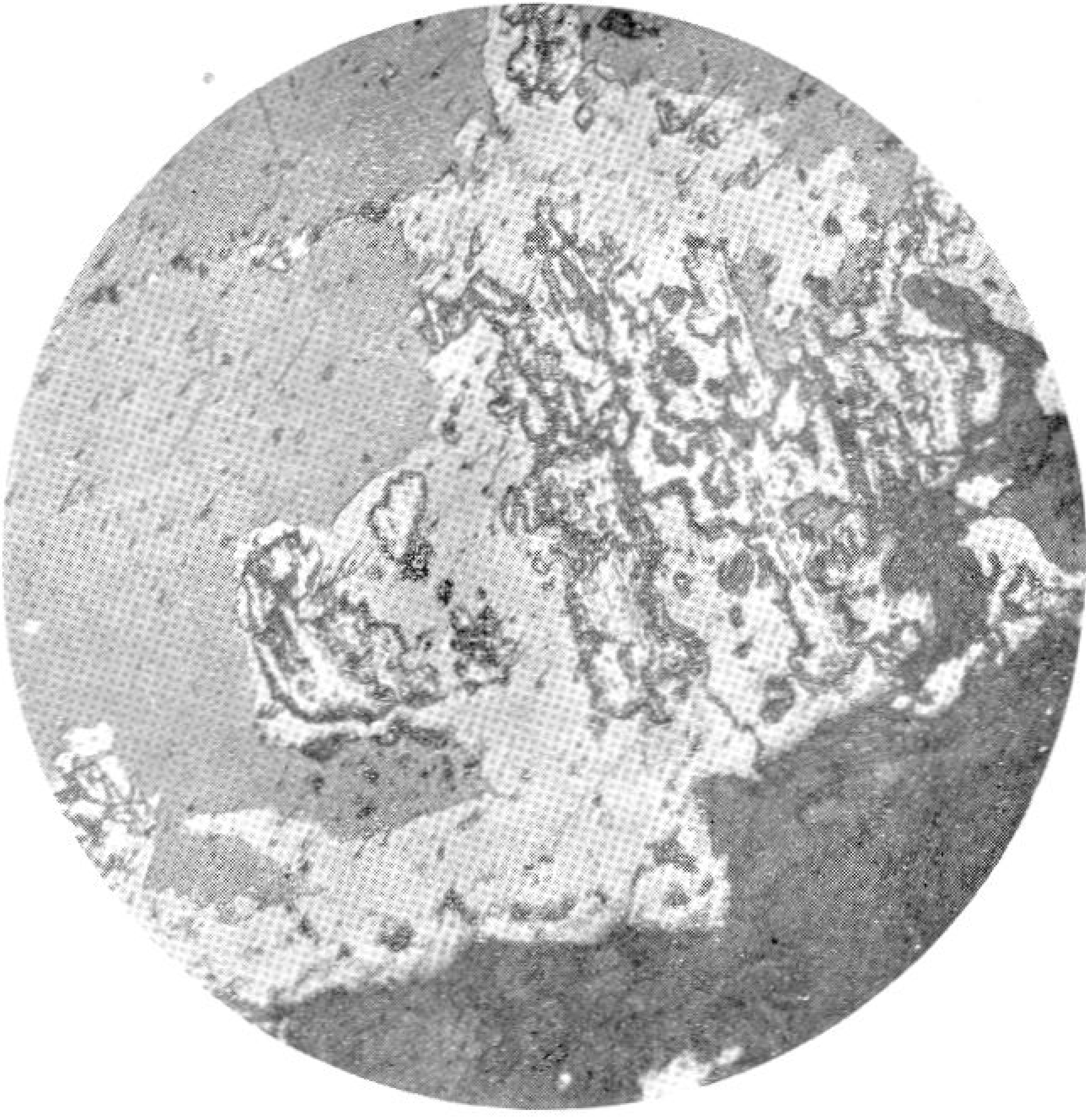
Greenstone









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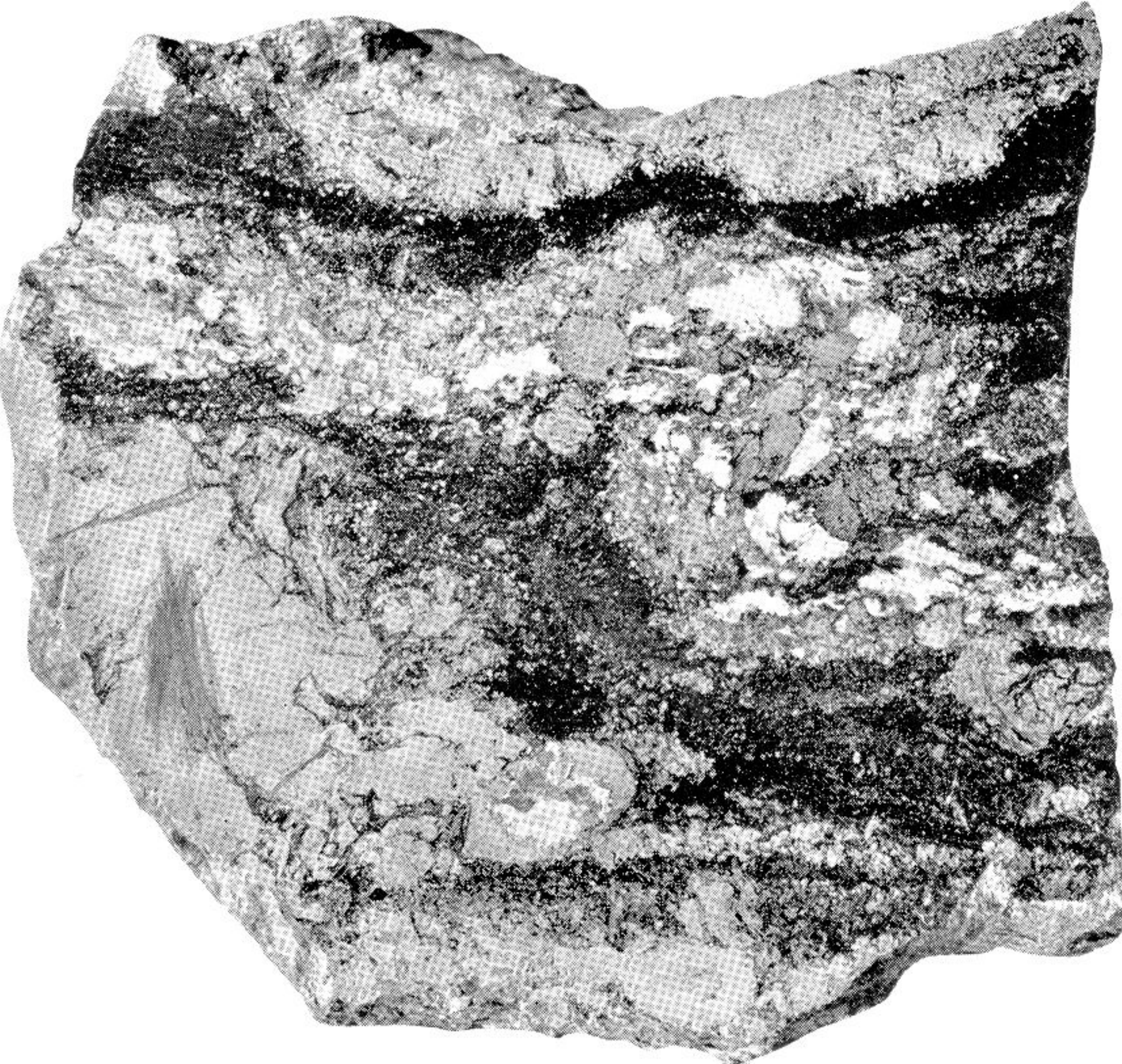

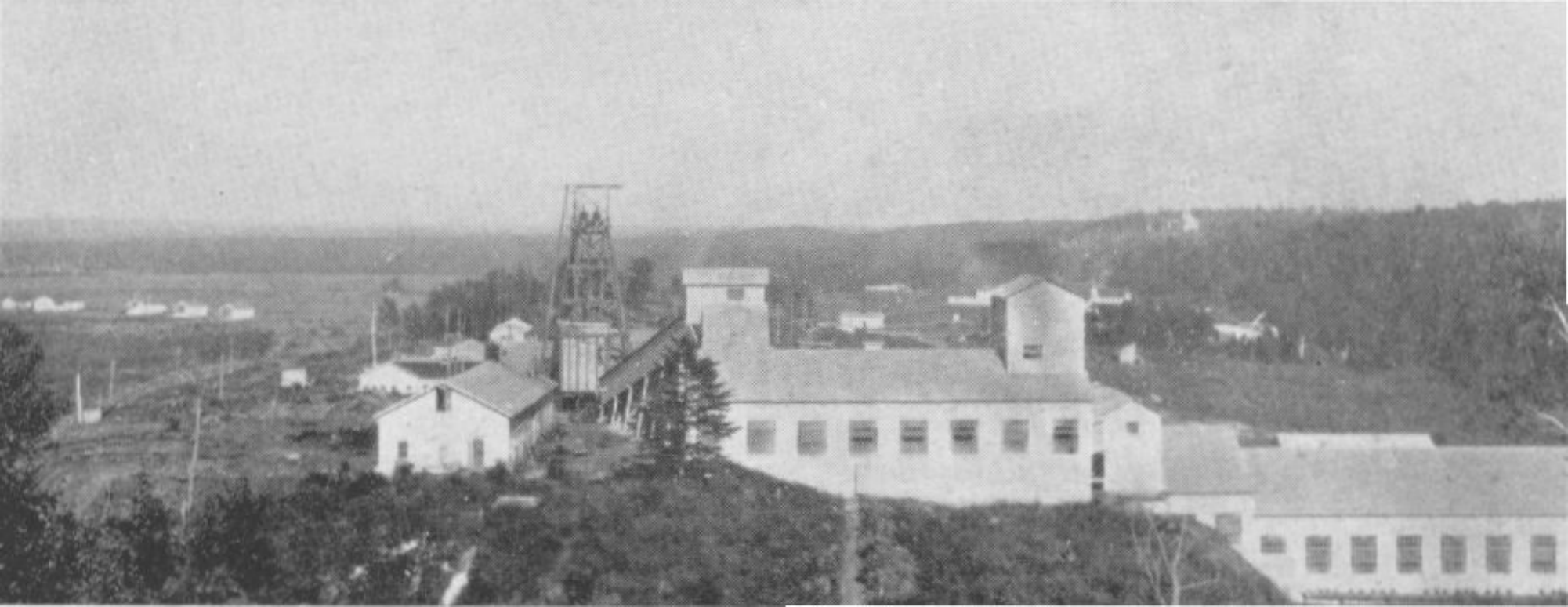

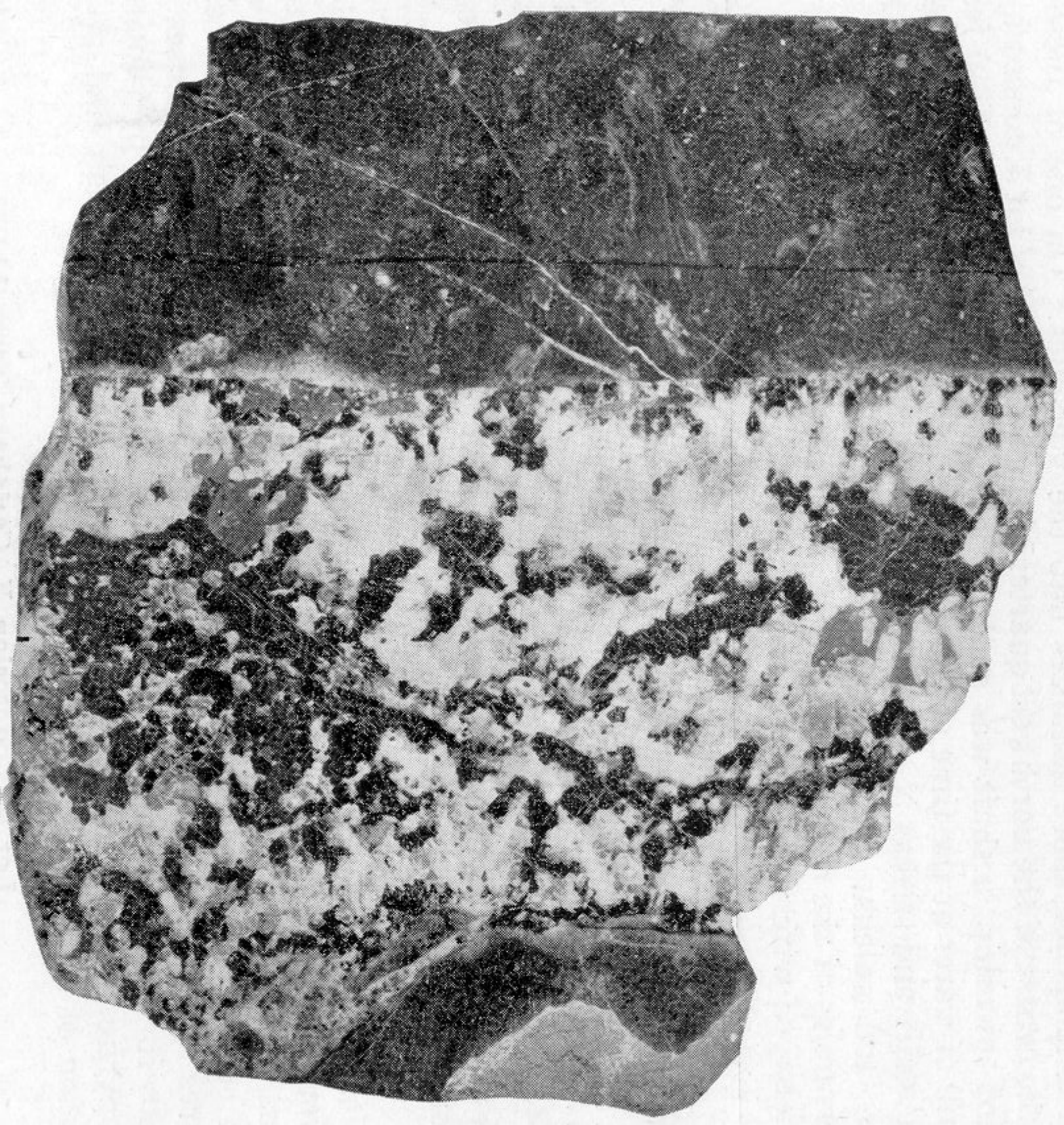

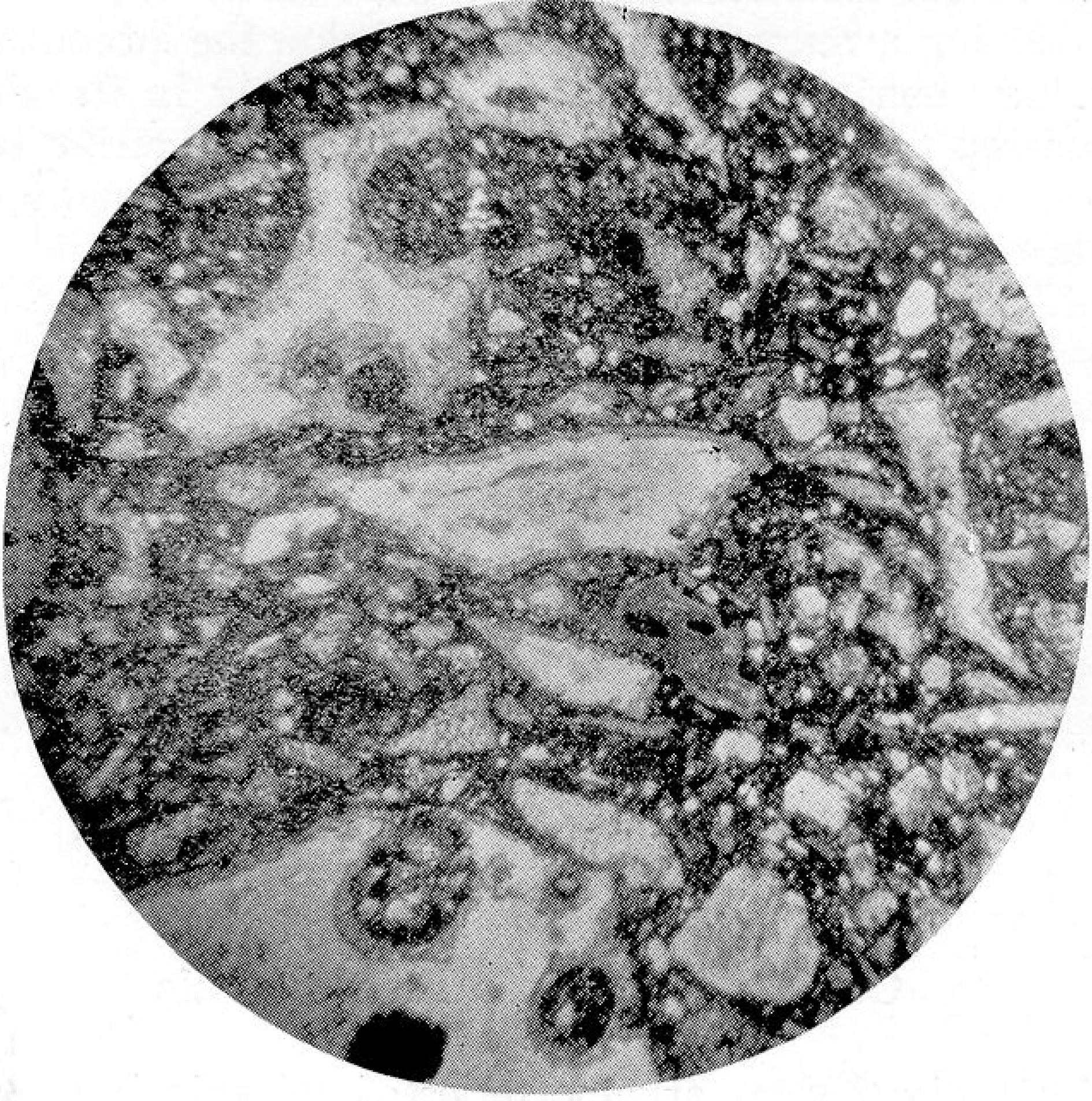

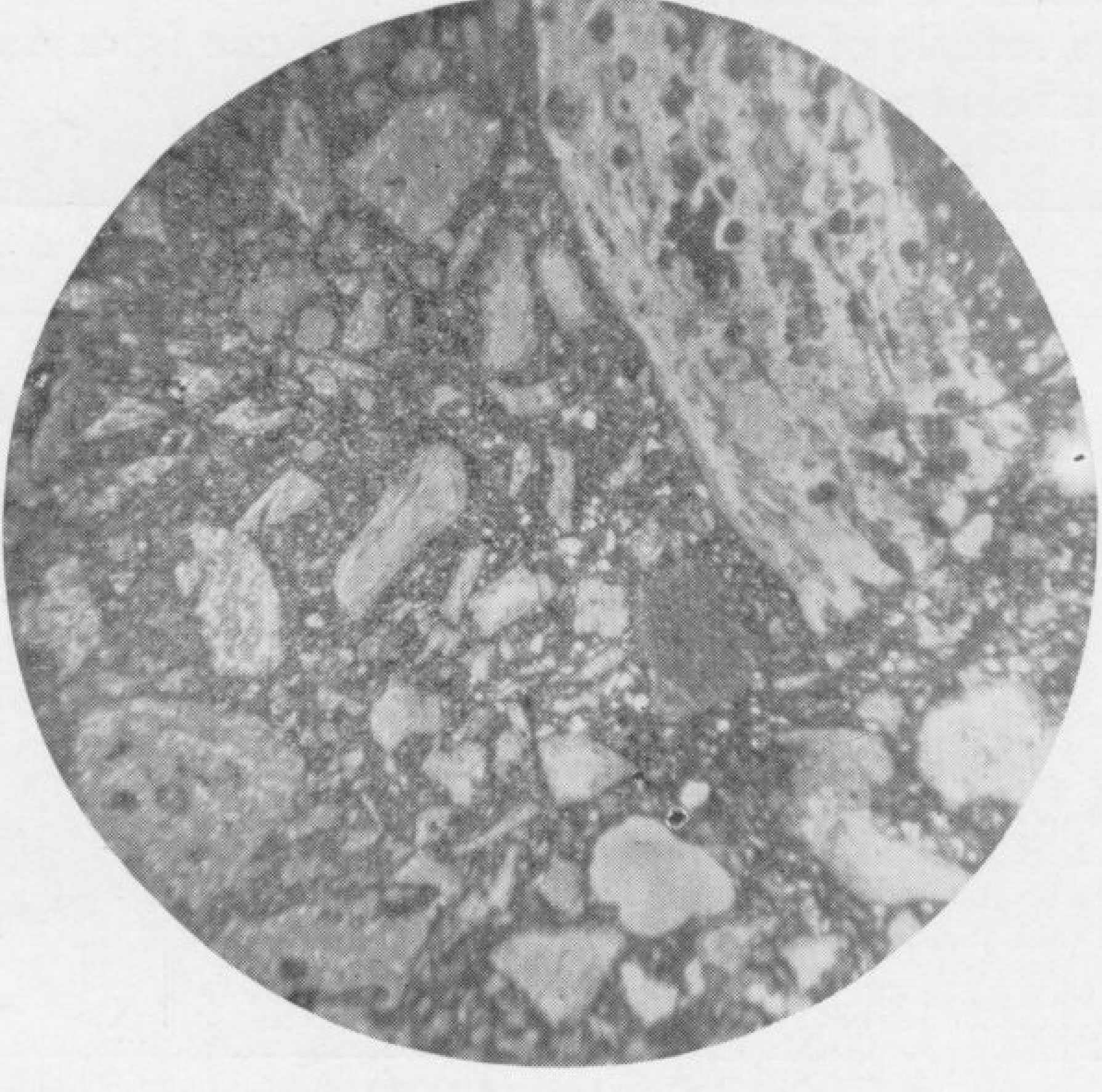

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. CHAS. MCCREA, *Minister of Mines.* THOS. W. GIBSON, *Deputy Minister.*

THIRTY-EIGHTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXVIII, PART IV, 1929

INVESTIGATIONS OF NON-METALLIC MINERAL RESOURCES OF ONTARIO, 1928

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Paleozoic Geology of the Albany River and Certain of Its Tributaries, by W. S. Dyer - 47-60

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The Ontario exhibit at the American Ceramic Exposition, Chicago, February 4 to 9, 1929.

General Review of Non-Metallic Mineral Resources, 1928

By W. S. Dyer

Introduction

The production of non-metallic minerals in Ontario, which properly include clay products and structural materials made from rock products, has been steadily increasing, as can be seen from the following table. The value of production will undoubtedly continue to increase steadily in proportion to the growth in population and industry. The table gives the record for each of the past five years, and also quinquennially for years preceding 1918:—

NON-METALLIC MINERAL PRODUCTION IN ONTARIO

Year	Structural materials	Clay products	Other non-metallics	Total
1891	.....	.....	.....	$4,316,958
1893	.....	.....	.....	5,505,991
1898	.....	.....	.....	5,546,875
1903	.....	.....	.....	7,628,018
1908	$3,396,406	$2,856,476	$2,629,749	8,882,631
1913	5,866,775	5,561,154	4,296,450	15,724,379
1918	4,297,401	2,018,450	7,815,062	14,130,913
1924	12,398,465	5,137,865	7,555,283	25,091,613
1925	12,451,174	5,148,626	7,448,034	25,047,834
1926	12,681,308	5,356,469	7,842,632	25,880,409
1927	14,160,552	5,853,035	7,638,605	27,652,192
1928	14,815,814	6,177,664	7,822,641	28,816,119

The non-metallics are generally regarded as the prosaic minerals, while the prospecting and mining of metals have always been surrounded with romance. Accordingly, the importance of the non-metallics is not always recognized. L. H. Cole states:[1]—

> In the past 33 years, namely, since 1895, the value of the non-metallics produced in Canada has exceeded the value of the metallics in 19 of the years, and for the last three years has been increasing rapidly. The war years (1915 to 1918, inclusive) naturally saw an intensive metallic production, but since that time, with the exception of 1925 when there was a general depression throughout the whole country, the non-metallics have been in the ascendancy. . . .
>
> It is to our official figures, as published by the Dominion Bureau of Statistics, that one should turn for convincing proof of the importance of non-metallics. Take, for example, the Annual Mineral Production of Canada for the year 1926. In a general table there is a reported production of 14 metals, while there are over 30 non-metallics listed, with a value of approximately $10,000,000 greater than the total value of metallics.

Ontario is the greatest metal-producing province in the Dominion, but even here the non-metallics comprise nearly one-third of the total mineral production. In 1928, the production of non-metallics was $28,816,119 and the production of metallics, $71,267,003. In recent years Ontario has been third among the provinces in non-metallics, its production being only slightly exceeded by that of Nova Scotia and Alberta, in which provinces a large part of the production is coal.

[1]Bull. Can. Inst. Min. & Met., March, 1929, pp. 482-483.

Clay products now form the largest item among the non-metallics, the production in 1928 being valued at $6,177,664, followed closely by Portland cement worth $5,520,897. Then follows natural gas with $4,535,312. The salt industry and gypsum and other rock product industries are in a thriving condition. There is also a good-sized production of talc (including some soapstone), arsenic, and feldspar; although Ontario possesses outstanding deposits of graphite and mica, the production is small, because foreign competition has been too keen. The production of actinolite and iron pyrites is now negligible, and at present no abrasives, apatite, asbestos, barite, diatomite, or fluorspar is mined, although interesting deposits occur within the province. All of these minerals, with the exception of diatomite, have been mined in former years.

The deposits of fire clay, lignite, and gypsum in the Moose River basin have recently been investigated and have very interesting possibilities; but owing to their present inaccessibility, there is not likely to be any production until railway facilities are provided.

The primary purpose of this report is to outline the investigations which have been made of the non-metallic minerals of the province by the Ontario Department of Mines in the year 1928, and to record more important developments in the industries based on them. The opportunity is also taken of summarizing those reports of the Mines Branch, Department of Mines, Ottawa, appearing in 1928, which deal either wholly or in part with Ontario's non-metallic minerals. For general information on the several minerals, including description of deposits, geology, geographical location, uses, etc., the reader is referred to the handbook entitled "Ontario's Mines and Mineral Resources,"[1] published by the Ontario Department of Mines, and to the literature referred to in it.

The Department of Mines is indebted to R. J. Montgomery, Professor of Ceramics at the University of Toronto, and to several ceramic firms in Ontario and one in Quebec for their co-operation in the investigation of clays. G. E. Gilmore, Superintendent of the Fuel Research Laboratories, and other officers of the Mines Branch, Ottawa, especially L. H. Cole and Howells Fréchette, very kindly assisted the Ontario Department in the investigation of lignite, gypsum, and clay, and in some cases did extensive research work on materials furnished them by the Department.

Abrasives

Part 3 of the report on Abrasives, by V. L. Eardley-Wilmot, of the Mines Branch, Ottawa, appeared during the year. This part deals with Garnet. Part 1, which was published in 1927, dealt with Siliceous Abrasives; and Part 2 (1927) with Corundum and Diamond. References to Ontario are scattered throughout all three parts. The following is a summary of the history of the abrasive industry in Ontario.

During the last two years there has been no production of abrasives in Ontario, but in earlier years production, particularly of corundum, has been considerable. Grindstones and scythestones were formerly made from basal Silurian sandstone (Whirlpool formation) in Dufferin and Simcoe counties, and grindstones said to be of excellent quality were made from a sandstone which borders the Ottawa river some two miles west of Deux Rivières portage. Good millstones for grinding grain were formerly produced from the Oriskany sandstone formation at Decewsville near Cayuga. No pulpstones have ever been

[1]Fourth Edition, 1929. The handbook was first issued in 1924 for the British Empire Exhibition.

produced in Ontario, but Eardley-Wilmot[1] states that a somewhat hard, pinkish-coloured, fine-grained quartzite, which might be used for pulpstone, occurs at intervals outcropping along the west shore of the Sibley peninsula, 20 miles east of Port Arthur. The best exposures, upon which there is practically no overburden, occur due south of Pass Lake station and to the north, near Loon lake. Small samples submitted to a pulp mill were favourably reported on, and negotiations are said to be under way to produce stone in the near future. The only provinces in Canada producing grindstones, sharpening stones, and pulpstones at the present time are Nova Scotia and New Brunswick, but there is quite a large importation from the United States. There is a good demand for pulpstones in Canada, about half a million dollars worth being used in 1926, but only 10 per cent. of them were obtained from Canadian localities.

Other siliceous abrasives that have been produced in Ontario in small quantities are granite grinding pebbles and quartz. About three years ago a small production of granite grinding pebbles was reported from the vicinity of Santoy near Jackfish on the north shore of Lake Superior. A small amount of quartz has been mined intermittently by the Orser-Kraft Company quarries near Christie Lake and Maberley, in Lanark county, and shipped to Canadian abrasive manufacturers. There are many other deposits from which suitable material could be obtained, if required. Eardley-Wilmot mentions that large masses of pure glassy quartzite, which might be suitable for abrasive purposes, occur from 1 to 3 miles east of Rutter station on the C.P.R., about 30 miles southeast of Sudbury. No Canadian sand or sandstone appears to have been used for sand blasting, but Eardley-Wilmot mentions that some of the lower beds of the Potsdam formation (white) of southern Ontario along the St. Lawrence river, particularly in the vicinity of Kingston and Gananoque, may be found suitable for this purpose. The main production centres are in the United States, namely, in New Jersey. Ohio, and Illinois. The first named are lake and beach sands, whereas the Ohio and Illinois sands are generally obtained from sandstone.

There is now no production of corundum in Canada but at one time Canadian corundum was regarded as the world's standard, and the production from Canada (all from Ontario) was much greater than from any other country. The peak year was 1906 when the marketable product was worth $262,448. The chief deposit was at Craigmont, in Renfrew county, the ore yielding 12 to 15 per cent. corundum. In recent years carborundum, an artificial abrasive produced in the electric furnace from silica and carbon, has replaced corundum for most abrasive purposes. The following notes are from Eardley-Wilmot's report:[2]—

> Although the existence and value of Canadian corundum were not appreciated for many years, nevertheless, once mining operations were started in 1900, the industry made very substantial and rapid progress in spite of many disadvantages, such as difficulties of transportation, of concentration, preparation for market, as well as its introduction into the world's markets. When the market was established, Canadian corundum was regarded as a standard, and for fourteen years was the world's leading producer.
>
> Almost from the beginning, the industry had a very serious competitor in the form of the artificial abrasives, first carborundum, the carbide of silicon, and later aluminous abrasives or artificial corundum. This increasing competition was the main cause of the steady decline in production from the peak year of 1906 until the final cessation of operations. During the last period when the old tailings were being treated the concentrates were naturally somewhat inferior to that of the freshly mined material, and tended to lower the high standard of Canadian corundum.
>
> Natural corundum is to-day being shipped from various places . . . throughout the world, the main producer being South Africa. There is still an appreciable demand, as it is considered preferable for certain abrasive purposes. The majority of wheel manufacturers and other users who employ the natural corundum state that the pure Canadian material is the best. Although

[1]Part I, Siliceous Abrasives, p. 41.
[2]Part II, Corundum and Diamond, p. 10.

the present-day costs of operating some of the old Canadian deposits would be excessive, there are, nevertheless, several that are fairly close to transportation and water power.

The recent use for corundum in any manufacture of artificial abrasives . . . may be the means of stimulating the production of Canadian corundum.

Emery is an intimate mixture of granular corundum and magnetite with some hematite. It is used for the manufacture of grinding wheels, in the form of loose grain for glass grinding and bevelling, wood-work, and metal polishes, or for the manufacture of emery cloth and paper. Commercial emery has not been found in Ontario, although a certain corundum deposit east of Madawaska river is so intimately mixed with magnetite that it is practically a coarse crystalline emery. A typical deposit occurs in lot 34, concession VII, Brudenell township, Renfrew county, where the mineral is thickly disseminated throughout a well-foliated nepheline syenite gneiss, which has been traced across its line of strike for about 300 yards. No work has been done on the deposit.

There has been no production in garnet in Ontario with the exception of small shipments from Parry Sound,[1] and Ashby township[2] in Lennox and Addington county, but good deposits occur in the province, of which Eardley-Wilmot gives a detailed account. These localities are in the counties of Frontenac, Haliburton, Hastings, Lennox and Addington, and Peterborough, and the districts of Parry Sound and Sudbury. Ninety per cent. of the world's production of garnet is used for abrasive papers and cloths. Garnet paper has now largely taken the place of sand and emery papers, particularly in the wood-working industries. These papers are manufactured in Canada to a small extent by the Western Abrasive Company, Victoria, B.C., but the largest output is maintained by Abrasives Limited, Brantford, a subsidiary of the American Glue Company. The material received from United States and Canadian mines is in the form of semi-graded concentrates that bring from $70 to $85 per ton according to quality. Recently, finer grades have been employed successfully by glass-grinding and bevelling industries. The world's best garnet is at present obtained from mines in New York state, the annual production of which is now over 8,000 tons. Owing to the present increase in milling capacity there has been a tendency for over-production, but there is still a fair demand for the higher quality of abrasive garnet.

Clay[3]

More extensive investigations were made on clays in 1928 than on any other of the non-metallics of the province. This was due largely to the interest taken in the fire clays of the Moose River basin, which show very interesting possibilities. They have already been reported on rather fully,[4] but additional tests were made during the year. Laboratory tests were made by Montgomery of clays collected by Dyer on the Abitibi and Mattagami rivers. Commercial tests were made by various firms to show the possibilities of the clay for the manufacture of fire brick, rockingham-ware, pottery, and sanitary porcelain. The results are described in a separate article in this report.

[1] Trial shipment, 1922.

[2] Bancroft Mines Syndicate, 1922-23.

[3] For further information on the clay and shale deposits of Ontario the reader is referred to the handbook, "Ontario's Mines and Mineral Resources," published by the Ontario Department of Mines, and to the literature referred to in it.

[4] W. S. Dyer, Geology and Economic Resources of the Moose River Basin, Ont. Dept. Mines, Vol. XXXVII, pt. 6, 1928; R. J. Montgomery and R. J. Watson, Fire-clay, Kaolin and Silica-Sand Deposits of the Mattagami and Abitibi Rivers, op. cit.

The Ontario Department of Mines with the co-operation of the Canadian National Clay Products Association assembled an exhibit illustrating the clay industry of Ontario, which was shown at the American Ceramic Exposition in Chicago, February 4 to 9, 1929. This exhibit included practically all lines of ceramic ware manufactured in the province, as well as raw clay from the Mattagami river, southern Saskatchewan, and St. Remi, Que. It proved interesting to 1,500 members of the American Ceramic Society, who were in attendance at the convention, as well as to the 70,000 people who visited the exposition. The Ontario exhibit is described in a separate article in this report.

During the year Professor Montgomery began his survey of the ceramic industry of Ontario. This survey is under the auspices of the Ontario Department of Mines, and the results will be published in their annual reports. An interim report appears on page 27. In 1905, M. B. Baker made a survey of the clay-working plants of Ontario, and his report was published in 1906 as part 2 of Volume XV of the Ontario Bureau of Mines. Since that time many changes have taken place and improvements in technique have been made in the industry. Montgomery's resurvey will supplant the old report. In the summer of 1928, he visited the plants in eastern Ontario and in the vicinity of Toronto, and in the summer of 1929 he continued the work into western Ontario. He is making notes in regard to raw products, methods and equipment, dimensions of kilns and dryers, and collecting figures available on quantities of fuel used in burning and drying. He is also collecting historical data on the oldest brick or clay-working plants in the several counties, the oldest brick buildings in various localities, with the dates on which the bricks were made and notes on how they have withstood the test of time. Professor Montgomery is particularly interested in plant troubles and problems and the manner in which the Department of Mines can best serve the industry in gathering and publishing statistics.

Steps were taken during the year to standardize the size of brick in Canada. In a letter canvass of the Canadian brick manufacturers in April, 1926, by Howells Fréchette,[1] Chief of the Ceramic Division of the Mines Branch, Ottawa, it was found that a very wide range of sizes of brick was being made in the country. As regards length alone, there was a variation of 7¾ to 9 inches. These facts were placed before the Canadian National Clay Products Association, and a committee was formed to determine a standard size. The following sizes were decided upon:—

Common brick	8 by 2¼ by 3¾ inches.
Rough-faced brick	8 by 2¼ by 3¾ inches.
Smooth-faced brick	8 by 2¼ by 3⅞ inches.

These sizes are slightly smaller than the average size of brick usually manufactured. They were approved by the various interests concerned and were sponsored by the Canadian Engineering Standards Association. Approval was given by the various provincial architectural organizations, and the cast stone and cement block manufacturers adopted standard sizes to conform with the standard sizes of brick and tile. It was hoped that the adoption of a standard-sized brick would have a beneficial effect on the whole construction field. Brick is the basic unit of construction, and on it depend the sizes of mill work, steel sash, arch stone, etc. Architects are reported to be enthusiastic about the manufacture of a standard brick, and in the adoption of a smaller brick the brick manufacturers stand to gain in several respects. This gain will not only

[1]Investigations in Ceramics and Road Materials, 1926, Mines Branch, Ottawa.

be represented by a lesser tonnage of clay per 1,000 bricks and a correspondingly greater number of brick per kiln, but in addition the drying time and burning time may be cut down to some extent. This will be especially true in plants where it has been the practice to make extra large brick. It has been learned recently that some important brick manufacturers did not adopt the standard size, which had the effect of throwing the whole plan into the discard. The building trades were in a measure responsible. To their membership it appeared that all the advantages were on the side of the manufacturers. If a larger size had been approved, standardization would doubtless have been approved.

Three papers of interest to brick manufacturers in Ontario, written by officers of the Mines Branch, Ottawa, appeared during the year as follows: "Methods of Using Barium for Scum Prevention in Soft Mud Brick" and "Manufacture of Grey Brick," by L. P. Collin; "Investigations in Ceramics and Road Materials, 1926," pages 5 to 8; "Treatment of Certain Clays to Overcome Drying Effects," by Howells Fréchette, Official Report of the 26th Annual Convention (Montreal, 1928) of the Canadian National Clay Products Association.

This last subject has been treated more fully by J. G. Phillips, of the Mines Branch, in a paper[1] read before the Winnipeg meeting of the Canadian Institute of Mining and Metallurgy in March, 1929. This subject is of more interest to brick manufacturers of the Prairie Provinces, many of whom are forced to use bentonitic clay, which possesses a strong tendency to crack on being dried from the plastic state, but it may be of some interest to Ontario brick manufacturers.

Much research work has been done outside of Canada in the general field of ceramics. Wonderful improvements have been made in refractories. Outstanding is the development of mullite, sillimanite, kaolinic, high alumina, and other refractories, which have greatly increased the scope of high-temperature furnace design and heat-curing processes. In face brick there are many new colours and textures and much improvement in quality. Machines and devices have been introduced to make possible the economical production of a practically unlimited range of colours and textures. In the United States there has been recently much improvement of quality in common brick. The possibilities in ordinary rough-texture brick for certain effects in exterior walls was discovered a comparatively few years ago. Further development of the idea and improved quality of the product have been responsible for the creation of an entirely new field of architectural design.

In Ontario recently there has been a marked increase in the output of clay products; in 1928 the production value was $6,177,664, an increase of $324,629 over 1927. The greatest increases were in structural tile and sewer pipe. Notable developments of the industry in Ontario were the construction of a new building by the Foster Pottery Company in Hamilton, resulting in increased production in flower-pots, which this firm has been making for many years; the erection of a new plant at Bridgeburg by the Canada Fire Brick Company; the expansion of the George Bailey Fire Brick Company[2] in Toronto; and the incorporation of the National Refractories, Limited, which will manufacture fire brick at Port Robinson.

It is also of interest to note that Cooksville Company, Limited, of Cooksville, have obtained a license to make "Haydite," a patented light-weight construction material, and that production commenced in the spring of 1929.

[1] A New Method of Drying Clays to Overcome Drying Effects, Bull. Can. Inst. Min. & Met., March, 1929, pp. 470-481.

[2] This plant was sold in the summer of 1929 to National Refractories, of Port Robinson.

Haydite is made by burning clay or shale in a rotary kiln, resembling in many respects a cement kiln. During the process the shale or clay is subjected to a temperature of 2000° F., which brings it to incipient fusion and causes puffing of the particles, expansion being about 2½ times the original size. The clinker thus prepared is ground and screened and is ready for use as aggregate with a cement binder. Haydite concrete weighs less than 100 pounds per cubic foot, as compared with ordinary concrete weighing 150 pounds per cubic foot. A Haydite hollow concrete block 8 by 8 by 16 inches weighs 32 pounds, whereas a similar concrete block weighs about 50 pounds. In a building requiring 1,000 cubic yards of concrete the reduction in dead load made possible by using this light-weight aggregate would be more than 650 tons. Haydite tiles are used for partition walls. The economy effected by the use of light-weight aggregates is not confined solely to structural jobs. In the field of concrete products masonry units made from this material have all the features of ordinary sand and gravel concrete hollow blocks with the added advantage of "nailability" and increased sound and heat insulation.

Diatomite

The publication during the year of a comprehensive report on Diatomite,[1] by V. L. Eardley-Wilmot, has attracted fresh attention to this interesting mineral,

Diatomite is composed of the fossil remains of microscopic marine plants known as diatoms, which flourish abundantly in both salt and fresh water. The siliceous skeletons are deposited in beds and are found at many places where bodies of water formerly existed. Diatoms have been found in the Cretaceous, but the Tertiary period seems to have been the more favourable for the growth and deposition of these plants, and during this period most of the deposits were formed. The Ontario deposits are of post-glacial age.

Diatomite when dry is a whitish substance, resembling chalk but is very much lighter in weight and more porous. It has many industrial uses based mainly upon its chemical inertness. These include use as an insulator against heat, cold, and sound, a filtering medium, a filler in rubber and cement, an inert base for the manufacture of dynamite, a mild abrasive; and in structural materials, especially in light-weight building blocks, partitions, and roofing tiles. The use of the crude powder as a concrete admixture is gaining in favour.[2] Some grades are also capable of bleaching and act in a similar way to Fuller's earth. In Canada its chief uses are as a filtering agent, generally in the preparation of sugars, and as an insulating ingredient in the manufacture of bricks and thermal electrical insulating pads.

In the year 1926 a total of 2,300 tons of diatomite was used in Canada, practically all of which was imported from the United States. The prices of powdered diatomite imported in car lots during 1927 were as follows: filtration materials $78 to $90, depending on grade; insulation $78; for concrete $60; and for best metal polish $200. For small lots of less than one-quarter of a ton the prices in some cases were almost double those quoted above.

In Ontario, Smith and Stone, Limited, of Georgetown, manufacturers of electrical porcelain, have recently started making a very fine class of thermal electrical insulating pads, which consist very largely of diatomite. These pads

[1] V. L. Eardley-Wilmot, Diatomite, Its Occurrence, Preparation and Uses, Mines Branch, Dept. of Mines, Ottawa, Bull. No. 691.

[2] "Diatomaceous Silica as Admixture in Concrete," Rock Products, March 16, 1929, p. 54; Albert S. Hastings, "Diatomaceous Earth," Rock Products, March 16, 1929, pp. 50-54.

are placed below the fire-clay elements of electric ranges and act as insulators, keeping the heat from going downward into the range and directing it all upward against the cooking utensil.

The largest known commercial deposits in the world are situated in the White hills of California, near Lompoc. The purest of these are being worked by the Celite Products Company, which was recently taken over by the Johns-Manville Corporation. This company produces between 80 and 90 per cent. of the total diatomite output of the United States, which country in 1926 produced about 80 per cent. of the world's supply.

Diatomite is found in many places in Canada, but mainly in the Maritime Provinces and British Columbia, with a few deposits in Ontario and Quebec. Over one hundred occurrences are known, but the majority are shallow and small. The greatest number of these occur in the Cobequid mountains of north-western Nova Scotia, but the largest and purest deposits so far discovered are those in the vicinity of Quesnel, B.C.

Eardley-Wilmot lists five diatomite occurrences in Ontario. The following notes are from his report:[1]—

In Ontario they [diatomite occurrences] are all confined to the Muskoka region (though samples have been received from north of Cobalt) and are either lake or marsh deposits similar to those of the Maritimes. Unlike most of the latter they are remarkable for the high percentage of perfect, unbroken diatoms, and the number of species is also considerably less than in the average of the Maritimes. The known deposits are small and shallow and the diatomites are high in alumina, though after calcining some of the muds or peats would give a good product. The Spence Lake deposit is about the largest and purest at present known in the district. It is more than probable that a considerable number of diatomite deposits exist in the Muskoka region since the conditions appear favourable to the past and present deposition of the diatoms. . . .

Medora Township, Concession D, Lot 11.—Diatomite occurs on the farm of Albert H. Edwards, on the bottom of a small bay of the Moon river near its junction with the Muskoka river, 2 miles northwest of Bala. The deposit extends over about half an acre and has a thickness of about one foot. It is covered with about one foot of mud and underlain by sand resting on blue clay. The diatomite is of a good white colour, but is badly contaminated with silt, only about 6 inches being fairly pure. It is quite high in silica but is also high in alumina. . . . The diatoms are mainly rod-shaped . . ., a type well suited for filtration purposes.

Concession IV, Lot 19.—On the bottom of a small bay of Lake Joseph near Glen Orchard, greyish brown diatomite covers about 10 acres to a depth of 3 to 5 feet. The material can be obtained only by dredging as the bay can not be drained. A few tons were dug many years ago and sold for polishing purposes by Thomas Orgill of Glen Orchard. . . . The diatoms are quite clean and fairly well preserved.

Chaffey Township, Concession X, Lots 19 and 20.—Grey-white diatomite, 6 inches to 1 foot in depth, occurs over 3 or 4 acres of high marshy ground, a few hundred yards north of Little East river on Tynan's farm, 7 miles north of Huntsville. The material is in places mixed with sand and covered with peat and vegetable matter, but in some places comparatively clean though somewhat gritty material may be obtained. The deposit contains well formed, unbroken diatoms but is high in alumina. . . . Mr. Tynan intends working the material in conjunction with a silt deposit which occurs alongside.

About half a mile farther west, on Harry Southby's land, locally known as the Beaver Meadows, about 50 acres of swampy ground are covered with long grass and a few alders. The swamp contains 4 to 6 feet of dark brown diatomaceous peat underlain by silt or sand. The dry peat is self-calcining, leaving a pink and gritty residue containing diatoms and sponge spicules. . . .

Draper Township, Concession X, Lots 3 and 4.—Diatomite occurs on the west end of Spence lake some 2 miles east of Muskoka Falls and 5 miles south of Bracebridge. Swampy meadows about a quarter of a mile wide and half a mile long extend on either side of the outlet. A small area of grey-white diatomite which in places is 18 inches thick, but averages 1 foot, and is underlain by blue-grey silt, is exposed in the banks and bed of the creek. This deposit contains about 200 tons of the only natural white diatomite so far found in this locality. However, a considerable area of grey-brown mud occurs, which in places varies from 6 to 10 feet in thickness. The calcined mud is pure white in colour and consists almost entirely of well-preserved rod and oval-shaped diatoms. . . . When calcined it appears to be of better quality than the burnt white

[1]V. L. Eardley-Wilmot, op. cit., p. 76 *et seq.*

material which assumes a slightly pink tinge. Almost 250 tons of the dry mud or 200 tons of the calcined would be produced per acre for each foot in thickness. . . .

The deposit is larger, and the calcined diatomite is better, than any other so far found in this region. The diatom structure is such that it should be suitable for all purposes including sugar refining. Recent power developments by the Ontario Hydro-Electric Company [Commission] have flooded this area, so that the deposit cannot be drained and the material can now be recovered only by dredging. The mining rights have been taken up by J. H. Widdicombe of Bracebridge.

Stisted Township, Concession XI, Lot 19.—About 12 miles northwest of Huntsville, a diatomaceous peat, 2 to 15 feet in thickness and covering about 50 acres, occurs on the north and west sides of Duck lake on Hodge's farm. The swamp extends for some hundreds of feet back from the north edge of the lake and the dried peat is somewhat similar to that from Beaver Meadows but contains less carbonaceous matter. The proportion of grit appears to increase with depth, but the best material occurs from 1 to 3 feet below the surface. The pink residue after calcining is gritty and high in alumina. About 200 to 250 tons of the calcined diatomite would be produced per acre for each foot in thickness. . . . The diatoms are well preserved.

The deposit has been leased by the Canadian Diatomite and Silica Company of Toronto.

Gypsum

The extensive gypsum deposits of the Moose River basin have been described in a recent publication of this Department,[1] but some additional tests have been made of this gypsum. The following analysis made by W. K. McNeill, Provincial Assayer, of the gypsum collected by the writer from the deposit on the northwest side of Moose river, opposite Smith island, shows the purity of the material:—

	Per cent.
Lime (CaO)	31.69
Sulphuric anhydrite (SO_3)	46.13
Water (H_2O)	20.40
Total	98.22

The following report of tests upon gypsum were kindly furnished to the writer by L. H. Cole, of the Mines Branch, Ottawa. The material was collected by W. Tees Curran of the James Bay Basin Oil Company, Montreal, from the same general locality as the above.

Weight of sample after crushing and grinding in burr mill, 124 pounds. Chemical analysis of ground material before calcining:—

	Moose River	Theoretically pure gypsum
	per cent.	per cent.
Insoluble	0.25	.....
Fe_2O_3	.06	.....
Al_2O_3	trace	.....
CaO	33.00	32.50
MgO	.21	.....
SO_3	46.90	46.60
H_2O	19.41	20.90
CO_2	.....	.....
	99.83	100

There is probably a small percentage of anhydrite present.

A 50-pound sample of the ground material was calcined at temperature of 325°F., or to first settle when the percentage of water remaining was 5.5.

The testing consistency was 71 cubic centimetres per 100 grammes of plaster. This is a little higher than usual but not excessive.

[1]W. S. Dyer, Geology and Economic Resources of the Moose River Basin, Ont. Dept. Mines, Vol. XXXVII, pt. 6, 1928.

Time of set of neat plaster mixed to testing consistency, 17 minutes. This is slightly slower than the average.

The tensile test on the neat plaster after drying to constant weight was 388 pounds per square inch.

The compressive strength on the neat plaster after drying to constant weight was 1,872 pounds per square inch.

The strength of the plaster as shown by these two tests is good.

The results of the tests on the plaster made from gypsum from the Moose River deposits show that the product is a smooth-working white plaster of good consistency and strength and suitable for many of the uses of gypsum plasters in the building trade.

The only company operating in Ontario at present is the Canada Gypsum and Alabastine, Limited. This company is maintaining its production from its Caledonia and Lythmore plants. It is also operating its mill at Montreal, where Nova Scotia gypsum is used as the crude material. Recently the Manitoba Gypsum Company, with its subsidiary, the British Columbia Gypsum Company, has been taken over by the Canada Gypsum and Alabastine Company, so that the company now has quarries and mills in all the producing provinces, except New Brunswick. The products manufactured by the company include "Gyproc" wall board, partitions, and roof tiles, "Insulex," "Alabastine," plaster of Paris, Keene's cement, etc. An interesting new gypsum product developed in the United States during 1928 was a gypsum lumber.[1] This consists primarily of 4-by 12-inch hollow tongue-and-grooved members that can be manufactured in lengths up to 29 feet and can be used for load-bearing and non-load-bearing partitions or flooring, according to prepared specifications. It has not yet been made in Canada.

Lignite

The lignite deposit at Blacksmith rapids on the Abitibi river, at a point 25 miles beyond the present end of steel, has already been described in detail in a report of this Department,[2] and short descriptions have appeared in the press. The seam is from 6 to 8 feet thick, but outcrops at only two points, one on the east side of the river and the other about 500 yards upstream on the west side. It is quite possible, however, that the seam is extensive, since it apparently belongs to the Mattagami formation, Lower Cretaceous age, and the formation appears to have been laid down in moderately extensive structural basins. A contract for the diamond-drilling of several holes in the Moose River basin has been signed by the Ontario Government, and work was begun about June 1. Several holes will be drilled in the vicinity of Blacksmith rapids and to the west at the junction of the Missinaibi and Mattagami rivers. The cores obtained should give valuable information on the extent of the lignite, the thickness and character of the fire clays, and the thickness and character of the Paleozoic sediments. It is possible that oil or gas may be found. Certainly something will be learned of the possibilities of the sediments as oil generators or reservoirs.[3]

[1]Rock Products, Dec. 22, 1928, pp. 140-141; ibid, March 30, 1929, pp. 74-81.

[2]W. S. Dyer, op. cit. pp. 47, 48.

[3]All drilling done during the summer of 1929 was in the vicinity of Blacksmith rapids, and a large deposit of lignite was blocked out. Many months, if not years, will be required to determine the boundaries of this deposit by drilling; the proposed drilling on the other rivers will be postponed. Twenty-one holes have been drilled to date. Twelve of these penetrated the lignite seam, which is nearly flat-lying; the minimum thickness shown was 13 feet, and the maximum 36 feet. Two of the holes were at points where the seam had been almost entirely eroded by glacial action, leaving a thickness of 1 or 2 feet. In the remaining seven holes the seam had been completely eroded by glacial action and replaced by boulder clay. No definite evidence has yet been obtained of the thinning or pinching out of the seam. The area now proved to be underlain by lignite is between two and three square miles ,and the average thickness of the lignite is 20 feet.

In the summer of 1929, about 800 pounds of lignite from Blacksmith rapids was collected by the writer and sent to the Mines Branch, Ottawa, for testing. Mr. Gilmore's report appears separately in this volume. Some of the outstanding results of his tests are: (1) The ash was found to be quite low, less than 7 per cent., on the "as received" basis, in 65 per cent. of the material tested, and 90 per cent. had less than 10 per cent. ash; the moisture "as received" varied from 25 to 39.9 per cent., most of it nearer the latter figure; (3) air dried to 60 per cent. humidity, the moisture is 17 per cent. The analyses of the lignite samples are very similar to those from the Estevan area, southern Saskatchewan. The lignite was put through a low-temperature carbonization test, which gave 44 per cent. char, with a calorific value estimated at 12,750 B.t.u., having very much the same composition as anthracite coal. The lignite can be used either in the raw state or in the carbonized or partially carbonized state for pulverized fuel for industries; or it can be made into briquettes for domestic use.

Provided the seam is found to be sufficiently extensive for exploitation, there would seem to be good possibilities for its use, particularly in Northern Ontario, let us say from North Bay northward. This part of the province is far removed from coal mines, and coal is high in price. The price of anthracite per ton in North Bay in 1928 was $16.50, at Haileybury it was $18.50, at Cochrance $18.50 to $19.00. Large quantities of bituminous coal and pulverized coal are used in the paper mills and smelter plants. It is estimated from experiments on similar lignite in North Dakota[1] that the cost per ton of char (including $1.50 as the cost of lignite per ton) is $4.86 per ton, and the cost of briquettes per ton (using $4.86 as the cost of the char) is $7.32 per ton. The cost of pulverizing the char would be very small. Assuming $1.00 per ton for freight charges from Blacksmith rapids, the char could be delivered at Cochrane for $5.86 and briquettes for $8.32. This does not include the cost of selling or profit. Announcement has recently been made that a plant with a capacity of 100 tons per day is producing carbonized briquettes at Bienfait near Estevan, Sask., utilizing the combined carbonizing and briquetting process along the lines developed by the Lignite Utilization Board. If such a product can be marketed in Saskatchewan, where freight rates on Alberta coal are not excessive, surely it could be done in Northern Ontario, where freight rates on competitive fuels are much higher. In selecting a plant for carbonizing lignite for Northern Ontario it should be kept in mind that the primary object is to produce a maximum amount of char; the by-products are a minor feature. Such a plant should be simpler and lower in cost than one in which the primary object is obtaining the by-products.

There are many possibilities in the use of raw lignite and partially carbonized lignite for domestic use. It is said that 70,000 tons of raw Saskatchewan lignite are consumed in Winnipeg each year, and $7.00 is given as the price of lignite delivered. The lump material, which makes up about 50 per cent. of the Blacksmith rapids seam, burns exceedingly well in the raw state and retains heat for a long period.

The deposit at Blacksmith rapids is the only coal deposit in Ontario so far located which gives promise of becoming commercially important. Lignite is found on the Mattagami river, but no seam of economic size or purity has been located. Ontario is and always has been dependent on imported fuel or on coke, part of which is imported and the remainder manufactured in the province from imported bituminous coal.

[1]Hood and Odell, Investigations of Preparation and Use of Lignite, U.S. Bur. Mines, Bull. 255.

Limestone and Structural Materials

Analyses were made in the Provincial Assay Office of samples of limestone collected by the writer from various localities in the Moose River basin and from the Abitibi river. These analyses and comments on them are published in a separate article in this report. Some of the limestones are very pure, and the localities in which they occur, especially Coral rapids at the present northern terminus of the T. & N.O. railway, 100 miles north of Cochrane, are near enough to smelters to be considered as a possible future source of flux.

A report of considerable interest to limestone producers is one by M. F. Goudge of the Mines Branch, Ottawa, entitled "Preliminary Report on the Limestones of Quebec and Ontario." This report appeared in 1927, but is mentioned here since it has not been referred to in any previous report of the Ontario Department of Mines. Goudge describes the limestones and dolomites of the province according to geological formations from the Grenville (pre-Cambrian) to the Hamilton (Devonian) and gives notes on the quarries and analyses of the limestones, as well as notes on the uses to which they may be put.

The limestones of Ontario include high-calcium limestones, magnesian limestones, and dolomites, which range in chemical composition from the very pure down to the most impure grades. These limestones are found chiefly in that part of the province south of the Ottawa river and Lake Nipissing. In the northern part of the area metamorphic rocks containing bands of crystalline limestones occur; the remaining and greater part of the area is underlain by sedimentary rocks in which are formations of great thickness and extent composed entirely of bedded limestones. Over the southern part of the Ontario peninsula the rocks are deeply covered by soil, and exposures of limestones are rare and usually are to be seen only in the deep river valleys. Over the central part of the peninsula and as far north as the Ottawa river the soil covering is much thinner and the limestones are exposed in prominent escarpments and ridges, which provide excellent quarry sites.

An idea of the value of these limestone resources may be gathered from the fact that from them there is annually obtained products such as lime, building stone, crushed stone, and stone for cement manufacture that approximate $5,000,000 in value. This is but a tithe of the value of products that could be obtained were the demand to arise.

Two other Mines Branch reports, appearing in 1928, of considerable interest in Ontario are: "Commercial Crushed Stone of Ontario and Quebec," by R. H. Picher;[1] and "Stone and Its Use in Road Construction,"[2] by the same author. In the first report Picher gives the results of tests on various types of stone in Ontario, performed with the view of obtaining their value for use on roads. Of the 83 samples, 53 were of crystalline limestone, limestone, and dolomite. The igneous types were from the pre-Cambrian group. The limestone samples were from the Black River, Chazy, Trenton, Lockport, Onondaga, Detroit River, Delaware, and Hamilton formations; and the dolomite from the Beekmantown, Cataract, Lockport, and Guelph formations. The localities are in all parts of southern Ontario. The second report is complementary to the first; it outlines the qualities a good road stone should possess, and describes under the head of each rock type the merits and demerits of each for road-building. The following notes have been abstracted from Picher's second report:—

Trap Rock . . . forms large masses in parts of Nova Scotia and New Brunswick, but is less common in Quebec and Ontario. It possesses to a high degree all the qualities required in a road stone, and is the best road material known, especially the dark, fine-grained varieties. . . . As compared with other rocks it is relatively scarce and is usually found in thinly populated areas where cheaper material, such as gravel, granite, and limestone satisfactorily answer the needs of local road traffic. . . .

[1] Investigations in Ceramics and Road Materials, 1926, Mines Branch, Bull. No. 690.
[2] Ibid.

Granite.[1]—Granite is scarcer and more local in distribution than other kinds of rock in the more thickly settled parts of southern . . . Ontario. . . . The darker types generally make better road materials than the lighter ones, but the colour is a less reliable guide than it is with the traps, and in neither case should it be regarded as infallible. Gabbro is best in point of road-making quality, with diorite a close second. . . . Granite [proper] and syenite are about equal in durability. Granite has a greater resistance to wearing and grinding, and syenite a greater resistance to pounding, as well as a higher cementing power, which makes it more desirable than the granite for use in waterbound macadam pavements. . . . Gneiss is generally considered unsuitable for roads, because of its banded or zoned structure and its strong tendency to break in thin slabs in a direction parallel with the bands. However, some gneisses show this weakness to a small degree only and are nearly equivalent to the granite and syenite in their durability as road material. . . .

Quartzite. . . . The qualities of quartzite as road material vary. Some quartzites are nearly equivalent to granite, whereas others are totally unfit for use. The two most usual defects that lower the value of this stone are a banded structure, which causes the stone to split into thin pieces, and vugs, or cavities within the rock, the effect of which is to decrease the resistance to impact. . . . The Ontario glassy quartzite has been successfully used in surfacing streets and roads in and around Brockville. It may be mentioned that the quartzite in the vicinity of Brockville is superior as a road stone to the average quartzite found farther west and north. . . .

Limestone.—This is by far the most common rock throughout the older settled parts of Quebec and Ontario, and for that reason has been the first stone used in road metalling. To-day, it still holds first rank as regards quantity used for road purposes. . . . Of the several rocks included under this name, magnesian limestones, better known as dolomites, and limestones proper only need to be considered here. Marble, besides being very scarce, is unsuitable for roads because of the readiness of the crystals constituting the rock to split along their cleavage-planes. Crystalline limestone, which is a very coarse marble, is still weaker than the latter, due to its coarse texture. . . . In Ontario two important areas [of dolomite] are found, one between Ottawa and Prescott, and the other forms a wide belt which runs from Niagara Falls to Georgian bay. The essential constituents of dolomite are the carbonates of lime and magnesia, but foreign matter or so-called impurities are always present. From the results of tests it would appear that the impurities, more particularly silica, impart to the stone its road-making qualities. This probably explains why a certain type of impure dolomite is such a good road stone, being equivalent to granite in durability. On the other hand, it has a very poor cementing power, and several failures of waterbound macadam surfaces in western Quebec and eastern Ontario were chiefly imputed to this fact. Colour is usually a good criterion by which to judge the road-making quality of dolomite. . . . The eastern Ontario dolomite was formerly extensively quarried for building purposes and lately much has been crushed to supply local road demands. Although on the average somewhat inferior to the Quebec stone, it has proved of good quality as aggregate in bituminous and concrete pavements. The road-making quality of the south-western Ontario dolomite varies over a wide range. The steel-grey and brownish-grey varieties are comparable in value to the eastern Ontario stone, but among the purer, lighter-coloured varieties, some make acceptable road metal, while others are totally unfit for use on roads, even in foundation work.

Limestone is the best known road stone in Quebec and Ontario, and the one which has been most useful in the improvement of our streets and roads. It is easy to quarry and crush to convenient sizes, wears very smoothly on the road, and has a good cementing power. Under our modern heavy road traffic, however, limestone will wear very fast and form much fine, objectionable dust in waterbound macadam surfaces, and even where a bituminous binder is used, will not withstand, satisfactorily, the wear of heavy traffic. Limestone is essentially made up of calcium carbonate, but always contains a certain amount of foreign matter which, as in the case of dolomite, appears to improve the quality of the stone as road material. . . . The Quebec stone is almost everywhere fresh and does not vary much in its physical properties from place to place. It is a stone of medium durability, quite suitable for use as aggregate in bituminous pavements subjected to light traffic, but will not withstand the wear of heavy traffic. The Ontario stone is also generally found to be fresh, but varies in its road-making qualities over a wider range than the Quebec stone. If we draw a line from Toronto to Georgian bay, most of the stone east of this line is about equivalent to the Quebec stone with regard to its qualities as road material. Exception to this is found in the Kingston district and a few other limited areas, in which the limestone is much better than the average and almost equal to the Quebec dolomite in durability. West of the line just mentioned, most of the limestone, which is comparatively free from foreign matter, is soft and unfit for use on roads, with the exception of the cherty limestone. This stone is very common along the eastern shore of Lake Erie, and is particularly well developed at Hagersville, where it is extensively quarried for concrete, ballast, and road purposes. The stone possesses, to a high degree, all the qualities of a good road material. The chert is mainly responsible for this, since the limestone, considered alone, is rather soft. Where the proportion of chert is quite high, the rock as a whole is sometimes referred to as quartzite.

[1]In the classification used by Picher, the igneous rocks are divided into traps and granites, mainly on the basis of the coarseness of the grain, granite being the coarser.

Sandstone.—There is no other rock the qualities of which, as road metal, vary over such a wide range as sandstone. Some are among the hardest and toughest rocks known, whereas others crumble readily to sand under the slightest traffic. It is a very common rock throughout eastern Canada, but most of it is unsuitable for road work, even foundation work. . . . Calcareous sandstone or, more properly, dolomitic sandstone, although not so durable as dolomite, makes a satisfactory material for surfacing roads where the traffic is not so heavy. The only deposits of dolomitic sandstone of any commercial importance are found between Ottawa and Prescott.

Structural materials (exclusive of ceramic products) are practically all produced from stone, and about one-half of them from limestone. Their production value increased by over half a million dollars in 1928; in 1927 the value was $14,160,552; and in 1928, $14,815,814. The only decrease in production was in sand-lime brick. All the other items, including cement, lime, sand, and gravel and stone (building and crushed), increased. The following is taken from the annual bulletin of mineral production, by W. R. Rogers and A. C. Young:[1]—

During 1928 the [cement] plants in operation were those of the Canada Cement Company, Limited, located at Belleville, Port Colborne, Lakefield; and that of the St. Marys Cement Company, Limited, at St. Marys. The Lakefield plant, the latest addition to Canada Cement Company's chain, was completely rebuilt and put in operation late in 1927. It is the largest plant in Canada with a daily capacity of 3,000 barrels. . . .

In the annual statement of the Canada Cement Company, Limited, for the fiscal year ending November 30th, 1928, mention is made of the generally prosperous business conditions that prevailed throughout Canada during 1928 as responsible for a better demand for cement; also that concrete roads were steadily gaining in favour, offering an increased market for cement. Canada now has some 2,000 miles of concrete roads, while the United States has nearly 100,000 miles, or a ratio of 1 to 50, which is not commensurate with the population ratio of about 1 to 12.

In February, 1928, an official announcement was made concerning the purchase of the National Cement Company of Montreal for $2,435,000 by Alfred Rogers, President of the Elias Rogers Coal Company. This plant, which is now privately owned and will operate independently of any other company, is a factor in supplying the needs of eastern Ontario.

The crushed stone industry is in a flourishing condition, and lime production is also steadily increasing. The building-stone industry, however, as based on the local stone, is not thriving. This is due to the competition of Indiana limestone, which has a warmer and more varied colour than Ontario limestone, and is more easily cut and finished owing to its softness. It is not, however, as durable a stone as Queenston (Lockport formation), the usefulness and beauty of which is demonstrated in the new East Block of the Parliament Buildings, Toronto. Queenston is perhaps the best Ontario building stone and there is plenty of it, but a limestone occurring at Shelburne (also Lockport formation) is also good and is nearest in colour to Indiana stone. This Shelburne stone is used in the interior of the East Block of the Parliament Buildings. The building-stone industry in Ontario generally, when imported stone is included, is healthy, because practically all cutting and finishing of imported as well as local stone is done in the province, owing to the spread in tariff between unfinished and finished stone.

There is every reason to believe that the present large consumption of all rock-product materials will continue indefinitely and grow steadily for many years to come, since new markets for rock products and construction materials are constantly developing. The next few years will undoubtedly see much building of large business structures and apartment houses in urban centres, also hydro-electric developments, including the erection of great dams and incidental structures. Air-ports will be built, grass or turf will give way to concrete walks and pavements, and gravelled or macadamed surfaces will be superseded by concrete roadways.

[1]Preliminary Report on the Mineral Production of Ontario in 1928, Ont. Dept. Mines, Bull. No. 68, 1929, p. 29.

Natural Gas

The developments in the natural gas industry in 1928, according to R. B. Harkness, Natural Gas Commissioner, were as follows:[1]—

The most important developments in the natural gas industry in 1928 were in the transmission and distribution of natural gas, rather than in production.

So far as production was concerned, there was some "wildcatting" without results. The gas field in Dawn township, Lambton county, has been extended to the eastern border of the township, but the field is small and narrow, and the limits are very difficult to define. It is possible that small isolated pools exist rather than one large pool. The drilling in the old Tilbury field has been confined to locations between producing wells; this is the case in the Haldimand, Norfolk, and Welland fields.

In the Dover field (Dover township, Kent county) the Ajax Company, after drilling two wells in the old field, located their third and fourth wells a quarter of a mile and a mile, respectively, to the east. Their fourth well, after having 300 quarts of nitro-glycerine exploded in it, produced a little over 5,000,000 cubic feet per day. This is the largest gas well in Ontario in the last ten years. It is too early to make predictions, but it would appear that a new deep[2] gas field will be opened up. The Union Natural Gas Company have extended their plant in Windsor over the new sections that have been built up in the last three or four years. They have built four Hortonspheres at the city limits that hold 1,250,000 cubic feet at about 50 pounds pressure. This is used to meet peak loads.

The Union Natural Gas Company, fearing a shortage of natural gas, have let a contract to build a gas-producing plant at the city of Windsor. This will be completed in the year 1929 and will be used entirely as a standby, only operating when the supply of natural gas fails. It is capable of producing gas at the rate of 6,000,000 cubic feet per day.

The experience of the Union Natural Gas Company in purifying the "sulphur gas" from the Tilbury field has led the Southern Ontario Gas Company to put in a similar purification plant; at the present time the only municipalities in Ontario that are served with sulphur gas are Cainsville, Leamington, and the adjacent townships.

The Dominion Natural Gas Company have been extending their distribution plant in the newer sections of East Hamilton, and are now supplying several thousand consumers in that district. Extensions to plant have also been made in the newer sections of the city of St. Catharines.

Petroleum

R. B. Harkness reports as follows:—

There has been no change in the activities in the oil fields of Ontario during the year 1928. A number of oil companies report that they have operated at a loss and keep their wells in operation in the hope of the price of oil improving. Extensive enquiry has been made into the methods of increasing the recovery of oil in the old fields, and an American company, with this in view, is now contemplating using some of the methods practised in the Pennsylvania and New York fields.

[1]Since the foregoing was written, such success has been met with in exploratory development as to make the future of the gas industry much brighter. An old well, 4 miles east of the eastern limit of the Tilbury field, was deepened 150 feet, and a flow of over 5,000,000 cubic feet resulted. Recent drilling in the Dover field is encouraging and indicates that the field may be more extensive than was at first thought. The gas field in Dawn township has been definitely extended some 6 miles east into Euphemia township.

[2]The gas horizon is in the Trenton.

Salt

A short visit was paid during the year to the Canadian Salt Company's plant at Sandwich, where most of the wells are located. Here the wells are recovering brine from the deeper salt horizon at 1,600 feet, where the salt is 350 feet thick. At Windsor the salt has been recovered from a shallower bed at 1,100 feet, but the bed is only 50 feet thick. Once salt has been extracted from the shallow horizon, wells cannot be drilled through to greater depths. As a consequence, the salt works are gradually being moved from Windsor to Sandwich.

The Canadian Salt Company has recently been purchased by the Canadian Industries, Limited,[1] and thus becomes another link in this rapidly growing chain of subsidiaries. This would indicate that the heavy chemical industry of Canada is rapidly increasing.

The Canadian Salt Company, at Sandwich, and the Brunner Mond Company, at Amherstburg, use salt brine for the manufacture of chemicals, such as bleaching powder, liquid chlorine, muriatic acid, caustic soda, and soda ash. The first four mentioned are manufactured in Sandwich, the output from Amherstburg being caustic soda and soda ash. The output of chemical derivatives from salt by the Canadian Salt Company has recently grown to such an extent that it has become more important than the basic production of salt.

The production of salt in 1928 by nine plants shows an increase over 1927 in quantity, but the selling value dropped off slightly.

Some interest has recently been taken in the possibilities of recovering salt in southwestern Ontario by mining rather than by drilling wells, which has been the practice heretofore. The salt and potash mines of Stassfurt, Germany, are very extensive, and salt-mining has been and is at present a lucrative business in the states of Michigan, New York, and Louisiana. The horizon of the salt bed in southwestern Ontario varies from about 1,000 to 1,600 feet below the surface. The chief difficulty to be expected in digging the shaft is from sulphur water, which is encountered in many wells and which caused considerable difficulty from sulphurous fumes in the digging of the salt shaft at Detroit. In such an undertaking the initial cost of sinking the shaft would be the greatest. Buildings and equipment costs would not be excessive, and the expense of mining and hoisting the salt would be small. For many purposes, for which the highest degree of purity of the salt is not required, such as fish-packing, meat-curing, ice-cream manufacturing, cow-licks, and in the manufacture of certain chemicals, the salt "as mined" would be quite satisfactory, and purification of the salt with all its necessary equipment would not be necessary.

Silica Sand

During the year a short visit was paid to the deposit of Sylvania sandstone occurring at Amherstburg. A description of the deposit appears in a separate article. The deposit has interesting possibilities since it is quite large and of good quality. It belongs to the same formation as the silica sand quarried extensively for glass-making purposes at Rockwood, Mich. There are, however, two difficulties in the way of its development. In the first place the overburden is rather heavy and consists partly of limestone, necessitating mining rather than quarrying the deposit. In the second place drill-holes which have been sunk to the sandstone reveal the fact that the dip of the bed is away from the

[1]Subsidiary of Imperial Chemical Industries, Limited, of London, England.

river; as the bed is known to outcrop in the Detroit river, it might be difficult to keep the water of the river from running into and flooding the mine workings. The cost of recovering the sand would undoubtedly be greater than in Michigan or Illinois, but the freight rates to points in Ontario are also considerably less. Whether the advantage on the freight rates would overcome the extensive cost of mining is a question which could only be decided after very careful investigation and consideration.

In a recent report L. H. Cole[1] describes the development of the silica sand property, in the Potsdam formation near Kingston, as follows:—

On the Gates property, 9 miles east of Kingston on the St. Lawrence river, a deposit of sandstone is being opened up by the same company [Canada Glass Products, Limited] operating the Scarf property [at Buckingham, Que.]. Plans are made for the erection of another modern mill and it is hoped to have this in full operation by the end of 1928.[2] A sample, taken recently from this property, and after washing in the laboratory, analysed as follows:—

	Per cent.
Silica (SiO_2)	99.39
Iron oxide (Fe_2O_3)	.06
Alumina (Al_2O_3)	.14
Lime (CaO)	.15
Magnesia (MgO)	trace
Loss on ignition	.18

The Potsdam formation of Cambrian age is composed of white and brown fairly pure sandstone suitable for making medium grades of glass and for other purposes. The formation outcrops in a number of places in the counties of Frontenac, Leeds, Lanark, and Carleton in eastern Ontario.[3]

The Oriskany formation of Lower Devonian age also consists of a fairly pure sandstone, which has in the past been quarried for glass making. The best known locality for this sandstone is in the vicinity of Nelles Corners in the townships of North Cayuga and Oneida in Haldimand county. The sandstone in this formation is, however, not so pure in general as the Potsdam sandstone. The Dominion Glass Company at various times, especially during the war, used some of the Oriskany sandstone from Nelles Corners, but found it suitable only for green and dark-green glass, as the iron oxide content was too high to give a good grade of flint glass.[4]

The quartz sands that occur in association with the fire clays and china clays in the Mattagami formation of Cretaceous age, on the Mattagami and Missinaibi rivers, are fairly pure and could be used for medium grades of glass, but the deposits are too far away from manufacturing centres to be of use in the immediate future.

Very little glass sand has been quarried in recent years because of severe competition from the United States (Michigan and Illinois), and from Belgium. Sands from these countries are very pure and are recovered at small cost. Belgian glass sand is delivered at the Port of Montreal for $4.55 a ton, and the sand from Ottawa, Ill., has been sold at as low a price as 50 cents per ton. In a report of the U.S. Bureau of Mines,[5] it is stated that the average price of glass sand in the United States in the year 1924 was $1.71 per ton.

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[1]Silica in Canada, pt. 2, Mines Branch, Ottawa, Bull. No. 686, pp. 43, 44.

[2]In a recent letter from Mr. Cole it has been learned that owing to the death of one of the principal holders in the Canada Glass Products Company, progress at the properties is at a standstill.

[3]L. H. Cole, Silica in Canada, pt. 1, Mines Branch, Ottawa, Bull. No. 555, 1923.

[4]Private communication from G. P. Cole, Dominion Glass Company, Montreal.

[5]Bull. No. 266, Technology and Uses of Silica and Sand.

Large quantities of quartz and quartzite, of which there are large deposits in Ontario, are quarried each year for a variety of purposes. Nickel-copper smelters at Sudbury and ferro-silicon plants of the Niagara peninsula consume the bulk of the output. During 1928 there was a decided increase in the production of all these materials, the figures being 194,503 tons, valued at $308,608, as against 159,150 tons, valued at $266,204, in 1927. The largest producer is the Dominion Mines and Quarries, Limited, which operates the Killarney quarry on the north shore of Lake Huron. The East Neebish quarry, operated in former years by this company, was idle during the period. Manitoulin Quartzite, Limited, continued developments at its Sheguiandah quarry on Manitoulin island, but reported no shipments. The works already completed include a dock 1,000 feet long to reach deep water. Buildings, including an office and blacksmith shop, were erected and plant railways were installed. The quarry face is roughly 100 feet high and 200 feet wide and has been stripped of overburden for 300 to 400 yards. The Mond Nickel Company again reported production, all of which was crushed to 1½-inch size and consumed in the Coniston smelter as flux. Wright and Company, of Sault Ste. Marie, were producers, part of their outfit going to supply raw material required in silica brick manufactured by the Algoma Steel Corporation for consumption in its own plants. During the year 1928 there were 1,596,819 silica bricks made, with a value of $86,323.

Semi-Commercial Tests on Northern Ontario Fire Clays

By W. S. Dyer and R. J. Montgomery

Introduction

Semi-commercial tests were made by five firms on Northern Ontario fire clays to determine the suitability of the clay for the manufacture of fire brick, pottery, sanitary porcelain, and rockingham-ware. In all but one of the tests the clay was collected and supplied to the firms by the Department of Mines. While some of these tests have been completed, others are in progress; and preparations for still further tests are now being made. This short article, therefore, serves as a report of progress.

The Department of Mines is indebted to these firms, who have spent a considerable amount of time on the work.

Tests by Smith and Stone, Limited, Georgetown

Fire brick to the number of 40 were made up using about 450 pounds of fire clay from the dump at the shaft dug for lignite at Great bend on the Mattagami river, 7 miles below the foot of Long portage. A description of the laboratory tests of this clay appears on page 23.

The brick were made up as follows:—

1. All raw fire clay.
2. Eighty per cent. fire clay and 20 per cent. broken saggers as grog.
3. Sixty per cent. fire clay and 40 per cent. broken saggers as grog.
4. Sixty per cent. fire clay and 40 per cent. Pennsylvania flint clay as grog.
5. Sixty per cent. fire clay and 40 per cent. crushed ganister rock as grog (supplied by the Algoma Steel Corporation and similar to that used in silica brick).
6. Fifty per cent. fire clay, 15 per cent. china clay, 10 per cent. flint, and 25 per cent. crushed ganister rock as grog.

The brick made from mixtures Nos. 3 and 4 gave the best appearance, but mixtures Nos. 5 and 6 also made good-looking brick. Nos. 1 and 2, made from all fire clay and 20 per cent. grog, respectively, were a little fine in texture. It appears that nearly 40 per cent. of the mixture would have to consist of grog, although 30 per cent. might be found sufficient, provided the grog was coarser than that used in the tests. The raw clay is too fine grained to use alone and the brick made of all clay shows a tendency to crack in burning, because of the difficulty in drawing off the moisture through the dense strucutre and because of its rather high burning shrinkage. This is true also when 20 per cent. grog is used, although to a less extent.

These brick are to be tested by Professor Montgomery, in his laboratory in the University of Toronto, for ability to carry load at high temperatures, the shrinkage on re-heating, and the porosity.

Additional clay from the same locality has been supplied to Smith and Stone, Limited, who are going to make up brick, using 40 per cent. Mattagami River fire clay calcined at cone 10 for grog.

Tests by George Bailey Fire Brick Company, Limited, Toronto

Fire clays from the dump dug for lignite at Great bend, Mattagami river, were supplied to the George Bailey Fire Brick Company, Limited, Toronto, in the summer of 1928, and the firm made several pieces of fire brick, locomotive tile, and flue linings, using 50 per cent. grog composed of ground fire brick. The burned ware appeared to be of very good quality and was shown by the Ontario Department of Mines in their booth at the Canadian National Exhibition.

The following is from a letter from the company:—

Mr. George Bailey looked after the mixing of the sample of Ontario fire clay, and he states that it was mixed on a fifty-fifty basis and withstood an approximate temperature of 2400°F. and that all samples came out of the fire in first-class condition. We might also state that we have as yet to find any foreign clay that can equal it as far as purity is concerned. The sample sent us was of a very plastic nature and worked well. Our superintendent has put one small pressed sample in the kiln four times and states that the fire it received did not change its colour or shape at all, which shows that the clay can stand a great deal more heat than we are able to produce in our kiln.

The soap-brick sample that we gave you, which measures approximately 2¼ by 2¼ by 9 inches, was made out of all fire clay and appears to us to be better than the other samples that were half ganister, but of course that would have to be proved by cones in a kiln that gives a higher heat volume than ours; but our general opinion is that it is every bit as good if not better than any foreign clay that we have used, and I think we have used nearly all of them in an effort to give our customers the best that can be manufactured in fire brick, fire-brick specials, and stove linings.

These particular samples were tested against the Missouri high heat calcined fire clay, which according to the manufacturer's claim is the best mined in the United States.

Tests by George Emery, Manufacturer of Ecanada Art Pottery, Hamilton

Light-grey fire clay collected by the writer at the foot of Long rapids, Mattagami river, was supplied to George Emery, of Hamilton, who made up six vases with the following mixes:—

1. Light-grey fire clay alone. The trial was slipped and cast without washing.
2. Light-grey fire clay alone. The clay was ground wet for three hours, screened through 120-mesh screen, and cast in the usual way.
3. Body made up of 85 per cent. light-grey fire clay, with 15 per cent. feldspar; ground and screened.
4. Body made up of 75 per cent. light-grey fire clay with 25 per cent. feldspar; wet ground two hours and screened.
5. Body made up of 65 per cent. light-grey fire clay, 35 per cent. feldspar; wet ground two hours and screened.
6. Body made up of 54 per cent. light-grey fire clay, 30 per cent. feldspar, and 16 per cent. flint; wet ground two hours and screened.

All these bodies, except No. 1, were treated with magnets to draw off free iron.

All six pieces were of good body and light-grey in colour. Greater freedom from spots was obtained with the screened mixes. The addition of feldspar increased the density, as would be expected.

These tests show the possibilities of use in the type of pottery in which the grey body colour would not be objectionable, such as products covered with an opaque glaze. The vases may be seen in the Department of Mines.

Tests by Crane, Limited, Montreal

A small quantity of fire clay from a bed on the east side of the Mattagami river at Great bend[1] was sent to Crane, Limited, Montreal, manufacturers of

[1]Same as sample D, p. 24.

sanitary porcelain, to determine if possible its adaptability to the manufacture of this type of ware. The clay was sent by Crane to their testing laboratories at Trenton, N.J., and the report was as follows:—

The clay samples Nos. 1 and 2[1] came out of the kiln to-day, good clean white burning clays. A small quantity of these materials might be used in the manufacture of sinks and tubs if the other necessary clays were mixed with them. Both fired alike and showed a very high silica content.

Tests by Canada Potteries, Limited, Hamilton

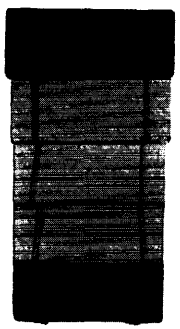
Two small baking dishes were made up by the Canada Potteries, Limited' using clays supplied them by J. D. Grant, who has some claims near those of the Northern Ontario China Clay Corporation at the foot of Long rapids. From a description of the clays they would appear to be the light-grey fire clay, such as that used by George Emery. The two pieces were glazed, one with a transparent glaze and one with a coloured glaze.

This was the first glazing trial made by the company on Northern Ontario clays, and there is no doubt that on further experiments a glaze more suitable to the body could be found. Nevertheless the ware was only slightly "crazed," and the body is good. The coloured glaze is better, since in the transparent glaze certain iron spots in the body tend to show up. There is little doubt that this clay could be used to make a good quality of stoneware or rockingham-ware, especially if it were screened. It is thought that the dark-coloured fire clays would also be suitable for stoneware or rockingham-ware, since they burn to a nearly white colour at intermediate temperatures; but tests to determine this have not yet been made.

[1]Both made from clay from the same locality.

No. 64-1

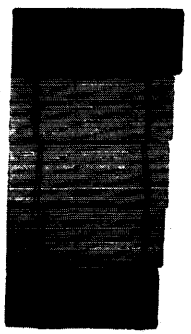
	% Porosity
Raw	
Cone 08 (1733° F.)	43·2
4 (2129° F.)	31·0
10 (2300° F.)	20·3
14 (2534° F.)	9·1



P.C.E.-Cone 33
(3173° F.)

No. 64-2

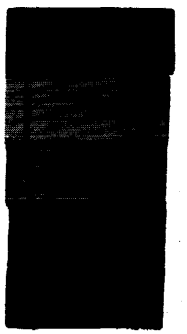
	% Porosity
Raw	
Cone 08	38·1
4	31·4
10	24·9
14	15·5



P.C.E.-Cone 32½
(3130° F.)

No. 64-3

	% Porosity
Raw	
Cone 08	34·4
4	23·8
10	9·3
14	11·4



P.C.E.-Cone 23
(2876° F.)

Test pieces (reduced to one-quarter actual size) of fire clay from the Mattagami river, showing porosity and shrinkage at progressively higher temperatures. The half tones illustrate the fact that the clay burns to ivory shades at intermediate temperatures.
No. 64-1 is the same as sample C, page 23; No. 64-2 as sample D, page 24; and No. 64-3 as sample E, page 24.

Laboratory Tests on Northern Ontario Fire Clays

By R. J. Montgomery

Laboratory tests were made during the year on five samples of fire clay collected by W. S. Dyer on the Abitibi and Mattagami rivers in the summer of 1928. The results are as follows:—

Sample A.—From the Abitibi river, east side, one mile above the Little Abitibi river.

This clay is black and of good plasticity. It is fine grained, practically all of it going through 100 mesh, and 2 per cent. being retained on 200 mesh. The residue is about one-half organic matter and one-half sand. The black colour is largely due to the organic matter, which is very fine, easily passing 200 mesh. The drying shrinkage is rather high, being 9.4 per cent. A test of refractoriness gave cone 28, which is about on the line between second and third quality fire clay.

At cone 1 (2120° F.) the burning shrinkage was 6.9 per cent. and the porosity 26.7 per cent. The body was steel hard. The colour was buff, with a decided black core. The carbon had not been burned out in the short laboratory burn.

At cone 10 (2381° F.) the burning shrinkage was 8.4 per cent. and the porosity 8 per cent. The body is steel hard and in good condition, except for the black core due to carbon.

This clay would be classed, therefore, as a stoneware, sewer-pipe clay, or bond clay. The high shrinkage would make it difficult to use by itself. The high carbon content might give trouble, as it is difficult to burn out owing to the density of the body.

Sample B.—From the Abitibi river, west side, foot of Long rapids, dated September, 1928.

This clay is a light grey-green and of good plasticity. It is fine grained, with less than 1 per cent. retained on 200 mesh, the residue being undecomposed rock. The drying shrinkage was 8.5 per cent. Fusion tests gave about cone 5, showing the clay to be an impure one.

At cone 08 (1742° F.) the burning shrinkage was 2.8 per cent. The body was red and steel hard with a very small black core due to organic matter.

At cone 1 (2120° F.) the clay bloated badly and had exceeded the temperature to which it should be burned.

This clay would be classed as a brick and tile clay burning red.

Sample C.—From the dump at the shaft dug for lignite, Great bend, Mattagami river.

This clay is dark-grey, due largely to organic matter, is smooth, not sticky, and works well. The sieve test showed lignite mixed with silica and mica on the 35-mesh screen and finer. The finer the screen the larger the proportion of silica. The lignite seems to be responsible for a rather porous structure which allows easy drying. The lignite, however, burns out slowly, and the laboratory burn of 6 hours was not sufficient to do this properly. The colour obtained, therefore, would be better in a longer burn.

The colours obtained are those typical of ball clays, rather than a fire clay, being light-buff up to cone 10. At cone 14 it is grey, due to iron discoloration. The clay showed some surface checking on burning, indicating that it might spall if used without grog. The body does not show iron specks at cone 10 and could probably be used in semi-porcelain to some extent where colour is not of prime importance, in addition to its value as a No. 1 fire clay.

This clay burns to a very good colour and is of high refractoriness for a fire clay. Fire brick are being made from it in a commercial plant, and the results of testing these brick will come later.

Sample D.—First bed on the east side of Mattagami river at Great bend.

This clay is very similar to "C" in the raw state, containing organic matter, especially on screens Nos. 35 and 48, and silica with mica on the finer screens. The colour, working, and drying properties are about the same.

In burning it is a little more open, especially at cones 10 and 14, and the organic matter burns out more easily. The colour on burning is typical of fire clay, being buff with small iron spots showing at cone 10 and a decided buff, a little spotty, at cone 14. The fusion cone showed local fusion of fluxes before the cone as a whole melted. Its value would be as a No. 1 fire clay for general purposes.

Sample E.—Second bed on the east side of Mattagami river at Great bend.

This clay is very much like the other two in the raw state, except that it has a higher drying shrinkage and strength. It works well and dries safely. The sieve test shows about the same amount of organic matter but more silica, mica, and other impurities, which lower the pyrometric cone equivalent (fusion point) and cause overfire at cone 14.

The colour of the burned clay is light-buff at cone 08, medium-buff at cone 4, dark-grey at cones 10 and 14. Its greatest density is at about cone 10, and while it does not become vitrified, it has a dense strong body having a transverse strength of 2,940 pounds per square inch. It would be classed as a third quality fire clay and probably could be used as a stoneware or sewer-pipe clay where the glaze is partly depended upon to prevent water absorption. The A.S.T.M. (American Society for Testing Materials) specification for sewer pipes gives 8 per cent. absorption as the maximum. At cone 4 this clay has an absorption of 13.5 per cent. At cone 10 it is 4.5 per cent., so proper burning will give the required properties.

These three samples taken from different layers in the same deposit indicate that the clay varies considerably at different depths. This checks the determinations made on samples reported on about one year ago.[1] The fact that a variety of clays is available means an increased number of uses but also means that selection will be necessary to obtain the kind desired.

The tabulated results for the last three samples are as follows:—

	Sample C	Sample D	Sample E
Water for plasticity.....per cent.	41	43	34
Type of plasticity.....	good	good	good
Drying linear shrinkage.....per cent.	6.5	6.9	8.1
Transverse strength, raw.....lbs. per sq. inch	404	311	503
Drying test, 2¼-inch cube, 95°C.....	no cracking	no cracking	no cracking

[1]See discussion of residues.

	Sample C	Sample D	Sample E
Sieve test:[1]	per cent.	per cent.	per cent.
On 35 mesh screen	1.6	0.45	1.3
48 " "	.8	.26	.9
100 " "	2.4	1.30	3.8
200 " "	1.2	1.86	3.2
Through 200 " "	94	96.13	90.8
Total	100	100	100
	per cent.	per cent.	per cent.
Burning linear shrinkage:			
Cone 08	3.5	2.6	2
Cone 4	8.5	5.6	4.7
Cone 10	10.8	8.2	7
Cone 14	11.3	9	6.5[2]
Burning porosity (1 hour boiling in water):			
Cone 08	43.2	38.1	34.4
Cone 4	31	31.4	23.8
Cone 10	20.3	24.9	9.3
Cone 14	9.1	15.5	11.4[2]
Burning, apparent specific gravity:			
Cone 08	2.54	2.42	2.43
Cone 4	2.46	2.41	2.29
Cone 10	2.39	2.38	2.23
Cone 14	2.27	2.34	2.20
Steel hard	Cone 4	Cone 10	Cone 10
Fusion cone	33	32½	23

The following chemical analyses were made by the Provincial Assayer:—

	Sample C	Sample D	Sample E
	per cent.	per cent.	per cent.
Silica	51.35	46.37	52.88
Ferric oxide	1.44	3.97	2.69
Alumina	31.08	32.33	21.22
Lime	.43	.43	3.94
Magnesia	.06	.07	.41
Alkalies	trace	.36	1.20
Carbon	1.88	1.97	2.85
Water	8.92	8.65	4.68
Carbon dioxide	.08	.82	3.76
Volatile matter	4.68	4.83	6.52
Total	99.92	99.80	100.15

[1]Ont. Dept. Mines, Vol. XXXVII, pt. 6, 1928, p. 112.
[2]Overfired.

Ontario Ceramic Exhibit at Chicago

By W. S. Dyer

The Department of Mines, with the co-operation of the Canadian National Clay Products Association, assembled an exhibit representative of the clay industry of Ontario. This was shown at the American Ceramic Exposition held at the Stevens Hotel, Chicago, February 4 to 9, 1929, inclusive. This exposition was one of the principal features of the annual convention of the American Ceramic Society. Practically all lines manufactured in the province were included in this exhibit, as well as samples of fire clay and china clay from the Mattagami river, ball clay from southern Saskatchewan, and china clay from St. Remi, Que. The author and W. R. Rogers, representing the Department of Mines, took charge of the booth[1] in Chicago, as well as of most of the details in connection with the assembling of the exhibits and their transportation to and from Chicago. The committee appointed by the Canadian National Clay Products Association included H. F. Dingledine, president of the association, G. C. Keith, secretary of the association, and Professor R. J. Montgomery of the Ceramic Department of the University of Toronto. An attractive booklet, entitled "The Ceramic Industry of Ontario," was prepared, and nearly 2,000 copies distributed. Sincere thanks are due to the various firms who so willingly supplied the samples of their wares, and also to Howells Fréchette, of the Mines Branch, Ottawa, for supplying the attractive model of a beaver done in Canadian clay, as well as special clays from other provinces.

The exhibit attracted considerable attention in Chicago among the 70,000 who visited the exposition, as well as the 1,500 members of the society who attended the convention. Pertinent enquiries were made of the new fire-clay deposits on the Mattagami river, and the samples of art pottery, face brick, floor tile, enamelled brick, etc., were greatly admired. The American Ceramic Society has accepted the invitation of the Canadian National Clay Products Association to hold its annual meeting in Toronto in February, 1930.

List of Exhibits

Brick.—Special textures and colours; enamelled brick in colours.

Structural Tile.—Plain, interlocking, and double-shelled.

Drain Tile.—Red burning clay.

Sewer Pipe.—Straight, branched, and trap; also telephone conduits (single duct).

Porcelain (Electrical).—High- and low-tension insulators, thermal-electric insulating pads and hot plates. High-tension suspension insulators shown (18 units to a string of 9 feet length) are standard on the new 230-mile, 220,000-volt transmission line of the Hydro-Electric Power Commission of Ontario now in use between the Gatineau river and Toronto.

Pottery.—(a) Flower-pots (plain). (b) Art pottery and decorative pieces. (c) Rockingham-ware. (d) Plaque of Canadian beaver (*Castor canadensis*) in natural habitat, modelled from Canadian clay. This piece, which was exhibited at the British Empire Exposition at Wembley in 1924 and 1925, is loaned by the Ceramics Division of the Mines Branch, Ottawa.

Floor, Wall, and Roofing Tile.—(a) Vitrified floor mosaics and wall tile. (b) Floor (quarry) and roofing tile.

Feldspar.—Crude lump, best potash spar.

Enamelled Ware.—(a) Steel kitchen utensils in a variety of colours. (b) Sanitary ironware (pedestal basin).

Fire Clay (Northern Ontario).—(a) Samples of raw material from Mattagami river. (b) Fire brick, stove linings, and locomotive blocks. (c) Pottery (unglazed and glazed). (d) Laboratory test pieces, showing behaviour at various temperatures. All fabricated articles from Northern Ontario fire clays are experimental.

Glass.—Bottles and hollow-ware.

[1]For illustration, see frontispiece.

A Survey of the Ceramic Industry in Ontario (Interim Report)

By R. J. Montgomery

Introduction

A survey of the ceramic industry in Ontario is being undertaken by the Ontario Department of Mines. The object is to revise and bring up to date the report prepared by M. B. Baker, and published as Part 2 of Volume XV, Ontario Bureau of Mines, in 1906. It is hoped that this technical survey will bring out some of the problems which face the industry, encourage closer co-operation among the manufacturers, and aid in a better understanding of the technical side of ceramic manufacture. This survey should also establish closer contacts between the industry and the Ceramic Department established at the University of Toronto for the training of young men for the industry.

The present report is one of progress and will give some idea of the ground to be covered and indicate in a general way some of the points being considered. During the summer of 1928, about 100 plants were visited in eastern Ontario and the Toronto district. Some of these plants are in operation, while others were either closed down temporarily or abandoned. An effort was made to determine the cause of the failure of these last-mentioned plants, and notes were also made of the changes in the industry that have taken place since 1906.

In the section covered, about 60 plants are in operation, as compared to 90 reported by M. B. Baker in 1906. This reduction in numbers means a decided change in the conditions of manufacture and marketing. There has been a change from the small plant usually working four to six months a year, to the larger plant operating the year round. This is especially true in the Toronto district. Mr. Baker in 1906 states that one of the largest plants made 10 million brick in a season of seven months. Now one plant reports a production of 25 million brick per year, and several run well over the 10 million mark. Several organizations, owning more than one plant, also exceed this figure. Consolidations of several plants under one head is another movement which has just recently started and one which will probably grow.

Brick

The sections of the country in which population and industrial development are not advancing do not require as many brick as formerly. The shift of the lumbering activities from southern Ontario northward evidently reduced the local prosperity in many sections where agriculture does not flourish and industrial plants have not fully replaced this loss. Many plants have closed or reduced production because of the falling off in local demand for brick or because of the shipping in of brick from larger plants. The shift in popularity from stock or soft-mud brick made from surface clays, to the dry press and wire-cut varieties made from shale has changed the markets. In 1906 most of the brick were supplied from local plants. Now many of the large buildings, such as schools and factories, require brick faster than the local plant can supply them, and they are shipped in from a distance. Ontario Department of Mines statistics indicate that the production of common brick reached a maximum about 1913, with a valuation of over three million dollars. In 1906, at the time of Baker's report, the total for the common brick was $2,157,000, whereas in 1927 the valua-

tion was a little over a million dollars. In 1906 all brick were listed as common, and evidently very few varieties other than soft-mud or stock brick were made. In 1927 the value of face brick, largely dry-press and wire-cut, with some selected soft-mud brick, was more than three times the value of common brick. Before 1913 common brick were used largely for the face or outside as well as for backing up in building construction. A certain amount of selection placed the harder burned brick in the better buildings. At present in many structures other materials are replacing common brick for backing up.

The period from about 1860 to 1890 must have been one of much building with brick, especially public buildings, churches, schools, etc. Most of the older buildings bear dates of about this period. Stock brick, red and grey, were used. Many of these buildings are still in good condition in 1928, but the occasional soft and weathered brick in many of them indicates that the brick were often "run of the kiln." The lack of proper selection of hard brick in the earlier days has not been a good advertisement for stock brick, and I believe this has had considerable influence on the swing away from using stock brick for outside work or for the face of buildings.

I found only one city in eastern Ontario in which practically all the new modern buildings were built of brick made from surface clay instead of shale. This was because the local brick manufacturer was progressive and produced the colours and textures demanded, making the best possible use of the surface clays at hand. Most of the plants using surface clays make only one or two colours and one texture. They find it impossible to compete with the shale brick having a large variety of both. Higher prices for the shale brick are willingly paid when colour and texture requirements are met.

I found that the plants in general are not working to capacity, and that there is a tendency toward over-production. In the smaller towns the plant which depends upon local trade only has hard going. Most of the more progressive plants depend upon shipping at least some of their product. The shipping of brick requires extended sales connections, and this can be accomplished better by larger organizations owning larger plants or a number of plants located at selected points to give a variety of kind of brick. The smaller plants are under considerable handicap when the local demand does not take care of their production.

There is a great difference in progressiveness at different plants. One owner pointed with pride to his soft-mud brick machine which he had rescued from the scrap pile in 1904 and which was still in use. Another owner is building a new plant with modern equipment, including a railroad tunnel kiln, to reduce costs and increase production. Unfortunately too large a number of the clay manufacturers are of the first type.

Many plants operate only a few months a year to take care of the local demand. For example, one plant operates about 78 days per year, making 300,000 brick. If these brick sell in the neighbourhood of $17 per thousand, there is a total of only $5,100 to finance the year. Fourteen of the 60 plants referred to in the first part of this report do not make over 500,000 brick per year. The men producing brick under these conditions deserve great credit. They are pioneers. They have made it possible for local townspeople and farmers to build with brick. This insures a comfortable house, which is important in sections of the province where winters are fairly severe. Comparatively speaking, the older homesteads in the section covered are of brick, with only a few of frame and stone.

The modernization of a plant means operating twelve months a year against rather severe weather conditions, and it is an open question whether the increased

output could be disposed of and the cost reduced. In many localities an increase in population would be necessary before modernization would be justified. At present very few plants are producing to capacity, and it is only through active sales effort, and by producing special colours and textures and shipping to distant points, that these few are able to do so.

Comparatively few plants have driers of the car-tunnel type, and many use scove kilns for burning. The simplest methods are used with as little investment as possible. The smaller plants use scove kilns, burning two to four times a season. It is often three to six months between the digging of the clay and the sale of the brick. Only about 60 per cent. of the product is of first quality because of poor heat distribution in the kilns and other defects. Modern practice can produce brick from raw clay in 65 to 70 hours. One of the trade papers[1] describes the transformation of one of these summer yards located in one of the New England states, making 3 to 4 million brick each summer, into a modern plant producing 15 million brick with almost no manufacturing loss. It took eleven years to accomplish this by gradual changes, financed out of the profits of the yard.

Clay-forming machinery is important and a recent study[2] of the auger machine indicates that with the older types of machine, friction used up an unjustified amount of power. A study of dies indicates that for most clays a 6-inch spacer between the auger tip and the die gives the best results for quality of bar and output per horse-power used.

The car-tunnel dryer is used in most of the plants operating all year, and the efficiency of these varies greatly. The average daily output of a 100-foot tunnel will vary from 1,000 to 2,200 brick. There seems to be very little control in most cases.

The burning equipment also varies widely, in time required to burn as well as in construction and proportion of grate, flues, and stacks. Published information indicates that the following ratios should be observed, or at least approached, to obtain good results.[3]

	Per cent.
1. Ratio of grate to kiln floor area	12.6
2. Ratio of floor openings to kiln floor area	2.8
3. Ratio of main flue to kiln floor area	1.4
4. Ratio of stack area to kiln area	1.6

The above figures are for a 28-foot kiln and will act as a guide for other sizes.

The space or arch over the fire was usually small in the kilns examined. Professor A. F. Greaves-Walker recommends 66 inches between the bottom of the ash pit and the top of the arch. Another point of importance that has received little consideration is the size of the throat through the bag into the kiln chamber. It is of little benefit to enlarge the space over the fire and have a very small opening into the kiln.

Control instruments are conspicuous by their absence in most plants. A few use pyrometers with some success, but often these are not properly used. I doubt if a draft gauge or pressure gauge is in constant use in any brick plant in Ontario, and there is no means of determining conditions of temperature and humidity in driers. The man who would not run a $1,000 automobile without a dashboard well fitted with indicating instruments seems perfectly satisfied to run a plant valued at $100,000 or more by guess. This criticism applies also to control of operations and analysis of costs.

[1]Clay Worker, December, 1923.
[2]U.S. Bur. of Standards, Jour. of Research, Vol. 1, p. 1023.
[3]U.S. Bur. of Standards, Bull. No. 271, p. 10.

This progress report is meant to be just a little critical, not to the extent of finding fault with what has been done or is being done, but rather to point out ways of improvement.

Pipe, Tile, Pottery, Etc.

In conclusion, the ceramic industries in Ontario other than brick can only be mentioned. The total value of these other branches is quite impressive. Consolidation has been the word in the sewer-pipe industry, and at present all the plants are operated under one head. Drain-tile manufacture has changed very little but showed a satisfactory increase in production last year. Hollow building-tile is a new development since Baker wrote his report, and an increasing number of plants manufacture this product. Pottery production is still low, although some very good ware is being made in a small way. The electrical porcelain industry is well developed, including both low-tension dry-press and high-tension plastic-body insulators. Very satisfactory floor tile are made. Flower-pots are produced in large numbers. Paving brick were attempted but are not made, as Ontario clays are unsuitable for this product. Terra cotta is made only in a small way. The interest in the manufacture of refractories is increasing. The enamel industry is well developed and includes both sheet-steel and cast-iron. Bottles are the only kind of glassware made, and these are made in a modern up-to-date plant. A plant at Oshawa has been built to make bottles from feldspar, using an electric furnace.

The points touched on in this progress report will be discussed in detail in the final report, which will include not only the eastern part, but all of Ontario. The writer is much indebted to the owners and superintendents of the various plants for their help. Their very cordial welcome made the plant visits a pleasure. Thanks are also due to the Canadian National Clay Products Association and the Ontario Department of Mines for their aid in making this survey possible.

Limestones of the Moose River and Albany River Basins

By W. S. Dyer

On the Albany river, limestones of Silurian and Devonian age are exposed at intervals from the mouth to within 25 miles of Martin falls, a distance of approximately 225 miles. Limestones are also found on the Kenogami river and its tributaries, such as the Pagwachuan, Drowning, and Little Current. Hand samples of limestone from Pagwachuan and Albany rivers were collected by the writer in the summer of 1928, and were analysed by the Provincial Assayer. A full description of the geology of these rivers will be found in this volume on pages 47 to 60.

The geology of the Moose River basin and the exposures of limestones have already been described in a report by the writer.[1] The analyses given below are mostly of hand samples collected by the writer and analysed by the Provincial Assayer, W. K. McNeill.

The limestones from this part of Ontario, especially of the Moose River basin, may prove to be of great value. As the clay belt along the Canadian National railway and along the coastal plain of James bay becomes settled, quantities of limestone will be required for building purposes, for hydrated lime or for Portland cement, and as a fertilizer to correct acidity in certain types of soil. Limestone is also used in the chemical pulp and metallurgical industries.

Most of the localities listed below are inaccessible at present, but two of them are near railways. The high limestone cliffs of Coral rapids on the Abitibi river are within 2 miles of the present terminus of the Temiskaming and Northern Ontario railway, and the cliffs of Grand rapids are within 20 miles of the same point. This terminus is 96 miles north of Cochrane.

Analyses of Silurian Limestone and Dolomites

	No. 1	No. 2	No. 3	No. 4
	per cent.	per cent.	per cent.	per cent.
Insoluble mineral matter	0.21	0.68	35.59	1.13
Ferric oxide	.27	.20	2.34	.75
Alumina	none	none	.88	none
Calcium carbonate	99.30	93.71	32.43	55.39
Magnesium carbonate	trace	5.69	25.70	38.93
Total	99.78	100.28	96.94	96.20

No. 1. Fossiliferous grey limestone, Albany river, 7 miles above Muswabik river, Pagwa River formation.

No. 2. Fossiliferous grey limestone, Pagwachuan river, between Savoff river and mouth, Pagwa River formation.

No. 3. Greenish-grey argillaceous dolomite, Albany river at Upper Sturgeon river (upper beds), Kenogami River formation.

No. 4. Cream-coloured dolomite, Albany river at Upper Sturgeon river (lower beds), Kenogami River formation.

[1]W. S. Dyer, Geology and Economic Resources of the Moose River Basin, Ont. Dept. of Mines, Vol. XXXVII, pt. 6, 1928.

Sample No. 1 is a very pure limestone. This was collected from an exposure in the bed of the Albany river, 7 miles above Muswabik river and 45 miles above the Forks. The limestone is grey and crystalline and contains numerous stromatoporoids. The beds rise only a few feet above summer water level. The writer did not travel any farther upstream from the exposure; but, according to Robert Bell,[1] yellowish and grey limestones are seen on the banks of the Albany river at intervals up to the northernmost part of Great bend (within about 20 miles of Martin falls). The age of this limestone is probably Guelph or Lockport (Middle Silurian).

Sample No. 2 is a slightly magnesian limestone, but notably free from impurities. This is representative of the Guelph or Lockport limestones, which make intermittent low outcrops in the banks of the Pagwachuan river, from 4 to 13 miles above its mouth.

Samples Nos. 3 and 4 are from the 65-foot cliffs on the southwest side of the Albany river at the mouth of the Upper Sturgeon river, 30 miles above the Forks. The lower beds (No. 4) are rather pure, thick-bedded dolomites, which grade upward into argillaceous dolomite (No. 3). The age of the beds is considered to be Salina (Upper Silurian).

Analyses of Devonian Limestone

Moose River Formation

	No. 1	No. 2	No. 3	No. 4
	per cent.	per cent.	per cent.	per cent.
Insoluble mineral matter	0.51	0.22	0.74	2.73
Ferric oxide	.35	.37	2.48	1.10
Alumina	none	none		
Calcium carbonate	79.98	99.75	95.71	94.55
Magnesium carbonate	15.35	trace	1.11	1.15
Total	96.19	100.34	100.04	99.50

No. 1. Buff magnesian limestone, Moose river opposite Murray island, immediately overlying gypsum.

No. 2. Brecciated grey limestone, Nettogami river at the Kiasko river.

No. 3. Limestone, upper end of island near head of Long rapids, Abitibi river, Geol. Surv. Can., Sum. Rept., 1924, pt. C, p. 96.

No. 4. Limestone, same locality as No. 3.

Judging from these analyses, the rocks comprising the Moose River formation, with the exception of the gypsum, do not differ much from those of the overlying Abitibi River formation. Three of the samples were of fairly pure limestone, and one (No. 1) was of magnesian limestone. The Moose River limestones, however, are finer grained and not so crystalline as those of the Abitibi River formation, and their bedding is more regular. In places they are finely banded. This formation seems to have been disturbed by original folding and faulting, and is in places noticeably brecciated. The best outcrops are at the island in midstream at the head of Long rapids on the Abitibi river and on the east side of the Abitibi river at Coral rapids, where at the south end of the outcrop 15 feet of Moose River limestone is exposed, lying below fossiliferous limestone of the Abitibi River formation.

[1]Geol. Surv. Can., Rept. of Progress, 1871-72, pp. 111, 112.

Abitibi River Formation

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Insoluble mineral matter	3.62	28.51	2.46	35.57	0.77	2.42	38.41	1.40
Ferric oxide	.44	.60	.40	62.	.74	1.85	.54	.36
Alumina	none	.11	none	none	none		.13	.04
Calcium carbonate	95.14	42.10	80.09	58.94	97.57	95.46	58.75	86.43
Magnesian carbonate	trace	trace	16.30	5.67	.78	1.09	2.58	10.94
Total	99.20	71.32	99.25	100.80	99.86	100.82	100.41	99.17

No. 1. Grey limestone, Albany river, 3 miles above Hat island, upper coral beds.
No. 2. Grey cherty limestone, 3 miles above Hat island, lower fossiliferous cherty beds.
No. 3. Grey fossiliferous magnesian limestone, Big Upper falls, Albany river.
No. 4. Grey, arenaceous, fossiliferous limestone, Kwataboahegan river.
No. 5. Grey, fossiliferous limestone, Coral rapids, west side of Abitibi river.
No. 6. Grey, fossiliferous limestone, head of Coral rapids, east side of Abitibi river (Geol. Surv. Can., Sum. Rept., 1924, pt. C, p. 96).
No. 7. Impure grey limestone, Louise island, Moose river.
No. 8. Grey magnesian limestone, Mattagami river, west bank, at Grand rapids, including all beds in a 25-foot cliff (Geol. Surv. Can., Sum. Rept., 1926, pt. C, p. 44).

As can be seen from the above analyses, the Abitibi River formation is limestone, with the rocks varying from a pure to somewhat magnesian limestone. Arenaceous and argillaceous limestones are also present. The most important exposures are those of Coral rapids on the Abitibi river, and Grand rapids on the Mattagami river. At the first locality the limestone cliffs are about 40 feet in height, and may be followed along both banks of the river from one-quarter to one-half mile. At the second locality the cliffs are about the same height and maintain this height for a mile. From the analyses, the limestone at Coral rapids would appear to be purer than that of Grand rapids, but the sample taken by McLearn from the latter locality includes all the beds in the 40-foot cliff, whereas the samples from Coral rapids are hand samples. No doubt pure beds occur at Grand rapids and some magnesian ones at Coral rapids.

Williams Island Formation

	Per cent.
Insoluble mineral matter	3.18
Ferric oxide	.79
Alumina	none
Calcium carbonate	95.46
Magnesian carbonate	trace

The sample of grey limestone from Williams island, Abitibi river, is from one of the lower fossiliferous beds and is not, therefore, representative of the whole formation. Lithologically, the formation resembles very closely the Moose River formation. For a description of the formation and a detailed study, the reader is referred to the author's report on the geology and economic resources of the Moose River basin.[1] The formation is known to outcrop at only one locality on the whole James Bay slope, i.e. at Williams island on the Abitibi river in the lower part of Long rapids. There it forms cliffs about 30 feet in height at the head of the island and on the left shore opposite the island.

[1]W. S. Dyer, op. cit.

Lignite Coal from Blacksmith Rapids, Abitibi River

By R. E. Gilmore

Summary

The shipment of Blacksmith Rapids coal[1] submitted by the Ontario Department of Mines was divided into three main samples, two of which were subdivided by screening. Analysis of the different sizes showed that the larger hard, tough lumps were best in quality, and that there was a progressive concentration of ash in the small and fines. The proportion with less than 7 per cent. ash on the "as received" basis was over 65 per cent., and nine-tenths of the sample had less than 10 per cent. ash. In colour the coal in question is not unlike that of air-dried peat, and the moisture content of the material, which closely approached 40 per cent., is high in comparision with other Canadian solid fuels on the market.

The results of preliminary chemical and physical examination show that the coal tested is to be classed as a "brown" lignite having many of the characteristics of the lignite mined in the Estevan area, Saskatchewan. Like the coal just mentioned, it disintegrates considerably on exposure to alternate wetting and drying and on this account has poor weathering qualities. Shipping and storage under cover will, therefore, be required to maintain the fairly good handling qualities of the freshly mined lumps. A preliminary burning test on a portion of the sample showed it to be a fuel comparing favourably with peat or wood of equal moisture content. The breaking up of the larger lumps to effect a partial drying is advisable, however, for use in domestic heaters or furnaces. It burns with a white smoke similar to that produced by hardwood, peat, and lignites, and has the characteristic odour of the latter.

Small-scale carbonization and briquetting tests were made according to standard laboratory procedure adopted in these laboratories. When carbonized at 600° C., a 37 per cent. yield of char was obtained, averaging slightly over 7 per cent. volatile matter and, roughly, 16½ per cent. ash. The combined yield of tar oils and light oils from the gas amounted to slightly over 6 Imperial gallons per ton of lignite as mined, having a crude oil value equal roughly only to that of fuel oil.

Preliminary briquetting tests showed that comparatively good briquettes can be made from the char, the heating value and general burning qualities of which will correspond to briquettes made from Pennsylvania anthracite of equal ash content. Approximately 2½ tons of lignite will be required for one ton of char, and at least 10 per cent. pitch will be required as binder.

As powdered fuel, although the possibilities of its use as partially air-dried slack are not to be disregarded, it will apparently be necessary to either oven-dry or carbonize it to insure ease of pulverizing and to give a high over-all burning efficiency in the boiler. For this, as well as for treatment by low-temperature carbonization, tests should be made on a large scale before a definite opinion can be expressed as to its value in comparison with other competitive fuels.

[1]Collected from the outcrop of the seam near the head of the rapids on the west side of the river.

Conclusions

The results of analyses and tests on the sample submitted show that the possibilities for its use either as mined, as partially dried material, or after carbonization and briquetting treatment, are good, but tests on larger quantities than those yet available are necessary before a definite opinion can be expressed as to its relative economic value. Other requirements of more importance, however, are a knowledge concerning the extent of the deposits and the comparative cost of mining, and whether or not there is a ready market close at hand.

Preliminary Report on Samples Submitted by the Ontario Department of Mines

Eight bags of coal submitted by the Ontario Department of Mines, as per correspondence between W. S. Dyer, Geologist, and Thos. W. Gibson, Deputy Minister, and between Mr. Gibson and John McLeish, Director of the Mines Branch, were received the latter part of October, 1928. The total sample, amounting roughly to 500 pounds was comprised of: (1) six bags of large fairly clean lumps with a comparatively small quantity of small lumps and fines; (2) two bags of smaller lumps with fines.

For the purpose of determining the variation in quality of the different sizes, the contents of the six and two bags, respectively, after a few of the larger lumps were removed and reserved for museum purposes, were divided and recorded as follows:—

Laboratory No.	Description	Approximate weight
		lbs.
5,331	Large, fairly clean, hard and tough lumps, hand picked from the 6 bags	265
5,332	Lumps, pea and nut size, and fines left after hand picking the 6 bags	70
(a)	On 6-mesh screen....33 lbs.	
(b)	Through 6-mesh screen....37 lbs.	
5,333	Smaller lumps and fines in 2-bag lots	115
(a)	Friable lumps (i.e., lump easily broken in hands)....10 lbs.	
(b)	On half-inch screen....23 lbs.	
(c)	Through half-inch screen on 6-mesh....37 lbs.	
(d)	Through 6-mesh screen....45 lbs.	

Analyses

The three main samples, Nos. 5,331-33, were air-dried to constant weight at 60 per cent. humidity in the constant humidity apparatus, according to the standard method employed in these laboratories. Part of sample No. 5,331 used for the carbonization test, the (a) and (b) samples of No. 5,332, and the (a), (b), (c), and (d) samples of No. 5,333 were partially air-dried in the open room before analysis. The results of analyses on three different bases for samples Nos. 5,331-33 are tabulated below (page 37), and the analyses of all samples on the partially air-dried and dry bases are shown in Table I.

TABLE I—PROXIMATE ANALYSES, CALORIFIC VALUES, ETC., OF THE DIFFERENT SIZES OF SAMPLES OF BLACKSMITH RAPIDS LIGNITE

(Reported by C. B. Mohr, Assistant Chemist, Mines Branch, Ottawa)

Lab. No.	Description	As received in Chemical Laboratory						Dry basis					Calorific value, dry ash-free basis
		Moisture	Ash	Volatile matter	Fixed carbon	Sulphur	Calorific value	Ash	Volatile matter	Fixed carbon	Sulphur	Calorific values	
		per cent.	per cent.	per cent.	per cent.	per cent.	B.t.u.	per cent.	per cent.	per cent.	per cent.	B.t.u.	B.t.u.
5,331	Large lumps, hand-picked from 6 bags	39.9*	7.3	26.8	26.0	3.0	6,172	12.2	44.6	43.2	4.9	10,270	11,700
5,332	Smalls and fines from hand-picking of No. 5,331	32.3*	14.3	27.4	26.0	1.9	6,310	21.1	40.4	38.5	2.7	9,330	11,817
(a)	Smalls remaining on 6-mesh screen	25.0	11.0	33.8	30.2	2.4	.....	14.7	45.0	40.3	3.2	.....	.....
(b)	Fines passing through 6-mesh screen	23.1	23.3	29.6	24.0	2.2	.....	30.3	38.4	31.3	2.8	.....	.....
5,333	Small lumps and fines from 2 bags	39.7*	10.5	25.3	24.5	1.0	5,940	17.5	41.9	40.6	1.7	9,860	11,941
(a)	Friable lumps from No. 5,333	33.4	15.9	27.0	23.7	.6	.....	23.9	40.5	35.6	.9	.....	.....
(b)	Remaining on half-inch screen	35.6	6.7	29.9	27.8	1.2	.....	10.5	46.3	43.2	1.9	.....	.....
(c)	Passing through half-inch on 6-mesh	34.4	13.1	27.5	25.0	1.3	.....	19.9	41.9	38.2	2.1	.....	.....
(d)	Fines through 6-mesh screen	31.9	14.1	27.8	26.2	1.0	.....	20.7	40.8	38.5	1.5	.....	.....

*These figures represent the moisture in the three main samples prior to air-drying in the constant humidity apparatus; the remaining moisture content figures are for material partially air-dried before analysis.

Proximate analyses, sulphur and calorific value	No. 5,331 (large lumps from 6 bags)	No. 5,332 (smalls and fines from 6 bags)	No. 5,333 (smalls and fines from 2 bags)
As Received Basis:	per cent.	per cent.	per cent.
Moisture	39.9	32.3	39.7
Ash	7.3	14.3	10.5
Volatile matter	26.8	27.4	25.3
Fixed carbon	26	26	24.5
Total	100	100	100
Sulphur per cent.	3	1.8	1
B.t.u. per pound	6,170	6,310	5,945
Coking properties	non-coking	non-coking	non-coking
Air-dried Basis (dried to constant weight at 60 per cent. humidity):			
Moisture per cent.	16.7	16.7	17.2
Ash per cent.	10.2	17.6	14.4
B.t.u. per pound	8,560	7,765	8,160
Dry Basis:	per cent.	per cent.	per cent.
Ash	12.2	21.1	17.5
Volatile matter	44.6	40.4	41.9
Fixed carbon	43.2	38.5	40.6
Total	100	100	100
B.t.u. per pound	10,270	9,325	9,860

The results reported above and in Table I show ash contents ranging from roughly 7 per cent. for the lump coal to 14 per cent. for the smalls, and as high as 23 per cent. for certain of the fines. Over 65 per cent. of the sample, however, may be considered as 7 per cent. ash coal, i.e. on the "as received" basis, and the proportion averaging less than 10 per cent. ash on the partially air-dried basis would be 90 per cent. or so of the sample as a whole. Using the results for sample No. 5,331, namely, the hand-picked lumps, a comparison of the material with lignites from Saskatchewan and Alberta and with peat and Australian brown coal may be made as follows:—

	Average moisture content		Average ash content on dry basis	Calorific value, B.t.u. per pound	
	As mined	Air-dried at 60 per cent. humidity		Dry basis	Dry and ash-free basis
	per cent.	per cent.	per cent.		
Black lignite from Drumheller area, Alta.	20	15	9.0	11,700	12,850
"Brown" lignite from Estevan area, Sask.	35	17	11.0	11,200	12,550
Lignite from Abitibi river, Ontario	40	17	12.0	10,300	11,700
Brown coal from Australia (Morwell)	50	.....	4.0	9,700	10,100
Peat from bog at Alfred, Ontario	90	17	6.0	9,750	10,350

Classification

In appearance the fresh lumps of the Blacksmith rapids sample are distinctly brown, similar to air-dried peat, which colour on continued exposure changes on the surface to an opaque black somewhat resembling the so-called "brown" lignites of Saskatchewan. The moisture content of the freshly mined Abitibi River material, it will be noticed, is midway between the brown lignites of the Estevan area and the Morwell brown coal. The calorific value on the dry and ash-free basis, i.e. on the pure coal basis, is between the lignites of Alberta and Saskatchewan on the one hand and Australian brown coal and peat on the other, although it is nearer the lignite values. It is evident, therefore, that the Blacksmith Rapids coal may be classed as a lignite closely approaching the brown lignite of Saskatchewan. Saskatchewan lignite and Australian brown coal are mentioned here, as they are now both being extensively used commercially. Announcement has recently been made that a plant with a capacity of 100 tons per day is producing a carbonized briquette fuel at Bienfait, Sask., utilizing the combined carbonizing and briquetting process along the lines developed by the Lignite Utilization Board; and the Morwell brown coal in Australia has found extensive use in boilers fitted with dryers, in which the flue gases from the boiler serve to dry the high-moisture content fuel charged. On the assumption, then, that both these low-grade fuels, viz. Saskatchewan lignite containing as high as 35 per cent. moisture when mined and Australian brown coal with 50 per cent. moisture, can be used commercially, the prospects of the lignite in Northern Ontario, finding commercial use appear good, providing, of course, that the supply is large, that the cost of mining is sufficiently low, and that a ready market is near at hand.

Weathering, Storage, and Handling Properties

Although hard and tough when freshly mined, the lumps of the Blacksmith Rapids lignite on exposure to warm dry air disintegrate considerably; and on successive wetting and drying, they break up and fall into small pieces. In this respect the Northern Ontario coal resembles the Saskatchewan lignite, which indicates that it has poor weathering qualities and that it will not stand shipping in open cars or storage in the open without appreciable deterioration. The handling properties of the weathered material will be poor, but evidently the freshly mined lumps when stored under cover will remain fair to good.

Burning Qualities

As for the possibility of its serving locally as a fuel for furnaces, stoves, Quebec heaters, or open grates, the results of observations of a burning test in a Daisy hot-water jacketed heater on a 50-pound sample of mixed sized lumps, as received, indicate that it is not entirely satisfactory on account of its high moisture content. In this respect, it is analogous to green wood, which requires air-drying to make it serviceable. Just how much air-drying it will stand and not become too friable for handling is a matter for further test and one which will require a larger sample than now available. Ignition will not take place until a considerable portion of the surface of the lumps is dried out, but once dried out it continues to burn with little draft, as do other lignites, peat, and wood. Like these, the Northern Ontario lignite also produces what is termed a white smoke. The pronounced smell of sulphur in the lignite, a characteristic odour from the Blacksmith rapids sample No. 5,331, due apparently to its comparatively high sulphur (pyrites) content, is an objection to it as a fuel where the

draft conditions are not exceptionally good. Roughly twice as much of this lignite will be required, however, to produce the same amount of heat as anthracite or high-grade steam coal.

Carbonization and Briquetting Tests

Carbonization Tests.—Carbonization tests were made on sample No. 5,331, namely, the hand-picked lumps, on a 10-pound scale in the temperature-control (lead bath) apparatus according to the standard laboratory low-temperature carbonization method used in these laboratories. The sample was first crushed to pea size and, after oven-drying to a moisture content of approximately 10 per cent., was carbonized at a maximum temperature of 600° C. Following is the data sheet, in part, of two runs made:—

	Grammes
Coal charged (10 per cent. moisture)	4,000
Char obtained	2,220
Aqueous liquor (sp. gr. = 1.00)	1,000
Tar oils (sp. gr. = 1.060)	176
Light oils from gas (sp. gr. = 0.7)	16
	Cu. ft.
Gas (at 60° F. and 30″ Hg. pressure)	5,145

The yields of products calculated to the basis of the lignite with 40 per cen moisture content as received and on the dry basis as percentages, and as per 2,000-pound ton, are as follows:—

	Dry lignite basis		Lignite as received	
	Weight	Yield per ton	Weight	Yield per ton
	per cent.		per cent.	
Char	61.6	1,232 lbs.	37.0	740 lbs.
Aqueous distillate	16.7	.....	49.9	.....
Tar oils	4.9	9.2 Imp. gals.	2.0	5¾ Imp. gals.
Light oils	.4	1 " "	.2	½ " "
Gas (by difference)	16.4	5,700 cu. ft.	10.0	3,400 cu. ft.

Tar Oils.—Fractionation of the tar oils according to standard laboratory procedure, and the yield, density, etc., of the different fractions were as follows:—

Fraction	Temperature	Vol. of tar	Imp. gals. per ton	Sp. gr. at 60° F.	Tar acids (phenols)	Neutral oils	Insoluble conc. H_2SO_4
		per cent.			per cent.	per cent.	per cent.
1	0–225°C.	40.5	4.1	1.015	74	24.7	56
2	225–255°C.	28.4	2.6	1.033	63	37.0	67
3	Pitch (wt. %)	27.7	melting point = 385° F.				

The specific gravity of the total tar acids was 1.065 and that of the neutral oil 0.931, and the calculated yields from fractions 1 and 2 of these products per ton of lignite as mined amounted to 3.0 and 1.3 Imperial gallons, respectively.

Briquetting Tests.—Briquetting tests were made on the carbonized residue or char obtained in the lead-bath retort. These were made on a small scale in an intermittently operated plunger press at comparatively high pressures. In tests made, first with 10 per cent. asphalt binder (melting point = 150° F.) and then

with 5 per cent. asphalt and 2 per cent. flour mixture, briquettes with good handling qualities were obtained. The analyses of the char before briquetting and of the briquettes with 10 per cent. asphalt binder are given below:—

	Char before briquetting	Briquettes with 10 per cent. asphalt binder
	per cent.	per cent.
Moisture	0.5	2.0
Ash	16.4	15.2
Volatile matter	7.3	13.7
Fixed carbon	75.8	69.1
Total	100	100
Sulphur.....per cent.	4.2	4.0
B.t.u. per pound	12,800	12,700

The char was granular and brittle, resembling somewhat the carbonized residue from Saskatchewan lignite, and the above results indicate that briquettes can be made from the Blacksmith rapids (Ontario) lignite as satisfactory as those now made commercially from Saskatchewan lignite. Briquettes with ash content in the neighbourhood of 15 per cent. as above will have a heating value corresponding roughly to Pennsylvania anthracite of equal ash. As to general burning qualities, however, they will be more free burning and will be smoky to the same extent as anthracite briquettes made with the same kind of binder.

Approximately 2½ tons of the lignite as mined will be required to produce a ton of char, and at least 10 per cent. pitch will be required as binder. Preliminary results indicate that the pitch available from the lignite tar as binder will amount to roughly only one-quarter of the total binder required. Further tests on a large scale in a roll press will, however, be necessary before an opinion may be expressed as to commercial amenability of the char to briquetting and as to the combined cost of carbonizing and briquetting.

Use as Powdered Fuel

The pulverizing qualities of the lignite as mined, especially the tough woody lumps, are poor, so that the material will require drying for use in powdered fuel-boiler installations. The char or carbonized residue will, no doubt, make a satisfactory pulverized fuel, but the suitability of the dry or partially dried material requires further investigation. Tests, therefore, on a large scale should be made before a definite opinion can be expressed, and for such tests a large quantity, say not less than 5 tons, should be available.

Sylvania Sandstone Deposit at Amherstburg

By W. S. Dyer

Introduction

In December, 1927, a short visit was paid by the writer to the deposit of silica sand of Sylvania (Lower Devonian) age which occurs on the farm of Edward Patton one mile south of Amherstburg. This deposit is of considerable interest, in the first place, because some of the purest glass sands in the United States are being recovered from the same formation in the state of Michigan, seven miles west of Amherstburg across the Detroit river; and in the second place, because the formation comes nearer the surface on the Patton farm than anywhere else in the province.

Sylvania Sandstone Formation

The Sylvania sandstone forms the base of the Devonian system in the Detroit River region.[1] A. W. Grabau and W. H. Sherzer[2] describe the sandstone as follows:—

> Typically, the sand rock is a remarkably pure, sparkling, snow-white aggregation of incoherent quartz grains. By drillers it is often compared with snow, flour, salt, and granulated sugar. Lumps of it may be crumbled in the hands, and when placed in water simply falls to pieces like some varieties of clay. At the Rockwood pit the rock is being disintegrated by means of a small stream of water from a hose, and with the grains in suspension pumped to the washing vats of an adjacent building. The small amount of binding material present consists of a dolomitic cement apparently introduced into the bed by percolating water, subsequent to the deposition of the sand. Immediately beneath the drift the rock is often discoloured by iron oxide to a depth varying from a few inches to several feet. Before marketing the sand for glass manufacture the dolomitic cement is removed by washing, when the per cent. of silica is over 99 per cent. Grains of minerals other than quartz are relatively very infrequent.

The formation does not outcrop in Ontario, but well records show that it is present at varying depths in Lambton and Essex counties. Drillers have also recognized a sandstone formation at a horizon which agrees with that of the Sylvania in the counties of Bruce, Middlesex, and Norfolk, but it is difficult to tell definitely, from drill samples, whether this is the Sylvania sandstone or the Oriskany sandstone, a formation of slightly later age and different origin which outcrops in Haldimand county.

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[1] M. Y. Williams, Geol. Surv. Can., Mem. 111, 1919, pp. 18-22.
[2] Mich. Geol. & Biol. Surv., Pub. No. 2, Geol. Ser. 1, 1909, pp. 71-72.

Data on Sylvania Sandstone[1]

Locality	Depth to top of sandstone	Approx. elevation of top of sandstone	Total thickness of sandstone
	feet	feet	feet
Kincardine, Bruce co	297	311	29
Courtright, Lambton co	1,062	—474	32
Petrolia, Lambton co	1,076	—429	16, 26, 47 (3 beds)
Port Lambton, Lambton co	1,200	—600	50, 40 (2 beds)
Wallaceburg, Kent co	1,000	.....	100
Windsor, C.P.R. well No. 11	535	75	55
Windsor, C.P.R. well No. 11	550	60	65
Anderdon tp., Essex co. (Sucker creek)	410	199	30
Malden tp., Essex co., lot 4, con. II (Parke well)	258	.....	84
Malden tp., Essex co., lot 2, con. I (Colwell Grove well)	260	.....	60
Near Comber, Essex co	360	240	10
Orford tp., Kent co. (Ravey well)	555	185	75, 85 (2 beds)
Orford tp., Kent co., lot 23, con. XIV (Grant well)	410	.....	90 (several)
Camden tp., Kent co., lot 2, con. V (Camden well)	413	.....	46
Camden tp., Kent co., lot 2, con. V (2nd Camden well)	559	.....	10
Lot 12, con. VI, Maidstone, Essex co	275	.....	25
Lot 64, con. I, Colchester S., Essex co	177	471	10
Lot 7, con. V, Tilbury W., Essex co	283	321	2, 10, 35 (3 beds)
Sandwich W. tp., Essex co	525	.....	100
Lot 7, con. III, Tilbury W., Essex co	283	.....	20
Lot 7, con. III, Tilbury W., Essex co	250	353	50
Rochester tp., lot 28, con. II, Essex co	228	392	40
Lot 3, con. II, Camden tp., Kent co	431	.....	46
Dresden, Kent co	482	.....	44
Port Rowan, Norfolk co	554	.....	15
Glencoe, Middlesex co	962	.....	38

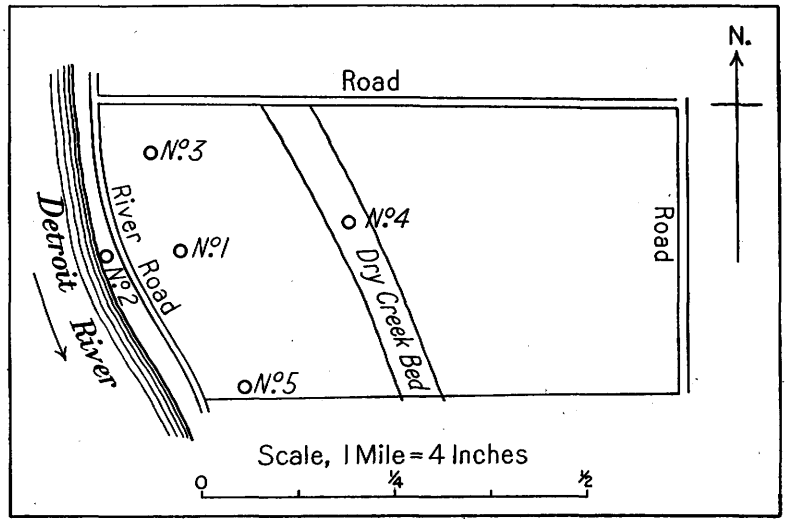
In a well drilled by him recently at Kingsville, Gosfield South township, Bon Jasperson, a driller, reports two sands, the upper one between 70 and 100 feet from the surface, and the other 490 feet from the surface, presumably separated by dolomite. From samples examined by the writer both these sands have the appearance of the Sylvania, consisting of clear white, rounded grains. The elevation of the upper sand would appear to agree with that of the Sylvania. This is the second instance reported of two sands separated by any great thickness of dolomite. The first instance was in a well drilled by the Solvey Process Company on lot 10, concession I, Sandwich West township, Essex county.[2] To the west, calcareous sandstone is reported in the Bass Island series of Upper Silurian age, about 175 feet below the Sylvania. The lower sand of the Jasperson well is, no doubt, also from the Bass Island series.

That the Sylvania sandstone comes closer to the surface on the Patton farm than at any other point in the province was discovered when the steamboat channel between the Canadian side and Bois Blanc island in Detroit river was being deepened. It is claimed that the dredgers brought up the sand from a depth of 17 feet below the bed of the river. In August, 1926, in the well drilled on the Patton farm for D. A. Hackett, one of the present owners of the property, the sandstone was found at a depth of 42½ feet below the surface. G. P. Cole, technical engineer of the Dominion Glass Company, Montreal, spent a few days in September, 1927, investigating the property and was instrumental in having

[1]L. H. Cole, Silica in Canada, pt. I, Mines Branch, Ottawa, No. 555, 1923, p. 13.
[2]M. Y. Williams, op. cit., p. 89.

a shaft sunk in the centre of the property at the water's edge. The sandstone was encountered at a depth of 29 feet, and the drilling was continued to 31 feet. Later in 1927, the Pennsylvania Drilling Company, of Pittsburgh, under contract with the owners of the property, drilled three holes on the Patton farm. Two of these wells passed through 52 and 54 feet of overburden, respectively, each encountering limestone, in one of them 47 feet of sandstone was found, and in the other 40 feet, without reaching the bottom of the formation. A third well passed through 55 feet of overburden, part of which was limestone, and was abandoned before reaching the sand.

In a report on the Patton property, written in 1924 by Thomas Nattress, of Valcartier, Que., it is stated that 14 feet of Sylvania sandstone was penetrated by a shaft dug on the Elliott Point farm, the farm lying to the south of the Patton farm, and that 25 feet of dolomite and 44 feet of drift overlay the sand.



Sketch of Patton farm, one mile south of Amherstburg, showing approximate location of bore-holes.

From the figures given on page 2 it is seen that in the Colwell Grove well, lot 2, concession I, Malden township (about 2 miles northwest of the Patton farm), a thickness of 60 feet of Sylvania sandstone was penetrated at a depth of 260 feet, and that in the Parke well, lot 4, concession II, Malden township, the second farm south of the Patton farm, 84 feet of sand was passed through at a depth of 258 feet. The locations of the wells on the Patton farm are shown in the sketch, and the logs of the wells are given below:—

No. 1—Well Drilled for D. A. Hackett by Roy Larabee, August, 1926

		Depth in feet
Clay		0–27
Sand, clay, and gravel		27–35
Fairly find sand		37
Black sand		39–42½
Sylvania	White sand, free	42½–52
	Hard white sand	52–56
	Softer white sand	56–58
	Fine white sand	58–68½
	Hard sand	68–69½
	Fine sand	69½–72

No. 2—Shaft Dug Under Direction of G. P. Cole

	Depth in feet
Overburden	0–29
Sylvania sandstone	29–31

No. 3—Well Drilled by Pennsylvania Drilling Company

	Depth in feet
Boulder clay	0–40
Limestone	40–52
Sand (Sylvania)	52–99

No. 4—Well Drilled by Pennsylvania Drilling Company

	Depth in feet
Boulder clay	0–36
Limestone	36–54
Sand (Sylvania)	54–94

No. 5—Well Drilled by Pennsylvania Drilling Company

	Depth in feet
Boulder clay	0–52
Limestone	52–55
Hole abandoned in limestone.	

The surface of the property is perfectly level and from 10 to 12 feet above the level of the river, except for the small depression running diagonally across the middle of the farm as shown in the sketch. This depression is the bed of an old swampy creek, and is about the same level as the Detroit river. Holes Nos. 1 and 3 were drilled on the surface, and the top of the holes were 10 feet above the river level. The depth of the Sylvania sandstone below river level would, therefore, be respectively 31½ feet and 42 feet. The top of holes Nos. 2 and 4 were at water level, hence the depth of the sandstone below river level would be respectively 29 and 54 feet. These figures show a dip to the northeast away from the river at the rate of about 22½ feet in about 1,300 feet, or 90 feet per mile. This has an important bearing on the value of the deposit, since any water from the river entering the sandstone would find its way down a dip into the mine workings, unless checked by some artificial means. That it would be possible for the water of the river to enter the sand is shown by the fact that the sand was dredged up in the river from a depth of 17 feet, as noted previously.

Quality of the Sandstone

The Sylvania sandstone is quarried extensively at Rockwood, Mich., and furnishes some of the purest glass sands in the United States. At Rockwood the formation is under about 20 feet of overburden. The Dominion Glass Company report[1] that they are using Rockwood sand for their plants at Hamilton and Wallaceburg, and that it was running 0.025 per cent. in iron oxide content. In 1927 the Dominion Glass Company were paying $2.25 per ton, F.O.B. Rockwood, for this sand.

The following analyses of the Sylvania sandstone on the Patton farm were supplied by G. P. Cole. Analyses were made by J. T. Donald & Company, Montreal:—

Sample No. 1, from Well Drilled for D. A. Hackett

	Per cent.
Silica	98.07
Iron oxide	.05
Alumina	.28
Lime	.68
Magnesia	.16
Loss on ignition	.62

[1]Private communication from G. P. Cole.

SAMPLE NO. 2, FROM SHAFT DUG UNDER DIRECTION OF G. P. COLE

	Per cent.
Silica	93.46
Iron oxide	.46
Alumina	1.09
Lime	1.84
Magnesia	.67
Loss in ignition	2.36

Mr. Cole reports that the sample was probably contaminated with ordinary river sand which directly overlaid the Sylvania sand.

SAMPLE NO. 3, CORE FROM A DEPTH OF 93 FEET IN FIRST WELL (NO. 3), DRILLED BY PENNSYLVANIA DRILLING COMPANY

	Per cent.
Silica	46.18
Ferric oxide	.23
Alumina	.61
Lime	16.28
Magnesia	11.54

The following iron oxide determinations were made by W. K. McNeill, the Provincial Assayer, on samples of core supplied the writer by the owners of the property:—

	Per cent.
Well No. 3, at a depth of 80 feet	0.085
Well No. 3, at a depth of 86 feet	.23
Well No. 4, at a depth of 60 feet	.115
Well No. 4, at a depth of 68 feet	.055

It appears from these analyses and ferric oxide determinations that a quantity of sand could be obtained running about 0.05 per cent. iron oxide, but it also shows that some of the sand is considerably higher in iron oxide and that some is highly siliceous dolomite. None of the determinations show the sand to be as free from iron oxide as Rockwood sand, but it would be suitable for all grades of glass with the exception of optical glass and higher grades of flint glass. No special effort was made to get samples of the purest quality, and it is possible that some of the sand would be purer than in any of the determinations. Before any extensive development is started it would be advisable to sink a shaft and have analyses made of the sand at frequent intervals.

The amount of good glass sand obtainable cannot yet be determined because the thickness of the sand pure enough to be worth recovering is not known. The thickness of the formation on the Patton farm according to the logs and the wells is over 47 feet and at the Parke well, over 80 feet; but that this is not of good grade is shown by the above analyses, especially sample No. 3. The Patton farm consists of about 100 acres, but the sand formation is, no doubt, fairly close to the surface for a considerable area outside the boundaries of the farm.

The property is very accessible, with highways on three sides of it. One of these, the Detroit River road, cuts directly through the property at the shoreline. Arrangements for shipping by water are ideal, since at minimum expense a wharf could be constructed by diking the water along the water front and at least 16 feet of water obtained at the wharf without in the least interfering with the main steamboat channel. Railway sidings could be readily extended if the property were developed. The following comparative freight rates, dated November 28, 1927, were supplied the writer by L. H. Cole, who obtained them from the Natural Resources and Intelligence Branch, Department of the Interior:—

	Ottawa, Ill., rail	Rockwood, Mich., rail	Amherstburg, water
	per ton	per ton	per ton
Detroit	$2.90	$0.88	$0.20
Toronto	4.28	2.27	.60
Hamilton	3.60	2.04	.60
Wallaceburg	3.50	1.80	.50
Montreal	6.50	4.48	1.25
Windsor	.....	1.40	.30

Conclusion

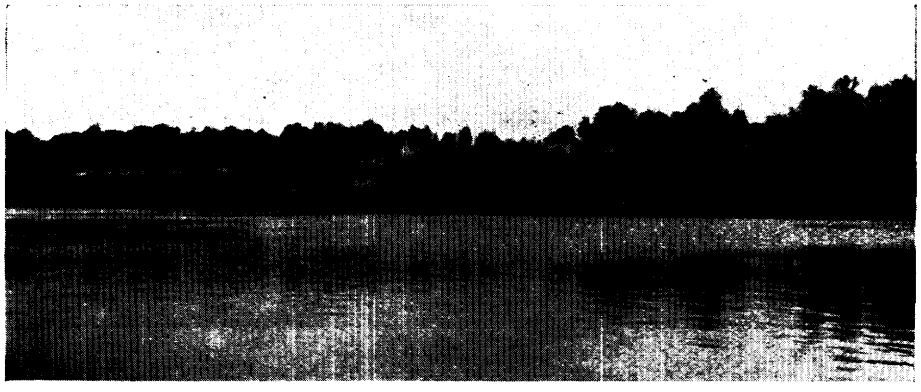
The deposit is probably purer in grade than any other deposit in Ontario, with the possible exception of those on the Mattagami and Abitibi rivers, which are too far away from the market. The deposit is excellently situated with respect to transportation to markets. Further investigation will have to be made, however, before opening it up. A shaft could be dug, from which samples could be taken for analysis, showing the exact character of the sand for every foot of its thickness. This might be done with the cores obtained from the diamond-drill holes which have already been drilled, if they are still intact. Once the sands are determined to be pure enough to compete with Michigan and Illinois sands, the question remains whether the advantage of cheaper freight rates is sufficient to overcome the disadvantage in the greater cost of mining over quarrying. This depends upon the overburden, which averages 50 feet, with 12 to 18 feet of limestone; and upon the thickness of the sand pure enough to be recovered, which is not yet determined and which also depends upon the extent of the difficulty to be encountered from water in the mine workings.

Paleozoic Geology of the Albany River and Certain of Its Tributaries

By W. S. Dyer

Introduction

The route followed by the writer in the examination of the Paleozoic geology of the lower Albany, lower Kenogami, and Pagwachuan rivers was the same as that used by fur traders and prospectors between Pagwa River station on the Canadian National railway and Fort Albany on James bay. This route follows the Pagwachuan river from the railway to its confluence with the Kenogami, a distance of 30 miles, thence down the Kenogami for a distance of 70 miles to its confluence with the Albany, and finally down the Albany river to James bay, a distance of approximately 150 miles. The writer also travelled up the Albany for 45 miles above the mouth of the Kenogami.



English River post, Kenogami river, showing buildings of Hudson's Bay Company. The buildings of Revillon Frères are to the right of the picture. Banks consist of marine (Champlainian) clay.

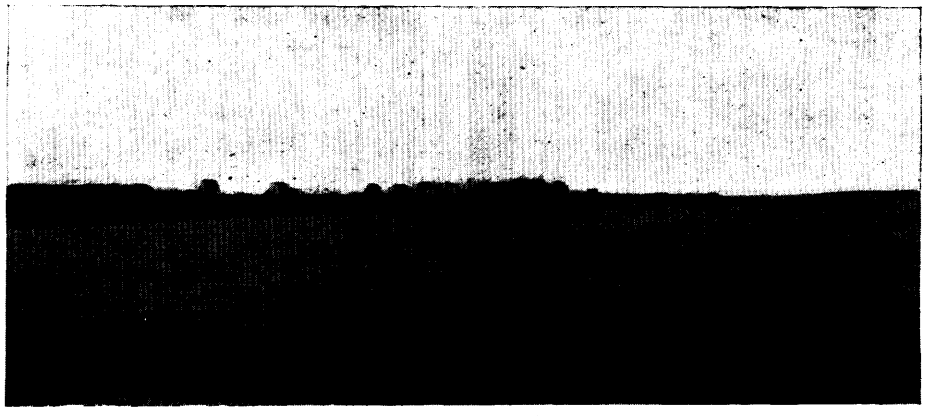
This route still provides the only uninterrupted waterway from rail to James bay, although the shorter route of the Abitibi river is almost without interruption, since the extension of the rail to Coral rapids. Even the former route can be used only for a few weeks or a month in the summer by heavily laden scows or canoes, owing to the shallow water in the Pagwachuan river. In the latter part of the summer, from about the first of August on, there is not sufficient water in some parts of the Pagwachuan river to float even lightly laden canoes. At these places the members of the party were forced to unload their canoe and carry the packs along the river. At the shallowest places a channel had to be cleared for the empty canoe.

The Revillon Frères Trading Company do a large amount of freighting each spring on this route, both for themselves and for the Hudson's Bay Company. Thirty scows, each measuring 46 by 12 feet and drawing 14 to 15 inches of water, are floated down the river each May in high water to English River post, from

which place a tug takes them, ten at a time, for the remainder of the distance to Fort Albany. About 10 of the scows are brought back each year; and the rest are broken up and the timber is used for various purposes. The tug is a flat-bottomed type, with a good cabin and a gasoline engine of 125 horse-power. Each scow is laden with 15 or 16 tons, making a total for the 30 scows of 450 to 500 tons of freight, which is carried each year to Fort Albany or to posts along the way. High water lasts about a month in good seasons, but in dry seasons it does not last long enough to get all the scows down the Pagwachuan river.

The personnel of the party consisted of a student assistant, a canoeman, and the writer, and the equipment of one 19-foot freighter canoe equipped with a 2½-horsepower Johnson outboard motor. Six weeks provisions were carried and a gasoline supply for two weeks. The gasoline supply was replenished from the gasoline reserves that the Ontario Forest Patrol maintains at the Forks of the Albany river and at Fort Albany.

All rock outcrops encountered en route were studied, fossils were collected, and as much information as possible on the attitude of the strata was obtained.



Fort Albany.

A. R. Crozier acted very capably as field assistant, and J. C. Bromley gave efficient service as canoeman. The writer is indebted to the officials of the Hudson's Bay Company and Revillon Frères, as well as to the Roman Catholic and Anglican missionaries, for many kindnesses shown to him and the members of his party.

The lower Abitibi and the lower Kenogami and their tributaries have been explored and their general features and geology described by Robert Bell,[1] W. J. Wilson,[2] and M. Y. Williams.[3] Bell described the Kenogami and Albany rivers; Wilson, the Little Current, Drowning, Pagwachuan, Nagagami, Kabinakagami, Ridge, and Stooping, as well as other rivers to the north and south of the Albany river drainage basin. Williams travelled over much the same country as the writer. His report on the geology and paleontology is more detailed than any of the others and is accompanied by a geological sketch map showing rock outcrops. As a matter of fact there is very little for the writer to add to Williams' report.

[1]Geol. Surv. Can., Rept. of Progress, 1870-71, pp. 338-341, 349, 350; ibid, 1871-72, pp. 109-113; Vol. II, pt. G, 1886, pp. 30-38.

[2]Geol. Surv. Can., Vol. XV, pt. A, 1902-3, pp. 222-233; Geological Reconnaissance of a Portion of Algoma and Thunder Bay Districts, No. 980, 1909, pp. 1-41.

[3]Geol. Surv. Can., Sum. Rept., 1920, pt. D, pp. 18-25.

General Character of the Country

The slope of the rivers from the railroad to James bay is very regular, averaging 2 feet per mile; the river bed of the Pagwachuan river at the railway is 500 feet above sea level. In general there is a river terrace from 10 to 30 feet above low-water level, which grades steeply upwards to the general level of the country, but this is not present where the red shales of Salina age outcrop on the banks.[1] At these points nearly perpendicular banks 50 to 60 feet high are encountered. As pointed out by Bell,[2] "The Kenogami river, and the Albany below the Forks, flow in the same great valley, which appears to be a more considerable depression of the country than that occupied by the portion of the Albany already described [above the Forks]." From the Forks down to James bay the Albany flows in long sweeping curves; and in two of the stretches known as the "long openings," the river is so straight that on looking from one end to the other the sky and water appear to meet at the horizon.

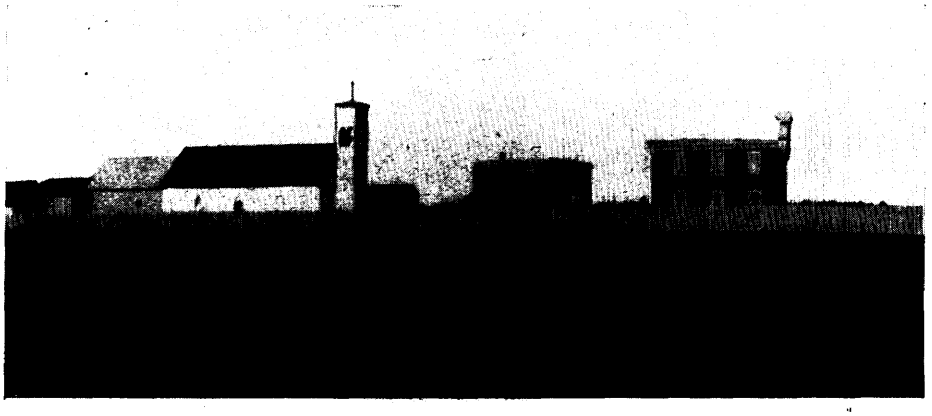
Long ridge, James bay, about half-way between Moose and Albany rivers.

Good stands of spruce, birch, and poplar line the rivers but do not extend inland more than a few hundred yards. The general surface of the country is muskeg covered with sphagnum moss, laurel, and Labrador tea, and sparsely studded with stunted spruce. Game is not plentiful, but quantities of fish, such as pickerel and pike, can be caught in the streams. Trout are said to be plentiful in the smaller rivers and creeks.

Rock outcrops, with the exception of the Salina shales, occur infrequently, and then only rise for a very feet feet above low-water level. On the Kenogami the Salina shales form banks from 30 to 40 feet high, and on the Albany still higher. Exposures of these shales on both rivers are several miles in length. Owing to the scarcity of outcrops very few of the contacts between the formations as described in this paper can be seen, and it is quite likely that certain beds do not outcrop at all. On the Albany river above the Forks and on the Kenogami and Pagwachuan above English River post, the Paleozoic rocks dip downstream at a slightly greater rate than the gradient of the river, but below these points the dip of the rocks appears to be nearly equal to the gradient of the river.

[1] See pages 54 to 56.
[2] Geol. Surv. Can., Rept. of Progress, 1871-72, p. 112.

The agricultural possibilities appear to be as good in the region studied as in the Moose River basin. The surface formation is pre-glacial marine clay of the same character as in the Moose River basin, and vegetables and cereals have been successfully grown at Fort Albany. At the new Mission school which the Oblate Fathers are erecting on the south side of the Albany river, about five miles upstream from Fort Albany, experimental plantings of potatoes, lettuce, cabbage, beans, tomatoes, corn, barley, and wheat have been made, and all were growing successfully. When the writer visited the mission on August 26, tomatoes were 2 inches in diameter and very nearly ripe. The corn was not very big but good. The wheat and barley had long stalks and full ears and were very nearly ripe. The Fathers report that it is comparatively easy to clear the land; the trees are, for the most part, small, and the roots, which do not grow deeply, after being allowed to dry in warm weather, are easy to take out of the ground. The ground is drained without difficulty by digging ditches 2 feet deep.



Roman Catholic mission, Fort Albany.

At Pagwa River station there are three stores, one of them the post of the Revillon Frères Trading Company and the others kept by independent traders. It is here also that the Revillon Frères build their scows and load them for shipment down the river. At English River post the Hudson's Bay Company and Revillon Frères Company both maintain posts, and there is in addition an Anglican mission. On the Kenogami river, about two miles above the Forks of the Albany, and at the mouth of Chipie or Ghost river, 50 miles below the Forks, the Hudson's Bay Company maintain sub-posts. At Fort Albany the Hudson's Bay Company and Revillon Frères Company both have posts, and a considerable part of the shipping to other points on James bay is done from here. There are also Roman Catholic and Anglican missions. As noted above, the Oblate Fathers of the Roman Catholic Church are building a new school on the south side of the river, 5 miles upstream from Fort Albany, about a mile off the main river and on higher ground than Fort Albany, in order to escape the spring floods which each year are a source of anxiety and danger to the inhabitants at Fort Albany. The new school will hold 50 or 75 children and the staff will consist of two fathers, eight brothers, and six sisters. A small creek, which is full of water for the greater part of the year, flows into the Albany at the school site. This will supply sufficient power to electrify the school.

Stratigraphy and Paleontology

The rocks of the region may be separated into three main divisions: the pre-Cambrian granite and gneiss at the base; the Paleozoic, which in turn may be divided into the limestones, dolomites, and shales of the Silurian, and the limestones of the Devonian; and on top the unconsolidated glacial marine clays, sands, gravels, and soil. The pre-Cambrian outcrops occur only within six miles of the railroad; the Silurian sediments occur on the Pagwachuan and Kenogami rivers and on the Albany above the Forks. Below the Forks the Paleozoic sediments are all of Devonian age. The marine clays begin at English River post and continue northward to the Bay, and the glacial boulder clays and outwash sands and gravels are found throughout the region.

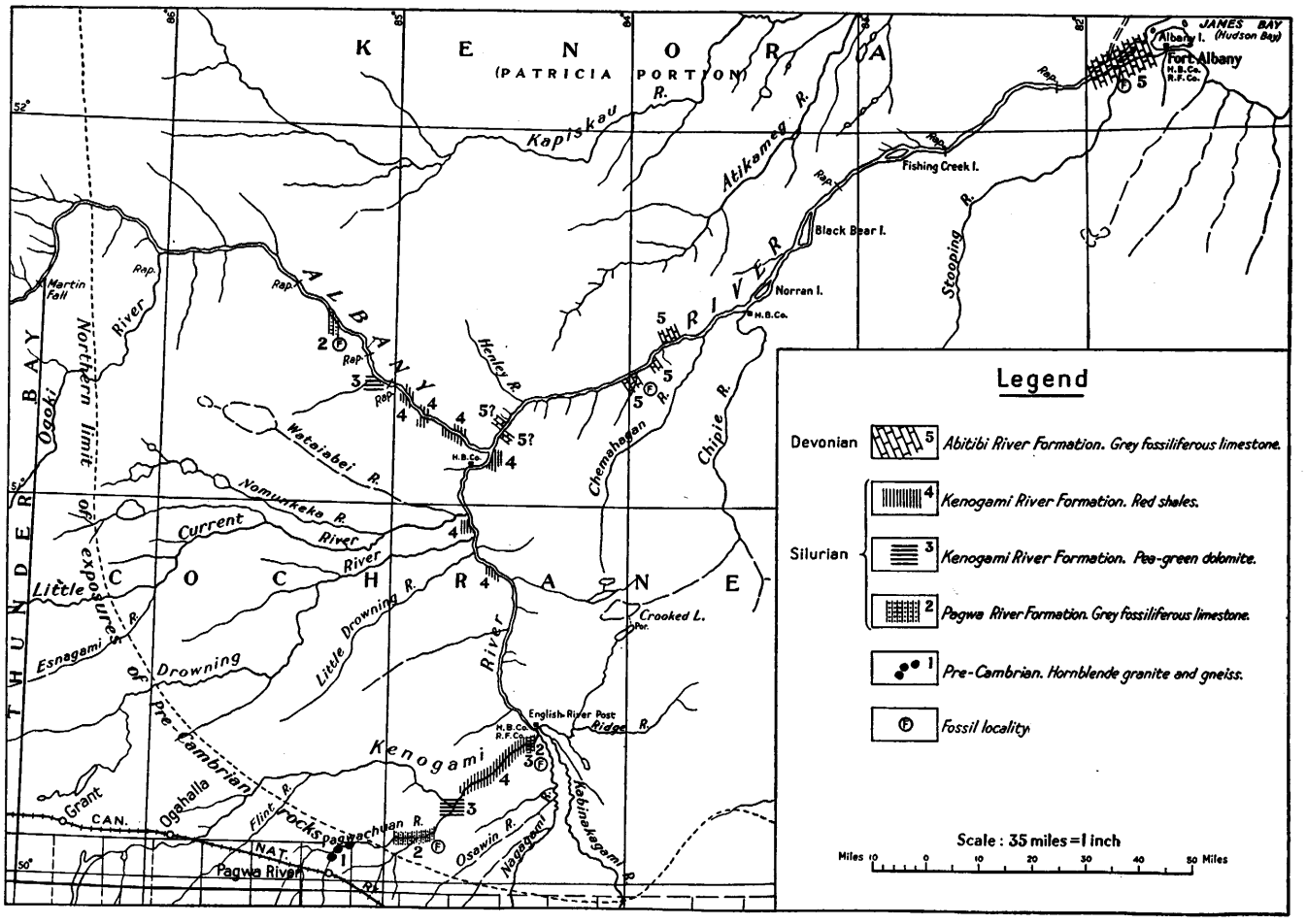
TABLE OF FORMATIONS

System	Series	Formation	Character of rocks	Correlation
Quaternary	Recent		Sands, gravels, and soils	
	Pleistocene		Marine clays and silts Boulder clays, etc.	Champlainian
Devonian	Middle Devonian	Abitibi River	Grey, fossiliferous limestone	Onondaga
Silurian	Upper Silurian	Kenogami River	Red and grey dolomitic shales; greenish-grey and cream dolomites	Salina
	Middle Silurian	Pagwa River	Grey, fossiliferous limestones	Guelph or Lockport
Pre-Cambrian			Hornblende granite, and gneiss	

Pagwa River Formation

The first Paleozoic sediments to be encountered on descending the river are exposed in the bed of Pagwachuan river, about 18 miles below the railway and 10 miles below the last pre-Cambrian outcrop. They consist of flat-lying, thin-bedded, grey crystalline limestone filled with chert nodules. About 4 miles farther down the stream and 2 miles above the Savoff river, the same type of beds reappear in the bed of the stream and continue for 4 miles, usually only in the bed of the stream, but sometimes attaining a height of 2 to 7 feet above low-water level, The beds are usually of the same type as those mentioned above but in places are more massive, very porous and crystalline, and filled with stromatoporoids; at other places they are thinner-bedded, somewhat cream-coloured, and less fossiliferous. The following fossils were collected from the limestones:—

Halysites catenulatus (*Linnaeus*).
Pycnostylus guelphensis, *Whiteaves*.
Favosites favosus (*Goldfuss*).
Syringopora retiformis, *Billings*.
Solitary cup corals.
Stromatoporoids.
Leptaena rhomboidalis (*Wilckens*).
Camarotoechia *sp.*
Strophomenoid brachiopods.
Crinoid columns.
Dalmanites limulurus, *Green*.



SKETCH MAP OF GEOLOGICAL FORMATIONS OF THE ALBANY RIVER AND ITS TRIBUTARIES.

In addition Williams reports the following species from the same locality:—

Streptelasma (Enterolasma) caliculum, *Hall?*
Palaeocyclus praecutus, *Edwards* and *Haime?*
Chonetes edmundsi, *Williams.*
Orthis flabellites, *Foerste.*
Dalmanella elegantula (*Dalman*).
Camarotoechia, *sp. nov.*
A species of ostracod.

The following list is taken from a report by Whiteaves.[1] The fossils were collected from the Drowning, Pagwachuan, Little Current, Nagagami, and Kabinakagami rivers. The horizon is given as "presumably about that of the Niagara or Guelph formation, of the fossiliferous limestone at the Attawapiskat, Ekwan, Winisk, and Fawn rivers."

Palaeocyclus *sp.*
Streptelasma (Enterolasma) caliculum, *Hall?*
Pycnostylus guelphensis, *Whiteaves.*
Pycnostylus elegans, *Whiteaves.*
Cyathophyllum *sp.*
Cystiphyllum *sp.*
Favosites gothlandicus *Lamarck* (=F. favosus, *Goldfuss*).
Halysites catenulatus (*Linnaeus*).
Clathrodictyon vesiculosum, *Nicholson* and *Murie?*
Clathrodictyon fastigiatum, *Nicholson?*
Actinostroma tenuifiliatum, *Parks.*
Stromatopora constellata, *Hall.*
Stromatopora carteri, *Nicholson.*
Stromatopora wilsoni, *Parks.*
Stromatopora *cf.* indianensis, *Parks.*
Stromatopora *sp.*
Atrypa reticularis (*Linnaeus*).
Actinoceras *sp.*
Ptenoceras tenuicostatum, *Whiteaves.*

The fossils as listed above suggest the correlation of the formation with the Lockport or Guelph of southwestern Ontario and New York state.

In the report on the "Geology and Stratigraphy of the Area of Paleozoic Rocks in the Vicinity of Hudson and James Bays," Savage and Van Tuyl[2] describe the Silurian sediments appearing on the Nelson, Severn, Winisk, and Ekwan rivers and divide them into the following formations: Attawapiskat Coral Reef, equivalent to the upper part of the Lockport; Ekwan River, equivalent to the lower and middle parts of the Lockport; Severn River, equivalent to the Cataract; and Port Nelson, correlatable with the basal part of the Stonewall of Manitoba and with the upper part of the Mayville in Wisconsin and northern Michigan. The Pagwa River formation is no doubt correlatable with either the Ekwan River formation or the Attawapiskat Coral Reef of the above authors, but the exact correlation cannot be stated until a more detailed study is made of the paleontology.

On the Albany river, 45 miles upstream from the Forks, there is an exposure of limestone which rises 5 feet above low-water level. The limestone is light-grey in colour, crystalline, very thick-bedded, almost structureless, and is filled with stromatoporoids of three or four species, with smaller members of solitary and compound corals, and with gastropods. The beds are undulating, with dips of 3 degrees observable. The fossils have not been identified, but judging from their appearance and from the location of the outcrop, upstream from the Salina

[1] J. F. Whiteaves, Notes on Some Fossils from the Cambro-Silurian Rocks of the Albany River Drainage System in Northwestern Ontario, Geol. Surv. Can., No. 980, Appendix I, 1909, pp. 36-41.

[2] T. E. Savage and F. M. Van Tuyl, Bull. Geol. Soc. Amer., Vol. 30, No. 3, Sept., 1919.

shale and dolomites, the beds would appear to be correlatable with the Pagwa River limestone. The river was not traversed at this time beyond this outcrop, but part at least of the yellowish and green limestone reported by Robert Bell[1] as occurring in the banks of the river as far up as the northernmost part of the Great bend (within about 20 miles of Martin falls) probably belongs to the same formation.

Kenogami River Formation

Between the fossiliferous limestones of the Pagwa River formation and the fossiliferous limestones of the Abitibi River formation, there is a thick series of barren rocks consisting chiefly of red and grey dolomitic shales and cream and greenish-grey dolomite. These rocks are grouped together into the Kenogami River formation. Owing to their stratigraphic position and shallow-water origin one would assume that they were Upper Silurian in age, probably equivalent to the Salina group, although the lower part of the formation (the cream and greenish-grey dolomites) may be equivalent to the Guelph. There is no evidence on which to correlate them, as has been suggested by Kindle,[2] with the red shales and sands of the Sextant formation of the Abitibi river, from which they differ widely in lithology; but the rather thick section exposed at the head of Mike island[3] on the Moose river contains similar-looking shales and dolomites and may be part of the same formation.

The lowest beds of the Kenogami River formation are exposed in a few small outcrops at the mouth of the Pagwachuan river and form the bed of the same stream for about two miles above the mouth. The rocks consist of thin-bedded, greenish-grey dolomite and are flat-lying. The dolomite grades upward into grey and reddish dolomitic shale. On the Kenogami river, 6 to 7 miles above English River post, beds of grey limestone with stromatoporoids are seen to alternate with the green dolomite. The grey limestone probably belongs to the Pagwa River formation; if so, the contact between this formation and the Kenogami River formation is transitional in character. The section follows:—

	Feet
Green dolomite	3
Green shale	25
Green dolomite	10
Grey limestone with stromatoporoids	1
Green dolomite	1
Grey limestone with stromatoporoids	1
Green dolomite (at water level)	1

Equivalent beds occur on the Albany river at the mouth of the Upper Sturgeon, 20 miles above the Forks. Here, there is a 60-foot cliff of dolomite; the lower beds massive, cream-coloured, almost pure dolomite, grading upward into thinner-bedded, grey, argillaceous dolomite.

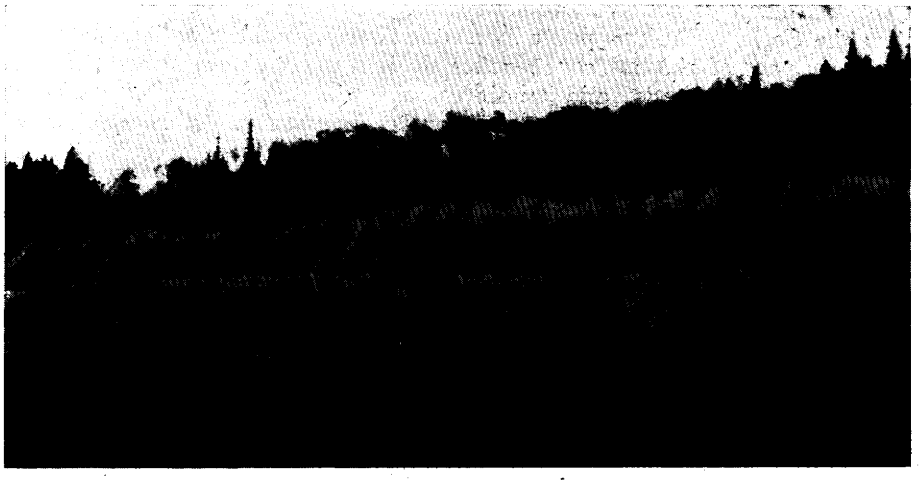
Above the greenish-grey dolomite comes a rather thick series of nodular, red and grey dolomitic shales. The red and grey colours often alternate in bands about a foot in thickness, giving a distinct banded appearance to the cliffs. On the Kenogami river these shales are exposed on one bank or the other almost all the way between the Pagwachuan and the Nagagami, a distance of 17 or 18 miles. The exposures are usually 30 to 35 feet high, but 10 miles below the Pagwachuan the cliff shows 60 feet of red shale. The valley as it cuts through

[1]Geol. Surv. Can., Rept. of Progress, 1871-72, pp. 111, 112.
[2]E. M. Kindle, Geol. Surv. Can., Sum. Rept., pt. C, 1923, p. 32.
[3]W. S. Dyer, Ont. Dept. Mines, Vol. XXXVII, pt. 6, 1928, pp. 17, 18.

the shales is marked by high steep banks surmounted by small poplar; the river is wide and the water very shallow. Elsewhere the banks are low, the river being narrow and the water deeper, and the forest consists chiefly of spruce.

On the Albany river high cliffs of red shale are found between 9 and 24 miles above the Forks. The appearance of the beds is the same as on the Kenogami, as is their height above water level.

On the Kenogami river, 3 miles above Little Drowning river, there is a small outcrop of dolomite and red ferruginous conglomerate with shale, dolomite, and chert pebbles. These rocks are referred to the Kenogami River formation. Some loose pieces of limestone containing fossils lay near by, but these were thought to be drift and to have come from the fossiliferous beds occurring either up or down stream. Between Drowning and Little Current rivers on the west side of the Kenogami there is a 15-foot outcrop of dolomite, which was also referred to the Kenogami River formation.



Red and grey shales of Kenogami River formation (Upper Silurian), on Kenogami river, 12 miles below English River post.

Among the red shales occurs a peculiar bed of limestone filled with spherules of calcite about one-tenth inch in diameter. In many places these have weathered out, leaving the limestone full of small holes. This bed was first seen on the Kenogami, 10 miles above English River post. Here it is 5 feet thick and occurs 20 feet above water level. A mile down stream the same peculiar bed is 40 feet above water level, showing a dip upstream at this point of about 20 feet per mile. The limestone is seen periodically in the outwash in the river banks for some miles below the Forks. What appears to be a different phase of the same bed occurs 15 feet above low-water level at the Forks of the Albany. This limestone, however, is oolitic in character; the oolites consist of pure calcite about one-tenth of an inch or less in diameter, the openings around the oolites being filled with soft marl or limestone.

It is naturally very difficult to form an opinion as to the thickness of the formation. The maximum observed thickness of the red shales is 60 feet, and the green dolomite the same. If the dip remains at the usual low figure (3 feet per mile) throughout the outcropping area, the thickness of the formation is not

much more than this, probably 200 feet in all, but if the dip of 20 feet per mile that was observed on the bed of spherulitic limestone continues for any distance, the thickness of the red shales may be considerably more than 60 feet, possibly as much as 200 feet, making a thickness for the whole formation of 300 or 350 feet.

Abitibi River Formation

The grey fossiliferous limestones of Devonian age outcropping on the lower Albany river are similar in all respects to and contain much the same series of fossils as the Abitibi River limestone occurring in the Moose River basin, which has previously been described in detail.[1] On the Albany, however, there are no extensive outcrops such as those of Grand rapids on the Mattagami river and Coral rapids on the Abitibi river. The limestone either forms the bed of the river or reaches a few feet above low-water level, and no folds or faults were seen by the writer.

The first outcrop definitely referred to the Abitibi River formation was seen on the south side of the river, about 10 miles below Snake island (27 to 28 miles below the Forks). At this point limestone rises 15 feet above low-water level. The lower part of the outcrop consists of light-grey, cherty limestone, full of brachiopods, pelecypods, and trilobites, and the upper part of darker-grey limestone with solitary and compound corals (*Favosites* sp. and *Streptelasma* sp.) The following fossils were identified from the cherty beds:—

Orthis *cf.* lenticularis, *Vanuxem.*
Leptaena rhomboidalis (*Wilckens*).
Stropheodonta hemispherica, *Hall.*
Stropheodonta *cf.* inequistriata (*Conrad*).
Stropheodonta perplana (*Conrad*).
Spirifer duodenaria (*Hall*).
Spirifer acuminata *var.*
Spirifer *cf.* arenosus (*Conrad*).
Amphigenia elongata (*Vanuxem*).
Atrypa reticularis (*Linnaeus*).
Chonetes hemisphericus, *Hall.*
Chonetes mucronatus, *Hall.*
Chonetes *sp. nov.*
Gypidula *sp.*
Centronella glansfagea, *Hall.*
Productella *sp.*
Conocardium cuneus (*Conrad*).
Actinopteria textilis arenaria, *Hall.*
Pleurotomaria *sp.*
Euryzone lucina (*Hall*).
Phacops logani (*Hall*).
Calymene platys, *Green.*

Williams[2] records most of these species and in addition the following:—

Dielasma calvini (*Hall* and *Whitfield*).
Orthothetes chemungensis (*Conrad*)*?*.
Orthis? eryna, *Hall.*
Spirifer audaculus (*Conrad*).
Nucleospira concinna, *Hall.*
Stropheodonta patersoni, *Hall.*
Zaphrentis ampla, *Hall.*
Favosites hemisphericus, *Yandell* and *Shumard?*
Stropheodonta perplana nervosa, *Hall.*
Dalmanites anchiops (*Green*).
Proetus macrocephalus, *Hall.*
Pterinea chemungensis (*Conrad*).
Lyriopecten priamus, *Hall?*

[1]W. S. Dyer, Geology and Economic Resources of the Moose River Basin, Ont. Dept. Mines, Vol. XXXVII, pt. 6, 1928.

[2]M. Y. Williams, Geol. Surv. Can., Sum. Rept., 1920, pt. D., p. 23.

The river at the head of Hat island and half way between Hat island and Chemahagan river is floored with limestone similar in appearance to that previously described.

Beginning 20 miles above Fort Albany and continuing to within about 5 miles of the post, flat-lying limestone often floors the river and in places makes small outcrops above low-water level. The best outcrop is at Upper Big rapid, 10 miles above the post. At this point grey limestone weathering buff rises 5 to 8 feet above low-water level. The lower beds have white chert inclusions. The following fossils were identified:—

Favosites *sp.*
Streptelasma *sp.*
Gypidula *sp.*
Chonetes mucronatus, *Hall.*
Spirifer arensosus (*Conrad*).
Spirifer duodenaria (*Hall*).
Leptaena rhomboidalis (*Wilckens*).
Amphigenia elongata (*Vanuxem*).
Anoplotheca concava, *Hall.*
Rhynchonella *cf.* prolifica, *Hall.*
Ostracods.
Conocardium cuneus (*Conrad*).
Atrypa reticularis (*Linnaeus*).
Bryozoa.
Pleurotomaria *sp.*
Stropheodonta hemisphericus, *Hall.*
Phacops *sp.*
Cephalopods.

In addition, Williams records *Plethomytilus ponderosus*, Hall. The fossil list given contains so many species that are common to the Abitibi River formation of the Moose River basin and the beds are so similar in appearance that there is no hesitancy in ascribing the Albany River beds to the same formation. As in the Moose River basin, the beds contain a dominating number of species characteristic of the Onondaga formation of southwestern Ontario and New York state. As is also true of the Moose River basin, many of the species of the Albany are also found in the Oriskany and Helderberg formations. In a previous report this was advanced as the reason for considering that the Onondaga seas had invaded the interior of the continent from the north. The species reported by Williams suggesting Hamilton, Marcellus, Portage, or Chemung affinities were not among the collections made by the writer.

It is a fact worthy of record that no beds definitely referable to the Moose River formation of the Moose River basin were seen on the Albany system. A few outcrops of buff dolomite, which may be correlatable with them, were seen, however, at two localities. The first of these outcrops, a small one, is on the north side of the Albany river about a mile below Old Man island, or six miles below the Forks, and the second was on the south side of the river about 5 miles above Fort Albany in front of the new Roman Catholic mission school.

Pleistocene and Recent Deposits

From the railway to within four miles of English River post the banks, where they do not consist of red shale, are made up of a typical boulder clay capped in places by a few feet of fine, sandy silt of lacustrine origin. At the point mentioned, however, post-glacial marine clay makes its appearance, and at English River post the following section was made by Williams from the low-water level up; sandy till containing boulders up to 1 foot in diameter, 24 feet; dark-grey

plastic clay containing specimens of *Saxicava rugosa*,[1] Linnaeus, 8 feet; cross-bedded sand containing *S. rugosa*, 3 feet; argillaceous sand and gravel, 3 feet; sandy loam, 3 feet.

At the mouth of the Kenogami river, east side, above the section of red shales and calcareous beds, there is about 35 feet of marine clays and sands full of shells. Marine clay was noticed also about 3 miles up the Albany river from the Forks, but was not seen above this point.

Robert Bell[2] reports the following Champlainian shells from the marine clay at the mouth of the Kenogami river and from the Albany, a short distance above the Kenogami:—

Saxicava rugosa.
Mya truncata.
Tellina proxima (change from columnar to linear form).
Cardium groenlandicum.
Leda truncata.
Mytilus edulis.
Tellina groenlandicum.
Buccinum undatum.

Downstream from the Forks to Black Bear island the banks of the river are quite low and sloping and covered with boulder pavement, turf, or outwash gravels and sands, and it is difficult to get a good section. At the foot of Black Bear island, however, the river quite suddenly becomes swifter and has cut its valley deeper; cut banks from 40 to 50 feet high are seen. These cut banks consist of boulder clay capped by sand and gravel, but marine clay may be expected back from the edge of the river at still greater elevations. The river valley continues quite steep to James bay, and cut banks of boulder clay are quite frequently seen as far down as the Head of the Island, about 17 miles above Fort Albany, where the river suddenly widens and is filled with islands. Low sloping banks are typical of this wide part of the river, and where clay banks occurred, these were of marine clay.

A peculiar section, probably of interglacial beds, was seen on the south side of Albany river, about 21 miles above the Forks. Williams[3] has measured the section as follows: brown shaly clay from water up, 6 feet; 2-inch bed of compact lignite, composed mostly of moss; 1½ feet of blue clay; 2-inch bed of lignite containing compressed roots about 2 inches in greatest diameter and 15 inches long; a few feet of blue clay overlain by boulder clay. Similar clay occurs in a high cut bank on the opposite shore a little farther downstream.

Economic Possibilities

Petroleum and Natural Gas

The oil and gas possibilities are not as good on the Albany as in the Moose River basin, where there are large areas underlain by complete sections of the Abitibi River limestone and covered by considerable thicknesses of the petroliferous shales of the Long Rapids formation and the clays and sands of the Mattagami River formation. It is considered that there is a fair chance that both the Abitibi River formation and the Long Rapids formation contain oil or gas. In the Albany River region, on the other hand, the Abitibi River formation is everywhere exposed and eroded. It is overlain only by unconsolidated boulder

[1]Fossils identified by E. J. Whittaker.
[2]Geol. Surv. Can., Rept. of Progress, 1871-72, p. 112.
[3]M. Y. Williams, op. cit., p. 24.

clays; the Long Rapids formation is not present. Oil and gas, however, have been found in Silurian and Ordovician sediments in southwestern Ontario, and in New York, Indiana, Ohio, and other states, but in the case of oil perhaps not in such quantities as in the Devonian. It is possible, therefore, that some oil or gas may be contained in the Silurian or Ordovician sediments in the Albany River region.

Ordovician rocks outcrop on the Hayes and Nelson rivers some 400 miles to the northwest, and their presence is indicated on the Little Current river by the following fossils[1] collected by W. J. Wilson from a point 82 miles above its mouth and identified by E. O. Ulrich.

Crinoid columns (probably some species of Heterocrinus).
Trematis sp. (closely allied to T. punctostriata, *Hall* and *Whitfield*.
Rafinesquina alternata (*Conrad*).
Anomalodontea gigantea, *Miller*.
Modiolopsis concentrica, *Hall* and *Whitfield*.

The horizon is given as Richmond. The Ordovician rocks no doubt underlie the younger sediments throughout large areas and may possibly underlie them in the Albany River region.

A sufficient cover of shales to retain oil or gas is probably present from the upper outcrops of red shales on the Upper Albany, Kenogami, and tributary rivers, down to James bay, but conditions would appear more favourable both for cover and thickness of sediments from the Forks down.

As far as can be seen the rocks dip very uniformly, and no one place in the whole area studied can be chosen as more favourable than another for drilling. Owing to the scarcity of outcrops, however, it cannot be said that favourable structure does not exist. Perhaps if test-drilling were contemplated, it would be as well to choose a location near Fort Albany. At the new Roman Catholic school, buff dolomites are exposed in the bed of the river; and as previously noted,[2] these dolomites may be correlatable with the Moose River formation, which underlies the Abitibi River formation in the Moose River basin. If this correlation is correct, the rocks are probably higher structurally in this locality than elsewhere in the region.

It has been previously pointed out that there are very shallow stretches on the Pagwachuan river during most of the season of navigation, which would cause some difficulty in transporting heavy drilling machinery down the river; but no doubt such machinery could be taken down the river in June or the early part of July.

Clays

Williams collected samples of "interglacial" clay from a point on the Albany river, 20 miles above the Forks, and referred this clay to Keele, who reported as follows: "Albany River clays would make very good common red brick, but would not be suitable for the manufacture of high grades of ware as they are easily fusible."

Since one 90-foot section of these clays is exposed there would, no doubt, be sufficient raw material for bricks in the immediate area. Boulder clays might be used in other places, but these clays are in general too variable and contain too much lime and too many boulders and pebbles to make good brick.

[1] J. F. Whiteaves, op. cit., pp. 34-36.
[2] See page 57.

Stone

Samples of dolomite and limestone from widely separated localities in the Albany River region were analysed in the Provincial Assay Office.[1] Two samples of the Pagwa River formation were found to be quite pure limestone; the one from the Upper Albany river, 7 miles above Muswabik river, was very pure, consisting of 99.30 per cent. calcium carbonate. Two samples of the Abitibi River formation were found to be quite high in calcium carbonate, but a third was cherty. Two samples of the lower member of the Kenogami River formation were found to be dolomites, one of them quite pure and the other argillaceous. There is, therefore, a large quantity of limestone for the manufacture of lime. Rough coursing stone could be obtained from almost any of the outcrops of limestone or dolomite, and it is probable that as quarries were opened up a better grade of building stone would be obtained.

[1]Pages 31, 32.

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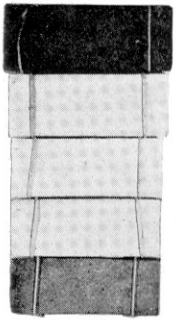
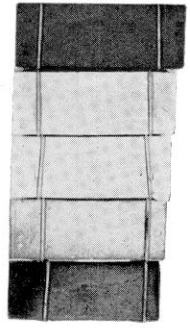


	% Porosity
Raw	
Cone 08 (1733°F.)	43·2
4 (2129°F.)	31·0
10 (2300°F.)	20·3
14 (2534°F.)	9·1

P.C.E.-Cone 33

(3173°F.)

Nº 64-2



	% Porosity
Raw	
Cone 08	38·1
4	31·4
10	24·9
14	15·5

P.C.E.-Cone 32½

(3130°F.)

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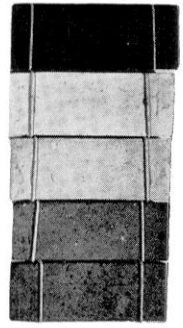
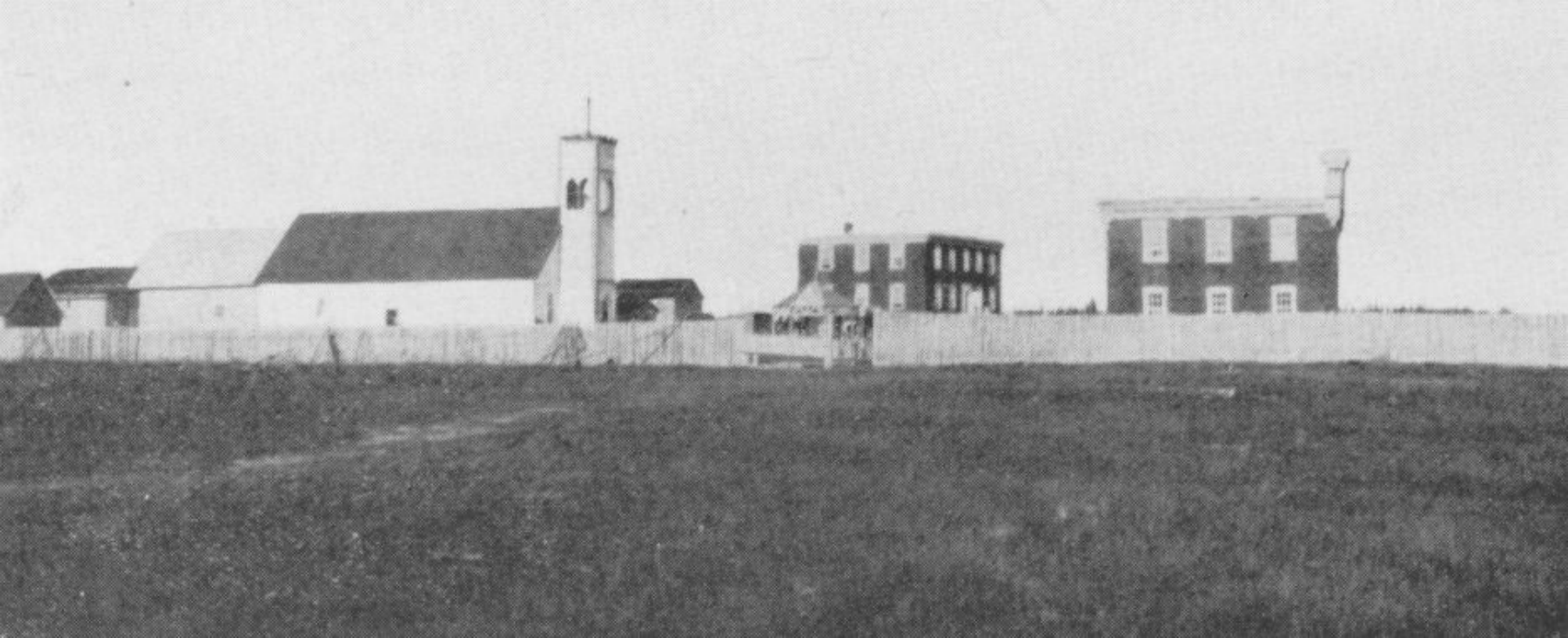
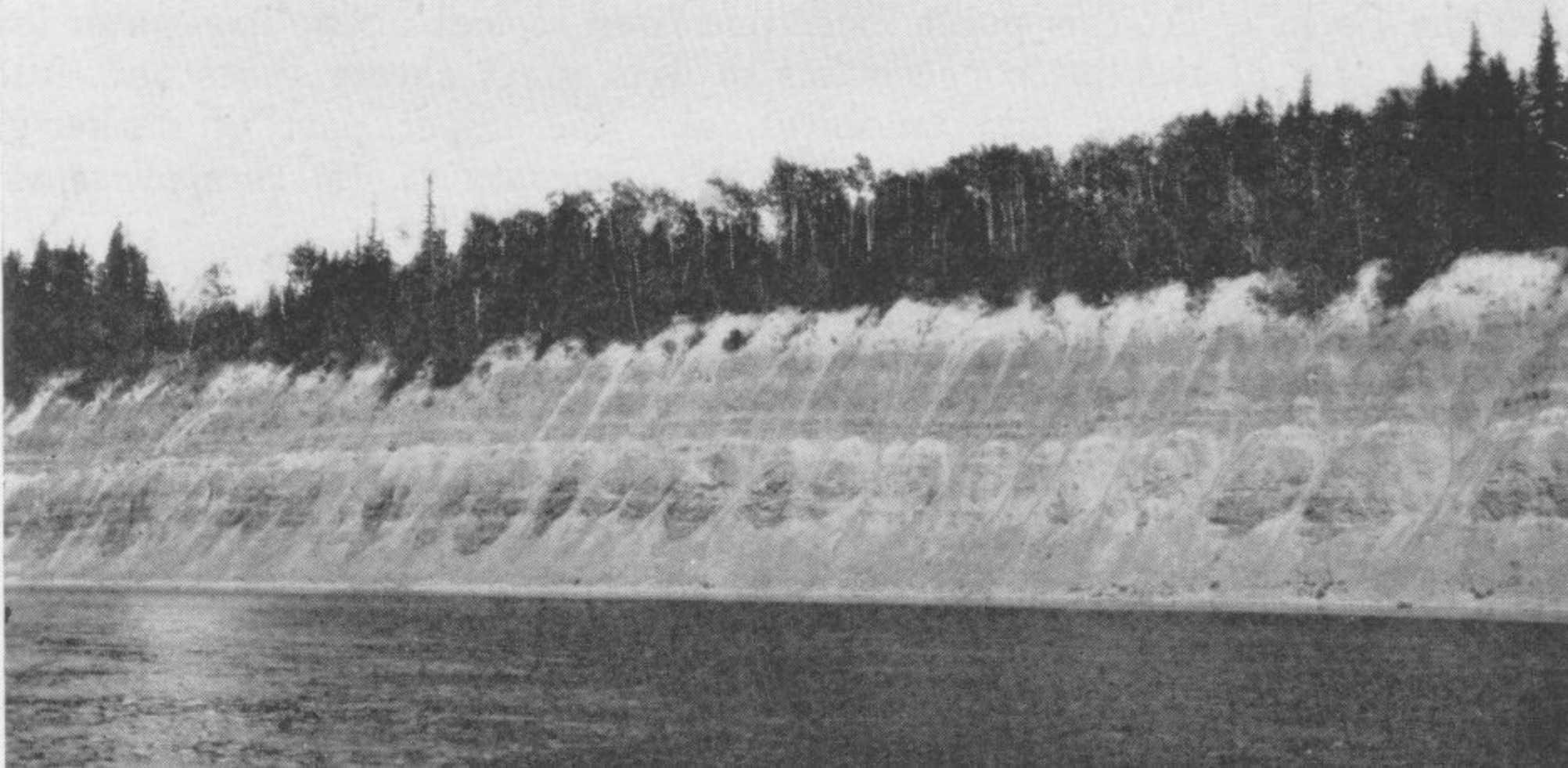


	% Porosity
Raw	
Cone 08	34·4
4	23·8
10	9·3
14	11·4

P.C.E.-Cone 23

(2876°F.)





Porcelain Tile Company
TILE
Province of Ontario
Province of Ontario
Canada

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. CHAS. MCCREA, *Minister of Mines* THOS. W. GIBSON, *Deputy Minister*

THIRTY-EIGHTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXVIII, PART V, 1929

Natural Gas in 1928, by R. B. Harkness - - - - - 1-34

Petroleum in 1928, by R. B. Harkness - - - - - 35-39

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NATURAL GAS IN 1928

By R. B. Harkness

General

The production of natural gas in Ontario in the year 1928 is valued at $4,535,312, which places this commodity fifth in importance among the minerals of this province, having exceeded in value the production of silver. The production by fields, as compared with past years, is given below in Table I.

TABLE I—NATURAL GAS PRODUCTION BY FIELDS, 1925–1928

County	Field	1925	1926	1927	1928
		M cu. ft.	M cu. ft.	M cu. ft.	M cu. ft.
Essex	Kingsville	4,966,207	5,365,423	4,994,071	5,228,451
Kent	Tilbury				
	Dover	126,687	159,136	189,438	178,273
Lambton	Dawn	50,913	14,937	12,666	16,204
	Oil Springs				
Middlesex	Crumlin	2,030	.....	.....	300
Elgin	Bayham	140,231	36,794	40,698	44,154
	Malahide				
Lincoln	Lincoln				
Haldimand	Haldimand	1,544,348	1,782,950	1,668,148	1,746,894
Wentworth	Wentworth				
Norfolk	Norfolk				
Brant	Onondaga	979	12,275	13,224	13,804
Welland	Welland	294,843	276,259	278,967	301,847
Bruce	Amabel	650	650	224	240
Peel	Caledon	.....	.....	1,500	100
Wells in surface drift	Howard and Sarnia	70,386	68,072	52,278	42,473
Private wells	.....	60,000	60,000	60,000	60,000
Total	.....	7,257,274	7,776,496	7,311,214	7,632,740

It will be noted that the increase in production is distributed over all the gas fields except the Dover field and the surface gas fields. This is explained by the fact that the Dover field is used only in times of excess demand or other emergency, and in 1928 the emergencies were fewer than in other years. The surface gas wells are very short lived, and the production depends on the discovery of new sources. These surface gas pools may supply one house for twenty years or more, but when they are required to supply a town they are exhausted in from two to five years.

The increase in the production (sales) of gas is due to the increase in the number of consumers, a more general use of gas for house-heating, a more severe winter accompanied by high winds, a healthy growth of Canadian industry, particularly the motor industry, where gas is used for soldering, brazing, welding, baking enamel, baking cores of moulds, tempering, and all the various uses for which a clean and concentrated heat is used in industry. Natural gas, burned with the correct proportion of air, gives a perfectly clean flame that can be

brought in contact with a metal surface without injury to the metal and without depositing scale, whereas in using oil, coal, or other fuel, the products of combustion must in most cases be kept from coming in contact with the metal surface. Gas, therefore, is a great time-saver, is very easily controlled, simplifies operations, and gives surer results. Consequently, there is a great demand for natural gas in industries where the above-mentioned operations are carried on.

The increase in the number of consumers is principally in Hamilton and Windsor. These cities have been growing rapidly in the past five years, and the gas companies are extending their pipes into new sections of these and other cities. This increase is most noticeable in 1927 and 1928.

The increased use of natural gas for house-heating is largely due to improvements in the application of the gas flame to the sides of the fire-box of furnaces and to the use of refractory materials in the fire-box. Further economy has been effected by the use of the thermostat, whereby the gas is turned on or off automatically.

Capital invested in all natural gas operations, including drilling, producing, and distribution, is $36,601,828; the number of men employed is 1,209; and the wages paid amount to $1,497,999.

The capital and wages included in drilling represent both oil and gas, so far as exploratory work is concerned. There are 31 drilling rigs operating within the province.

Changes and Improvements in Service

The Dominion Natural Gas Company report the purchase of the Sterling Natural Gas Company's well-pipe lines in Moulton, Sherbrooke, Wainfleet, and Humberstone townships and the distributing plant in the village of Humberstone and the town of Port Colborne.

Following the sale, the Dominion Natural Gas Company tied the Sterling pipe lines into their own system, thereby giving Port Colborne an additional supply of gas from the 800 wells of the Dominion Company in Haldimand and adjacent counties.

The Dominion Natural Gas Company have materially increased their distributing plants in Hamilton East and in St. Catharines, and have secured franchises in the township of Saltfleet and the village of Burlington. They have laid special 10-inch pipe lines across the new Welland canal to provide for future expansion. This company reports having made a systematic leakage survey of their distributing plants in Dundas, Thorold, Hagersville, Strafford-ville, Vienna, Port Burwell, and Wheatley, and have made necessary repairs.

The Southern Ontario Gas Company have built a purification plant at Glenwood to remove the hydrogen sulphide from the gas from their wells in the Tilbury field. This is described in detail on page 3. They have also done exploratory drilling, with some success, along the western margin of the Tilbury field.

The Union Natural Gas Company report having laid 58½ miles of 2- to 16-inch pipe line in the city of Windsor and the Border Cities, and 12½ miles of 1- to 8-inch pipes in Chatham and the surrounding area. They have connected the Dawn gas field directly to the main transmission pipe line from the Tilbury gas field to Sarnia; this will give a much more flexible service from the gas field in Dawn township.

Pipe replacements in the main transmission lines are as follows: Ridgetown line, 5½ miles of 6-inch; Windsor line, 1½ miles of 8-inch; Chatham line, 1 mile

of 8-inch; Petrolia line, 5 miles of 6-inch; Sarnia line, 2 miles of 10-inch; Tilbury line, 4 miles of 4-inch, replacing the old 3-inch line.

These improvements reflect the efforts of the gas companies to give better service and to reduce leakage.

Removing Sulphur from Natural Gas

Mention has been made[1] of previous experience in removing hydrogen sulphide from natural gas by washing with soda ash (sodium carbonate, Na_2CO_3). The Union Natural Gas Company have been using this process successfully since December, 1924. The Southern Ontario Gas Company's wells in the Tilbury field produce "sulphur gas," or natural gas containing from 350 to 400 grains of sulphur per cubic foot. The gas is distributed by this company in southern Essex county and to Hamilton through a pipe line that passes through the villages of West Lorne, Rodney, and Shedden, running near St. Thomas and London, and through Ingersoll, Woodstock, Paris, Galt, and Brantford. The residents of these municipalities had complained for some years about the odour of hydrogen sulphide in the gas and sulphur dioxide in the products of combustion; finally, when the experiment of the Union Natural Gas Company with the Koppers process had proved a success, the Southern Ontario Company decided to install a similar plant.

Briefly, the process is as follows: Two tanks are erected, one about 30 feet high, which is the treatment tank, and another twice this height, which is the revivifying tank. Each tank is filled with perforated wooden trays, so arranged that liquid and gas passing through will be brought into intimate contact over as great an area as possible. A solution of soda ash is pumped in at the top of the treatment tank and allowed to spray downward against a countercurrent of gas that enters at the bottom of the tank. A chemical action takes place in which the hydrogen sulphide in the gas is changed into sodium sulphate and other combinations and passes into the solution. The natural gas passes into the gas mains with the sulphur content reduced to between 7 and 15 grains per cubic foot; the solution of soda ash and sodium sulphate is pumped to the top of the revivifying tank and sprayed through the wooden trays against a countercurrent of air that is blown in at the base. The air purges the solution of the sulphur compounds and carries them to the atmosphere through a tall stack; the soda ash is returned to the tank to be used again.

It has been found that over a period of a year all solids in the gas are deposited on the trays in the tanks in the form of a slime, which dries to a grey powder. Many solids in a finely divided state are carried along with the gas stream, which may travel as fast as 60 miles per hour at times of "peaks." Fine particles of rock are carried out of the wells and scale from the pipes, but principally a fine dust, which is mostly sulphate of iron formed by the contact of hydrogen sulphide in the gas with the iron of the pipes. Before the gas was purified, this dust was carried for miles through the pipes[2] causing trouble with meters and regulators.

At present, this dust in the pipes between the wells and the purification plant is caught on these trays. There should be little more dust in the transmission pipe lines than was left in these lines before the gas was purified, and this should become less each year.

[1]Ont. Dept. Mines, Vol. XXXIV, pt. 5, 1925.
[2]Ont. Dept. Mines, Vol. XXXI, pt. 5, 1922, p. 15.

Increase in Domestic Consumption

Below is an analysis of the consumption of natural gas in Ontario in homes where gas is paid for. The free consumers and industries have been omitted, so also have the consumers in the city of Hamilton, who used natural gas mixed with manufactured gas until March, 1925, when the sale ceased upon the concluding of an agreement with the distributing company in the city.

Year	No. pay consumers	Quantity used
		cu. ft.
1921	58,609	5,937,316
1922	63,229	6,028,947
1923	62,352	6,210,459
1924	61,100	5,933,595
1925	62,338	5,300,424
1926	63,695	5,595,521
1927	66,818	5,210,315
1928	70,259	5,699,553

The decrease in the number of consumers in the years 1923 and 1924 coincides with the increase in gas rates, and suggests that it had the effect of turning a considerable number to other fuels, but the increase in the years following would indicate that they returned to gas as a fuel, or else new consumers took their places. The variation in the quantity of gas consumed while the number of consumers steadily increased is due entirely to the mildness or severity of the winters. There has been no material change in the gas rates since the year 1925. It is worthy of note that in 1928, with 12,000 more consumers than in 1921, nearly 240,000 M cubic feet less gas was used. Details of this comparison can be found in the reports for the years indicated in the tables giving the consumption of gas in towns, cities, and townships.

Exploratory Drilling

In the year 1928 very little exploratory drilling was done.

A well on St. Joseph's Island, near Sault Ste. Marie, was carried through the sediments to the "granite" without results.

A well near Shelburne, Dufferin county, drilled several hundred feet into the granite, was deepened with a diamond-drill; no report of any oil or gas has been made.

A well near the village of Acton, Halton county, was drilled through the Trenton to the granite without any commercial production, drilling being continued in the hope of finding oil or gas in the pre-Cambrian.

A well in the southeast corner of Moore township, Lambton county, has reached a depth of about 2,200 feet, and is being carried through the Trenton.

The Ajax Oil and Gas Company has completed a well (No. 3) through the Trenton in lot 1, concession IV, Dover East township, with an open flow of over one million feet. This proves that the Dover field extends in the direction indicated on the map accompanying part 5, Volume XXXII, of the Ontario Department of Mines. This company is planning further tests.

The Southern Ontario Gas Company and Bon Jasperson have each found extensions of the Tilbury field westward in Romney township.

Analysis of Gas Consumption

Tables II and III give details concerning the gas consumed in Ontario. By comparing these tables with those published in previous years, the history of prices and quantity consumed can be traced from year to year. It will be found of interest to note the changes in the ratio of gas used to the price charged from year to year.

TABLE II—GAS CONSUMPTION IN TOWNS AND CITIES, 1928

Town or city	Population	No. of consumers		Quantity consumed, M cu. ft.			Distance from gas field	Net rate per M cu. ft.
		Pay	Free	Pay	Free	Industrial		
							miles	
Aylmer	2,300	690	....	31,343	.....	.....	16	$0.90
Bartonville	300	54	....	3,089	.....	.....	19	.60
Belle River	800	178	....	17,280	.....	571	29	.55–.80
Belmont	350	53	....	2,191	.....	.....	9	.95
Binbrook	100	10	1	1,144	150	.....	1	.25–.40
Blenheim	1,560	569	1	52,370	148	8,105	20	.50–.75
Brantford	30,190	3,384	6	117,773	1,040	7,728	140	.80
Bridgeburg and Fort Erie	4,221	1,115	5	58,296	3,657	.....	8	1.00–1.30
Brigden	300	157	....	14,446	.....	1,581	30	.50–.75
Cainsville	400	128	....	6,204	.....	.....	4	.80
Caledonia	1,326	540	....	47,240	.....	.....	7	.60
Canfield	200	52	....	4,057	.....	691	1	.40
Cayuga	752	206	1	20,901	60	384	6	.60
Chatham	15,600	3,894	....	489,601	.....	7,607	22	.50–.75
Chippawa	1,100	119	....	7,883	.....	.....	5	.40–1.00
Comber	608	135	....	16,866	.....	1,723	19	.50–.75
Cottam	300	87	3	9,600	228	687	35	.55
Courtland	400	50	....	4,033	.....	89	3	.60
Courtright	441	120	....	12,917	.....	89	49	.50–.75
Crystal Beach	252	67	....	5,891	.....	.....	1	1.30
Delhi	750	269	....	23,007	.....	852	4	.60
Dorchester	360	103	....	7,931	.....	.....	95	.60–.75
Dresden and Tupperville	1,450	511	....	55,393	.....	419	30	.50–.75
Dundas	5,000	1,092	3	52,556	23	3,724	172	.70
Dunnville	3,705	969	4	103,109	406	12,563	7	.40–.60
Dutton	825	248	2	25,827	212	752	52	.55–.70
Echo Place	200	58	....	2,787	.....	.....	3	.80
Eden	88	26	....	1,567	.....	.....	11	.60
Essex	1,600	498	....	60,439	.....	3,839	33	.55–.80
Fairground	40	14	....	666	.....	.....	1	.60
Fenwick	164	98	....	5,737	.....	.....	18	.75
Fingal	460	46	1	3,813	99	799	71	.55–.70
Fisherville	72	53	....	5,382	.....	276	2	.50
Fonthill	740	190	....	7,227	.....	.....	25	1.20–.95
Galt	13,222	1,081	1	45,640	216	5,007	147	.80
Hagersville	1,200	397	....	35,595	.....	.....	14	.60
Hamilton	121,000	2,875	3	54,597	519	501,566	47	.75–1.00
Hamilton West		160	....	5,438	.....	.....	47	.70
Hepworth	330	10	....	240	.....	.....	1	.75
Highgate	410	114	1	12,604	138	.....	32	.50–.65
Ingersoll	5,000	876	2	40,036	323	2,365	100	.80
Jarvis	500	196	....	21,549	.....	.....	9	.60
Kingsville	3,500	709	1	95,479	254	1,328	30	.50–.55
Lake Shore	.....	347	....	8,379	.....	.....	16	1.50
Lambeth	475	88	....	5,807	.....	.....	84	.60–.75
Leamington	4,200	1,455	....	200,356	.....	4,728	20	.50
Lynedoch	151	45	....	3,481	.....	3,914	2	.60
Mabee	82	11	....	737	.....	.....	1	.60

TABLE II—GAS CONSUMPTION IN TOWNS AND CITIES, 1928—*Continued*

Town or city	Population	No. of consumers		Quantity consumed, M cu. ft.			Distance from gas field	Net rate per M cu. ft.
		Pay	Free	Pay	Free	Industrial		
							miles	
Merlin	350	148	....	16,755	.....	1,150	2	$.50–.75
Merritton	2,600	259	....	6,435	.....	.....	35	.75
Nelles Corners	55	26	....	3,022	.....	.....	1	.50
Niagara Falls	15,400	2,714	....	113,583	.....	.....	11	1.00–1.30
Oil Springs	500	111	....	6,994	.....	.....	2	.75
Paris	4,435	495	1	19,676	142	1,588	129	.80
Petrolia	2,836	769	....	87,433	.....	.....	60	.55–.80
Port Burwell	700	231	....	16,085	.....	.....	3	.60
Port Colborne and Humberstone	5,500	1,573	....	68,275	.....	3,750	5	.60–.95
Port Dover	1,575	542	....	51,890	.....	484	1	.60
Port Rowan	640	266	....	18,190	.....	.....	1	$0.60
Ridgetown	2,000	646	2	68,830	1,983	564	28	.50–.75
Ridgeway	700	204	....	14,892	.....	.....	1	1.00–1.30
Rodney	676	244	1	25,233	164	663	40	.55–.70
Ruthven	438	52	....	8,205	.....	.....	25	.55
St. Anns	90	29	....	1,018	.....	.....	7	.90
St. Catharines	22,000	4,345	2	212,998	517	11,623	35	.75
St. George	569	97	....	3,742	.....	55	148	.80
St. Williams	319	110	....	7,378	.....	966	1	.60
Sarnia	15,176	4,520	....	359,528	.....	.....	69	.55–.80
Selkirk	585	139	1	14,261	107	1,502	1	.60
Shedden	409	93	....	7,895	.....	.....	63	.55–.70
Simcoe	4,000	1,572	3	186,170	518	10,934	20	.60
Smithville	332	145	....	5,520	.....	.....	6	.80
Sombra and Port Lambton	2,000	175	....	16,886	.....	657	45	.55–.80
Stevensville	423	31	....	2,309	.....	.....	1	1.00
Straffordville	215	82	....	7,694	.....	409	6	.60
Thorold	7,624	886	....	36,837	.....	.....	35	.75
Tilbury	2,000	496	1	51,231	291	938	17	.50–.75
Tillsonburg	3,086	1,010	1	87,991	347	2,580	16	.63
Vienna	284	80	1	3,706	77	.....	1	.60–.80
Vittoria	260	86	....	5,611	.....	.....	3	.60
Wallaceburg	4,530	1,148	....	136,314	.....	102,987	27	.50–.75
Wallacetown	244	43	1	4,159	146	553	60	.55–.70
Welland	8,646	2,359	3	85,712	406	14,464	3	.45–1.30
Wellandport	141	17	1	334	25	.....	3	.75
West Lorne	818	216	3	23,605	284	734	49	.55–.70
Wheatley	647	242	....	24,253	.....	1,295	12	.50–.75
Windsor (Border Cities)	60,626	10,980	....	1,265,283	.....	29,952	45	.55–.80
Woodstock	10,196	1,569	1	70,215	270	2,025	110	.80
Total	.....	62,897	57	4,954,652	12,750	761,260	.....	.....

TABLE III—GAS CONSUMPTION IN TOWNSHIPS, 1928

Township	Population	No. of consumers		Quantity consumed, M cu. ft.			Net rate per M cu. ft.
		Pay	Free	Pay	Free	Industrial	
ESSEX:							
Gosfield, North	2,190	99	2	10,296	226	192	$0.55
Gosfield, South	2,301	299	1	44,045	550	40,684	.50–.55
Maidstone	2,099	77	7	7,042	1,557	587	.55–.80
Mersea	3,835	334	2	49,970	308	41,313	.40–.55
Rochester	1,931	197	6	17,486	1,391	435	.55–.80
Sandwich, East	1,090	20	1	2,413	583	.....	.55–.80
Sandwich, South	1,423	111	.....	12,879	.....	404	.55–.80
Sandwich, West	2,764	21	.....	3,249	.....	.....	.55–.80
Tilbury, North	1,788	25	.....	2,000	.....	48	.50–.75
Tilbury, West	1,543	23	1	1,565	179	.....	.50–.75
LAMBTON:							
Dawn	2,317	44	3	3,921	692	.....	.40–.65
Enniskillen	2,666	79	.....	7,191	.....	1,116	.55–.80
Euphemia	1,385	.....	6	.....	1,200	.....	.....
Moore	3,215	329	.....	24,920	.....	1,554	.50–.75
Sarnia	2,540	14	11	1,183	2,369	.....	.40–.80
Sombra	2,857	60	.....	3,954	.....	531	.50–.75
KENT:							
Chatham	4,935	68	.....	5,256	.....	642	.50–.75
Dover	3,606	411	1	50,740	129	7,690	.50–.65
Harwich	4,372	447	9	48,339	2,853	10,736	.50–.75
Howard	2,768	179	3	19,166	443	.....	.50–.75
Orford	1,870	21	2	2,709	344	.....	.50–.65
Raleigh	3,671	638	23	78,552	8,202	985	.40–.65
Romney	1,500	101	39	11,231	13,170	6	.40–.65
Tilbury, East	2,914	251	79	25,425	21,550	26,731	.40–.65
ELGIN:							
Aldborough	2,837	25	2	1,984	429	.....	.55–.60
Bayham	3,112	65	16	3,557	3,096	349	.60–.80
Dunwich	2,522	56	.....	5,485	.....	.....	.55–.60
Malahide	2,953	55	3	2,332	488	.....	.60–.80
Southwold	3,510	106	.....	8,976	.....	1,186	.55–.70
MIDDLESEX:							
Dorchester, North	3,056	21	1	1,341	300	.....	.60–.95
Westminster	6,122	141	.....	16,132	.....	.....	.60–.75
NORFOLK:							
Charlotteville	2,512	6	6	574	975	.....	.60
Middleton	2,037	27	4	2,039	695	.....	.60
Townsend	3,694	33	.....	3,861	.....	.....	.60
Walsingham, North	1,424	5	4	558	655	.....	.60
Walsingham, South	1,481	7	7	687	710	.....	.60
Windham	3,005	2	2	216	425	.....	.60
Woodhouse	1,964	160	11	17,600	1,806	.....	.60
BRANT:							
Brantford	7,220	7	.....	241	.....	.....	.80
Burford	3,833	3	.....	204	.....	.....	.80
Dumfries, South	2,532	8	.....	205	.....	.....	.80
Onondaga	1,017	48	15	3,601	3,114	.....	.60–.70
OXFORD:							
Oxford, East	1,724	9	.....	614	.....	.....	.80
Oxford, West	1,810	45	.....	5,379	.....	.....	.80

TABLE III—GAS CONSUMPTION IN TOWNSHIPS, 1928—*Continued*

Township	Population	No. of consumers		Quantity consumed, M cu. ft.			Net rate per M cu. ft.
		Pay	Free	Pay	Free	Industrial	
HALDIMAND:							
Canborough	902	90	41	6,886	7,283	592	$0.40–.60
Cayuga, North	1,309	32	16	1,615	3,704	.....	.40–.60
Cayuga, South	509	63	16	3,602	2,946	.....	.60
Dunn	796	124	11	7,633	2,689	.....	.60
Moulton	1,628	132	36	9,228	6,864	.....	.50–.60
Oneida	1,287	69	13	6,304	1,681	.....	.50–.60
Rainham	1,690	144	28	11,488	5,113	880	.40–.60
Seneca	1,561	130	35	13,063	7,219	.....	.60
Sherbrooke	277	55	11	4,089	1,405	.....	.40–.60
Walpole	3,042	313	61	22,341	9,632	931	.40–.60
LINCOLN:							
Caistor	1,220	63	2	5,842	393	266	.50–.60
Grantham	4,175	14	1	695	254	.....	.75
Grimsby	2,236	12	.....	561	.....	.....	1.25
Louth	2,548	10	.....	511	.....	.....	.75
WELLAND:							
Bertie	3,298	102	72	7,570	13,434	.....	.50–1.00
Crowland	3,748	80	24	3,556	3,938	.....	.75–1.00
Humberstone	2,047	145	38	9,665	7,180	.....	.75–1.00
Pelham	2,359	61	2	3,586	200	.....	.75
Stamford	4,896	165	4	9,482	748	.....	1.00
Thorold	3,369	20	1	820	160	.....	.75–.80
Wainfleet	2,357	104	32	6,659	6,600	.....	.40–.80
Willoughby	865	27	30	1,971	5,498	.....	1.00
WENTWORTH:							
Ancaster	4,524	51	.....	6,026	.....	.....	.70–.80
Barton	7,658	467	.....	67,763	.....	.....	.60
Binbrook	1,098	74	26	8,129	4,640	959	.45–.60
Glanford	1,417	123	4	15,068	949	869	.60
Saltfleet	4,682	15	.....	1,600	.....	.....	.60–.75
Total	.....	7,362	771	744,871	160,969	139,686	.....

SUMMARY

	M cu. ft.
Total distribution to customers	6,774,188
Used by companies for all purposes	113,698
Used by private well-owners	74,000
Leakage on transmission lines	394,805
Leakage on distribution plants	346,717
Leakage on rural lines	33,954
Leakage or loss on purchased gas	12,017
Total amount of gas distributed	7,749,379

Gas Wells and Their Production

In Table IV is given a summary by townships and fields of the number of gas wells in Ontario, their production, and the number abandoned; the number of new wells drilled, with their open flow; and the rock pressure of each field. An attempt has been made in past years to record the total number of acres under lease and the rentals paid in the province, but so many private individuals hold leases, from whom no satisfactory report can be obtained, and who rarely pay any rentals, that only operating companies have been reported.

TABLE IV—GAS WELLS AND THEIR PRODUCTION, 1928

County	Township	No. of wells producing	No. of wells abandoned	Wells drilled			Production	Rock pressure, lbs. per sq. in.	Acres under lease	Rental paid
				No. dry	No. producing	Open flow				
						M cu. ft.	M cu. ft.			
Essex	Gosfield, South	20			1	50		240	1,260	$466
	Mersea	3						275		
Kent	Romney	142	1	2	13	5,987	5,228,451	268	11,426	2,354
	Tilbury, East	138	4		12	2,615		255	100	400
	Raleigh	17			1	386		255	19,435	12,632
	Harwich							16	22,221	14,443
	Howard							9		
	Dover	9	1		3		178,273	333	5,216	3,933
Lambton	Dawn	14		4	4	2,247	5,910	669	69,565	45,289
	Enniskillen	3	1		1		6,994	100	730	
	Euphemia	6					1,200			
	Sarnia	14					2,100	70		
Middlesex	Dorchester, North	3					300	81	100	
Elgin	Bayham	41					44,154	172		
	Malahide	2						215		
Norfolk	Houghton	3						300		
	Middleton	25	1					314		
	Walsingham, South	15						360		
	Walsingham, North	9			1	95		365		
	Windham	8						220		
	Charlotteville	16		3				237		
	Woodhouse	55		2	6	344		242		
	Townsend	1						305		
Haldimand	Walpole	182	1	11	18	1,401		242		
	Rainham	152	1	5	23	2,716		236		
	Cayuga, North	103	4	8	17	253		233		
	Cayuga, South	60	3	2	3		1,746,894	151	183,456	62,439
	Oneida	23						134		
	Seneca	128	8	3	6	342		110		
	Canborough	129	1					96		
	Dunn	30	1	5	1			210		

TABLE IV—GAS WELLS AND THEIR PRODUCTION, 1928—*Continued*

County	Township	No. of wells producing	No. of wells abandoned	Wells drilled			Production	Rock pressure, lbs. per sq. in.	Acres under lease	Rental paid
				No. dry	No. producing	Open flow				
						M cu. ft.	M cu. ft.			
	Moulton	95	10	.....	.....	.....		103		
	Sherbrooke	12	.....	.....	.....	.....		150		
Wentworth	Binbrook	43	3	.....	.....	.....		76		
	Glanford	14	6	4	.....	.....		67		
Lincoln	Caistor	36	.....	.....	.....	.....		93		
	Gainsborough	5	.....	.....	.....	.....		160		
Welland	Wainfleet	41	.....	.....	2	16		45		
	Humberstone	90	2	.....	2	22		42		
	Crowland	48	5	.....	2	25	301,847	105		
	Willoughby	39	.....	.....	.....	.....		20		
	Bertie	85	3	.....	.....	.....		85		
Brant	Onondaga	27	1	.....	.....	.....		130	.....	.....
	Tuscarora	7	.....	.....	7	265	13,804	160	10,500	200
Bruce	Amabel	2	.....	.....	.....	.....	240	125	500	.....
Peel	Caledon	6	.....	.....	.....	.....	100	36	600	90
Surface wells	Howard	69	.....	.....	.....	.....	14,000[1]	.....	.....	.....
	Harwich						26,541[2]			
	Sarnia	2	1	.....	.....	.....	1,932	16	.....	.....
Private wells[3]	.....	300	6	2	6	.....	60,000[4]	.....	.....	.....
Total		2,272	64	51	129	16,764	7,632,740	.....	.....	.....
Imported mixed gas		.....	.....	.....	.....	.....	116,639	.....	.....	.....
Total distributed		.....	.....	.....	.....	.....	7,749,379	.....	.....	.....

[1]This gas is not metered and therefore must be estimated. The wells are owned privately, and the gas used for domestic purposes.
[2]This gas is sold to the Union Natural Gas Company, and was used in Ridgetown and Sarnia.
[3]Principally in Haldimand, Norfolk, and Welland counties.
[4]Estimated.

Leakage

The following tables give a statement of the measured leakage of gas from pipe lines between the wells and the consumer. This is not by any means all the leakage, as only 70 per cent. of the gas produced is measured.

The total measured leakage is 775,476 thousand cubic feet. If the leakage from the pipe lines where the gas is not metered is in the same proportion (and it is probably greater), the total leakage on all pipe lines in Ontario would be 1,107,823 thousand cubic feet, or 14.5 per cent. of the total production. Considering our extremes of temperature and the fact that nearly all the pipe lines where gas is measured have for years been subjected to sulphate corrosion, this is not excessive.

Gas companies have been making greater efforts in searching for defective and leaky pipe, and they conduct surveys of distribution plants or parts of plants to find the sources of the leakage. In most cases where excessive leakage is apparent it can be traced to one locality where the character of the soil accelerates corrosion, where there is some defective pipe, or where poor workmanship in installing the pipe is the cause.

TABLE V—LEAKAGE IN DISTRIBUTION PLANTS, 1928

Cities and towns	Company	Equivalent miles of 3-inch pipe in distribution plants	Volume received	Volume delivered	Leakage for year		Average No. of consumers	Leakage per consumer	Pressure distribution plants, ounces per sq. in.
					Actual	Allowable			
			M cu. ft.	M cu. ft.	M cu. ft.	M cu. ft.		cu. ft.	
Belle River	Union Natural Gas Co	3.25	18,109	17,851	258	650	180	1,433	6
Belmont	Ontario Salt Co	.67	7,893	2,391	5,502	134	60	91,700	6
Blenheim	Union Natural Gas Co	11.1	61,718	60,921	797	2,220	573	1,391	5
Brantford	Brantford Gas Co	91.59	137,722	126,598	11,124	18,318	3,368	3,295	4
Brigden	Union Natural Gas Co	3.4	16,521	15,608	913	680	159	5,742	5
Cainsville	Dominion Natural Gas Co	5.23	9,655	8,463	1,192	1,046	184	6,478	5
Chatham	Union Natural Gas Co	72.10	516,176	507,866	8,310	14,420	3,901	2,130	6
Comber	Union Natural Gas Co	2.75	19,362	18,589	773	550	139	5,561	5
Courtright	Union Natural Gas Co	2.8	13,915	12,999	916	560	121	7,570	5
Dorchester	Southern Ontario Gas Co	2.86	10,064	9,072	992	572	116	8,551	4
Dresden	Union Natural Gas Co	12	57,000	55,906	1,094	2,400	513	2,111	5
Dundas	Dominion Natural Gas Co	11.84	61,601	56,303	5,298	2,368	1,107	4,786	4
Dunnville	Dominion Natural Gas Co	13.17	109,250	104,613	4,637	2,634	976	4,751	4
Fenwick	United Gas Companies	1.37	7,284	6,334	950	274	103	9,233	4
Galt	Dominion Natural Gas Co	30.69	62,370	50,844	11,526	6,138	1,128	10,218	4
Hagersville	Dominion Natural Gas Co	7.24	44,005	35,595	8,410	1,448	397	21,183	4
Ingersoll	Dominion Natural Gas Co	22.25	51,471	42,725	8,746	4,450	920	9,506	4
Kingsville	Southern Ontario Gas Co	14.71	106,199	100,260	5,939	2,942	732	8,113	4
Leamington	Leamington Corporation	25.47	239,904	205,084	34,820	5,094	1,459	23,865	10
Merlin	Union Natural Gas Co	2.85	21,250	20,026	1,224	570	151	8,106	6
Mount Hamilton	Dominion Natural Gas Co	23.44	80,660	67,886	12,774	4,688	1,286	9,937	4
Paris	Dominion Natural Gas Co	13.56	31,637	21,668	9,969	2,712	517	19,282	4
Petrolia	Union Natural Gas Co	15.16	95,278	87,779	7,499	3,032	769	9,751	6
Port Burwell	Dominion Natural Gas Co	3.83	13,587	10,337	3,250	766	140	23,214	4
Port Lambton	Union Natural Gas Co	3.34	8,233	7,752	481	668	80	6,012	5
Ridgetown	Union Natural Gas Co	18.01	76,935	71,659	5,276	3,602	652	8,092	5
St. Catharines	United Gas Companies	53.38	278,918	223,132	55,786	10,676	4,388	12,713	4
St. George	Dominion Natural Gas Co	2.11	4,199	3,679	520	422	111	4,684	4
Sarnia	Union Natural Gas Co	92.96	402,205	360,690	41,515	18,593	4,520	9,184	5
Shedden and Fingal	Southern Ontario Gas Co	6.11	16,669	12,527	4,142	1,222	137	30,233	6
Simcoe	Dominion Natural Gas Co	29.33	205,758	194,453	11,305	5,866	1,774	6,372	4
Sombra	Union Natural Gas Co	2	8,889	8,875	14	400	98	143	6
Straffordville	Dominion Natural Gas Co	1.34	8,778	8,103	675	268	85	7,941	6

Thorold	United Gas Companies	12.79	39,961	38,744	1,217	2,558	896	1,358	4
Tilbury	Union Natural Gas Co	8.5	52,866	52,614	252	1,700	502	502	5
Tillsonburg	Dominion Natural Gas Co	23.15	94,902	90,057	4,845	4,630	1,018	4,759	4
Vienna	Dominion Natural Gas Co	1.04	1,605	1,136	469	208	18	26,055	6
Wallaceburg	Union Natural Gas Co	21.55	143,847	135,155	8,692	4,310	1,153	7,538	6
West Hamilton	Dominion Natural Gas Co	2.09	6,997	5,438	1,559	418	166	9,391	4
Wheatley	Southern Ontario Gas Co	3.61	29,048	25,548	3,500	722	248	14,112	5
Windsor	Union Natural Gas Co	151.5	1,342,673	1,295,235	47,438	30,300	11,028	4,301	5
Woodstock	Dominion Natural Gas Co	47.83	84,628	72,510	12,118	9,566	1,555	7,792	4
Total			4,599,742	4,253,025	346,717				

TABLE VI—LEAKAGE IN TRANSMISSION LINES, 1928

Transmission line	Size of pipe line	Equivalent miles of 3-in. pipe	Volume received	Volume delivered	Actual leakage	Average pressure on pipe lines
			M cu. ft.	M cu. ft.	M cu. ft.	lbs. per sq. in.
Dundas to Hamilton	6-inch	8.8	97,355	93,513	3,842	25
Gas field to Sarnia and Petrolia	6-, 8-, 10-, 12-in.	331.93	1,106,098	1,040,525	65,573	40–80
Dunnville to St. Catharines	8-inch	57.1	337,077	301,625	35,452	40
Kingsville to Hamilton	6-, 10-, 12-inch	710.5	1,730,003	1,563,609	166,394	70
Gas field to Chatham	6-, 8-inch	44.7	594,873	563,307	31,566	30–50
Gas field to Windsor	8-, 10-, 12-, 18-in.	284.01	1,595,407	1,547,877	47,530	30–100
Gas field to Ridgetown	4-, 6-, 8-inch	82	292,315	247,867	44,448	30–80
Total			5,753,128	5,358,323	394,805	

TABLE VII—LEAKAGE ON RURAL LINES, 1928

Township	Equivalent feet of 3-inch pipe in all rural lines	Volume received	Volume delivered	Leakage for year		Average No. of consumers	Leakage per consumer	Average pressure on pipe lines	
				Actual	Allowable			Low pressure	High pressure
		M cu. ft.	M cu. ft.	M cu. ft.	M cu. ft.		cu. ft.	ozs.	lbs.
Chatham	7,590	7,260	6,953	307	288	54	5,685	5	3
Dawn	13,445	2,176	2,161	15	509	15	1,000	5	.....
Dover	108,539	48,060	44,589	3,471	4,112	367	9,458	6	6
Enniskillen	11,292	6,021	4,926	1,095	426	56	19,554	6	7
Harwich	106,399	45,887	43,039	2,848	4,030	414	6,879	5	4½
Howard	16,363	9,994	9,538	456	620	91	5,011	6	3
Moore	21,972	14,890	13,559	1,331	832	218	6,105	6	4½
Raleigh	96,418	59,164	53,838	5,326	3,652	323	16,489	6	5
Raleigh (Blake system)	58,714	16,267	6,813	9,454	2,224	95	99,516	10	25
Rochester	30,652	23,475	22,205	1,270	1,161	170	6,471	5	6
Sandwich, South	4,506	6,358	6,043	315	171	47	6,703	5	7
Sandwich, West	2,508	4,907	4,853	54	96	35	1,542	5	.....
Sombra	3,042	846	647	199	115	13	15,307	5	.....
Tilbury, East	35,130	29,084	25,851	3,233	1,331	180	17,971	6	5½
Westminster	44,035	16,860	12,280	4,580	1,668	93	49,247	4	8
Total	560,605	291,249	257,295	33,954	21,235	2,171	.....	.....	.....

Licenses Issued in 1928

The Natural Gas Conservation Act, 1921, and the Well Drillers' Act, 1925, provide that all operations connected with natural gas and the drilling of oil wells shall be carried on under license. Tables VIII, IX, X, XI, and XII list the names of those to whom these licenses were issued in 1928.

TABLE VIII—OPERATORS LICENSED TO LEASE AND PROSPECT FOR NATURAL GAS, 1928

License No.	Name	Address
280	Ajax Oil and Gas Co.	501 Federal Building, Toronto, Ont.
282	Blain, E. B.	684 Main Street East, Hamilton, Ont.
292	Cherry, Robert	Collingwood, Ont.
277	Cliff Gas Co	Union Trusts Building, Rochester, N.Y.
273	Dominion Natural Gas Co.	Buffalo, N.Y.
271	Doran, Benj	R.R. 3, Meaford, Ont.
272	Hoover and May	Selkirk, Ont.
279	Industrial Natural Gas Co.	St. Catharines, Ont.
284	McCrimmon, J. E.	23 Peel Street, Brantford, Ont.
289	McKillop, Lambert	20 Hatt Street, Dundas, Ont.
276	McQuillan, M. W.	Dunnville, Ont.
290	Merchant, F.	Saginaw, Mich.
275	Patterson, W. C.	Jamestown, N.Y.
278	Petrol Oil and Gas Co.	146 King Street West, Toronto, Ont.
281	Pilkington Bros.	17 Mercer Street, Toronto.
313	Port Colborne–Welland Gas Co.	St. Catharines, Ont.
283	Seynuck, Tony	Acton, Ont.
291	Smith, H. B.	117 Oak Avenue, Windsor, Ont.
274	Southern Ontario Gas Co.	Buffalo, N.Y.
285	Union Natural Gas Co.	Chatham, Ont.
286	Union Natural Gas Co.	Chatham, Ont.
287	Union Natural Gas Co.	Chatham, Ont.
288	United Development Co.	Chatham, Ont.

TABLE IX—OPERATORS LICENSED TO DRILL OR BORE FOR NATURAL GAS, 1928

License No.	Name	Address
247	Bollert Gas and Petroleum Field Syndicate	129 King Street, Kitchener, Ont.
246	Culver and Bloomfield	Dunnville, Ont.
242	Georgian Bay Oil and Gas Co.	86 Drury Street, Toronto, Ont.
273	Gregory, G. F.	Petrolia, Ont.
244	Hoover and May	Selkirk, Ont.
245	Hoover and May	Selkirk, Ont.
265	Hussey and Perkins	Dunnville, Ont.
252	Industrial Natural Gas Co.	St. Catharines, Ont.
243	Jasperson, Bon	Kingsville, Ont.
304	Kerwin and Dawson	Merlin, Ont.
255	Kiser Bros.	Chatham, Ont.
256	Kiser Bros.	Chatham, Ont.
257	Kiser Bros.	Chatham, Ont.
258	Kiser Bros.	Chatham, Ont.
269	Lauer, D. G.	Tillsonburg, Ont.
253	Lymburner and Webber	Dunnville, Ont.
259	McCutcheon, T. J.	Dunnville, Ont.
260	McCutcheon, T. J.	Dunnville, Ont.

TABLE IX—*Continued.*

License No.	Name	Address
266	McCutcheon, T. J	Dunnville, Ont.
267	McCutcheon, T. J	Dunnville, Ont.
262	McKechnie, S	Dunnville, Ont.
263	McKechnie, S	Dunnville, Ont.
264	McKechnie, S	Dunnville, Ont.
248	McKillop, Wm	Hepworth, Ont.
249	McKillop, Wm	Hepworth, Ont.
254	McLister, J. J	Dunnville, Ont.
271	McMullen, Richard	Manitowaning, Ont.
275	Merchant, F	Saginaw, Mich.
251	Oil Springs Oil and Gas Co	Oil Springs, Ont.
306	Port Colborne–Welland Gas Co	Port Colborne, Ont.
299	Randall, A. E	R.R. 6, Hagersville, Ont.
268	Schafer and Benner	Delhi, Ont.
272	Seynuck, Tony	Acton, Ont.
270	Snively, F. L	Hamilton, Ont.
274	Snively, F. L	Hamilton, Ont.
250	Stover, F. H., and Son	Chatham, Ont.
261	Sundy, Basil K	Dunnville, Ont.
276	Willets, D. E	Bothwell, Ont.

TABLE X—OPERATORS LICENSED TO PRODUCE NATURAL GAS, 1928

License No.	Name	Address
404	Ajax Oil and Gas Co	501 Federal Building, Toronto, Ont.
409	Azoff Gas Co	Canboro, Ont.
438	Canboro Gas and Oil Co	Cayuga, Ont.
407	Canfield Natural Gas Co	Canfield, Ont.
395	Cliff Gas Co	Union Trusts Building, Rochester, N.Y.
399	Coleman, J. A	Wellandport, Ont.
391	Dominion Natural Gas Co	Buffalo, N.Y.
398	Dunn Natural Gas Co	Dunnville, Ont.
393	Erie Gas and Oil Syndicate	Fisherville, Ont.
410	Fisherville Gas Co	Fisherville, Ont.
401	Industrial Natural Gas Co	St. Catharines, Ont.
388	Jasperson, Bon	Kingsville, Ont.
430	Medina Natural Gas Co	Chatham, Ont.
397	Midfield Natural Gas Co	Hamilton, Ont.
389	Nelles Corners Syndicate	R.R. 2, Hagersville, Ont.
406	Niece, Hosea and Son	Lowbanks, Ont.
403	Oil Springs Oil and Gas Co	Oil Springs, Ont.
394	Patterson, W. C	Jamestown, N.Y.
400	Petrol Oil and Gas Co	146 King Street West, Toronto, Ont.
440	Port Colborne–Welland Gas Co	Port Colborne, Ont.
405	Provincial Natural Gas Co	Niagara Falls, Ont.
402	Rainham Gas and Oil Syndicate	Fisherville, Ont.
434	Smith, Robt. H	Lowbanks, Ont.
392	Southern Ontario Gas Co	Buffalo, N.Y.
432	Springvale Gas and Oil Co	Hagersville, Ont.
408	Sterling Natural Gas Co	Port Colborne, Ont.
387	Stevensville Gas Co	Stevensville, Ont.
411	Union Natural Gas Co	Chatham, Ont.
390	United Gas Companies	St. Catharines, Ont.
442	Vacuum Gas and Oil Co	Toronto, Ont.
396	Yager, J. J	Selkirk, Ont.

TABLE XI—OPERATORS LICENSED TO DISTRIBUTE NATURAL GAS, 1928

License No.	Name	Address
313	Brantford Gas Co.	Brantford, Ont.
348	Central Pipe Line Co.	Chatham, Ont.
329	Chatham Gas Co.	Chatham, Ont.
320	Chippewa Development Co.	Chippawa, Ont.
316	Cliff Gas Co.	Union Trusts Building, Rochester, N.Y.
323	Coleman, J. A.	Wellandport, Ont.
312	Dominion Natural Gas Co.	Buffalo, N.Y.
326	Fisherville Gas Co.	Fisherville, Ont.
322	Industrial Natural Gas Co.	Thorold, Ont.
324	Lakeshore Gas Co.	Fort Erie, Ont.
325	Leamington Corporation	Leamington, Ont.
315	Manufacturers Gas Co.	Hamilton, Ont.
321	Oil Springs Oil and Gas Co.	Oil Springs, Ont.
351	Port Colborne–Welland Gas Co.	Port Colborne, Ont.
318	Provincial Natural Gas Co.	Niagara Falls, Ont.
311	Southern Ontario Gas Co.	Buffalo, N.Y.
349	Springvale Gas and Oil Co.	Hagersville, Ont.
317	Sterling Natural Gas Co.	Port Colborne, Ont.
327	Union Natural Gas Co.	Chatham, Ont.
314	United Gas Companies	St. Catharines, Ont.
328	Windsor Gas Co.	Windsor, Ont.

TABLE XII—OPERATORS LICENSED TO OPERATE PIPE LINES, 1928

License No.	Name	Address
77	Central Pipe Line Co.	Chatham, Ont.
69	Dominion Natural Gas Co.	Buffalo, N.Y.
68	Southern Ontario Gas Co.	Buffalo, N.Y.
71	Union Natural Gas Co.	Chatham, Ont.
70	United Gas Companies	St. Catharines, Ont.

Logs of Wells

The logs of oil and gas wells drilled in Ontario in 1928 are given on the pages following. They show the formation, total depth, and occurrences of gas, oil, and water as reported by the drillers.

These logs are on file in the office of the Natural Gas Commissioner, and they give the length of casing used as well as other information regarding the texture of formations. In many cases samples of drill cuttings are available to the public. The source of the information for the logs that follow is the company or the person whose name appears at the top of each log.

ABBREVIATIONS

Tp.....Township.
Con.....Concession.
Pt.....Part.
N.E.¼.....Northeast quarter.
S.E.¼.....Southeast quarter.
B.F.....Broken front.
N.T.R.....North of Talbot Road.
R.R.....River Range.
S.H.R.....South of Hamilton Road.
S.T.R.....South of Talbot Road.
T.R.....Talbot Road.

Brant County

WM. MCKILLOP, HEPWORTH
Lot F, Indian Trail, Brantford tp.

Completed June 15, 1928.
Open flow: 20,000 cu. ft.
Rock pressure: 150 lbs.

Formation	Thickness, ft.
Surface	75
Guelph	71
Niagara (Lockport)	194
Black shale (Rochester)	41
Clinton	23
Red Medina	54
Grey shale (Cabot Head)	66
White Medina (Whirlpool)	12
Queenston	70
Total depth	606

Gas at 530 feet.

WM. MCKILLOP, HEPWORTH
Lot F 1, S.H.R., Brantford tp.

Completed September 2, 1928.
Open flow: 30,000 cu. ft.
Rock pressure: 190 lbs.

Formation	Thickness, ft.
Surface dry sand	80
Guelph	65
Niagara	201
Black shale	28
Clinton	28
Red Medina	42
Grey shale, soft	35
Grey shale, hard	35
White Medina	16
Red shale	75
Total depth	605

Gas at 524 feet.

FRED MANN, BRANTFORD
Pt. of lot 6, con. III, Onondaga tp.

Completed September 25, 1928.
Open flow: 9,700 cu. ft.

Formation	Thickness, ft.
Clay	123
Brown lime	55
Niagara	222
Shale	34
Clinton	20
Red Medina	25
Blue shale	55
White Medina	21
Red shale	50
Total depth	605

Gas at 457 feet.

CAINSVILLE GAS AND OIL SYNDICATE, KITCHENER
Lot 6, con. III, Onondaga tp.

Completed December 22, 1928.
Open flow: 10,000 cu. ft.
Rock pressure: 160 lbs.

Formation	Thickness, ft.
Surface	110
Brown lime	60
Niagara	225
Grey shale	53
Clinton	10
Red Medina	20
Blue shale	55
White Medina	22
Red shale	50
Total depth	605

Gas at 553 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 42, R.R., Tuscarora tp.

Completed October 17, 1928.
Open flow: 107,000 cu. ft.

Formation	Thickness, ft.
Clay	39
Salina	15
Guelph and Niagara	255
Rochester	61
Clinton	15
Red Medina	15
Cabot Head	71
White Medina	18
Queenston	103
Total depth	592

Gas at 485 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 43, R.R., Tuscarora tp.

Completed November 13, 1928.
Open flow: 55,000 cu. ft.
Rock pressure: 160 lbs.

Formation	Thickness, ft.
Clay	55
Salina	15
Guelph and Niagara	260
Rochester	54
Clinton	18
Red Medina	18
Cabot Head	72
White Medina	18
Queenston	100
Total depth	610

Gas at 530 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 45, R.R., Tuscarora tp.

Completed December 4, 1928.
Open flow: 110,000 cu. ft.
Rock pressure: 160 lbs.

Formation	Thickness, ft.
Sand	20
Clay	48
Salina	15
Guelph and Niagara	260
Rochester	50
Clinton	21
Red Medina	20
Cabot Head	65
White Medina	18
Queenston	102
Total depth	619

Gas at 536 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 27, R.R., Tuscarora tp.

Completed March 23, 1928.
Open flow: 10,000 cu. ft.
Rock pressure: 50 lbs.

Formation	Thickness, ft.
Clay	116
Salina	31
Guelph and Niagara	235
Rochester	52
Clinton	12
Grey shale	12
Red Medina	15
Cabot Head	57
White Medina	20
Queenston shale	50
Total depth	600

PETROL OIL AND GAS CO., TORONTO
Lot 15, con. VI, Tuscarora tp.

Completed January 25, 1928.
Open flow: 134,500 cu. ft.
Rock pressure: 40 lbs.

Formation	Thickness, ft.
Clay	53
Salina	42
Guelph and Niagara	242
Rochester	50
Clinton	16
Red Medina	17
Manitoulin	70
White Medina	14
Queenston	116
Total depth	620

Gas at 495 feet.

Haldimand County

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 47, con. I, Cayuga N. tp.

Completed September 8, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	29
Flint	60
Lime and shale	340
Niagara	225
Shale	55
Clinton	30
Red Medina	30
Shale	55
White Medina	15
Shale	5
Total depth	844

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 34, con. II, Cayuga N. tp.

Completed January 14, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	58
Brown lime	20
Lime and shale	232
Niagara	225
Shale	55
Clinton	30
Red Medina	45
Shale	51
White Medina	12
Red shale	3
Total depth	731

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 41, con. II, S.T.R., Cayuga N. tp.

Completed June 1, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	10
Flint	7
Lime and shale	428
Niagara	225
Rochester	55
Clinton	30
Red Medina	40
Cabot Head	55
Whirlpool	17
Queenston	6
Total depth	873

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 34, con. II, Cayuga N. tp.

Completed October 30, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	17
Hard rock	5
Shell rock	5
Hard rock	20
Shell rock	43
Lime and shale	260
Niagara	225
Shale	55
Clinton	30
Red Medina	45
Grey shale	50
White Medina	13
Red shale	3
Total depth	771

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 35, con. II, Cayuga N. tp.

Completed December 5, 1928.
Open flow: 39,000 cu. ft.
Rock pressure: 368 lbs.

Formation	Thickness, ft.
Surface	10
Shell rock	87
Lime and shale	258
Niagara	225
Shale	55
Clinton	30
Red Medina	45
Grey shale	47
White Medina	12
Red shale	3
Total depth	772

Gas at 638 and 662 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 46, con. I, S.T.R., Cayuga N. tp.

Completed July 25, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	17
Flint (Onondaga)	60
Lime and shale (Salina and Akron-Bertie)	318
Niagara	250
Shale (Rochester)	50
Clinton	32
Red Medina	45
Shale (Cabot Head)	55
White Medina	15
Shale (Queenston)	4
Total depth	846

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 23, con. I, N.T.R., Cayuga N. tp.

Completed April 5, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	62
Lime and shale	220
Niagara	230
Shale	50
Clinton	30
Red Medina	40
Grey shale	50
White Medina	16
Red shale	4
Total depth	702

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 24, con. I, S.T.R., Cayuga N. tp.

Completed January 3, 1928.
Open flow: 72,000 cu. ft.
Rock pressure: 315 lbs.

Formation	Thickness, ft.
Surface	44
Lime and shale	251
Niagara	225
Shale	48
Clinton	32
Red Medina	40
Grey shale	50
White Medina	14
Red shale	3
Total depth	707

Gas at 592 feet.

H. BARTLETT, CHAS. ROSS, D. HOUCK, D. P. FRY, DUNNVILLE
End of Deltz Road, Dunnville

Open flow: 20,000 cu. ft.
Rock pressure: 160 lbs.

Formation	Thickness, ft.
Surface	82
Salina shale	200
Guelph and Niagara	215
Rochester shale	63
Clinton	34
Red Medina	40
Grey shale	60
White Medina	12
Red shale	50
Total depth	756

Gas at 569 feet.

H. BARTLETT, CHAS. ROSS, D. HOUCK, D. P. FRY, DUNNVILLE
Cedar St., Dunnville

Open flow: 33,000 cu. ft.
Rock pressure: 155 lbs.

Formation	Thickness, ft.
Surface	83
Salina shale	220
Guelph and Niagara	215
Rochester shale	63
Clinton	32
Red Medina	42
Grey shale	58
White Medina	12
Red shale	49
Total depth	774

Gas at 720 feet.

H. BARTLETT, CHAS. ROSS, D. HOUCK, D. P, FRY, DUNNVILLE
Broad St., Dunnville

Open flow: 36,000 cu. ft.
Rock pressure: 155 lbs.

Formation	Thickness, ft.
Surface	83
Salina shale	237
Guelph and Niagara	218
Rochester shale	63
Clinton	32
Red Medina	48
Grey shale	59
White Medina	12
Red shale	48
Total depth	800

Gas at 750 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 7, con. III, Rainham tp.

Completed January 17, 1929.
Open flow: 272,000 cu. ft.
Rock pressure: 415 lbs.

Formation	Thickness, ft.
Surface	18
Flint	88
Lime and shale	371
Niagara	225
Shale	58
Clinton	30
Red Medina	42
Shale	55
White Medina	18
Red shale	67
Total depth	972

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 9, con. IV, Rainham tp.

Completed January 10, 1928.
Open flow: 52,000 cu. ft.
Rock pressure: 445 lbs.

Formation	Thickness, ft.
Surface	35
Flint	29
Lime and shale	395
Niagara	235
Shale	53
Clinton	32
Red Medina	40
Shale	55
White Medina	15
Red shale	7
Total depth	896

Gas at 772 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 10, con. IV, Rainham tp.

Completed September 29, 1928.
Open flow: 65,000 cu. ft.
Rock pressure: 472 lbs.

Formation	Thickness, ft.
Surface	5
Flint	50
Lime and shale	383
Niagara	232
Shale	62
Clinton	29
Red Medina	42
Shale	55
White Medina	17
Shale	5
Total depth	880

Gas at 752 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 11, con. II, Rainham tp.

Completed September 18, 1928.
Open flow: 88,000 cu, ft.
Rock pressure: 393 lbs.

Formation	Thickness, ft.
Surface	22
Flint	100
Lime and shale	298
Niagara	280
Shale	52
Clinton	28
Red Medina	40
Shale	55
White Medina	16
Shale	6
Total depth	897

Gas at 800 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 11, con, II, Rainham tp.

Completed December 13, 1928.
Open flow: 535,000 cu. ft.
Rock pressure: 378 lbs.

Formation	Thickness, ft.
Surface	9
Flint	110
Lime and shale	346
Niagara	235
Shale	56
Clinton	30
Red Medina	40
Shale	57
White Medina	15
Red shale	69
Total depth	967

Gas at 893 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 23, con. I, Rainham tp.

Completed June 22, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	11
Flint	40
Lime and shale	369
Niagara	230
Shale (Rochester)	57
Clinton	25
Red Medina	45
Shale	57
White Medina	20
Shale	7
Total depth	861

DOMINION NATURAL GAS CO., BUFFALO, N.Y.,
Lot 10, con. II, Rainham tp.

Completed October 30, 1928.
Open flow: 78,000 cu. ft.
Rock pressure: 373 lbs.

Formation	Thickness, ft.
Surface	21
Flint	100
Lime and shale	330
Niagara	250
Shale	57
Clinton	28
Red Medina	40
Shale	56
White Medina	16
Red shale	57
Total depth	955

Gas at 892 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 17, con. I, Rainham tp.

Completed April 28, 1928.
Open flow: 30,000 cu, ft.
Rock pressure: 370 lbs.

Formation	Thickness, ft.
Surface	14
Flint	70
Lime and shale	346
Niagara	235
Shale	62
Clinton	30
Red Medina	43
Shale	53
White Medina	18
Shale	4
Total depth	875

Gas at 777 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lots 9 and 10, con. III, Rainham tp.

Completed November 5, 1928.
Open flow: 39,000 cu, ft.
Rock pressure: 310 lbs.

Formation	Thickness, ft.
Surface	23
Flint	48
Lime and shale	383
Niagara	241
Shale	58
Clinton	29
Red Medina	42
Shale	56
White Medina	18
Shale	7
Total depth	905

Gas at 797 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 11, con. II, Rainham tp.

Completed August 4, 1928.
Open flow: 34,000 cu. ft.
Rock pressure: 378 lbs.

Formation	Thickness, ft.
Surface	23
Flint	100
Lime and shale	297
Niagara	280
Shale	50
Clinton	28
Red Medina	40
Shale	55
White Medina	16
Shale	5
Total depth	894

Gas at 790 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 9, con. IV, Rainham tp.

Completed June 27, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	26
Flint	32
Lime and shale	388
Niagara	235
Shale	58
Clinton	27
Red Medina	43
Shale	55
White Medina	17
Shale	6
Total depth	887

DOMINION NAUTRAL GAS CO., BUFFALO, N.Y.
Lot 10, con. IV, Rainham tp.

Completed May 15, 1928.
Open flow: 185,000 cu. ft.
Rock pressure: 420 lbs.

Formation	Thickness, ft.
Surface	16
Flint	37
Lime and shale	391
Niagara	239
Shale	55
Clinton	29
Red Medina	42
Shale	53
White Medina	16
Shale	4
Total depth	882

Gas at 763 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 18, con. I, Rainham tp.

Completed February 11, 1928.
Open flow: 55,000 cu. ft.
Rock pressure: 372 lbs.

Formation	Thickness, ft.
Surface	14
Flint	71
Lime and shale	345
Niagara	240
Shale	65
Clinton	30
Red Medina	45
Shale	44
White Medina	18
Shale	3
Total depth	875

Gas at 780 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 19, con. I, Seneca tp.

Completed November 17, 1928.
Open flow: 80,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	72
Shale	150
Niagara and shale	225
Shale	52
Clinton	24
Red Medina	43
Shale	44
White Medina	12
Red shale	50
Total depth	672

Gas at 618 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 9, NW. ¼, con. III, Rainham tp.

Completed December 7, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	30
Flint	40
Lime and shale	384
Niagara	234
Shale	63
Clinton	29
Red Medina	42
Shale	55
White Medina	19
Shale	5
Total depth	901

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 15, Young tract, Seneca tp.

Completed November 30, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	18
Lime and shale	172
Niagara	223
Shale	45
Clinton	25
Red Medina	38
Shale	52
White Medina	15
Red shale	4
Total depth	592

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 10, con. IV, Rainham tp.

Completed August 4, 1928.
Open flow: 500,000 cu. ft.
Rock pressure: 465 lbs.

Formation	Thickness, ft.
Surface	12
Flint	43
Lime and shale	385
Niagara	233
Shale	58
Clinton	29
Red Medina	42
Shale	55
White Medina	19
Shale	5
Total depth	881

Gas at 751 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 18, con. I, Seneca tp.

Completed December 10, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	60
Shale	166
Niagara and lime	224
Shale	60
Clinton	22
Red Medina	42
Shale	50
White Medina	9
Red shale	5
Total depth	638

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 19, con. I, Rainham tp.

Completed March 24, 1928.
Open flow: 21,000 cu. ft.

Formation	Thickness, ft.
Surface	7
Flint	65
Lime and shale	358
Niagara	235
Shale	61
Clinton	22
Red Medina	44
Shale	53
White Medina	18
Red shale	4
Total depth	867

Gas at 768 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 14, con. IV, Seneca tp.

Completed August 16, 1928.
Open flow: 36,000 cu. ft.
Rock pressure: 148 lbs.

Formation	Thickness, ft.
Surface	70
Lime and shale	70
Niagara	233
Shale	49
Clinton	28
Red Medina	34
Shale	58
White Medina	12
Red shale	50
Total depth	604

Gas at 547 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 13, con. IV, Seneca tp.
Completed September 1, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	49
Shale	63
Niagara and lime	238
Shale	43
Clinton	18
Red Medina	32
Shale	62
White Medina	12
Red shale	3
Total depth	520

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 15, con. IV, Seneca tp.
Completed September 17, 1928.
Open flow: 14,400 cu. ft.
Rock pressure: 129 lbs.

Formation	Thickness, ft.
Surface	55
Shale	65
Niagara and lime	232
Shale	51
Clinton	23
Red Medina	33
Shale	57
White Medina	14
Red shale	51
Total depth	581

Gas at 526 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 4, con. II, Seneca tp.
Completed October 13, 1928.
Open flow: 52,000 cu. ft.
Rock pressure: 175 lbs.

Formation	Thickness, ft.
Surface	36
Shale	89
Niagara and lime	238
Shale	41
Clinton	26
Red Medina	38
Shale	58
White Medina	12
Red shale	6
Total depth	544

Gas at 440 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 4, con. II, Seneca tp.
Completed October 31, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	45
Shale	85
Niagara and lime	235
Shale	49
Clinton	23
Red Medina	42
Shale	58
White Medina	11
Red shale	50
Total depth	598

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
SE. pt. Fish Carrier tract and NW. pt. Young tract fronting on Grand river, Seneca tp.
Completed January 4, 1929.
Open flow: 65,000 cu. ft.
Rock pressure: 190 lbs.

Formation	Thickness, ft.
Surface	52
Lime and shale	164
Niagara	230
Shale	44
Clinton	35
Red Medina	30
Shale	55
White Medina	15
Red shale	50
Total depth	675

Gas at 530 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 18, con. I, Seneca tp.
Completed January 4, 1929.
Open flow: 17,280 cu. ft.
Rock pressure: 190 lbs.

Formation	Thickness, ft.
Surface	80
Shale	145
Niagara	225
Shale	50
Clinton	30
Red Medina	41
Shale	52
White Medina	12
Red shale	50
Total depth	685

Gas at 629 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lots 6 and 7, con. X, Walpole tp.
Completed April 24, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	38
Flint	47
Lime and shale	365
Niagara	282
Grey shale	32
Clinton	35
Red Medina	25
Blue shale	61
White Medina	9
Red shale	4
Total depth	898

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 6, con. III, Walpole tp.
Completed September 14, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	46
Flint	90
Lime and shale	387
Niagara	279
Shale	34
Clinton	30
Red Medina	27
Shale	68
White Medina	12
Shale	4
Total depth	977

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 19, con. X, Walpole tp.

Completed August 30, 1928.
Open flow: 49,000 cu. ft.
Rock pressure: 480 lbs.

Formation	Thickness, ft.
Surface	11
Flint	54
Lime and shale	392
Niagara	250
Shale	46
Clinton	25
Red Medina	30
Shale	57
White Medina	12
Shale	5
Total depth	882

Gas at 788 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 22, con. V, Walpole tp.

Completed October 4, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	17
Flint	73
Lime and shale	380
Niagara	230
Shale	85
Clinton	24
Red Medina	38
Shale	60
White Medina	13
Red shale	4
Total depth	924

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 21, con. X, Walpole tp.

Completed October 6, 1928.
Open flow: 84,000 cu. ft.
Rock pressure: 525 lbs.

Formation	Thickness, ft.
Surface	1
Flint	58
Lime and shale	395
Niagara	255
Shale	36
Clinton	27
Red Medina	35
Shale	60
White Medina	12
Red shale	2
Total depth	881

Gas at 792 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 21, con. VII, Walpole tp.

Completed June 1, 1928.
Open flow: 70,000 cu. ft.
Rock pressure: 422 lbs.

Formation	Thickness, ft.
Surface	10
Flint	75
Lime and shale	365
Niagara	230
Rochester	85
Clinton	28
Red Medina	38
Shale (Cabot Head)	59
White Medina (Whirlpool)	14
Shale (Queenston)	5
Total depth	909

Gas at 813 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 23, con. V, Walpole tp.

Completed November 5, 1928.
Open flow: 121,000 cu. ft.
Rock pressure: 460 lbs.

Formation	Thickness, ft.
Surface	10
Flint	80
Lime and shale	380
Niagara	230
Shale	88
Clinton	26
Red Medina	38
Shale	55
White Medina	14
Shale	4
Total depth	925

Gas at 840 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y
Lot 7, con. V, Walpole tp.

Completed January 28, 1928.
Open flow: 210,000 cu. ft.
Rock pressure: 455 lbs.

Formation	Thickness, ft,
Surface	38
Flint	97
Lime and shale	380
Niagara	278
Shale	39
Clinton	30
Red Medina	30
Shale	59
White Medina	12
Red shale	5
Total depth	968

Gas at 868 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 14, con. VI, Walpole tp.

Completed March 13, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	18
Flint	72
Lime and shale	380
Niagara	260
Shale	83
Clinton	25
Red Medina	34
Shale	61
White Medina	14
Shale	4
Total depth	951

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 22, con. IX, Walpole tp.

Completed January 12, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	20
Flint	40
Lime and shale	393
Niagara	253
Shale	42
Clinton	28
Red Medina	30
Shale	67
White Medina	10
Red shale	5
Total depth	888

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 6, con. V, Walpole tp.

Completed September 14, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	46
Flint	90
Lime and shale	387
Niagara	279
Shale	34
Clinton	30
Red Medina	27
Shale	68
White Medina	12
Shale	4
Total depth	977

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 19, con. X, Walpole tp.

Completed April 13, 1928.
Open flow: 171,000 cu. ft.
Rock pressure: 488 lbs.

Formation	Thickness, ft.
Surface	16
Flint	54
Lime and shale	365
Niagara	271
Shale	38
Clinton	24
Red Medina	30
Shale	59
White Medina	12
Shale	6
Total depth	875

Gas at 791 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 21, con. IX, Walpole tp.

Completed March 7, 1928.
Open flow: 49,000 cu. ft.
Rock pressure: 452 lbs.

Formation	Thickness, ft.
Surface	2
Flint	45
Lime and shale	388
Niagara	266
Shale	41
Clinton	32
Red Medina	29
Shale	61
White Medina	12
Red shale	5
Total depth	881

Gas at 767 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 22, con. V, Walpole tp.

Completed September 12, 1928.
Open flow: 157,000 cu. ft.
Rock pressure: 468 lbs.

Formation	Thickness, ft.
Surface	8
Flint	82
Lime and shale	380
Niagara	230
Shale	90
Clinton	26
Red Medina	38
Blue shale	58
White Medina	13
Red shale	5
Total depth	930

Gas at 834 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 20, con. IX, Walpole tp.

Completed December 8, 1928.
Open flow: 46,000 cu. ft.
Rock pressure: 432 lbs.

Formation	Thickness, ft.
Surface	8
Flint	52
Lime and shale	393
Niagara	250
Shale	37
Clinton	27
Red Medina	35
Shale	60
White Medina	12
Shale	6
Total depth	880

Gas at 754 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 22, con. VI, Walpole tp.

Completed July 12, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	17
Flint	68
Lime and shale	365
Niagara	230
Shale	86
Clinton	27
Red Medina	37
Shale	61
White Medina	12
Red shale	4
Total depth	907

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 7, con. V, Walpole tp.

Completed May 12, 1928.
Open flow: 30,000 cu. ft.
Rock pressure: 450 lbs.

Formation	Thickness, ft.
Surface	47
Flint	95
Lime and shale	376
Niagara	282
Shale	38
Clinton	32
Red Medina	25
Shale	61
White Medina	15
Shale	55
Total depth	1,026

Gas at 834 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 23, con. IX, Walpole tp.

Completed May 2, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	13
Flint	52
Lime and shale	391
Niagara	240
Shale	43
Clinton	25
Red Medina	35
Shale	60
White Medina	10
Shale	2
Total depth	871

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 22, con. VIII, Walpole tp.

Completed March 9, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	13
Flint	57
Lime and shale	385
Niagara	250
Shale	45
Clinton	27
Red Medina	35
Shale	63
White Medina	8
Red shale	4
Total depth	887

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 20, con. IX, Walpole tp.

Completed July 25, 1928.
Open flow: 25,000 cu. ft.

Formation	Thickness, ft.
Surface	13
Flint	47
Lime and shale	390
Niagara	247
Shale	40
Clinton	27
Red Medina	35
Shale	66
White Medina	11
Red shale	4
Total depth	880

Gas at 764 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 21, con. X, Walpole tp.

Completed November 6, 1928.
Open flow: 25,000 cu. ft.
Rock pressure: 450 lbs.

Formation	Thickness, ft.
Surface	20
Flint	60
Lime and shale	392
Niagara	250
Shale	33
Clinton	25
Red Medina	30
Shale	55
White Medina	11
Shale	4
Total depth	880

Gas at 795 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 21, con. V, Walpole tp.

Completed August 13, 1928.
Open flow: 34,000 cu. ft.
Rock pressure: 375 lbs.

Formation	Thickness, ft.
Surface	20
Flint	70
Lime and shale	375
Niagara	230
Shale	95
Clinton	30
Red Medina	33
Shale	60
White Medina	14
Shale	50
Total depth	977

Gas at 926 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 8, con. IX, Walpole tp.

Completed January 17, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	17
Flint	75
Lime and shale	388
Niagara	285
Shale	29
Clinton	28
Red Medina	37
Blue shale	62
White Medina	7
Red shale	5
Total depth	933

DOMINION NATURAL GAS CO., BUFFALO, N.Y
Lot 6, con. V, Walpole tp.

Completed March 24, 1928.
Open flow: 25,000 cu. ft.

Formation	Thickness, ft.
Surface	46
Flint	99
Lime and shale	372
Niagara	272
Shale	47
Clinton	24
Red Medina	29
Shale	62
White Medina	12
Shale	2
Total depth	965

Gas at 872 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 8, con. V, Walpole tp.

Completed June 22, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	35
Flint	90
Lime and shale	370
Niagara	294
Shale	31
Clinton	28
Red Medina	29
Shale	62
White Medina	13
Red shale	3
Total depth	955

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 20, con. IX, Walpole tp.

Completed January 11, 1928.
Open flow: 171,000 cu. ft.
Rock pressure: 352 lbs.

Formation	Thickness, ft.
Surface	12
Flint	51
Lime and shale	367
Niagara	277
Shale	33
Clinton	28
Red Medina	28
Shale	60
White Medina	12
Red shale	53
Total depth	921

Gas at 866 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 18, con. X, Walpole tp.

Completed June 16, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	10
Flint	60
Lime and shale	379
Niagara	255
Rochester	38
Clinton	24
Red Medina	40
Shale	55
White Medina	10
Shale	2
Total depth	873

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 21, con. V and VI, Walpole tp.

Completed April 28, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	20
Flint	65
Lime and shale	375
Niagara	240
Shale	85
Clinton	23
Red Medina	38
Shale	55
White Medina	12
Red shale	5
Total depth	918

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 15, con. VI, Walpole tp.

Completed January 27, 1928.
Open flow: 84,000 cu. ft.
Rock pressure: 460 lbs.

Formation	Thickness, ft.
Surface	30
Flint	60
Lime and shale	370
Niagara	260
Shale	80
Clinton	25
Red Medina	38
Shale	65
White Medina	12
Red shale	5
Total depth	945

Gas at 845 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 23, con. V, Walpole tp.

Completed December 12, 1928.
Open flow: 25,000 cu. ft.
Rock pressure: 465 lbs.

Formation	Thickness, ft.
Surface	20
Flint	65
Lime and shale	385
Niagara	230
Shale	85
Clinton	24
Red Medina	38
Shale	55
White Medina	15
Shale	6
Total depth	923

Gas at 825 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 3, con. VI, Walpole tp.

Completed November 12, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	50
Flint	90
Lime and shale	380
Niagara	277
Shale	38
Clinton	24
Red Medina	30
Blue shale	57
White Medina	12
Red shale	4
Total depth	962

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lots 21 and 22, con. IV, Walpole tp.

Completed January 22, 1929.
Open flow: 80,000 cu. ft.
Rock pressure: 355 lbs.

Formation	Thickness, ft.
Surface	15
Flint	70
Lime and shale	380
Niagara	230
Shale	86
Clinton	25
Red Medina	38
Shale	60
White Medina	14
Red shale	5
Total depth	923

Gas at 824 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 7, con. V, Walpole tp.

Completed July 31, 1928.
Open flow: 25,000 cu. ft.
Rock pressure: 465 lbs.

Formation	Thickness, ft.
Surface	35
Flint	95
Lime and shale	375
Niagara	272
Shale	40
Clinton	31
Red Medina	30
Shale	62
White Medina	13
Shale	5
Total depth	958

Gas at 838 feet.

Kent County

AJAX OIL AND GAS CO., LTD., TORONTO
Lot 1, con. IV, Dover E. tp.

Completed December 16, 1928.
Open flow: 300,000 cu. ft.
Rock pressure: 1,180 lbs.

Formation	Thickness, ft.
Surface	80
Soapstone	175
Middle lime	10
Soapstone	25
Big lime and other limes	1,675
Clinton shale	100
Red Medina shale	35
White Medina	40
Red shale	310
Grey shale	215
Brown shale	200
Black shale	35
Trenton lime	390
Total depth	3,290

Gas at 3,005 feet.

AJAX OIL AND GAS CO., LTD., TORONTO
Lot 2, Front con., Dover W. tp.

Completed January 23, 1928.
Open flow: 325,000 cu. ft.
Rock pressure: 485 lbs.

Formation	Thickness, ft.
Surface	85
Soapstone	180
Middle lime	15
Soapstone	20
Limestone	1,680
Clinton shales	100
Red Medina shale	65
White Medina	55
Red shale	300
Grey shale	200
Brown shale	150
Black shale	35
Trenton lime	340
Total depth	3,225

Gas at 3,145 to 3,150 feet.

AJAX OIL AND GAS CO., LTD., TORONTO
Lot 2, con. III, Dover W. tp.

Completed July 23, 1928.
Open flow· 75,000 cu. ft.
Rock pressure: 630 lbs.

Formation	Thickness, ft.
Surface	82
Soapstone	180
Middle lime	10
Soapstone	25
Limestone	1,671
Grey shale	100
Red shale	50
White Medina	45
Red shale	260
Grey shale	250
Brown shale	200
Black shale	71
Trenton lime	404
Total depth	3,348

Gas at 3,185 to 3,190 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 164, T.R., Raleigh tp.

Completed October 24, 1928.

Formation	Thickness, ft.
Surface	150
Black shale	30
Hamilton shale	147
Onondaga and Detroit River	373
Salina	730
Total depth	1,430

Gas at 1,430 feet.

SOUTHERN ONTARIO GAS CO., BUFFALO, N.Y.
Lot 192, N.T.R., Romney tp.

Completed July 30, 1928.

Formation	Thickness, ft.
Surface (clay)	170
Gravel and sand	25
Soap	45
Dark-grey lime	270
Sharp sand	130
Water sand	145
Dark-grey lime	315
Light-grey lime	140
Dark-grey lime	110
Light-grey lime	40
Total depth	1,390

Gas at 1,382 feet.

SOUTHERN ONTARIO GAS CO., BUFFALO, N.Y.
Lot 193, T.R., Romney tp.

Completed October 15, 1928.

Formation	Thickness. ft.
Clay	178
Quicksand	17
Soap	56
Dark-grey lime	109
Light-grey lime	190
Sharp sand	110
Water sand	110
Dark-grey lime	330
Light-grey lime	125
Dark-grey lime	164
Total depth	1,389

Gas at 1,385 feet.

SOUTHERN ONTARIO GAS CO., BUFFALO, N.Y.
Lot 192, T.R., Romney tp.

Completed November 17, 1928.

Formation	Thickness, ft.
Clay	185
Quicksand	15
Soapstone	44
Brown lime	66
Grey lime	200
Sharp sand	90
Light-brown lime	200
Grey lime	110
Slate and shale	70
Light-brown lime	80
Slate and shale	110
Blue lime	60
Light-grey lime	113
Grey lime	62
Total depth	1,405

Gas at 1,401 feet.

SOUTHERN ONTARIO GAS CO., BUFFALO, N.Y.
Lot 191, T.R., Romney tp.

Completed January 2, 1929.
Dry hole.

Formation	Thickness, ft.
Clay	175
Quicksand	25
Soapstone	47
Brown lime	73
Grey lime	205
Sharp sand	80
Light and dark brown lime	95
Grey lime	110
Blue lime	95
Blue shale	75
Blue lime	160
Slate and shale	70
Light-grey lime	212
Total depth	1,422

SOUTHERN ONTARIO GAS CO., BUFFALO, N.Y.
Lot 193, T.R., Romney tp.

Completed Sept. 10, 1928.

Formation	Thickness, ft.
Clay	178
Gravel and sand	11
Soapstone	71
Dark-grey lime	290
Sharp sand	125
Water sand	95
Dark-grey lime	330
Light-grey lime and shale	175
Dark-grey lime	114
Total depth	1,389

Gas at 1,375 feet.

BON JASPERSON, KINGSVILLE
Lot 25, con. II, Romney tp.
Completed July 21, 1928.
Open flow: 500,000 cu. ft.
Rock pressure: 470 lbs.

Formation	Thickness, ft.
Clay	170
Gravel	46
Rock soapstone	29
Total depth	245

Oil and gas at 1,400 feet.

SOUTHERN ONTARIO GAS CO., BUFFALO, N.Y.
Lot 192, con. I, Romney tp.
Completed May 15, 1928.

Formation	Thickness, ft.
Surface	160
Sand and clay	40
Soapstone	45
Dark-grey lime	105
Light-grey lime	335
Water sand	115
Dark-grey lime	320
Light-grey lime	100
Dark-grey lime	148
Total depth	1,368

Gas at 1,347 feet.

SOUTHERN ONTARIO GAS CO., BUFFALO, N.Y.
Lot 193, T.R., Romney tp.
Completed April 3, 1928.

Formation	Thickness, ft.
Surface	175
Quicksand	5
Clay	12
Soapstone	56
Dark-grey lime	62
Light-grey lime	205
Sharp sand	110
Water sand	150
Brown lime	325
Light-grey lime	100
Dark-grey lime	174
Total depth	1,374

Gas at 1,352 feet.

SOUTHERN ONTARIO GAS CO., BUFFALO, N.Y.
Lot 194, con. I, N.T.R., Romney tp.
Completed February 6, 1928.

Formation	Thickness, ft.
Soft clay	175
Quicksand	25
Soapstone	55
Grey lime	355
Sharp sand	110
Water sand	60
Dark-grey lime	592
Total depth	1,372

Gas at 1,365 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 179, T.R., Romney tp.
Completed March 12, 1928.

Formation	Thickness, ft.
Surface	178
Hamilton shale	72
Onondaga and Detroit River	450
Salina	705
Total depth	1,405

UNION NATURAL GAS CO., CHATHAM
Lot 179, T.R., Romney tp.
Completed January 28, 1928.

Formation	Thickness, ft.
Surface	172
Hamilton shale	68
Onondaga and Detroit River	420
Salina	695
Total depth	1,355

UNION NATURAL GAS CO., CHATHAM
Lot 179, T.R., Romney tp.
Completed April 8, 1928.

Formation	Thickness, ft.
Surface	172
Hamilton shale	76
Onondaga and Detroit River	432
Salina	680
Total depth	1,360

UNION NATURAL GAS CO., CHATHAM
Lot 180, T.R., Romney tp.
Completed February 22, 1928.

Formation	Thickness, ft.
Surface	176
Hamilton shale	36
Onondaga and Detroit River	388
Salina	708
Total depth	1,308

UNION NATURAL GAS CO., CHATHAM
Lot 165, T.R., Tilbury E. tp.
Completed May 27, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	158
Black shale	20
Hamilton shale	157
Onondaga and Detroit River	340
Salina	715
Total depth	1,390

Gas at 1,375 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 165, T.R., Tilbury E. tp.
Completed June 21, 1928.

Formation	Thickness, ft.
Surface	155
Black shale	20
Hamilton shale	143
Onondaga and Detroit River	402
Salina	655
Total depth	1,375

Gas at 1,345 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 165, T.R., Tilbury E. tp.
Completed September 20, 1928.

Formation	Thickness, ft.
Surface	151
Black shale	19
Hamilton shale	150
Onondaga and Detroit River	370
Salina	710
Total depth	1,400

Gas at 1,370 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 166, T.R., Tilbury E. tp.
Completed April 28, 1928.

Formation	Thickness, ft.
Surface	150
Black shale	15
Hamilton shale	147
Onondaga and Detroit River	363
Salina	700
Total depth	1,375

Gas at 1,350 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 166, T.R., Tilbury E. tp.
Completed June 22, 1928.

Formation	Thickness, ft.
Surface	150
Black shale	25
Hamilton shale	139
Onondaga and Detroit River	376
Salina	695
Total depth	1,385

Gas at 1,348 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 166, T.R., Tilbury E. tp.
Completed September 19, 1928.

Formation	Thickness, ft.
Surface	152
Black shale	20
Hamilton shale	146
Onondaga and Detroit River	367
Salina	725
Total depth	1,410

Gas at 1,390 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 166, T.R., Tilbury E. tp.
Completed March 29, 1928.

Formation	Thickness, ft.
Surface	145
Hamilton shale	155
Onondaga and Detroit River	360
Salina	702
Total depth	1,362

Gas at 1,345 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 168, T.R., Tilbury E. tp.
Completed July 19, 1928.

Formation	Thickness, ft.
Surface	148
Black shale	15
Hamilton shale	135
Onondaga and Detroit River	362
Salina	705
Total depth	1,365

Gas at 1,334 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 168, T.R., Tilbury E. tp.
Completed August 20, 1928.

Formation	Thickness, ft.
Surface	158
Hamilton shale	140
Onondaga and Detroit River	372
Salina	710
Total depth	1,380

Gas at 1,365 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 168, T.R., Tilbury E. tp.
Completed August 20, 1928.

Formation	Thickness, ft.
Surface	158
Hamilton shale	140
Onondaga and Detroit River	372
Salina	710
Total depth	1,380

Gas at 1,365 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 169, T.R., Tilbury E. tp.
Completed July 24, 1928.

Formation	Thickness, ft.
Surface	150
Black shale	10
Hamilton shale	128
Onondaga and Detroit River	377
Salina	706
Total depth	1,371

Gas at 1,325 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 169, T.R., Tilbury E. tp.
Completed August 22, 1928.

Formation	Thickness, ft.
Surface	167
Hamilton shale	126
Onondaga and Detroit River	372
Salina	705
Total depth	1,370

Gas at 1,340 feet.

Lambton County

UNION NATURAL GAS CO., CHATHAM
Lot 24, con. XIII, Dawn tp.
Completed December 28, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	45
Black shale	85
Hamilton lime and shale	285
Onondaga, Detroit River, and Salina	1,420
Guelph and Niagara	100
Rochester shale	50
Clinton	10
Cabot Head	75
Manitoulin dolomite	50
Queenston shale	16
Total depth	2,136

UNION NATURAL GAS CO., CHATHAM
Lot 23, con. I, Dawn tp.

Completed November 1, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	45
Black shale	12
Hamilton lime and shale	347
Onondaga, Detroit River, and Salina	1,306
Guelph and Niagara	196
Rochester shale	39
Clinton	6
Cabot Head	79
Manitoulin dolomite	66
Queenston shale	10
Total depth	2,106

UNION NATURAL GAS CO., CHATHAM
Lot 24, con. XIII, Dawn tp.

Completed November 5, 1928.
Open flow: 2,016,201 cu. ft.
Rock pressure: 735 lbs.

Formation	Thickness, ft.
Surface	50
Black shale	90
Hamilton lime and shale	245
Onondaga, Detroit River, and Salina	1,395
Guelph and Niagara	147
Rochester shale	48
Clinton	5
Cabot Head	95
Manitoulin dolomite	40
Total depth	2,115

Gas at 1,665 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 25, con. VIII, Dawn tp.

Completed July, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	70
Black shale	120
Hamilton lime and shale	255
Onondaga, Detroit River, and Salina	1,295
Guelph and Niagara	235
Rochester shale	10
Cabot Head shale	36
Total depth	2,021

UNION NATURAL GAS CO., CHATHAM
Lot 30, con. XIII, Dawn tp.

Completed August 19, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	61
Black shale	19
Hamilton lime and shale	273
Onondaga, Detroit River, and Salina	1,547
Guelph and Niagara	125
Clinton	5
Cabot Head	10
Manitoulin	132
Queenston shale	7
Total depth	2,179

UNION NATURAL GAS CO., CHATHAM
Lot 24, con. XIII, Dawn tp.

Completed December 28, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	45
Black shale	85
Hamilton lime and shale	285
Onondaga, Detroit River, and Salina	1,420
Guelph and Niagara	100
Rochester shale	50
Clinton	10
Cabot Head	75
Manitoulin dolomite	50
Queenston shale	16
Total depth	2,136

UNION NATURAL GAS CO., CHATHAM
Lot 24, con. VI, Dawn tp.

Completed April 12, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	75
Black shale	145
Hamilton shale and lime	254
Onondaga (Big lime), and Salina	1,451
Guelph and Niagara	115
Clinton	9
Cabot Head shale	21
Manitoulin dolomite	120
Queenston shale	11
Total depth	2,201

UNION NATURAL GAS CO., CHATHAM
Lot 19, con. I, Dawn tp.

Completed December 13, 1928.
Open flow: 25,000 cu. ft.
Rock pressure: 705 lbs.

Formation	Thickness, ft.
Surface	60
Black shale	205
Hamilton shale and lime	234
Onondaga, Detroit River, and Salina	1,416
Guelph and Niagara	105
Rochester shale	45
Clinton	5
Cabot Head	80
Manitoulin dolomite	65
Queenston shale	285
Dundas shale	330
Utica shale	83
Trenton	937
Pre-Trenton (arkose)	5
Granite	14
Total depth	3,869

Gas at 1,690 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 24, con. XIV, Dawn tp.

Completed September 1, 1928.
Open flow: 105,809 cu. ft.
Rock pressure: 815 lbs.

Formation	Thickness, ft.
Surface	55
Black shale	105
Hamilton shale and lime	300
Onondaga, Detroit River, and Salina	1,330
Guelph and Niagara	170
Clinton	5
Cabot Head shale	62
Manitoulin dolomite	88
Queenston shale	3
Total depth	2,118

Gas at 1,665 feet.

C. E. Judson and Company, Port Huron, Mich.
Lot 18, SE. ¼, con. XII, Enniskillen tp.
Completed March 28, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	65
Black shale	65
Top rock	68
Top soap	125
Middle lime	20
Lower soap	47
Lower lime	105
Total depth	495

Gas at 475 feet.

British Petroleum Co., Hamilton
Lot 23, con. VIII, Plympton tp.
Completed August, 1928.
Show of oil.

Formation	Thickness, ft.
Surface	80
Gravel	8
Shale	40
Lime	112
Top soap	140
Limestone	6
Lower soap	59
Drilled into lime	111
Total depth	556

Norfolk County

Dominion Natural Gas Co., Buffalo, N.Y.
Lot 7, con. XI, Charlotteville tp.
Completed May 16, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	206
Brown and grey lime	149
Flint lime	135
Mixed lime and slate	403
Niagara lime	203
Grey shale	49
Clinton	30
Red Medina	3
Red and blue shale	81
Grey Medina	8
Red shale	5
Total depth	1,272

Dominion Natural Gas Co., Buffalo, N.Y.
Lot 19, con. VIII, Charlotteville tp.
Completed January 2, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	215
Lime	125
Flint	90
Lime	60
Blue shale	95
Grey lime	30
Blue shale	220
Niagara lime	216
Shale	58
Clinton sand	20
Red Medina	15
Red and grey shale	84
White Medina sand	6
Big red mud	4
Total depth	1,238

Dominion Natural Gas Co., Buffalo, N.Y.
Lot 24, con. II, Charlotteville tp.
Completed December 11, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	102
Brown and grey lime	118
Flint	135
Lime	35
Shale	385
Niagara lime	205
Shale	63
Clinton sand	22
Red Medina sand	22
Shale	93
White Medina	8
Red shale	8
Total depth	1,196

Dominion Natural Gas Co., Buffalo, N.Y.
Lot 20, con. XIV, Walsingham N. tp.
Completed January 7, 1928.
Open flow: 95,000 cu. ft.
Rock pressure: 570 lbs.

Formation	Thickness, ft.
Surface	221
Brown and grey lime	150
Flint	154
Mixed lime and shale	390
Niagara lime	235
Grey shale	53
Clinton sand	29
Red Medina	5
Blue shale	40
Total depth	1,277

Gas at 1,212 feet.

Dominion Natural Gas Co., Buffalo, N.Y.
Lot 1, B.F., gore, Woodhouse tp.
Completed April 18, 1928.
Open flow: 95,000 cu. ft.
Rock pressure: 625 lbs.

Formation	Thickness, ft.
Surface	148
Lime	127
Flint	125
White lime	35
Shale	365
Niagara lime	224
Shale	59
Clinton sand	22
Red Medina	18
Blue shale	90
White Medina	8
Red shale	42
Total depth	1,263

Gas at 1,219 feet.

Dominion Natural Gas Co., Buffalo, N.Y.
Lot 3, con. II, Woodhouse tp.
Completed August 1, 1928.
Open flow: 35,000 cu. ft.
Rock pressure: 400 lbs.

Formation	Thickness, ft.
Surface drift	155
Grey and brown lime	85
Onondaga flint	130
Lime and slate	415
Niagara	200
Shale (Rochester)	52
Clinton	44
Red Medina sand	9
Blue shale	67
White Medina	11
Red shale (Queenston)	6
Total depth	1,174

Gas at 1,071 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 1, B.F., Woodhouse tp.

Completed June 6, 1928.
Open flow: 17,000 cu. ft.
Rock pressure: 400 lbs.

Formation	Thickness, ft.
Surface	129
Brown and grey lime	129
Flint and lime	92
Lime	40
Shale	395
Niagara	215
Grey shale (Rochester)	64
Clinton	20
Red Medina sand	18
Grey sand	10
Shale (Cabot Head)	81
White Medina	8
Queenston	40
Total depth	1,241

Gas at 1,198 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 1, gore, Woodhouse tp.

Completed July 17, 1928.
Open flow: 37,000 cu. ft.

Formation	Thickness, ft.
Surface	125
Brown and grey lime	130
Flint	115
Lime	30
Shale	375
Niagara	218
Shale	58
Clinton	23
Red Medina	21
Shale	82
White Medina	8
Red shale	42
Total depth	1,227

Gas at 1,177 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 3, con. III, Woodhouse tp.

Completed September 27, 1928.
Open flow: 4,000 cu. ft.

Formation	Thickness, ft.
Surface	135
Grey and brown lime	85
Flint	120
Lime and shale	395
Niagara	228
Shale	52
Clinton	42
Red Medina	10
Blue shale	76
White Medina	12
Red shale	4
Total depth	1,159

Gas at 1,027 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 2, con. III, Woodhouse tp.

Completed November 17, 1928.
Open flow: 26,000 cu. ft.
Rock pressure: 500 lbs.

Formation	Thickness, ft.
Surface	157
Grey and brown lime	80
Flint	123
Mixed limestone and slate	395
Niagara lime	225
Shale	64
Clinton sand	42
Red Medina sand	8
Blue shale	68
White Medina sand	9
Red shale	3
Total depth	1,174

Gas at 1,059 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 1, B.F., Woodhouse tp.

Completed October 24, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	147
Lime	118
Flint	115
Lime	40
Mixed shale	380
Niagara lime	205
Shale	66
Clinton sand	23
Red Medina sand	15
Blue shale	91
White Medina sand	8
Red shale	6
Total depth	1,214

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 1, B.F., Woodhouse tp.

Completed September 5, 1928.
Open flow: 134,000 cu. ft.
Rock pressure: 550 lbs.

Formation	Thickness, ft.
Surface	166
Lime	119
Flint	115
Lime	40
Mixed shale	370
Niagara lime	220
Shale	62
Clinton sand	22
Red Medina	15
Blue shale	85
White Medina	12
Red shale	40
Total depth	1,266

Simcoe County

ROBERT CHERRY, COLLINGWOOD
Opposite lot 39, con. V, Georgian Bay shore, Nottawasaga tp.

Completed December, 1928.
Open flow: 200,000 cu. ft.

Formation	Thickness, ft.
Surface	1
Hard grey lime	69
Soft grey shale and lime	18
Hard dark-grey lime	72
Soft lime and shale	65
Hard grey lime	17
Blue shale	1
Hard lime	9
Soft lime	1
Hard lime	17
Very hard lime	18
Soft lime, 1 inch.	
Very hard lime	4
Soft shale	1
Hard white lime	22
Soft shale	12
Hard lime	35
Coarse white sandstone	1
Fine red sandstone	1
Total depth	364

Show of gas at 22, 72, and 214 feet.
Large flow at 315 feet.
Strong flow of salt water at 364 feet.

Wellington County

BOLLERT G. AND P. FIELD SYNDICATE, KITCHENER
Lot 7, con. IV, Puslinch tp.

Completed June 25, 1928.
Deepened January 31, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	58
Guelph, buff	95
Lockport	215
Clinton	2
Medina-Cataract	58
Manitoulin	25
Whirlpool—Richmond (Queenston) red shale	450
Lower Richmond and Dundas grey shale	665
Utica and Collingwood grey and black shale	113
Trenton and Black River grey limestone and shale	645
Arkose	38
Pre-Cambrian granite	20
	2,384
Deepened:	
Granite	286
Total depth	2,670

Wentworth County

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 10, con. V, Glanford tp.

Completed May 23, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	104
Niagara	211
Shale.	
Clinton	12
Shale	35
White Medina	10
Queenston	12
Total depth	384

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 6, con. VI, Glanford tp.

Completed July 26, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	83
Niagara and lime	205
Shale	23
Clinton	4
Total depth	315

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 12, con. VI, Glanford tp.

Completed June 19, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	128
Niagara	172
Rochester	48
Clinton	28
Red Medina	23
Shale	58
Whirlpool	12
Queenston	1
Total depth	470

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 10, con. IV, Glanford tp.

Completed July 6, 1928.
Dry hole.

Formation	Thickness, ft.
Surface	60
Niagara and lime	195
Shale	40
Clinton	15
Red Medina	3
Total depth	313

PETROLEUM IN 1928

By R. B. Harkness

General

The production of petroleum in 1928 amounted to 134,164 barrels, valued at $249,981, which is 5,442 barrels below the previous year's production. The decrease in value is $39,410. Details of production by fields are given in Tables I and II.

The principal decrease in production is in the extension to the Thamesville pool in Camden township, which was discovered in 1927 and at one time appeared to have great promise. However, the results obtained from the first few wells did not offer the operators sufficient encouragement to test the area thoroughly, and the few small wells are showing rapid depletion. In the old fields there is a seasonal fluctuation due to the severity of winters or spring floods and to transfers of properties. It is fairly well recognized that only a few operators are deriving a profit from their wells and that the rest are keeping their wells pumping with the hope that the price of oil will improve; for, if these shallow wells, with casing probably twenty years old or more, are closed down, leaks will develop that may flood a great area and do serious injury before they are discovered. Very little new pipe has been put in these wells. When wells are abandoned the best lengths of pipe are retained for making renewals in wells that are being operated; invariably, this is old pipe and very thin, after years of corrosion.

TABLE I—OIL WELLS AND THEIR PRODUCTION, 1928

Field	Wells			Wells drilled		Production		Gain or loss in 1928		Average production per well per year
	Operating	Not operating	Abandoned	Producing	Dry			Gain	Loss	
						bbls.	gals.	bbls.	bbls.	bbls.
Petrolia and Enniskillen	998	890	47	2	.....	60,547	16	1,123	.....	63.7
Oil Springs	1,106	119	12	.....	1	35,652	20	.....	1,628	32.2
Moore tp	62	35	7	.....	.....	2,147	33	35	.....	34.6
Sarnia tp	83	44	12	.....	.....	1,220	26	.....	369	14.6
Plympton tp	22	12	.....	.....	.....	370	27	.....	869	16.8
Bothwell	261	43	12	.....	.....	24,254	28	.....	969	92.9
Dover West tp	2	.....	.....	.....	.....	773	6	171	.....	386.5
Raleigh tp	.....	6	.....	.....	.....	.....	.....	.....	275	12.3
Onondaga tp	15	22	.....	.....	.....	185	28	.....	24	96.9
Mosa tp	75	36	1	.....	.....	7,268	1	.....	178	62.8
Thamesville	16	12	.....	.....	.....	1,006	3	.....	3,132	.....
Euphemia tp	.....	114	.....	.....	.....	.....	.....	.....	.....	.....
Dunwich tp	.....	99	.....	.....	.....	.....	.....	.....	.....	.....
Dawn tp	.....	40	.....	.....	.....	.....	.....	.....	.....	.....
Brooke tp	1	2	.....	.....	.....	.....	.....	.....	.....	.....
Tilbury East tp	.....	1	.....	.....	.....	735	31	.....	.....	.....
Other fields	.....	.....	.....	1	10	.....	.....	.....	.....	.....
Total	2,641	1,475	91	3	11	134,163	9	1,329	7,444	.....
								Net loss, 6,115		

TABLE II—OIL PRODUCED IN ONTARIO BY FIELDS, 1921—1928

Field	1921	1922	1923	1924	1925	1926	1927	1928
	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.
Petrolia and Enniskillen	68,484	64,935	64,159	60,916	53,166	55,485	59,424	60,547
Oil Springs	40,967	43,214	39,090	41,320	39,137	38,349	37,281	35,653
Moore tp	7,536	7,275	4,790	4,483	8,195	2,438	2,112	2,148
Sarnia tp	4,069	3,224	2,387	2,068	1,905	1,890	1,590	1,221
Plympton tp	481	695	872	525	1,424	1,047	1,241	371
Bothwell	26,877	25,681	27,665	26,700	26,243	25,382	25,224	24,255
Tilbury East tp	1,003	127	1,950	.....	.....	.....	60	736
Dover West tp	7,473	5,482	5,618	3,898	2,957	959	602	773
Raleigh tp	3,320	663	302	783	887	676	276	.....
Onondaga tp	566	489	237	456	261	361	210	186
Mosa tp	10,764	11,959	10,319	8,862	8,397	7,868	7,447	7,268
Thamesville	1,319	384	567	.....	289	2,376	4,139	1,006
Euphemia tp	.....	.....	.....	.....	39	.....	.....	.....
Dunwich tp	.....	387	594	1,351	1,001	139	.....	.....
Dawn tp	.....	217	.....	.....	.....	.....	.....	.....
Romney tp	.....	.....	849	2,955	1,235	.....	.....	.....
Total	172,859	164,732	159,399	154,317	144,249	136,971	139,606	134,164
Value	$466,716	$466,587	$395,300	$390,423	$369,154	$376,822	$289,391	$249,981
Average price	$2.68½	$2.65	$2.47	$2.51¼	$2.56	$2.73	$2.11	$1.86

Exploratory drilling has been dealt with in the Natural Gas section of this report. It is impossible to separate oil and gas in exploratory work, as it is not known which product will be encountered until the well is completed.

The capital invested in operating oil wells and the equipment pertaining to these is $2,011,923. The number of men employed operating the wells shown in Table I is 131, and the wages paid to them $108,865. This information has been supplied by the Dominion Bureau of Statistics, Ottawa.

Refining Operations

Four refineries were in operation in the year 1928 and worked at full capacity, giving the greatest output of refined products in the history of Canadian refining operations.

PETROLEUM REFINERIES, 1928

Company	Location of refinery	Head office address	Days operated
British American Oil Co., Ltd.	Foot of Cherry St., Toronto.	Royal Bank Bldg., Toronto.	365
Canadian Oil Companies, Ltd.	Petrolia	Excelsior Life Bldg., Toronto.	360
Imperial Oil Refineries, Ltd.	Sarnia	Sarnia	365
McColl Bros	Foot of Cherry St., Toronto.	114 Don Esplanade, Toronto.	365

The total number of employees for the year was 1,853; the salaries and wages paid amounted to $3,013,872; and the capital invested was $19,570,531.

Price of Crude Petroleum

The following prices are published through the kindness of the Imperial Oil Company, of Sarnia, and show the fluctuations in the market price of oil in Ontario. The prices follow those of the United States very closely, as the price of imported oil controls the market. The variation of the prices as between fields is due to the specific gravity of the oil: The lightest oil, or that containing most gasoline, commands the highest price.

1928	Fluctuation	Price
January 1		$2.11
February 10	Decrease 16 cents	1.95
July 26	Increase 5 cents	2.00
December 31		2.00

The price of crude petroleum from Oil Springs is 7 cents higher than the above prices. The price of oil from the remainder of the fields, where most of the production is secured, is the same as Petrolia crude; some of the smaller fields have a slightly lower quality, and the price paid for it is a few cents less than Petrolia crude.

Products of Ontario Refineries

Table III gives a summary of the output of the refineries in Ontario in the year 1928. It will be noted that the proportion of Ontario crude refined to the total refined has fallen to 1.71, the lowest yet in the history of the industry, while the imported crude has increased over the previous year by nine times the total Ontario production, and has doubled since the year 1917.

The value of refined products has again shown a large increase over the previous year's total. It is presumed that all these refined products, as well as the refined products imported, are consumed in Ontario; any exchange between provinces will probably be nearly equal, if the location of refineries is an indication. This being the case, the value of all refined products consumed in Ontario, both of domestic manufacture and imported, totals $45,102,722. This is the value at wholesale prices delivered at wholesalers' warehouses.

TABLE III—PETROLEUM REFINING OPERATIONS, 1924—1928

Schedule	Unit of measure	1924	1925	1926	1927	1928
Canadian crude produced	Gallons[1]	5,401,102	5,024,770	4,693,999	4,886,199	4,695,714
	Value	$390,424	$369,154	$376,822	$289,391	$249,981
Imported crude distilled	Gallons	151,381,481	161,895,295	183,347,749	218,200,977	257,929,514
	Value	$11,575,058	$13,056,823	$16,940,505	$15,900,079	$17,617,756
Canadian crude distilled	Gallons	5,123,683	4,859,148	5,017,500	5,205,097	4,484,858
	Value	$394,398	$358,245	$422,159	$363,320	$283,959
Percentage of total		3.27	2.92	2.66	2.33	1.71
PRODUCTS						
Gasoline	Gallons	61,493,214	73,083,022	84,936,377	100,944,586	122,792,092
	Selling value	$9,392,837	$11,032,134	$14,983,322	$13,641,570	$18,199,305
Illuminating oil	Gallons	28,816,322	18,677,629	8,088,787	23,712,369	21,304,385
	Selling value	$3,055,188	$2,222,569	$1,266,577	$2,828,872	$2,650,877
Lubricating oil	Gallons	12,011,116	13,297,275	16,025,753	17,040,724	16,822,292
	Selling value	$2,009,732	$2,364,320	$3,540,786	$3,237,375	$2,813,371
Engine distillate and naphtha	Gallons			53,869	4,045,416	3,062,787
	Selling value			$10,774	$510,960	$445,526
Gas and fuel oil	Gallons	36,702,043	46,064,129	41,883,125	53,767,638	76,469,354
	Selling value	$2,494,858	$2,947,378	$2,949,770	$3,280,343	$4,104,338
Tar and grease	Pounds	10,325,835	9,301,674	11,260,812	11,254,706	14,626,752
	Selling value	$187,544	$177,474	$221,826	$221,694	$267,563
Paraffin wax and candles	Pounds	9,112,143	15,502,029	9,858,490	9,526,072	17,030,064
	Selling value	$551,434	$734,322	$648,303	$505,133	$599,341
Acid and petroleum coke	Short tons	36,200	31,501	45,774	44,768	49,409
	Value	$226,005	$212,085	$265,481	$282,828	$314,794
Acid oil	Gallons	1,350,450	1,858,176	711,970	768,171	[2]
	Value	$61,748	$85,761	$35,823	$46,634	[2]
Still gas	M cu. ft.	524,737	431,713	630,325	811,666	823,320
	Value	$172,555	$167,869	$256,935	$207,370	$185,595
Asphalt	Gallons				1,060,761	1,276,098
	Selling value				$58,919	$65,003
Miscellaneous	Value	$29,261	$1,596	$2,978	$434,655	$387,544
Total value of refined products		$18,181,162	$19,945,508	$24,182,575	$25,256,353	$30,033,257
Employees	Average No.	1,603	2,165	2,241	1,871	1,853
	Wages	$2,453,082	$2,702,034	$2,876,150	$2,883,575	$3,013,872
Capital invested			$16,372,960	$20,441,740	$19,354,638	$19,570,531

[1]Gallons refer to Imperial gallons.
[2]Included in acid coke.

Petroleum and Refined Products Imported

Table IV shows a comparison in the quantity and value of crude petroleum and refined products imported into Ontario in the years 1927 and 1928. This affords a better basis of comparison in values than the previous two years, when a sudden decrease in values disturbed the oil markets of the world.

An examination of this table will show that there is a general decrease in all products except paraffin waxes and candles, and vaselines. In spite of the increase in the capacity of Ontario refineries and the addition of one large refinery, the importation of refined gasoline (irrespective of casing-head or blending gasoline) has increased by two and a half million gallons and of lubricating oils by about one million gallons, or the output of a small refinery.

Practically all of these imports are from the United States.

TABLE IV—PETROLEUM AND REFINED PRODUCTS IMPORTED IN 1927 AND 1928

Import	1927		1928	
	Imperial gallons	Value	Imperial gallons	Value
CRUDE PETROLEUM:				
Petroleum, 0.790 specific gravity or heavier, for refining	215,172,375	$9,882,693	260,328,023	$11,588,107
REFINED PETROLEUM:				
For use in concentrating ores	2,994	$1,792	4,877	$2,890
Gasoline lighter than 0.725 specific gravity (casing-head gasoline)	41,989,202	3,941,055	51,505,215	5,668,996
Gasoline between 0.770 and 0.725 specific gravity	6,860,050	705,403	9,312,836	1,064,398
Kerosene and illuminating oils	2,182,990	177,485	1,863,101	162,494
Gas oils, 0.790 specific gravity or heavier, imported by refiners	6,844	780	40,787	4,088
Lubricating and other oils	5,417,889	1,630,337	6,306,623	1,951,565
Fuel oil, 0.8235 specific gravity or heavier	8,308,386	537,578	9,029,113	586,014
Total	64,768,355	$6,994,430	78,062,552	$9,440,445
PETROLEUM PRODUCTS:				
Axle grease.....lbs.	2,463,158	$121,329	2,604,351	$118,581
Vaseline, toilet and medicinal petroleum		130,612		121,687
Paraffin wax.....lbs.	2,237,412	101,302	1,342,590	71,047
Paraffin wax candles.....lbs.	250,557	53,407	213,560	47,778
Other petroleum products.....gals.	1,056,956	177,089	1,735,097	309,136
Total		$583,739		$668,229
Total value		$17,460,862		$21,696,781

Total net value of petroleum and refined products imported in 1928	$21,696,781
Duty paid on the above, calculated on existing tariff schedule	682,297
Sales tax at 3 per cent	650,903
Freight, approximately	9,988,168
Total value delivered in Ontario	$33,018,149

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ONTARIO

PROVINCE OF ONTARIO

DEPARTMENT OF MINES

HON. CHAS. MCCREA, *Minister of Mines* — THOS. W. GIBSON, *Deputy Minister*

THIRTY-EIGHTH ANNUAL REPORT

OF THE

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COLOURED GEOLOGICAL MAPS

(In pocket at back of report)

Map No. 38*c*—Oba Area, District of Algoma. Scale, 2 miles to the inch.
Map No. 38*d*—Part of the Boston Creek Gold Area. Scale, 800 feet to the inch.
Map No. 38*e*—Sapawe Lake Area, District of Rainy River. Scale, ¾ mile to the inch.
Map No. 38*f*—Townships of Dorion and McTavish, District of Thunder Bay. Scale, 1 mile to the inch.

GEOLOGY OF THE SAPAWE LAKE AREA
With Notes on Some Iron and Gold Deposits of Rainy River District

By J. E. Hawley

INTRODUCTION

Considerable prospecting activity in the vicinity of Sapawe lake, Steeprock lake, Banning, and Bad Vermilion lake in the southern part of Rainy River district, occasioned a survey of these areas in the first part of the summer of 1928. A detailed map was made along the Atikokan river system from a point 6 miles east of Atikokan station on the Canadian National railway to the eastern end of Crooked Pine lake, an area herein called the Sapawe Lake area. Years ago and also recently, gold discoveries were made in veins associated with quartz porphyries intrusive into a complex of basic rocks which form a narrow belt trending eastward and lying between a large granite batholith on the north and a series of schistose sedimentary rocks on the south. Other dis-

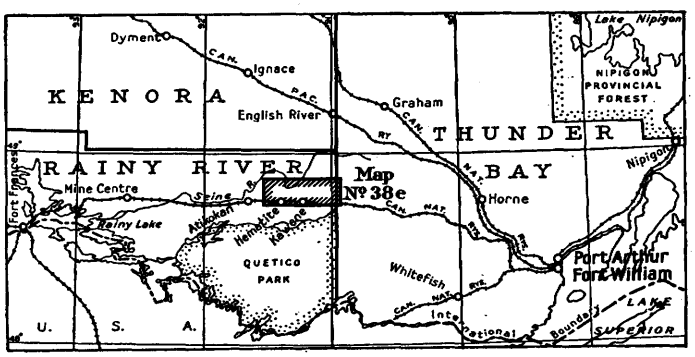

Fig. 1—Key map of Sapawe Lake area.
Scale, 70 miles to the inch.

coveries of gold have been made in veins in the granite itself, and along the southern border of the basic belt occur the magnetite and sulphide deposits of of the old Atikokan iron mine.

To the west of this area rediscoveries of gold have been reported near Steeprock lake in veins in altered granite. While our examination of these areas was being made, a mineralized schistose belt north of Banning was being explored for copper and gold, and at the Mayflower mine, west of Flanders, a crosscut was being driven to intersect a vein outcropping just north of the shaft.

In the vicinity of Mine Centre and Bad Vermilion lake prospecting was being actively carried on following the discovery of pockets of high-grade gold ore in a vein on the Isabella property of W. E. Stone, which had been optioned by the Northern Red Lake Mines in the early part of 1928. Notes regarding the geology of these smaller areas are included in this report with sketch maps of many of the prospects.

In the field the writer was most ably assisted by J. E. Thomson, E. D. Johnson, and R. A. Young. The description of the Atikokan iron range is largely

the work of Mr. Thomson, who is indebted to Dr. E. S. Moore, of the University of Toronto, for advice and suggestions in carrying out the laboratory investigations. All assays of ores have been made by the Provincial Assayer, W. K. McNeill, and T. E. Rothwell. The writer is also indebted to H. R. Aldrich, of the Wisconsin Geological Survey, for reading parts of the manuscript.

The Seine River Sheet No. 6, of the Geological Survey of Canada, issued in 1897, includes the Sapawe Lake area; the geological surveys are by W. H. Smith and W. McInnes.[1] Geological and magnetometric maps of the Atikokan iron range appear in the Appendix of Volume II of the Iron Ore Occurrences in Canada, Mines Branch Publication No. 217, 1917. In the vicinity of Mine Centre the general geology has been mapped by A. C. Lawson.[2] In this same area, detailed claim maps of the Golden Star and Foley mines have been made by E. L. Bruce.[3]

SAPAWE LAKE AREA

Introduction

Sapawe lake lies in Rainy River district, north of the Canadian National railway line, about half way between Port Arthur and Fort Frances. The area covered by map No. 38*e*, extends 16 miles east from the lake to the boundary between Rainy River and Thunder Bay districts, and west for 9 miles. North and south it is approximately 8 miles wide. Atikokan station and the geologically famous Steeprock lake lie about 6 miles west.

Within the area are two base lines and the first and second meridians surveyed by Niven in 1891. These have been entirely obliterated by the fires of 1903 and a vigorous second growth of forest. Two townships, McCaul on the southwest and Ramsay Wright on the northeast, are partly bounded by these lines. A large part of the area is covered by mining claims, many of which were also surveyed and patented in the late nineties; while many have since been restaked, their relocation has not been exact as most of the old lines and corner posts have disappeared.

A geological survey was made of the area with the Seine River sheet as a base. A micrometer survey of Sapawe lake was made for an accurate local base, and a chain survey was made of a try line cut by W. S. Jackson to the north of the lake in the vicinity of several quartz veins. Compass-pace traverses made across country were tied either to new surveys or to definitely located points on the Seine River sheet.

Sapawe lake is most easily reached from Iron Spur siding on the railway by a portage 20 chains long. The Atikokan river may be easily reached from several points on the railway between Hematite and Atikokan.

Previous Work

A general account of the geology of the Sapawe Lake area is given in McInnes's report of 1899, as already noted. Most of the gold mines and prospects in this area have received mention in the annual reports of the Ontario Department of Mines for the years 1894 to 1906. The reports are by A. P. Coleman and W. G. Miller. Accounts of the work done at such mines as the

[1]W. McInnes, Report on the Geology of the Area Covered by the Seine River and Lake Shebandowan Map-Sheets, Geol. Surv. Can., Vol. X, pt. H, 1899.

[2]A. C. Lawson, The Archaean Geology of Rainy Lake Re-studied, Geol. Surv. Can., Mem. 40, 1913 (Map No. 98A).

[3]E. L. Bruce, Gold Deposits of Kenora and Rainy River Districts, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925.

Minto, Sunbeam, Roy, Jack Lake, and White Lily are contained in reports by W. E. H. Carter and E. T. Corkill, Ontario mining inspectors.

The Atikokan iron range, situated near Iron Spur, has been described by A. C. Lawson, W. G. Miller, A. H. A. Robinson, E. Lindeman, and L. L. Bolton, and is mentioned by T. L. Tanton. A bibliography is given below.

ARCHIBALD BLUE, Ont. Bur. Mines, Vol. V, 1895, pp. 140-48.

J. A. Bow, Ont. Bur. Mines, Vol. VII, pt. 1, 1897, p. 67; Vol. VIII, pt. 1, 1899, p. 93; Vol. IX, 1900, p. 81; Vol. X, 1901, p. 84.

E. L. BRUCE, Gold Deposits of Kenora and Rainy River Districts, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925; Geol. Soc. Am., Vol. 38, 1927, pp. 771, 782.

W. E. H. CARTER, Ont. Bur. Mines, Vol. X, 1901, pp. 106-7; Vol. XI, 1902, pp. 239, 242; Vol. XIII, pt. 1, 1904, pp. 71, 72; Vol. XIV, pt. 1, 1905, pp. 56, 57.

A. P. COLEMAN, Ont. Bur. Mines, Vol. IV, 1894, pp. 58, 59, 73-76; Vol. VI, 1896, pp. 73, 74; Vol. VII, pt. 2, 1897, p. 132; Vol. XI. 1902, p. 150.

E. T. CORKILL, Ont. Bur. Mines, Vol. XV, pt. 1, 1906, pp. 48-50; Vol. XVI, pt. 1, 1907, pp. 56, 57, 60.

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F. F. GROUT, Geol. Soc. Am., Vol. 36, 1925, p. 359.

A. C. LAWSON, Report on the Geology of the Rainy Lake Region, Geol. Surv. Can., Vol. III, pt. F, 1887-88; The Archaean Rocks of Rainy Lake, Geol. Surv. Can., Sum. Rept., 1911; The Archaean Geology of Rainy Lake Re-studied, Geol. Surv. Can., Mem. 40, 1914.

E. LINDEMAN and L. L. BOLTON, Iron Ore Occurrences in Canada, Mines Branch, Dept. Mines, Can., Vols. I, II, 1917.

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W. G. MILLER, Ont. Bur. Mines, Vol. XII, 1903, pp. 81, 306.

A. H. A. ROBINSON, Mines Branch, Dept. Mines, Can., Sum. Rept., 1918, pp. 18-20.

T. L. TANTON, Geol. Surv. Can., Sum. Rept., pt. C, 1925, p. 5; Trans. Roy. Soc. Can., Vol. XX, Sect. IV, 1926, pp. 39-49

W. L. UGLOW, Geol. Surv. Can., 12th Internat. Geol. Cong., Guide Book No. 8, pt. 1, 1913.

C. R. VAN HISE and C. K. LEITH, The Pre-Cambrian Geology of North America, U.S. Geol. Surv., Bull. No. 360, 1909.

C. D. WALCOTT, Notes on Fossils from Limestone of Steeprock Lake, Geol. Surv. Can., Mem. 28, 1912.

Topography and Drainage

This area like so many of the pre-Cambrian sections of Ontario has a relatively low relief, differences in elevation seldom exceeding 200 feet. Nevertheless, the country has a rather rugged character, occasioned by the endless succession of rocky ridges and flat muskegs. The low ridges in general follow the schistose trend of the rocks, N. 80° E., with modifications produced by the scouring action of the glaciers, which flowed in a general south-southwest direction. The elevations range from 1,350 to 1,550 feet above sea-level.

The topography varies little where the underlying rocks change from granite to Keewatin schists, chiefly for the reason that in the latter regions are numerous acidic and basic intrusives. Over the southern part of the area, underlain by the softer schistose sedimentary rocks, the differences in elevation become still less, owing partly to the uniformity of the rocks and partly to the wide level stretches of sand plain and drift deposited by glacial waters.

One marked feature of the region, however, is a distinct depression along which the Atikokan river and its lake expansions flow from Crooked Pine lake on the east to and beyond Steeprock lake. The valley marks, in a general way, as noted by Lawson, the contact between the sedimentary rocks and the belt of basic igneous rocks of Keewatin and post-Keewatin age. For most of this distance the rocks are covered by water, swamp, or drift, but occasional outcrops are of highly schistose rocks, belonging in part to the Keewatin and probably in part to the sedimentary series. It is believed that this depression

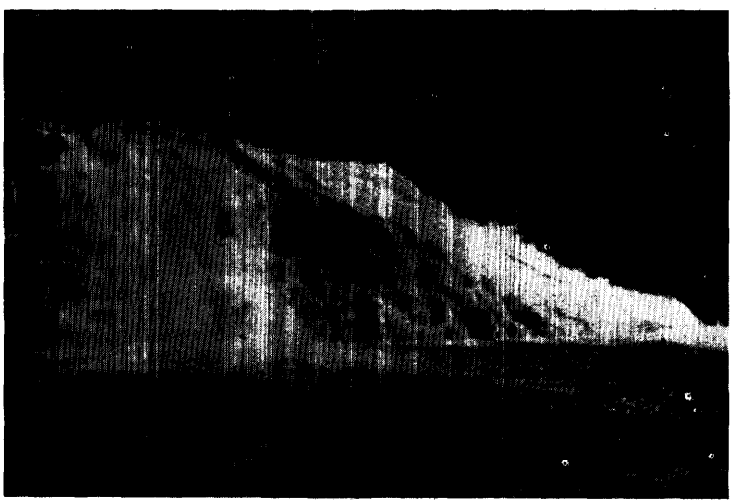
marks the site of a fault or large shear zone, the movement along which developed the severely schisted rocks.

All the waters of the region with outlets, drain eventually into the westward-flowing Seine river system, either by way of the Atikokan river or by the

Falls on the Atikokan river between Whiskey Jack and Magnetic lakes.

upper reaches of the Seine river proper. Excellent canoe routes are afforded by these rivers for the entire length of the area on both the north and south sides.

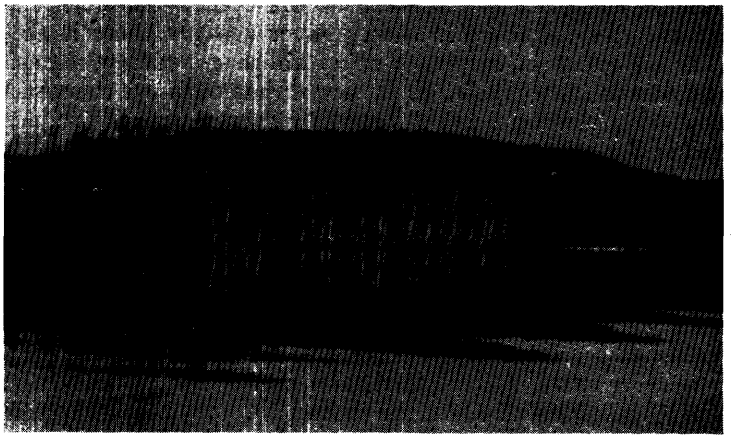
Along the Atikokan river in this area are several small rapids and falls, the largest of which lies between Whiskey Jack and Magnetic lakes. This



View of the higher fall on the left of the upper photograph.

portion of the river is shallow and quite narrow. Between Whiskey Jack and Sapawe lakes are two small rapids with drops of 2 to 3 feet each. From Sapawe lake to two miles east of Atikokan there are numerous small rapids and falls. From there to Steeprock lake the river follows a meandering course in a fertile silted-up flood plain.

In the northern part of the area, Lower Seine lake and the Seine river, as far up as Island falls, have been flooded by the recently constructed dam at the entrance of the Seine river into Steeprock lake. The flooding of the low-lying lands adjoining these waters has moved the shoreline back in places as much as a quarter of a mile and has resulted in the drowning of the small growth of spruce and poplar. About the much indented Reserve island, just below Island falls, the geography has been altered considerably by the creation of new islands from peninsulas, by the elimination of others by complete flooding, and by the widening and deepening of tributary streams and the drowning of rapids. At Island falls, the drop reported by Coleman[1] as 23 feet has been



Drowned lands along the Seine river near Reserve island.

reduced approximately 10 feet by the flooding. Island falls and the falls on the Atikokan river have been mentioned in previous reports as capable of being utilized for power development.

Timber

The entire area is covered with a relatively young growth of forest which has sprung up since the fires of 1903 and 1904. It is reported that these fires swept large sections of the country quite bare, but occasional small stands of older trees which survived may be found in the lower sections. The most abundant trees are spruce, balsam, poplar, birch, and jackpine. In some of the swamps cedars attain good size. A few white and red pine occur along the Seine river near Island falls. Timbering has been carried on in the past along Crooked Pine lake as evidenced by rafts and logs at the outlet. Much pulpwood could be obtained in the area, but on the whole the larger growths are patchy.

Game and Fish

Of the larger wild animals, moose are the most common, especially along the grassy stretches of the Atikokan river. A few red deer were seen. Black bears are rather numerous near Sapawe lake and caused some damage to cabins and the supplies of prospectors. Ducks are also plentiful in this same region.

In all of the lakes and rivers travelled the only plentiful fish found were jackfish or pike, which on the Seine river reach a good size. The great scarcity of other varieties suggests their nearly complete extermination.

[1]Ont. Bur. Mines, Vol. VI, 1896, p. 74.

Economic Geology

Deposits of both gold and iron occur within the Sapawe Lake area. Native gold has long been known to occur in quartz veins in the Laurentian granite and within the belt of Keewatin greenstones to the south. The earliest discovery is reported[1] to have been at Partridge lake in 1872. From 1893 to 1906, mining and prospecting activities were carried on in many places. From then until the last few years gold-mining operations were at a standstill. In 1927 and 1928 activity was renewed in the southern portion, attention being confined largely to the Keewatin areas where old discoveries have been re-examined and a few new ones made in the vicinity of Sapawe lake. There are no producing mines in the area and no ore bodies of commercial size have yet been found. As elsewhere in Rainy River district, there is abundant evidence of wasted effort in attempts to establish producing mines. For this area and the district as a whole, E. L. Bruce[2] has outlined the various reasons for the failure of numerous mines to become more permanent producers. Chief among these is the waste of time and money on veins "too small or too low in gold content" to be considered ore. Other reasons advanced are the over-ambition of companies with regard to small ore bodies, inefficient mining and milling methods, and lack of knowledge of the structure and nature of the vein deposits. Further exploration in this area may yet reveal deposits of sufficient size and grade to warrant mining, but from an examination of all the veins so far discovered the chances of this do not appear very great. In the greenstone areas, the gold-bearing veins are associated with abundant lenticular porphyritic intrusions and, like them, are very irregular in size and value. In the granitic areas, while the veins are stronger the values are not persistent, and mining of both types of veins would be costly and highly speculative.

The deposits of iron ore in the Atikokan iron range, like the gold deposits, have been known for many years. Mining and prospecting operations were carried on at these deposits between the years 1905 and 1913, though the first discovery dates back to 1882. The ore is magnetite and contains a relatively high percentage of sulphur. Some of it has been successfully mined and smelted after roasting. West of the Atikokan iron mine the deposits are largely of pyrrhotite, in which traces of chalcopyrite are found. Detailed maps and reports on this iron range have been issued by the Mines Branch of the Department of Mines of Canada. Regarding the richer deposits at the Atikokan iron mine, Lindeman and Bolton[3] estimate that there are several million tons of ore available for mining, though accurate estimates in view of the irregular nature of the ore lenses are impossible. They point out that this fact and the very high sulphur content affect the value of the deposit considerably.

Since 1913 all operations have been discontinued at the Atikokan iron mine. Mine buildings and the spur railway line are now in much disrepair.

General Geology

The consolidated rocks of the area include both sedimentary and igneous rocks of the early to middle pre-Cambrian. The exact age and relationship of these to one another cannot be told entirely from observations within the area, and studies of similar rocks to the west were made in an attempt to determine the proper sequence. From south to north four eastward-trending belts of

[1] W. McInnes, op. cit., p. 594.

[2] E. L. Bruce, op. cit., pp. 1, 2.

[3] Iron Ore Occurrences in Canada, Mines Branch, Dept. Mines, Can., Vol. I, 1917, p. 34.

different rocks are exposed. The southernmost is a red biotite granite, in part gneissic, which intrudes on the north a belt of highly schistose clastic sedimentary rocks, chiefly quartzites, arkosites, and slates. Near Iron Spur a crudely elliptical stock of this granite is entirely surrounded by sediments. To the north of the Atikokan River system is a belt of dominantly basic rocks extending throughout the area with a width of from 1 to 2 miles. Along the southern margin of this occur the magnetite and pyrrhotite deposits of the Atikokan iron range. The rocks of this belt are of three main types: very fine grained chloritic and hornblendic schists of probable Keewatin volcanic origin; abundant intrusive lenticular masses of quartz and feldspar porphyry and felsite; and similar irregular intrusives varying in composition from quartz diorite to gabbro. The latter appear to be of two distinct ages. Over the larger part of the area on the north is a large batholith of a grey biotite to hornblende granite and granite gneiss, which contains numerous lenses of chlorite and hornblende schist. This granite is intruded in a few places by narrow dikes of diabase.

Two of the above groups may be placed rather definitely as to age: the chlorite and hornblende schists of the central belt of basic rocks as Keewatin; and the intrusive grey granites and related porphyritic intrusives as pre-Huronian or Laurentian, since the granite may be traced westward to Steeprock lake where it is overlain unconformably by the Steeprock Lake series of sediments. Of the basic intrusives in the central belt of Keewatin rocks, both are intrusive into the Keewatin; one group of older gabbros and diorites is intruded by Laurentian acidic dikes, and a second group of fresher diabase dikes cuts both the older gabbros and diorites and the Laurentian granite. The latter may be related in age to gabbros intruding the Steeprock Lake series.

The sedimentary series on the south and the red biotite granite are of questionable age. Originally the sediments were considered by McInnes[1] and Smith[2] as Coutchiching or pre-Keewatin. Lawson[3] divided the western extension of this series into two groups, the southern part of which he regarded as Coutchiching, and the northern part as post-Keewatin or Seine and younger than even the Steeprock Lake series of sediments. Later both Grout[4] and Tanton[5] agree that the sedimentary series cannot thus be divided. Grout places them as post-Keewatin in age; Tanton, as pre-Keewatin or Coutchiching. For the Sapawe Lake area and to the southwest of Steeprock lake, the present writer accepts the view that the sediments lying to the south of the Keewatin are essentially all of one age and presents additional data to support a post-Keewatin age for the series, though it is admitted that much more detailed information is required before a final conclusion can be reached.

The following table of formations for this and adjoining areas is an attempt to show the various age possibilities.

[1]W. McInnes, op. cit., p. 17.
[2]W. H. C. Smith, who did most of the geological work on the Seine River sheet.
[3]A. C. Lawson, op. cit.
[4]F. F. Grout, Geol. Soc. Am., Vol. 36, 1925, p. 359.
[5]T. L. Tanton, Recognition of the Coutchiching near Steep Rock Lake, Ontario, Trans. Roy. Soc. Can., Vol. XX, Sect. IV, 1926, pp. 39-49.

TABLE OF FORMATIONS

	Sapawe Lake area	Steeprock Lake area	Other possible correlations
RECENT AND PLEISTOCENE:	River silts, glacial drift, morainic and fluvio-glacial deposits of sand, gravel, and boulder clay.		
PRE-CAMBRIAN			
ALGOMAN:	Red biotite granite and gneiss.		
	Intrusive contact		
SEINE:	Sedimentary series, south of Atikokan River system, quartzites, arkosites, slates.		Coutchiching of McInnes and Tanton; Seine and Coutchiching of Lawson.
POST-STEEPROCK LAKE:	Diabase, diorite and gabbro.	Gabbro.	Possibly Algoman or even Keweenawan.
	Intrusive contact		
LOWER HURONIAN:		Steeprock Lake series, limestone conglomerate, and volcanics.	
	Unconformity		
LAURENTIAN:	Grey hornblendic to biotite granite and granite gneiss; quartz porphyry; micropegmatite.		
	Intrusive contact		
	Altered gabbro and diorite.		
	Intrusive contact		
KEEWATIN:	Chlorite and hornblende schists; metabasalts and other volcanics.		
COUTCHICHING:	Sedimentary series.		Listed above as Seine.

KEEWATIN

Under this general heading will be described both the volcanic schists and post-volcanic basic intrusives, since both are cut by Laurentian granites and related rocks.

The minor part of the central belt of basic rocks, undivided on the map, extending along the north side of the Atikokan river system consists of fine-grained greenstones and either chloritic or hornblendic schists. In the vicinity of acidic intrusives these are altered in many places to rusty-weathering carbonate schists. This belt is a continuation of similar rocks mapped as Keewatin to the south of Steeprock lake. There the alteration has not been sufficient to destroy completely the original textures and structures typical of volcanic flows. Throughout the Sapawe Lake area, however, no well-preserved volcanic textures or structures were observed in the finer-grained basic schists, but there can be

little doubt that these are largely the metamorphic derivatives of basic to intermediate volcanic flows. This does not mean that all the greenstone schists are of this type, since the later intrusive gabbros and diorites have locally been altered to chlorite schists which are indistinguishable in many cases from volcanic derivatives.

In the western part of the area occasional white-weathering rhyolitic lenses occur with the greenstones. Acidic flows of this type become more abundant to the west.

Regarding the age of the group of contiguous greenstones and basic lavas lying to the south and west of Steeprock lake, it has been stated, "that McInnes and all geologists who have subsequently examined the field agree that the greenstone assemblage is of Keewatin age."[1] This does not necessarily apply to the basic intrusives which become more prominent to the east in the Sapawe Lake area.

On the north shore of Sapawe lake and adjoining many of the lenticular intrusions of quartz porphyry, rusty-weathering green carbonate schists are common. These are identical with the carbonate rocks of other Keewatin areas such as Porcupine.[2] The carbonated rocks are usually impregnated with innumerable quartz and carbonate stringers, and in a few places an apple-green chromiferous mica has been developed. Near other intrusions the greenstones have been altered to hornblende schists.

Along the southern border of the basic rocks, across the greater part of the area, is a band of fissile schists which vary from chlorite to sericite and are locally slaty. To the north lie more massive diorites and gabbros, and to the south are clearly defined sedimentary schists. The origin of the schist band between these two is not known. The greater part is thought to be derived from the Keewatin because of the dominance of chlorite. In part the schists may be derived from acidic or basic intrusives and in part from the dominantly acidic sediments to the south. The well-defined nature of this schistose band has occasioned its separate mapping. As noted below (page 16) this shear zone is interpreted as a fault, but the actual displacement cannot easily be measured.

DIORITE AND GABBRO

By far the greater portion of the greenstone belt, which includes the Keewatin schists, is composed of lenticular intrusions of medium to fine grained diorites and gabbros. These rocks have a dark-brown to green colour and are both massive and highly schisted. Most of them are considerably altered, and their usual fine grain makes it difficult to distinguish them from volcanics. They appear as narrow intrusions seldom over 10 chains in width, and generally less, with their long dimensions parallel to the regional eastward-trending schistosity. The more massive intrusions stand out as low ridges, bounded on either side by swampy land, and their relation to other rocks is generally obscured. Intrusive contacts with fine chloritic Keewatin schists, however, are common. The relations strongly suggest that the intrusions occurred after the Keewatin had been folded and partly schisted. Later shearing has locally rendered the diorites and gabbros highly schistose. The relation of many of these intrusions to Laurentian granite and porphyries is not firmly established. That some and probably the greater part are of pre-Laurentian age is suggested by several occurrences.

On the Minto trail leading from Hill's cabin on the Atikokan river, narrow dikes of grey-weathering felsite are found cutting massive, fine-grained diorite.

[1] T. L. Tanton, op. cit., p. 41.
[2] A. G. Burrows, Ont. Bur. Mines, Vol. XXIV, pt. 3, 1915, pp. 14, 15.

The felsite is related to the Laurentian granites on the north. North of the central part of Sapawe lake, on claim F.F. 912, an exposure was found showing massive fine diorite intruded by an impure chloritic and porphyritic granite with blue eyes of quartz. At other places quartz veins associated with intrusive felsites lie in fractures in altered diorite or gabbro.

There are, however, other gabbros and diorites, usually with a diabasic texture in this same belt of rocks which are intrusive into the older gabbros and into the Laurentian as well. These will be described later.

In the field the two ages of gabbroic rocks are not easily distinguished unless in contact, and their separate mapping has not been possible. The younger group may be equivalent to gabbros which intrude the Steeprock Lake series of sediments, as reported by Tanton.[1] The older may be the equivalent of hornblende gabbros and other basic intrusives described by Lawson in the Rainy lake region. The latter have been placed in the Keewatin since they appear to have suffered as much deformation as the Keewatin volcanics. The age of the gabbroic rocks containing the deposits of magnetite and sulphides along the Atikokan river cannot be fixed with certainty. Their schistose character suggests that they belong to the older group. Their relation to the sedimentary series on the immediate south is likewise in doubt, as no contacts are visible.

Thin sections of the older intrusives show a range in composition from quartz diorites to gabbros. A specimen taken from Hill's trail contains chiefly hornblende, andesine-oligoclase, ilmenite, and fresh quartz. Abundant alteration products are epidote, chlorite, sericite, and zoisite. A diorite from a spot north of Magnetic lake has a slight ophitic texture and contains ilmenite, leucoxene, green hornblende, and andesine-feldspar, as well as many common alteration products. A quartz diorite from a locality north of Mark lake contains an intermediate plagioclase intergrown with quartz, abundant chlorite, and much carbonate. No hornblende remains unaltered.

A specimen of the intrusion in which the Atikokan iron ores occur is of a hornblende gabbro with labradorite as the chief feldspar. Another specimen shows a slight ophitic texture. Alteration products are chiefly chlorite, epidote, and carbonate; some secondary quartz is found, as well as pyrite.

Many other specimens can be classified only as diorite or gabbro, as the feldspars and other minerals are too highly altered to sericite, zoisite, chlorite, and carbonates to make determination exact. The occurrence in a few intrusions of fairly fresh hornblende and much altered feldspar suggests that they are the result of contact metamorphism, and some of these may be related to the Laurentian granites.

Along the north shore of Magnetic lake and the east end of Crooked Pine lake occurs a pseudo-porphyritic schistose diorite or gabbro. In this are angular segregations of fine, light-pink minerals, which have a distinct conchoidal fracture and might otherwise be mistaken for feldspars. They are composed chiefly of fine zoisite, probably alteration products of feldspar phenocrysts.

LAURENTIAN

Northern Granites and Gneisses

The term Laurentian, implying a post-Keewatin and pre-Huronian age may be applied to the granitic rocks occupying the northern half of the map-sheet and extending beyond, as mapped originally by W. H. C. Smith and

[1]T. L. Tanton, Geol. Surv. Can., Sum. Rept., pt. C., 1925, p. 5.

W. McInnes. The rocks have been well described by McInnes as essentially hornblende-biotite granite and gneiss.

This granite was originally called protogine and is still known by that name to prospectors. In appearance it is usually grey to white, though reddish phases appear locally. The grain is even and medium to coarse. In the southern part of its exposure it is massive, but towards the north becomes gneissic and foliated. Everywhere it has suffered shearing and fracturing. On the Seine river below Island falls the gneissic structure appears in part to be due to the inclusion and partial recrystallization of basic schists. Irregular bands composed dominantly of hornblende and lesser feldspar and quartz are interspersed with light aplitic bands in which ferromagnesian minerals are almost lacking. Many inclusions of hornblendic rocks still retain their angular outlines; others are strewn out parallel to the gneissic structure. Near Upper Seine lake, north of the map-sheet, McInnes separated the grey hornblende granite gneiss on the south from a biotite granite gneiss on the north. Narrow dikes of the latter may be found cutting the former, but it is doubtful if any broad distinction can be made as hornblendic gneisses continue to the north.

In most specimens of the grey granite the ferromagnesian minerals, hornblende and biotite, have been altered completely to chlorite. Others contain little hornblende, but biotite is present. A reddish granite from near Jacks lake contains, besides quartz and orthoclase, microcline, acid plagioclase, and a few graphic intergrowths of quartz and orthoclase. Some feldspars are largely replaced by sericite or carbonates, and epidote appears with chlorite after biotite.

Where sheared, as it is near many quartz veins, the granite has been much altered and contains fine mosaic quartz, filling the interstices between highly sericitized feldspars. Biotite is altered completely to chlorite, and some limonite appears. In other cases fissile sericite schists have been formed.

Throughout the area basic chlorite and hornblende schist lenses are numerous and near many of these, gold-bearing quartz veins have been deposited in fractures. Most of these inclusions are narrow, seldom exceeding a few feet in width. There are also darker grey dioritic and quartz dioritic phases of the granite, which have been mentioned by McInnes.[1] They appear as impure border phases and are cut in many places by a lighter and often reddish granite in which basic minerals are few. At Osinawi lake these darker phases are common.

The age of the grey biotite and hornblende granite was established by H. L. Smith as Laurentian, since in the vicinity of Steeprock lake it is intrusive into the Keewatin and is overlain unconformably by the basal conglomerate of the Steeprock Lake series, which has been correlated with the Lower Huronian of Marquette by Van Hise, Lawson, and others. This granite is not intrusive, so far as is known, into the large belt of sediments known variously as the Seine and Coutchiching and lying to the south of the Keewatin. A few fine-grained diabase dikes are found cutting the granite.

Quartz-Feldspar Porphyry and Micropegmatite

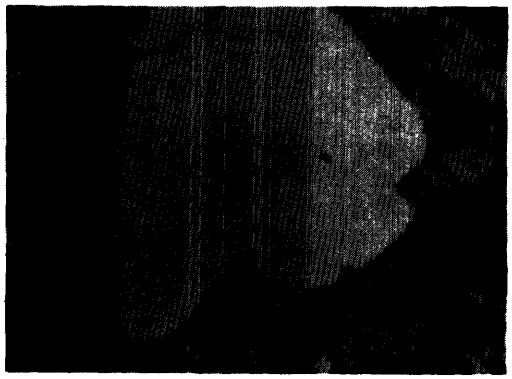
Within the basic belt of greenstones are innumerable small lenticular intrusions of a grey to white weathering felsite, classed in the field as quartz porphyry and having a very similar aspect to quartz porphyries of other regions. It is with these that certain gold-bearing quartz veins occur. In general the porphyritic character is not evident in a hand specimen.

In most places the intrusions follow the schistose structure of the enclosing rocks and range in width from a few feet to several chains. Their lengths are

[1]W. McInnes, op. cit., p. 14.

in proportion to their widths. Their characteristic lenticular shape is well illustrated on claim B.J. 119, where considerable stripping has been done. Here masses of various sizes intrude green schists *en échelon,* cutting gradually across the schistosity from southwest to northeast, as shown in Fig. 9 (page 30). Their lenticular nature makes it impossible to join up different bodies even though they occur directly along the strike. Wherever traverses have been made across the greenstones abundant lenses of felsite are found. It is certain that there are many more than have been mapped.

Microscopic examination of several specimens shows that they are composed chiefly of quartz, orthoclase, and albite, with occasionally a few flakes of biotite. Sericite, chlorite, and carbonate are secondary minerals. The proportion of the



Photomicrograph of porphyritic micropegmatite. (× 40.)

feldspars varies in different intrusives, but albite appears to be the most common. Other specimens contain small intergrowths of quartz and orthoclase. The texture is usually fine and fairly even grained, though small phenocrysts of both quartz and feldspar are present locally. A specimen from claim F.F. 823 is porphyritic micropegmatite with phenocrysts of quartz, orthoclase, and ablite clearly defined in a matrix of micrographic intergrowths of feldspar and quartz, which display a beautiful centric structure. (See photomicrograph above.)

Many of the porphyritic dikes or lenses with which quartz veins are associated have been subjected to intense shearing and alteration. Fissile sericite schists are the usual result, and many of these have been carbonated as well and impregnated with narrow quartz stringers and sulphides. In other cases, as on claim B.J. 118, the porphyries have been intensely fractured and partly schisted. The schists have been carbonated, and into the fractures and between the folia quartz stringers have been introduced which in part replace the porphyry itself. Thin sections of such rocks show a great abundance of mosaic quartz partly replacing feldspars. Carbonation of the schists appears to have preceded the introduction of the quartz, though in vein deposits some carbonates are intergrown with the quartz.

While the specimens examined are few compared with the innumerable intrusions, all seem characterized by an abundance of soda feldspar and quartz. Along the northern border they pass gradually into the grey granite with increasing amounts of orthoclase and ferromagnesian minerals, chiefly biotite. In this vicinity porphyritic granite occurs with small blue eyes of quartz. The weathered surface of the granite is always bleached, and except for its slightly coarser

texture its appearance is identical with the finer dikes in the greenstone. The apparent gradation of the porphyries and felsites northward into the grey granite and the occurrence of gold in both may be taken as evidence that they are more or less contemporaneous, and both the result of one period of igneous intrusion, the more alkaline porphyries being a differentiation of the main batholith.

As noted above, the felsitic intrusives cut both Keewatin and a series of diorites and gabbros. Their probable Laurentian age is the basis on which the diorite-gabbro group are placed as pre-Laurentian.

SOUTHERN SEDIMENTARY SERIES OF PRE- OR POST-KEEWATIN AGE

Crossing the southern part of the Sapawe Lake area is a series of fine-grained sedimentary rocks consisting essentially of quartzites, arkosites, slates, and their schistose derivatives. The width of their exposure is from 2 to 3 miles. Along their strike they continue to the east and west beyond the map area. On the south they are intruded by red granite and on the north are bordered by the belt of basic rocks. The series have been described by McInnes as Coutchiching in age but have not been completely differentiated from the Keewatin on his map. Lawson describes them as of post-Keewatin age, and several others have discussed their correlation, as will be seen below. Fig. 2 shows the distribution of the series in this area and to the west of Steeprock lake.

Lithology

The sedimentary rocks weather to a brownish grey or green. Where schistose they are often chloritic and not easily recognized as sediments. Massive bedded arkosites are common in the east, south of Crooked Pine lake, and resemble fine-grained igneous rocks. In general, however, the beds are thin, 1 to 3 inches thick, and interlaminated slates and quartzites may usually be found. All are of fine grain, and only seldom can the tops of beds be told by variation in coarseness of grain. No conglomerates are present in this area.

The quartzitic rocks predominate. Under the microscope their clastic nature is readily apparent. The grains are chiefly of quartz, but feldspars, largely acidic plagioclase, are quite common, hence the name arkosite, as used by Tanton. In the thin sections examined, the feldspars vary in composition from orthoclase to oligoclase-andesine. Many of them show sericitic alteration. The grains are angular to subangular and lie in a fine-grained matrix, chiefly of chlorite and quartz. Small flakes of biotite are usually present and some secondary hornblende. At Iron Spur, as described by Lawson, the sediments have been intruded by granite and altered around the contact to dark quartz-biotite and quartz-hornblende schists. Along the south shore of Sapawe lake a quartzose bed containing magnetite was noted. The slates are usually in very thin beds and, with more quartzose beds, give the sediments a distinct varve-like appearance, a fact noted by Tanton for the same rocks to the west. Most of the slaty beds are intensely sheared.

The composition of the sediments shows that they have been derived from a land mass of granitic composition; the abundance of little-altered feldspar is evidence that they were produced more by mechanical disintegration than chemical decomposition. The fine grain and evenness of the strata point to their deposition in quiet waters at some distance from shore lines. It has been suggested that they are of deltaic origin.[1]

The absence of interbedded conglomerates or of a well-established basal conglomerate is exceptional in view of their origin. Under the theory that the

[1]E. L. Bruce, Geol. Soc. Am., Vol. 38, 1927, pp. 778-79.

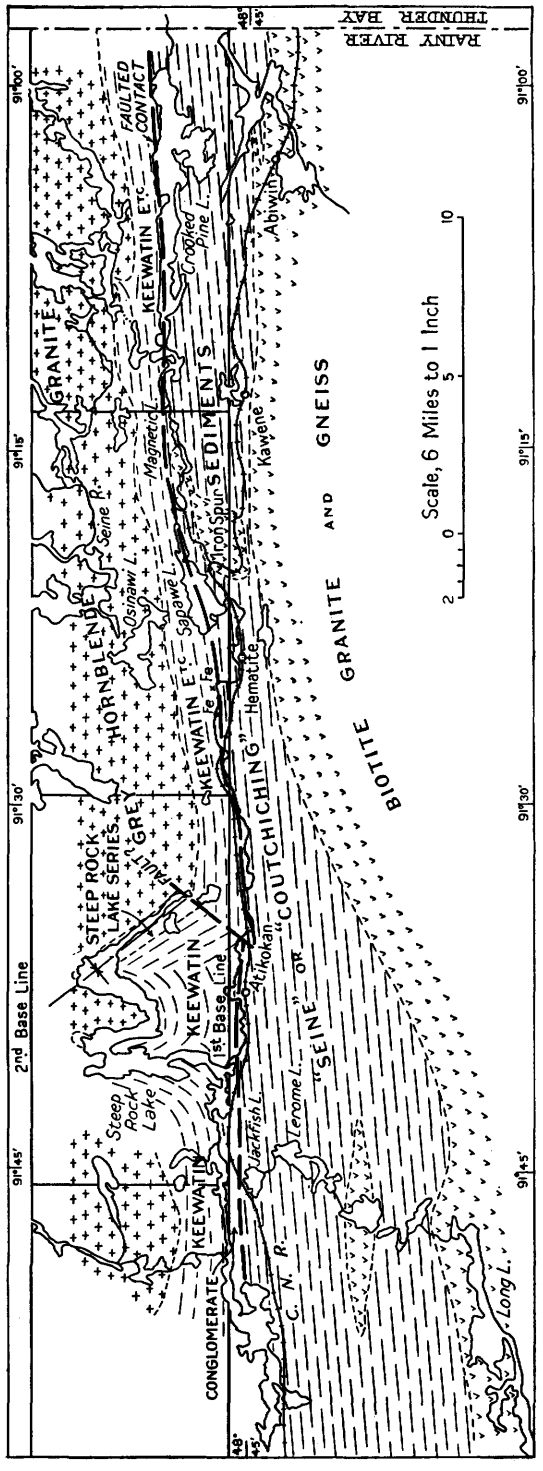


Fig. 2—Geological sketch map of Steeprock Lake and Sapawe Lake areas.

sediments are pre-Keewatin, conglomerates might not be expected, since they would underlie the strata now exposed. There are conglomeratic masses, however, occurring along the contact of this series and the Keewatin, which have been considered as being of the same age as, or of a younger age than, the finer sediments. These lie to the west of the Sapawe Lake area. A detailed examination of one such occurrence was made and is described below in the discussion of the age of the sediments.

Structure

The sediments are closely folded into a series of anticlines and synclines, according to Tanton,[1] the axes of which trend as do the beds in a general direction, N. 65° to 85° E., but the details of folding are not well known. All the strata are practically standing on edge, or dip steeply north or south as does the schistosity. The majority of the beds now dip south. Observations in this area were confined largely to the northern part of the belt in order to determine its relation to the Keewatin. Opposite interpretations of the structure of this series have led to the dispute as to its age with respect to the Keewatin. A previous conception of the structure was that the series dipped south as a monocline and lay unconformably above the Keewatin. The local occurrence along the contact near Jackfish lake of a conglomerate which is clearly derived in part from the Keewatin supported this idea, as well as other larger structural features. Tanton,[2] on the other hand, has shown that the sediments along their northern contact dip under the Keewatin. He believes the sediments are, therefore, pre-Keewatin and that the conglomerate was deposited unconformably on both the Keewatin and sediments and later infolded with them.

Structural data gathered by the writer, though scanty, support Tanton in his conclusion that the sediments appear to dip under the Keewatin, but the corollary, that the sediments are therefore pre-Keewatin, is seriously questioned, since it may be shown that the contact is a faulted one.

Determination of Tops of Beds.—As noted by others, the most satisfactory method of determining the tops of beds, and from them the structure, is by means of gradation in size of original grains, particularly in thinly bedded arkosites. At no place in this area was cross-bedding observed. Here, also, the value of determining the attitude of the beds by the relation of flow and fracture cleavage to bedding in vertical section seems questionable. Not only are the determinations difficult to make with accuracy, since they differ in dip by only a few degrees, but the dips in many places vary from steeply north to steeply south. This may be due to minor crumpling or later tilting. Furthermore, its value in deciphering the structure depends on its origination during the primary folding of the beds. Should it be related to a later major shearing and faulting movement, its use might lead to erroneous conclusions. Besides, cleavages of more than one age and orientation are present and more than one deformation is indicated locally. Likewise drag folds seem of little value, since about equal numbers were found pitching east and west.

Of innumerable detailed examinations of the sediments made near the Keewatin contact in this area, only five cases were found where a gradation in grain showed indisputably that the tops were on the north. One case was noted where the opposite was true. Since the first five examples are rather uniformly spaced along the northern border, it may be concluded that for the Sapawe Lake area the sediments appear to dip under the Keewatin, corresponding with Tanton's

[1] T. L. Tanton, Trans. Roy. Soc., Vol. XX, Sect. IV, 1926, p. 44.
[2] Ibid.

finding in the area west of Steeprock lake. Indications of tops of beds by fracture cleavage, if this is related in most cases to the original folding, also give a majority of tops on the north, though several cases of tops on the south were also found in this way, along the northern border of the sediments. As will be seen later it is possible that elsewhere, no matter what their age, the sediments may be found to dip over rather than under the Keewatin, by virtue of their faulted nature.

Faulted Nature of Contact.—From the west edge of the Sapawe Lake area to the east end of Magnetic lake, the strike of the beds parallels approximately the contact with the greenstone complex on the north. This is true at Sapawe lake where the contact swings northward, owing perhaps to the elliptical intrusion of granite at Iron Spur. From Magnetic lake east to the end of Crooked Pine lake, careful plotting of strikes brings out the fact that the strata are truncated at a low angle of 8 to 20 degrees by the northern contact. The contact here is almost a straight line and is marked by a band of highly schistose rocks, all of which suggests a fault of considerable magnitude. It is believed that this structural feature continues westward, paralleling the bedding for the most part, but still marked by a topographic depression and highly schistose rocks throughout its length.

To the west of Steeprock lake, Tanton[1] describes the Keewatin rocks as more schistose and variable in composition along their southern border than to the north. This he recognizes as being possibly due to faulting, the influence of which, however, is not considered.

Further proof of the faulted nature of this contact is obtained by a regional study of the major folds. According to earlier interpretations the series of sediments under discussion are younger than the Keewatin and the Steeprock Lake series[2] of sediments. One of the strongest arguments for this age is that the latter two groups have been folded with axes trending somewhat west of north, whereas the sediments on the south (and the Keewatin as well in the east) lie with a uniform trend of about N. 80° E. This major structural discordance was explained by postulating the folding of the Keewatin and Steeprock Lake sediments as preceeding the deposition of the southern series. Recognition of a major fault along the south contact of the Keewatin does not necessarily alter this interpretation, but in view of Tanton's and the writer's observations of the sediments to the south, that they dip under the Keewatin, a fault is needed to account for their present attitude.

On the other hand, should the sediments be of pre-Keewatin or Coutchiching age, a fault may account for the fact that the northwest folding of the Keewatin and Steeprock Lake series is not reflected in the underlying sediments. No other explanation seems possible and that even a fault may explain this will probably be questioned. In either case a fault of considerable size is required. That no fault gouge or breccia was observed along the shear zone may be accounted for in several ways. Only a very small portion of the zone is exposed, the greater part being covered by drift, swamp, and water. Any fault breccias may have been obliterated by continued shearing, or no breccia may have been formed if the shearing along the zone at present exposed took place at some depth and was distributed over a long period of time.

[1]T. L. Tanton, op. cit., p. 46.

[2]The Steeprock Lake series consists of conglomerate, algal limestone, basic lava flows, and green schists of doubtful origin. It has a relatively local distribution at Steeprock lake and structurally is a sharp syncline resting unconformably above a Keewatin-Laurentian contact. The axis of the fold trends northwest.

Indirect evidence of faulting is found in the Sapawe Lake area in the occurrence of the Atikokan iron deposits of magnetite and sulphides. These occur just north of the contact in altered basic intrusions. They have a distinct linear arrangement, paralleling the contact, which suggests a definite structural control over their deposition, even though they partly replace the rocks in which they occur. Since they do not occur exactly in the sediment-Keewatin contact, fracturing and shearing of the rocks adjacent to the contact must have influenced the site of deposition. The fracturing and shearing can be best related to the major faulting in the area.

Nature and Direction of Fault Movement.—The data at hand give some suggestion as to the nature and direction of the faulting, but more facts are needed before a final conclusion is reached. An interpretation of the deformation is given, recognizing that more details may require a change in emphasis.

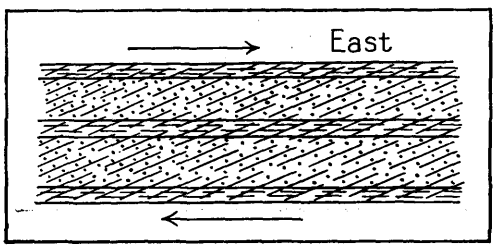


Fig. 3—Sketch illustrating dominant cleavages found in the sediments in the Sapawe Lake area. In the finer beds, the slaty cleavage is nearly parallel to the bedding. The larger fracture cleavage in places cuts across both arkosites and slates.

Since the fault is now represented by a highly schistose zone, generally covered in one way or another, and since no definite horizons are cut by it, the true nature of the major movement can only be inferred by a study of the minor structural features on either side. In the sediments these features, such as drag folds, fracture and flow cleavage, and minor faults, are best displayed, but great difficulty is presented in distinguishing them from similar features related to the major folding of the sediments. As noted, cleavages of different orientation are found imposed on one another. Drag folds with both east and west pitch occur, as do drags caused by opposite differential movement.

Dip of Fault.—The dip of the highly schistose zone mapped along the contact is practically vertical. Variations of 10 degrees on either side may be due to later causes. The dip of the fault plane at the level now exposed is, therefore, essentially vertical. The schistose nature of the fault zone suggests that it is more of a shear-thrust than a normal fault type.

Horizontal Movement.—Horizontal movements in both east and west directions (more or less parallel to the fault) are indicated, and the effects of one are found superimposed on another, but that of the north side eastward appears the more permanent.

The sediments along the southern border within the Sapawe Lake area have a well-defined fracture cleavage striking as a rule 10 to 30 degrees more to the north than the beds. It is best displayed in the arkosites, but it also cuts across a slaty cleavage, which is more nearly parallel with the beds (Fig. 3). It is possible that this fracture cleavage is related to a major faulting movement

rather than to the original folding, or it may be the result of one stress which produced both folding and faulting. In either case it implies a movement of the north side eastward. To the west of this area, south of Atikokan, a similar prominent cleavage but with a strike more southerly than the beds was noted (Fig. 4), and Tanton[1] has illustrated the same direction of cleavage for beds still farther west. Near Jackfish lake, however, the direction of the most prominent cleavage is again similar to that at Sapawe lake.

A study of the general geology in the vicinity of Steeprock lake and west along the Seine river suggests again that a major movement occurred along the contact with the north side moving east. Two occurrences are as follows:—

At a point along the contact, 1½ miles east of Atikokan, a fault of post-Steeprock series age has been indicated[2] as swinging down southwest from the east

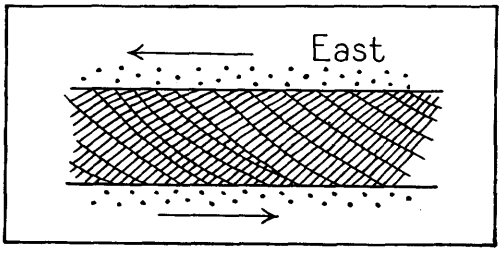


Fig. 4—Sketch illustrating a younger northwestward-trending cleavage cutting an older northeasterly cleavage in sediments south of Atikokan. The older cleavages are displaced between the later set.

arm of Steeprock lake and cutting across the contact of the Keewatin into the sediments. Here, this fault is suggested by a schistose and much crumpled zone and on the east side by the offsetting of the sediment-Keewatin contact to the south. Whether the offset is entirely due to the projected post-Steeprock Lake fault is not known. It is possible that this fault is a branch of the main one being discussed, or later, but a movement of the north side eastward is indicated.

Farther west, near the conglomerate lens lying north-northwest half a mile from the portage to Jackfish lake, which has been studied by Lawson,[3] Grout,[4] and Tanton,[5] the Keewatin-sediment contact appears to have been drag-folded by an easterly movement of the north side. Faulting of this contact probably preceded the drag-folding, which is also reflected in the conglomerate itself.

Vertical Movement along Fault Zone.—Little positive data regarding the major vertical displacement along the faulted contact have been obtained. A suggestion is given by the easterly pitch of some drag-folds that the northern block moved up and east, but drag-folds with opposite pitch have been noted. It is evident therefore that both upward and downward movements have occurred along the north side. As to which direction was the more important quantitatively cannot readily be told from the minor structures. But just to the east of the Steeprock Lake fault, which tends northeastward, are indications that the south, sedimentary side has moved up an appreciable amount, and

[1]T. L. Tanton, op. cit., p. 45.
[2]Geol. Surv. Can., 12th Internat. Geol. Cong., Guide Book No. 8, pt. 1, 1913, map facing p. 48.
[3]A. C. Lawson, op. cit., p. 65.
[4]F. F. Grout, op. cit., p. 359.
[5]T. L. Tanton, op. cit., p. 47.

west with respect to the north, Keewatin side. This is borne out by the apparent disappearance of the Steeprock Lake series to the south, in that the southern extension was up-faulted and eroded, and by an occurrence at mile 139 on the railway. Here gouges and a crude mullion structure may be noted along the face of schistose sediments, striking approximately N. 70° E. and dipping vertically. Slickensiding and gouges indicate a movement of the south side up and west past the north at an angle in the east-west vertical plane of 30 degrees.

Interpretation of Fault Movement.—The contact between the Keewatin and southern sedimentary series is faulted. The fault zone now exposed is essentially vertical. Movements of opposite directions are indicated along the zone. The major movement, as suggested by the data at hand, was a movement of the southern sedimentary rocks west and up with respect to the Keewatin rocks on the north. Of the two components, the horizontal one, parallel to the fault, seems the greater, since the fault is nearly vertical and gouges dip at 30°E. in the fault plane.

The intense schisting along the contact and its vertical attitude indicate clearly a strong horizontal shearing movement of the north side east and that the fault is not, therefore, of the simple gravity or normal type. That such a shearing may have caused thrusting of the south block over the north is suggested by the slight overturning of the folds towards the south. How much overthrusting occurred, however, cannot be told, since the fault plane is visible at only one horizon. It may flatten southward. Indications of an opposite direction of shearing, north side west, are of a minor order and are to be expected.

The age of the faulting is important. In time, it is preceded by the folding of the sediments on the south, but by what interval is not known. The fact that the north-south folding of the Steeprock Lake series (and Keewatin) on the north of the fault does not appear anywhere on the south may be taken as an indication that the faulting is post–Steeprock Lake (post–Lower Huronian) in age. The occurrence of the Atikokan iron ores and sulphides along and near the fault zone, and their possible relation to nearby intrusive granites, suggests also that the fault preceded slightly the intrusions of granite and the infiltration of the ores. As a corollary, the granite must be post-Laurentian or Algoman.

While it is often dangerous to infer direction of stress from a given structure, it is profitable to consider here the stress-strain relationships of both the fault and folded rocks in the vicinity, and thereby inquire as to the relation between the folding and faulting. If all the structural features fit a given stress or stress couple, some deductions may be considered.

All the known details of the fault have been given. Only a few facts are known about the folding of the southern sedimentary series. Tanton has shown that they lie in close folds, with axes possibly half a mile apart. They are, on the whole, slightly overturned to the south. It seems improbable they are straight folds, since drag-folds all indicate a moderate pitch both to the east and west. The most prominent cleavage cuts the beds at about N. 50° E., whereas the bedding, where observed, strikes more to the east, N. 85° E. If the major cleavage is related to the period of folding, the axial planes then strike about parallel to the cleavage. Thus we have a suggestion of the orientation of the folds. Folds may be produced by a variety of stresses. Mead[1] has shown that folds may be due to horizontal shearing movements as well as to horizontal compression. Folds formed in the former case have their long dimension parallel

[1]W. J. Mead, Notes on the Mechanics of Geologic Structures, Jour. Geology, Vol. XXVIII, 1920, p. 519.

to the direction of elongation and at an angle to the shearing stress (Fig. 5). The folds are arranged *en échelon*, and all are pitching in both directions. With continued shearing and continued rotation of the strain ellipsoid the direction of elongation and of the axial planes of the folds approach parallelism with the direction of the stresses. The inferred attitude of the folds in this area fits the suggested stress in their orientation to the stress, in their lack of any marked overturning, and in their pitching both to the east and west as do their drag-folds.

To the same stress couple, inferred as capable of producing the close folding of the southern sedimentary series, the faulting along the north border may be referred. The attitude of the fault is essentially vertical and nearly parallels the direction of shearing. On the strain ellipsoid it corresponds to one plane of maximum shear. In the same figure the Steeprock Lake fault, noted above,

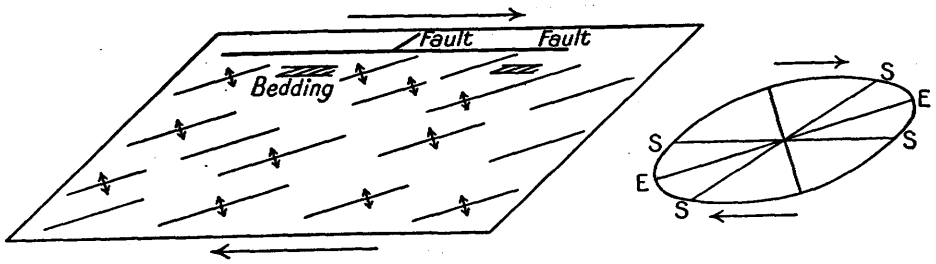


Fig. 5—Diagram showing structural relationship of folding and faulting in the "Seine" series. The axes of the folds, as interpreted from the major cleavage, lie parallel to the direction of elongation (E-E) of the strain ellipsoid. The two faults shown correspond with the directions of the planes of maximum shear (S-S). All may be produced by a horizontal shear.

may possibly correspond to the other plane of maximum shear. It is clear, therefore, that the same stresses which produced the folds may later have produced the faults, and it is, therefore, possible and even probable that the two structural features are closely related in time.

The folding of the southern sediments (with east-west axes) and the northern folding of the Keewatin and Steeprock Lake series with northward-trending axes have heretofore been considered of two distinct ages. Since the Steeprock Lake folding does not appear in the east-west folds, it was believed to have preceded the latter. One might inquire why is not the later, east-west folding imprinted on the older Steeprock Lake folding, since it was just as intense if not more so. If the east-west folding were caused by compression from the south, why were the rocks a mile or so to the north unaffected? The steep folding of the southern series must have died out very abruptly northward. Were the fault a major thrust from the south, one would still expect some folding to the north as in the foothills of many mountain ranges. A possible explanation for the two separate directions of folding not overlapping one another may be found in an hypothesis that both folds and accompanying faults were produced by the same type and direction of stress exerted in one general period of diastrophism, rather than that they were produced at different times.

It should be remembered that the Steeprock Lake series and the southern sedimentary series are situated within a few miles of each other but are nowhere in contact. Inferences as to their age have been based largely on their structure. In the above interpretation of the stresses causing the southern folding and faulting it has been shown that both may be related to an east-west shearing with the north block moving eastward. A further possible interpretation of the

regional structure is that the eastward movement of the north block caused compression of the Keewatin and Steeprock Lake series, which buckled into folds with their axes trending northward. Granites of Laurentian age there would act as buttresses against which this buckling would take place. Similar or as marked buckling did not occur to the south, the southern portion moving more as a mass or block along the faulted Keewatin-sediment contact. In this area, no massive granites were present at that time but were intruded shortly after (Fig. 6).

This interpretation satisfies the hypothesis that all the major structural features of the area were caused by movements along one direction and probably during one age of intensive deformation and mountain-building. The explanation offered accounts for apparent structural discordances which can hardly be

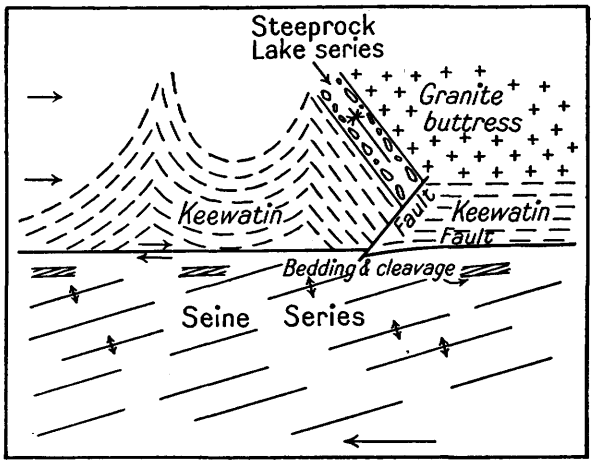


Fig. 6—Diagram showing the relationship of the folding and faulting of the "Seine" series to the folding of the Keewatin and Steeprock Lake series on the north of the fault.

accounted for by attributing to them distinct differences in age. The age of this widespread deformation is of necessity post-Steeprock Lake series. Since it was accompanied by granitic intrusions it may be referred to as Algoman. A previous period of great deformation undoubtedly occurred at the time of the Laurentian intrusions into the Keewatin.

Age of the Sediments, "Coutchiching" or "Seine"

The southern sedimentary series has been considered as of one of two ages: Coutchiching (pre-Keewatin), or "Seine" (post-Keewatin and post-Steeprock Lake series). No other age seems possible. The proof presented by Tanton for a pre-Keewatin age hinges largely on the fact that the sediments appear to dip under the Keewatin. A conglomerate of post-Keewatin age, lying along this contact near Jackfish lake is supposed by this writer to be unconformably above the southern sedimentary series. Lawson and Grout, on the other hand, believe that the series is of "Seine" age, on the basis that the conglomerate is essentially of the same age as the sediments which dip south from it, and that the north-south folding of the Keewatin and Steeprock Lake series to the north must have preceded the east-west folding of the Seine, since the folding of the former is not found in the latter. A review of the evidence bearing on the age of the southern sedimentary series follows.

Conglomerate near Jackfish Lake.—The small conglomerate lens occurring along the contact of Keewatin and the disputed sedimentary series, half a mile north and west of Jackfish lake, which was recently mapped by Tanton, was visited in an endeavour to check up the various interpretations placed upon it. Lawson and Grout both believe the conglomerate, which is clearly post-Keewatin and in part derived from it, to be conformable with the finer sediments on the south and underlying them, thus supporting a post-Keewatin age for the sediments as a whole. Tanton, on the other hand, concludes that the conglomerate is unconformable to the finer arkosites and slates on the south which appear to

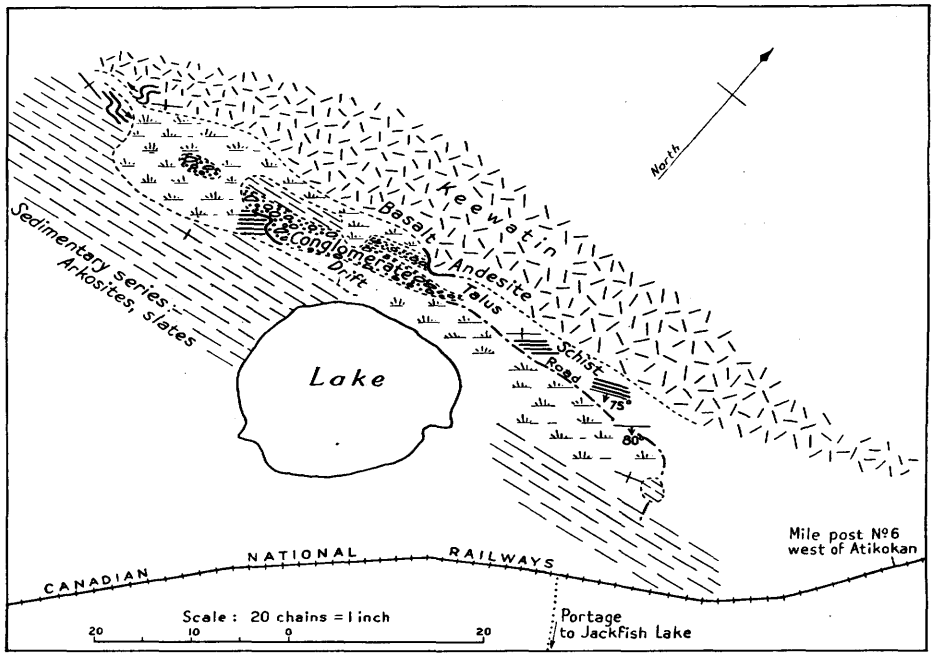


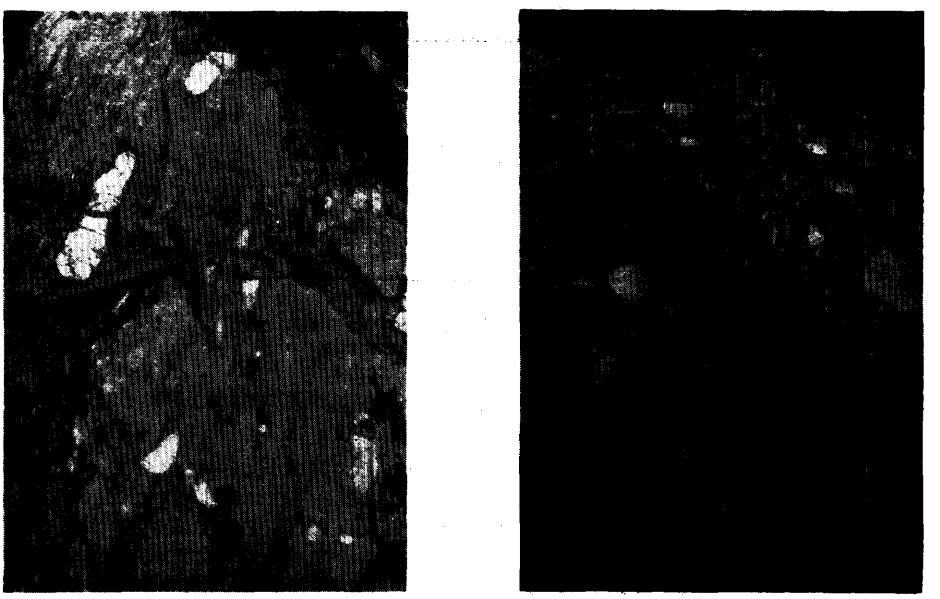
Fig. 7—Geological sketch map showing conglomerate at the contact of the Keewatin and sedimentary series in the vicinity of the portage from Seine river to Jackfish lake.

dip under the Keewatin. Its occurrence along the contact on this basis must be explained in the same manner as Lawson explained a similar occurrence in the vicinity of Rainy lake, that is, by deposition along the eroded contact of older sediments and Keewatin, and later infolding with them. According to Tanton, the conglomerate near Jackfish lake is lithologically identical with the Falls Bay conglomerate of the Steeprock Lake series, with which he correlates it. It also resembles the conglomerate of the "Seine" series (post-Keewatin) at Shoal lake to the west.

A detailed map of this peculiarly occurring conglomerate was made (Fig. 7). It will be noted that except at the northeast corner, the conglomerate is completely isolated from both the Keewatin and the main sediments on the south, by either drift or swamp. On the north of the main conglomerate bed is a band of massive grey arkosite; on the northeast are two other narrow bands of conglomerate interbedded with greenish-grey schists (slates or greywacké). On the southwest side similar green (greywacké) schists are drag-folded with the main conglomerate. To the east the conglomerate lens extends along a steep hillside

and becomes gradually more and more schistose until even the pebbles have disappeared in a grey sericite schist. To the west, across the swamp, no conglomerate was found adjoining either the Keewatin or sediments, but both of these are drag-folded and contorted. The general strike of the conglomerate and associated finer clastics does not differ much from the general strike of the main sedimentary group. The dip of both is essentially vertical and both have the same degree of schistosity.

At the northeast corner, the actual contact between Keewatin and the conglomeratic bands may be observed. Here the contact is in the nature of a drag-fold which appears to be reflected in the conglomerate on its southern



Schistose conglomerate near Jackfish lake, west of Steeprock lake. In the view on the left, pebbles may be seen at the crest of a drag-fold.

contact. The relation to the Keewatin is distinctly unconformable and discordant. The unconformable relation of the conglomerate to Keewatin is, of course, further shown by the basic pebbles derived from the latter. That the contact is faulted is supported by the variation of the Keewatin from basalts to more acidic flows along the contact, as already noted.[1]

The relation of the conglomerate to the main sedimentary group on the south is not so clear. A contact of conglomerate and greenish-grey schist or greywacké shows a perfect drag-fold on the southwest side, the pebbles in the conglomerate being drawn out in the folding (see photographs above). The schistosity cuts through both schist and conglomerate, and the fold pitches steeply east. Near by, small faults occur between green slaty beds and conglomerate (Fig. 8). Between this and the finely bedded arkosites and slates on the south is a sharp drift-filled gully 30 feet wide.

Within the conglomerate and associated beds no tops could be determined. The mass as a whole has not a definite synclinal structure, which one would expect if it is younger than the sediments to the south and was actually infolded at the contact. Tanton has indicated that the sediments on the south dip

[1]T. L. Tanton, op. cit.

under the conglomerate and Keewatin. This could not be checked by the writer, but holds true a short distance east of the railway. About 5 chains south of the conglomerate, one bed was found with an apparent top on the south.

Abundant evidence has been presented that the main sedimentary-Keewatin contact is a faulted one. It is believed that the conglomerate is of a general wedge shape lying along this major fault plane. The lack of any synclinal structure in the conglomerate, its very local occurrence, and its highly sheared nature on the south and east point to this conclusion. Thus the conglomerate mass as a whole may appear structurally unconformable to the sediments on the south, but any discordance may be due to faulting rather than to differences in age. The lithological similarity of the conglomerate and finer sediments

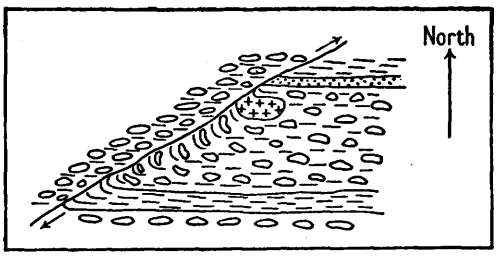


Fig. 8—Plan of minor fault in conglomerate and interbedded green slaty bands.

suggests a similar age. Positive proof of this age must rest on the finding of a contact which is not faulted.

The Significance of Faulting.—Since the contact between the southern sedimentary series and the Keewatin and post-Keewatin conglomerate is faulted and the steeply folded sediments are truncated in places by the fault it is entirely possible that anticlines and synclines may alternate along the contact, especially since it is not known how closely the folds are spaced. The fact that various geologists have found the beds apparently dipping both under and over the Keewatin on the north supports this contention. Hence, the actual dip of the beds with respect to the Keewatin indicates nothing as to their age.

It is clear that to prove definitely the age of the southern sedimentary series it must be found in a proved unfaulted condition adjacent to the Keewatin. From the nature of the faulting, however, it is possible to state the probabilities in the case.

The major structural features of the area and vicinity, other than those of definite Laurentian age, have been accounted for by one general period of deformation, the time of which is fixed as following the deposition of the Steep-rock Lake series (Lower Huronian) and preceding, by a short interval, the invasion of the southern Algoman granites. It is true rocks as old as Keewatin, at least, have been subject to this deformation, and it cannot be denied that if pre-Keewatin sediments were present they too would be affected. The association of the southern sediments with this folding and no other, suggests a post-Laurentian age.

Consider the faulted nature of the Jackfish Lake conglomerate and the southern sediments. If the two represent near-shore and off-shore phases, respectively, of one age of sediments, the faulting required to bring the two together in their present form would not be excessive. To assume, however, that the finer sediments are pre-Keewatin requires either a much greater amount of

displacement along the fault, or, if the conglomerate were laid down on the eroded contact of the sediments and Keewatin, the folding of the southern series must antedate the faulting by at least one and possibly two geological periods. In the first case it has been shown that the fault is not a great overthrust from the south but more of a horizontal shear. In the second case all of the structures have been related to one major period of deformation. The probability, then, is that the southern sedimentary series are post-Keewatin, as is the Jackfish Lake conglomerate.

Evidence of Lithology.—The lithology of the sediments shows clearly that for the most part they were derived by the disintegration of a granitic land mass

Southward-dipping "Coutchiching" schists at Bears Pass on the Canadian National railway. These are intruded near here by granite and are almost identical in general appearance with the sedimentary schists near Iron Spur in the Sapawe Lake area.

of fairly wide distribution, the products from which either suffered little decomposition or relatively short transportation.[1] Sufficiently detailed sections across the series at different localities have not been made to establish any lateral variation, such as would occur off shore, nor to determine any relationship between lateral variations and possible source rocks now visible. If the series be considered of pre-Laurentian age, it is indeed peculiar that no trace of pre-Laurentian and pre-Keewatin granitic rocks have ever been found in this pre-Cambrian area. The relative uniformity of the sediments and their probable great thickness emphasize this. On the other hand, if a post-Laurentian age for the sediments be considered, possible granitic source rocks abound on the north, separated from them by only a narrow band of basic Keewatin. The environments under which the sediments were produced and deposited closely resemble those of the so-called "Seine" series, as is shown below, which are definitely post-Keewatin-Laurentian. Thus, in a negative way the lithology favours a post-Laurentian age for the sediments.

Evidence of Intrusives.—The disputed sedimentary series are intruded by red biotite granite on the south. The age of this granite depends on the age of the sediments. It has been placed as Algoman (post-Laurentian) by Lawson.

[1] *Cf.* A. C. Lawson, op. cit., p. 62

The granite intruded the sediments after they were folded to essentially their present vertical position. The time of intrusion, however, was not necessarily much later than the folding, and it is well known that many granite batholiths probably owe their intrusion to the same causes which produced intense folding of the intruded rocks. The folding and faulting have been related to a period between the Lower Huronian and the invasion of granite. The granite, therefore, appears to be practically of the same age as the deformation, or Algoman. It is true post-Keewatin granites might invade pre-Keewatin sediments. But, it should be noted, widespread Laurentian granites occur immediately to the north of the great southern sedimentary series, and it is indeed peculiar that none of them are found cutting the sediments if the latter are pre-Keewatin.

View of schistose slates and quartzites of the "Seine" series, west side of East Shoal lake.

Again, in the Keewatin immediately on the north of the sedimentary contact in the Sapawe Lake area, are abundant small lenticular intrusions of much altered and sheared diorite and gabbro. None of these appear in the sediments, and since they are clearly post-Keewatin, their non-occurrence south of this contact suggests the sediments were laid down after their intrusion, even though they be considered as sills or as dikes intrusive into the Keewatin before or after the folding and schisting of the latter.

Relation of the Southern Sedimentary Series to the Coutchiching of Rainy Lake and the Knife Lake Slates of Minnesota.—The southern sedimentary series have been traced by Lawson and Grout between the Steeprock and Sapawe Lake areas and Rainy lake. At Shoal lake, in the latter area, only a brief examination was possible. Here on the north, Lawson's upper or "Seine" series lies on both Keewatin and Laurentian, is steeply folded into synclines, and contains large conglomerate, quartzite, and greenish slaty beds (see photograph above). They are separated from the lower "Coutchiching" on the south by a band of chloritic igneous schists, interpreted as Keewatin. Farther west they are contiguous. In most places the contact between the two series is highly schistose and generally covered. Lawson holds that the latter dip under the Keewatin, Grout that the reverse is true. All the rocks strike east. It is not definitely known that faulting has occurred here, but schisted and buried

contacts suggest this possibility. The differences in lithology in the two groups are more of size of grain than of quality and may be explained as well by their position relative to the shoreline at the time of deposition as to differences in age. Conversely, if the finer grained phases of both series suffered the same amount of metamorphism they would not be distinguishable. The upper or Seine series on the whole is the less metamorphosed of the two, as evidenced by the preservation in quartzites of beautiful cross-bedding. This may be due to the presence of more competent beds in the Seine, or to protection from the full intensity of shearing movements, as well as to differences in age.

Comparing the Rainy Lake and Steeprock-Sapawe Lakes area, the writer can find no difference between the main sedimentary series of the eastern area and Lawson's Coutchiching south of Shoal lake. The Jackfish lake conglomerate resembles the Seine conglomerate of Shoal lake and, as Tanton has noted, the Steeprock lake conglomerate also. It is possible, then, that the conglomerate at Jackfish lake is really a faulted fragment of the "Seine" conglomerate. The possibility that the larger sedimentary group called Coutchiching is of the same age as both conglomerates cannot be denied on lithological grounds. Further detailed mapping between the two areas may bring together the present opposite views held as to the structure, especially since faulting will account for the apparently contradictory observations.

Continuing west and south, Grout has traced a large part of Lawson's Coutchiching into Minnesota to a similar group of sediments known as the Lower-Middle Huronian and composed largely of the Knife Lake slate series, all of which are definitely above the Keewatin. There has as yet been no evidence produced to question the superposition of the Knife Lake slates as regards the Keewatin. If this correlation of Grout's be established, the balance of evidence supports for the most part a post-Keewatin age for the larger portion of the sediments placed by Lawson and Tanton as Coutchiching. The Knife Lake slate series was laid down unconformably upon the Keewatin following a period of erosion, though both were later closely folded. The suggestion by Bruce that in Archean times there may have been sedimentation going on in one area, volcanic extrusions in another, while in adjoining areas the reverse order of events occurred, may be still applicable to the Minnesota (Vermilion) and Rainy Lake areas, depending on the amount of pre-Keewatin sediments that may be finally recognized.

Summary.—That the southern sedimentary series of the Sapawe-Steeprock Lakes area may be of post-Keewatin age is supported by the following:—

1. The structure of the series can be related to one period of deformation, later than the Steeprock Lake series, and the structure also may be a result of the same deformation that produced the Steeprock Lake folds. The deformation is considered to have been largely of an east-west shear movement rather than a thrust from the south. This interpretation brings into harmony the discordant structures on the north and south of the faulted contact of Keewatin and southern sediments; the discordant structures, then, are not necessarily safe criteria for inferences as to the age of the sediments. Since the deformation is probably of Algoman age, the southern sediments may well be post-Keewatin and pre-Algoman. If the deformation was Laurentian, the sediments would necessarily be pre-Laurentian in age. In view of the faulted nature of the sediment-Keewatin contact, proof of their age must rest on unfaulted contacts and other data.

2. The faulting of the Keewatin-sediment contact is such that the apparent dip of the sediments under the volcanics cannot be taken as an indication of their age.

3. Both the folding and faulting can be related to one period of deformation. On this basis the faulting required to bring the Coutchiching sediments up against the post-Keewatin conglomerates requires a much larger thrusting from the south and a much greater displacement than if the sediments and conglomerates are essentially of the same age. Otherwise, a pre-Keewatin age for the sediments requires a separation of the folding and faulting by at least one geological period or more.

4. Lithologically the fine sediments cannot be distinguished (except on a basis of size) from post-Keewatin conglomerates and arkosites. The arkosic character of the strata indicates derivation from a granitic land mass, and such a land mass of Laurentian age lies just to the north of the sediments, while no pre-Laurentian granites have been found here.

5. No definitely recognized Laurentian granites have ever been found intruding the sediments of disputed age, though granites of a later period are abundant. Similarly post-Keewatin or Keewatin intrusives are found along the northern border of the sediments but none of these have been proved intrusive into the strata.

6. The southern sediments have been traced west to Rainy lake, where there is still some doubt as to whether the structure is faulted or not. Grout has traced these southwest to Minnesota where he correlates them with the Knife Lake slates of post-Keewatin (Lower-Middle Huronian) age.

It is concluded, therefore, that the disputed sedimentary series are of post-Keewatin age. This does not imply that no Coutchiching sediments exist in parts of the Rainy Lake area. The above discussion and conclusions, it may be repeated, are advanced in a tentative way, in the hope that they will contribute something to the final solution of this important pre-Cambrian problem.

There remains to establish the relationship between the southern sedimentary series, which may be referred to as the "Seine" series, and the Steeprock Lake sediments. The term "Seine," as originally applied, signifies an age subsequent to that of the Steeprock Lake series.

Possible Relation of Southern Sedimentary Series to the Steeprock Lake Series

The southern sedimentary series and the Steeprock Lake series are nowhere definitely in contact if the conglomerate near Jackfish lake be considered as a part of the southern sediments. The main formations are separated only by a distance of about two miles. The southern extension of the Steeprock Lake series appears to have been upfaulted and eroded. It is not possible, therefore, to say definitely that it occurred below or above the southern sediments. The two groups of sediments have never been considered the same in age for two reasons. Though they both appear to contain similar conglomerates, the Steeprock Lake series consists of algal limestones; the southern series, entirely of clastic sediments. Obviously they were formed under somewhat different environments. The Steeprock Lake series also contains volcanic flows and probably tuffaceous green schists, and is intruded by gabbros. Neither the volcanics nor gabbros occur in the southern series. The age of the gabbro with respect to the southern "Algoman" intrusives is not known. These differences, however, suggest strongly that there is some difference in age and that the southern series are the younger, particularly since they are not intruded by the gabbros. If the gabbros are a phase of the Algoman intrusives, however, the southern series may be younger or older than the Steeprock Lake series. From the nature of the sediments and on the supposition that the earlier series were formed after the Laurentian revolution, dominantly clastic sediments would be expected, to be

followed some time later by the deposition of chemical sediments when the high lands had largely been eroded away. On this basis the southern series of clastics would be the older. No final conclusion as to the relative age of these two groups of sediments can yet be reached. The various possibilities are here suggested in the hope that further field work will yield the required information.

SOUTHERN GRANITE (ALGOMAN)

Along the southern portion of the Sapawe Lake map-sheet, and extending for many miles to the south, a red biotite granite has been mapped by McInnes and Smith.[1] This granite intrudes the sediments whose age has been questioned. Lawson placed it as Algoman. The evidence presented above supports a post-Keewatin age for the sediments and a post-Laurentian age for the granite. The granite is, therefore, considered as of Algoman age.

In the vicinity of Iron Spur and the Atikokan iron range a roughly elliptical stock of this granite intrudes the sediments without greatly disturbing their easterly strike, but producing noteworthy contact metamorphic changes.

The granite both in stock and main batholith is of a reddish hue. Fresh specimens contain quartz, microcline, orthoclase, oligoclase, and biotite. The feldspars are altered in part to sericite; the biotite to epidote and chlorite. Near the border of the stock the granite is very dark and contains abundant hornblende. Certain phases are essentially hornblende-biotite syenite. With increasing hornblende the rock grades almost to a hornblendite. In the adjoining sediments the chief alteration has been the formation of quartz-biotite schists, locally with hornblende instead of biotite.

Along the southern margin of the main granite batholith, injection of dikes and stringers of granite into the sedimentary schists has given rise to granitic gneisses.

The proximity of the small stock of granite to the Atikokan iron range with deposits of magnetite and iron sulphides, situated as it is along the faulted contact of the sediments and Keewatin, suggests some relation between the two. Discussion of this is given below.

BASIC INTRUSIVES

On the Seine river, at Reserve island and to the north, are a few narrow dikes of diabase and quartz diabase cutting Laurentian grey granites and gneisses. The dikes are fine-grained and brown-weathering. Under the microscope a specimen of quartz diabase has a clearly defined ophitic texture, fine laths of feldspar (andesine) being included in pale-green chloritic hornblende. Another has a less clearly defined ophitic texture and is a gabbro in composition, having augite, labradorite, biotite, and magnetite or ilmenite. Their alteration is not great.

To the south in the greenstone belt are similar small intrusions cutting an older gabbro or diorite, the relation of which to the Laurentian felsites has not been ascertained. The occurrence at Steeprock lake of gabbros intruding the Steeprock Lake sediments suggests a post–Steeprock Lake age for the diabase, but whether Algoman, or even Keweenawan, cannot be told.

Many of these intrusives are marked for their freshness, massive character, and lack of schistosity. Their probable post-Laurentian age has a bearing on the gold deposits of this belt, since their intrusion into gold-bearing rocks may seriously affect the latter. Their known distribution does not appear great enough to be considered as a decided disadvantage. On the other hand, should

[1]W. McInnes, op. cit.

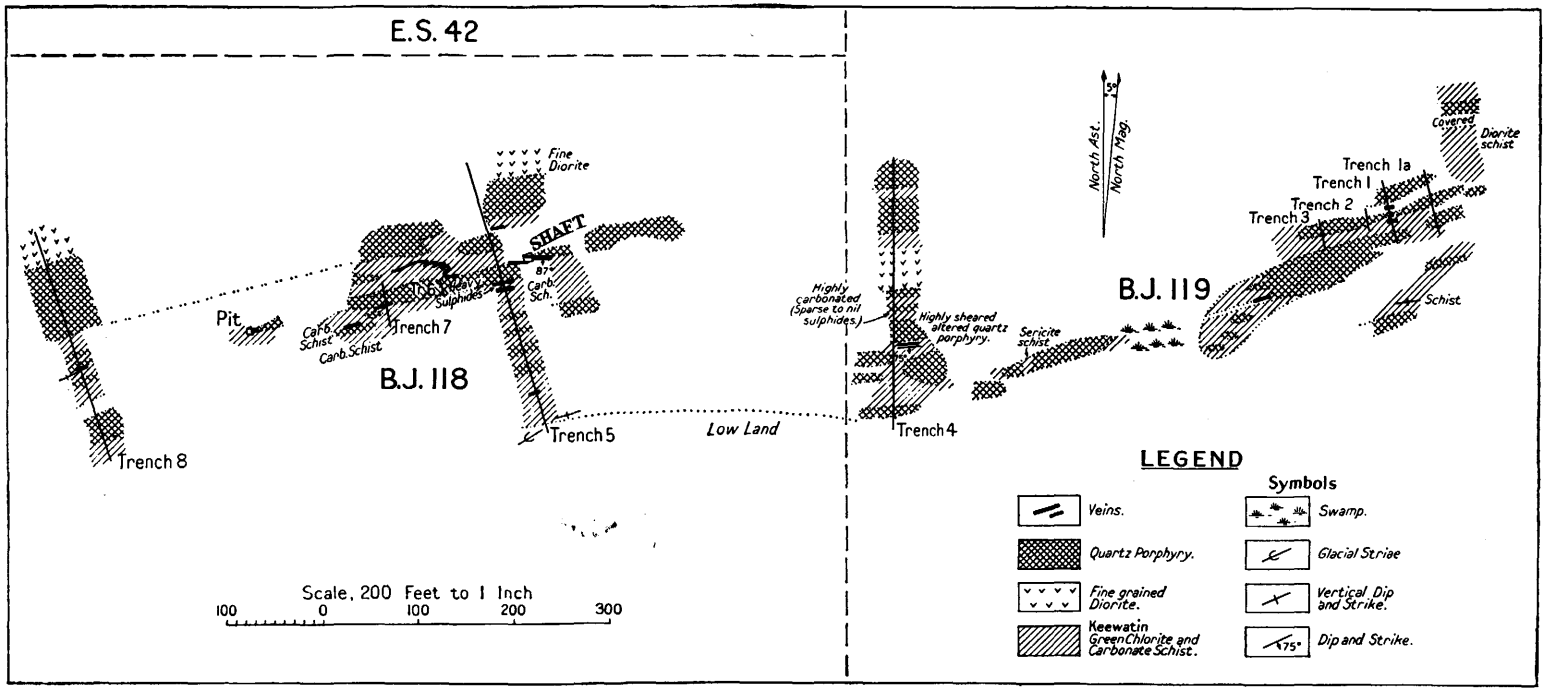


Fig. 9—Sketch map showing geology in the vicinity of Walsh shaft, Jackson Syndicate.

the more numerous and more altered gabbros and diorites in this belt, described in a preceding section, be even partly of this age, their presence must be looked on as unfavourable.

Gold Deposits

In the Sapawe Lake area gold deposits occur either in the Laurentian granite and gneiss, often near inclusions of greenstone, or in the Keewatin greenstones adjoining intrusives of quartz porphyry or related rocks, and in these intrusives as well. They fall into several classes as regards their shape; they occur as true fissure veins, typically developed in the granite; composite veins or veinlets; fahlbands or shear zones; and single lens or pipe-like deposits; or as combinations. All appear related to one major period of granitic intrusions of Laurentian age.

Throughout the annual reports of the Ontario Department of Mines and the Canadian Geological Survey from the years 1894 to 1907 appear accounts of the geology and mining activities in this region. Discoveries made in more recent years are comparatively few, partly due to the now well-forested nature of the country, and undoubtedly to the failure of previously existing mines. The properties explored in 1928 consisted almost entirely of claims along the north side of Sapawe lake and the Atikokan river, as well as a few southwest of Osinawi lake. Included in the following account of the properties examined is summarized information taken from earlier reports.

Vein Deposits in Greenstone Area

Walsh Shaft, Jackson Syndicate (Claims B.J. 118-20; E.S. 28, 29, 43-45, 65, 70; F.F. 995-97).—In the summer of 1928, W. S. Jackson, of Fort William, was in charge of exploration work on this group of claims for the Jackson Syndicate, which leased the property from the owners, including Maylor Hayne, J. Matheson, A. G. Seiman, and others. Work on the property consisted of a large amount of stripping and trenching on claims B.J. 118 and 119, cleaning out the old Walsh shaft, known also as the Rosa Blanda, and sampling of various veins and sulphide bands encountered in stripping. Camps were also built near the lake.

The Walsh shaft was sunk by J. J. Walsh in 1901 and is described by A. P. Coleman and others.[1] Two veins are reported: No. 1, on which the shaft was sunk; and No. 2, about 800 feet inland north of No. 1. "In the spring of 1903 a 3 gravity stamp mill with gasoline engine power equipment was set up on the shore of Sapawe lake, and some lots of ore from both No. 1 and No. 2 veins tested, giving good returns in gold."

The geology in the vicinity of the shaft is shown on the accompanying sketch map (Fig. 9). The rocks consist of fine chloritic and hornblendic Keewatin schists, much intruded by lenticular masses of quartz porphyry. These have been sheared and altered. Fine-grained diorite dikes are present on the north. Associated with the porphyry and filling small fractures in it are numerous quartz veins of irregular length and width. Locally the green schists have been impregnated with quartz and sulphides. The largest vein, on which the shaft was sunk, has a maximum width of 5 feet at a depth of 40 feet, but this includes green schist lenses and chlorite leaves interbanded with pure quartz. The vein strikes diagonally across the shaft and dips steeply south. It lies in a relatively narrow band of Keewatin schist. On the north wall of the shaft carbonated and silicified quartz porphyry is exposed. On the south or footwall is a 4-foot band of green schist containing narrow quartz stringers; and at the top on the south

[1]Ont. Bur. Mines, Vol. XI, 1902, pp. 150, 242; Vol. XIII, pt. 1, 1904, p. 72.

wall, a second lens of quartz porphyry dips south out of the shaft. On the surface the vein cannot be traced far. To the west a continuation of the vein is much drag-folded. To the east it narrows to 2 feet and disappears in a gully. Numerous other veins occur to the west, and a test pit was sunk on one. These lie along contacts between porphyry and green schist and are seldom over a foot wide. Quartz also replaces the porphyry adjoining these veins.

In the shaft the quartz is white to grey and carries relatively few sulphides near the surface. At 30 or 40 feet, the sulphides are more plentiful. They include pyrite, chalcopyrite, fine grey tetrahedrite, and fine free gold. The latter seems more abundant near the copper sulphides. Black stringers, in part tourmaline, and some carbonates are also present in the quartz.

In trench No. 1, claim B.J. 119, arsenopyrite accompanies quartz and pyrite in schistose porphyry. In trench No. 5, just south of the shaft, a 7-foot schistose zone is well mineralized with fine pyrite, some chalcopyrite, and a little arsenopyrite. The schist is chiefly chloritic but is penetrated by many inch-wide bands of sericite schist.

Since it was thought by some that the altered and silicified quartz porphyry intrusives cut by numerous quartz stringers were ore, samples of these and associated schists were taken for assay. They are as follows:—

	Gold per ton
1. Waxy quartz impregnating green schist and mineralized with cube pyrite, trench No. 1	$1.20
2. Mineralized green schist, trench No. 1	.20
3. Silicified quartz porphyry	nil
4. Silicified quartz porphyry with pyrite and arsenopyrite	nil
5. Carbonated quartz porphyry, trench No. 4	1.20
6. 3 feet quartz and mineralized schist, trench No. 5	12.80
7. Walsh shaft, west wall, 15 feet deep, 33 inches quartz	11.20
8. Walsh shaft, west wall, 15 feet deep, composite 39 inches footwall and 24 inches hanging wall	1.60

From the above assays it is clear that the principal values lie in the quartz and in the green schist where it is highly impregnated with quartz. The silicified quartz porphyry carries practically no values. In further prospecting these facts should be taken into consideration.

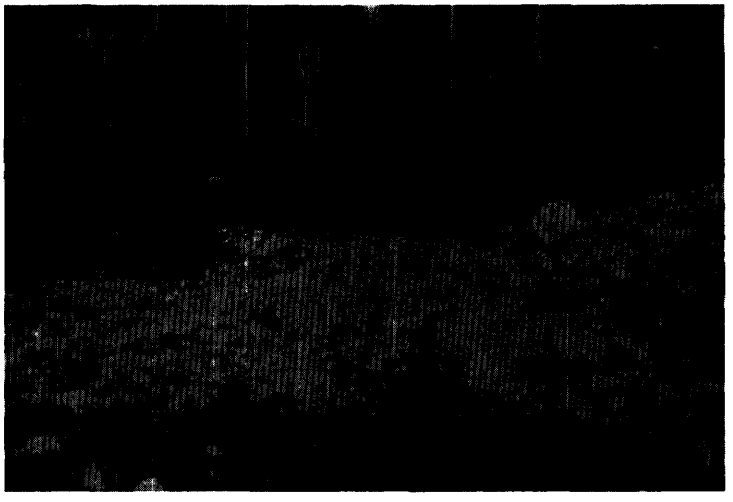
The so-called vein No. 2 of earlier reports appears to be about 9 chains north and west of the Walsh shaft. A trail leads from it to a cabin on the lake-shore. The outcrop which has been stripped consists of rusty-weathering carbonated schist intruded by abundant small lenses of quartz porphyry which here, as to the south, cut across the schist *en échelon*. No distinct vein was observed at this point.

To the southwest of the Walsh shaft, about 4 chains north of the lake, a much contorted and drag-folded quartz vein, carrying black schist and tourmaline streaks, lies in carbonated green schist. In width it ranges from 1 to 2 feet, the thicker parts being at the crests of the folds. It can be traced for 35 feet. The quartz carries a small amount of pyrite and chalcopyrite. A 4-foot lens of quartz porphyry intrudes the schist on the south. On the lake-shore to the southwest of this vein an old pit has been sunk on a vein in fissile green schist. This vein has been largely mined out, and the ore treated in the stamp mill. It is reported to have carried native gold.

On claim E.S. 29 to the north of the try line, a 35-foot dike of quartz porphyry intrudes green schist. Both greenstone and porphyry are now highly schistose and rusty from decomposed carbonates. In two schistose zones, each about 1½ feet wide, some mineralization has occurred, pyrite and chalcopyrite accom-

panying quartz and carbonates. This schist had not been uncovered along its strike. To the south of the try line a vein occurs in foliated chloritic schist with a length of 4 chains. It pinches and swells to a maximum width of 4 feet at the east end. At the west end, coarse hornblende gabbro lies on the south of the vein, and to the east it appears on the north. The quartz is clear and vitreous and contains green schist inclusions but no sulphides. Other veins resembling the above have been noted on claims E.S. 43 and 44.

On claim E.S. 28, near the No. 1 post, a well-defined quartz vein occurs over a length of 175 feet, ranging in width from 2 inches to 15 feet and striking N. 75° E. This is apparently an old discovery. Stripping of the vein has been done but no trenching. The vein lies mainly in chlorite schist, but at the west end cuts across a narrow quartz porphyry dike and contains several large inclusions of this rock. The quartz is very white and contains no visible sulphides.



Hill vein, claim F.F. 804, looking east. The white foreground consists entirely of quartz.

J. Hill (*Claims F.F. 804, 805*).—In the centre of claim F.F. 804, along the old Minto trail, quartz veins occur in sericite and chlorite schists, striking approximately east. The larger of these are shown on the accompanying sketch (Fig. 10). A picket line was run across the claim by J. Hill. Trenches were made at intervals, and the larger quartz bodies were blasted.

The largest vein is a lens 90 feet long and 20 feet wide (see photograph above). To the east and west it plays out in small quartz stringers. It lies largely in sericitized and carbonated quartz porphyry, which intrudes green schists. On the south is a fairly massive band of fine-grained diorite also intruding the schists. Near the southern margin of the quartz "blow-out," mineralization is fairly heavy, clusters of arsenopyrite crystals half an inch in diameter occurring in the quartz with lesser amounts of chalcopyrite and pyrite. A chip sample of unmineralized quartz across the southern 10 feet gave only small amounts of gold. A 1-inch band of quartz with no visible gold or sulphides, sampled by J. Hill, gave $10 in gold per ton. A sample of quartz containing 31 per cent. arsenopyrite on assay gave $7 in gold per ton. Another grab sample containing chalcopyrite and pyrite gave only low values in gold. The gold seems to be concentrated along the southern footwall and in association with arsenopyrite.

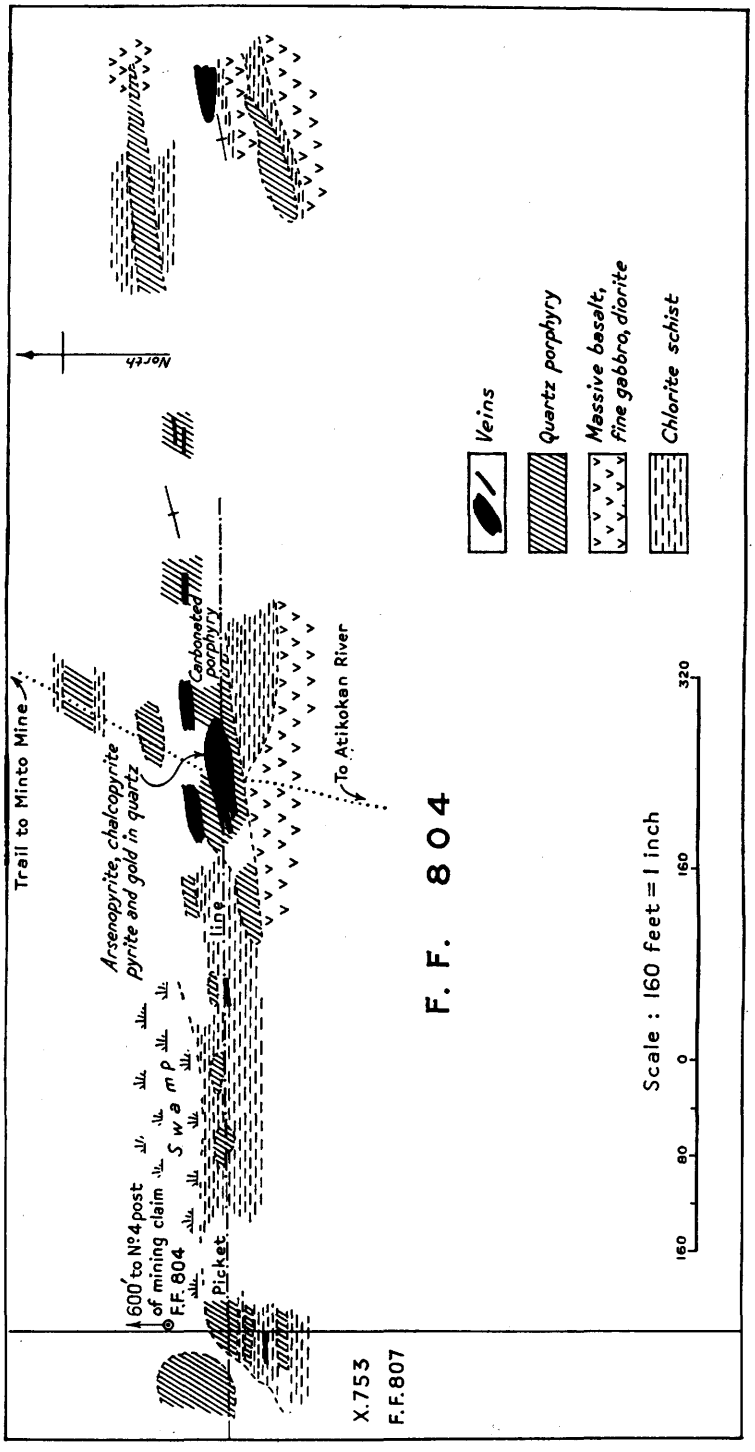


Fig. 10—Sketch map of Hill veins, claim F.F. 804.

A few feet to the north of this vein a longer vein extends east and west for 230 feet and has a maximum width of 10 feet. To the east it plays out into several stringers and to the west is covered. It is mineralized sparingly with chalcopyrite.

As shown on the general map, to the east of Hill's main showing on claim F.F. 804, other veins occur along the strike. These are in chloritic schists and are generally associated with small lenses of quartz porphyry. Two of these veins have been uncovered and opened up by blasting. On the east side of claim No. 805 and the west of No. 804, a vein 2 to 3 feet wide may be traced for 50 feet. It occurs in green carbonated schist, striking N. 110° E. The schist is well mineralized with cube pyrite; the quartz only sparingly so. To the south is a small mass of quartz porphyry, and to the north a bluff of fine basalt or diorite.

Claim F.F. 864.—Along the strike of the Hill veins in this claim, a 3-foot quartz vein lies in schistose basalt. The schist is 20 feet wide and the vein may be traced for 70 feet. The quartz carries disseminated chalcopyrite and pyrite. While this vein and those described above on the adjoining claims to the west lie more or less along a straight line, they are all distinct and separate lenses. Their alignment suggests a major shear zone, but one which has not been greatly mineralized nor greatly injected with veins. This may be accounted for by the variety of rocks which the zone crosses, particularly the massive fine diorites which have not yielded to the shearing as much as the quartz porphyries and Keewatin schists.

Hill Claim, F.F. 805 (A.L. 239).—Along the north line of this claim a lenticular quartz vein has been stripped for 100 feet. On the east it pinches out and at the west end where it disappears into low ground it is 5 feet wide. The vein occurs along the contact of altered porphyry or fine granite and much contorted and drag-folded chlorite schist. Pyrite occurs in thin stringers of schist in the quartz, which is otherwise not mineralized. The drag-folds in the schist on the south side of the vein pitch west at 60 degrees.

Gray (Claims F.F. 885, 886, 890, 891, and Others).—On a small peninsula on the north shore of Scotty lake, on claim F.F. 890, a large quartz vein runs for approximately 140 feet with a general strike of N. 110° E. and dips steeply to the north. At both ends the vein disappears in the lake, thinning out in both directions. At about the centre the vein is drag-folded to the south (see photograph on page 36). Its eastern extension is 18 feet wide, its western 10 feet. The vein appears to replace interbanded carbonated quartz porphyry and chloritic schist and contains silicified inclusions of these rocks as narrow stringers. The quartz is white to milky and contains no visible sulphides. It is reported to assay $4 per ton on the surface, though a chip sample of 10 feet of quartz failed to give a trace of gold. This vein is known as the Gray No. 1. Work done consists of stripping and sampling. The International Minerals Corporation are reported as undertaking further exploration.

In the northwest corner of claim F.F. 886, north of a small lake, a vein, known as the Gray No. 2, strikes E. 45° S. and cuts carbonated green schist striking E. 27° S. The vein consists of two lenticular masses of quartz averaging from 12 to 15 inches in width, but reaching a maximum of 3 feet. It is uncovered for 65 feet. On the north is altered and partly replaced quartz porphyry into which pass small stringers of quartz. The quartz is locally well mineralized with

chalcopyrite, a grab sample of which gave 1.68 per cent. copper and a trace of gold. Here, as at Hill's showing, the presence of chalcopyrite does not presage values in gold.

McWilliams (Claims F.F. 871-73).—In the northwest corner of claim F.F. 872, a lenticular quartz vein has been uncovered for over 50 feet. This strikes N. 85° E. and ranges in width from 1 to 12 feet. On the north it partly replaces altered quartz porphyry, and on the south are highly carbonated chloritic schists. Its occurrence is almost identical with many other veins in the area. The quartz is white and barren of sulphides. Schistose leaves are included in it with some rusty-weathering carbonate. A chip sample across 3 feet gave no trace of gold. To the west along the strike, stripping and trenching

Gray vein No. 1, claim F.F. 890, showing folded nature of vein which runs into Scotty lake.

revealed a few minor quartz stringers in a well-schisted band of Keewatin. Small lenses of quartz porphyry intrude the schist *en échelon*. Other veins are reported on these claims, but were not found.

Mammoth Vein (Claim E.S. 53).—Just to the north of Sapawe lake on this claim occurs a highly schistose band of chloritic and sericitic rocks with a width of 30 feet, striking N. 75° E. In places the schist contains small lenses of quartz and an apple-green chromium-bearing mica. Pits have been sunk 5 to 10 feet on this zone at two localities where a few sulphides are present.

About 6 chains north of the lake occurs a band of rusty-weathering, carbonated, chlorite schist, 25 feet wide and traceable for about 250 feet. This is known as the Mammoth vein. At the west end the schist is penetrated by a stockwork of fine quartz and carbonate veins, with a stronger vein on the north, 18 inches wide. Across the stockwork of quartz and schist, samples are reported to assay never less than $4 in gold per ton. The values appear to lie in the larger quartz vein on the north, 16 inches of which gave $8 in gold per ton. To the north of the veins and schist, outcrops of quartz porphyry occur for the entire length of the stripping. To the west, along the strike of the main vein, other outcrops of similar carbonated schist with quartz stringers have been uncovered. The zone strikes west into a bay of Sapawe lake.

Claims E.S. 47, F.F. 945-47.—To the northwest of Mark lake, lying between Sapawe and Osinawi lakes, quartz veins are being explored by Mark Whitehead, and considerable stripping has been undertaken. The veins appear to lie on claim E.S. 47, although the posts of this claim were not found. Here several quartz veins cut across and parallel eastward-trending chlorite schist. One vein has an exposed length of 35 feet and averages 2½ feet in width, but in places, including schist lenses, attains a width of 7 feet. The quartz is white and vitreous and locally is well mineralized with chalcopyrite. On the south is massive saussuritized diorite or gabbro, very much altered. About 6 chains to the west, another vein was uncovered for a length of 110 feet. In width it varies from 5 to 25 feet and includes numerous schist lenses which it apparently has largely replaced. In a few places both schist and quartz are heavily mineralized with chalcopyrite. Shearing movements clearly continued after the introduction of quartz, since locally a beautiful augen structure has resulted, the quartz being drawn out into large eyes. A sample of quartz, carrying abundant chalcopyrite, on assay gave only low values in gold. Another with no sulphides gave only a trace.

White Lily Mine (Claim B.J. 101).—The White Lily mine is situated on claim B.J. 101 just to the west of Upham lake. It is reached by canoe from the east end of Crooked Pine lake, and by trail from Kawene station on the C.N.R. A trail leads north and west from cabins on Upham lake to another small lake, on the shores of which a 2-gravity stamp mill has been set up with a boiler, crusher, and Wilfley table. In the years 1906-7, a shaft was sunk on a narrow vein located 5 chains to the north of the mill. The vein lies between quartz porphyry and carbonated green schist. The porphyry forms a small cliff on the north, and along the face of this are numerous splashes of quartz. The vein may be traced for 40 feet east of the shaft. In a pit immediately to the east it dips 80° S. and has a width of 14 inches, but within the schist, on the south, are irregular thin sheets of quartz. The shaft has a depth of about 80 feet. In it the vein appears wider, consisting of 3 feet of interbanded quartz and schist. The dump contains mainly sheared porphyry and greenstone. The quartz shows no mineralization, but a sample taken from near the shaft across 12 inches of quartz gave $9 in gold per ton. To the west of the shaft the porphyry contact swings south and the vein appears to end.

To the east of the shaft beyond the vein, the chlorite schist is cut by several small dikes of porphyry or related rocks, from 2 to 20 feet wide. Both porphyry and greenstone have been highly sheared locally and contain several 2½-inch quartz stringers. A few chains to the north, coarser grained granite cuts up through the Keewatin schists as dikes, which continue to the north at frequent intervals until the main granite batholith is reached.

From the small showing on the surface, the installation of the mill appears as another example of little foresight illustrated at many points throughout the Rainy River district. Even though the one vein carries good values, its size would never warrant mining. The work done, however, dates back to times when the discovery of native gold was thought to be sufficient warrant for sinking a shaft.

Day Claim, F.F. 1,156 (E.S. 72).—On the southeast side of Day lake, southwest of Osinawe lake, trenching has uncovered a well-defined quartz vein exposed intermittently over a length of 300 feet. In width it ranges from 3 to 12 feet. The general strike is N. 95° E. The central part of the vein is illustrated (Fig. 11), since it is typical of many occurrences like it. On the north is partly

schisted quartz porphyry and on the south a 2- to 3-foot zone of carbonated schist impregnated and replaced by a stockwork of fine quartz veins. The vein itself is here about 12 feet wide and includes a 1½-foot lens of sericitized porphyry. Stringers of quartz penetrate the porphyry on the north. Both quartz and porphyry contain narrow inclusions of green schist. The quartz is white and vitreous and in a few places is stained red by weathered sulphides, pyrite and chalcopyrite. No assays of this vein were made.

Veins in Granite Area

Jacks Lake Mine, Claim A.L. 325 (F.F. 815).—Jacks Lake mine is situated near the shore of Jacks lake, which lies about 1½ miles northwest of Osinawi lake. Accounts of the mining activity and of the geology of this location are

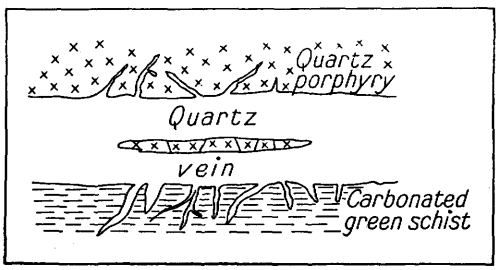


Fig. 11—Diagram showing typical relations of quartz veins and intrusive quartz porphyry.

contained in annual reports of the Ontario Bureau of Mines for 1900 and 1901. The original owners were the Jacks Lake Gold Mining Company, of Saginaw, Mich. It is reported that recently others have taken an interest in the property, and some fresh stripping has been done to the west of the shaft on claim A.L. 325.

The vein on which the shaft was sunk lies in highly altered and schisted grey biotite granite, and strikes N. 85° E. The schistose zone ranges from 10 to 15 feet in width. About 100 feet west from the shaft a sharp ravine suggests a fault, to the west of which the vein has been moved a few feet southward. On the east wall of this gorge a 1-foot quartz vein is exposed for a height of 25 feet, lying between massive granite on the south and fissile sericite schist on the north, with a practically vertical dip. Across the ravine the vein narrows and lenses out about half way down the valley side. Here it lies between sheared granite on the south and a 6-foot lens of green schist, which is highly impregnated with granite stringers. Along the strike to the west, at 3½ chains, an old pit was opened on 2 feet of quartz.

To the east of the shaft, the vein has been covered by the dump. It is reported by Bow[1] to consist of a 20-foot reef, on one side of which occurs a quartz vein, 6 to 24 inches wide, carrying large quantities of galena, sphalerite, pyrite, chalcopyrite, and visible gold. "On the other side is 3½ feet of poorer grade quartz with indefinite walls." Between these two lie siliceous schist and interlaminated lenses of quartz. Native gold is also reported in the vein in the shaft. The main vein here varies from 16 inches to 4 feet wide and, with more quartz lenses and stringers interbanded with light-coloured chloritic schist, totals 8 feet.

[1]J. A. Bow, Ont. Bur. Mines, Vol. IX, 1900, p. 81.

The shaft,[1] 8 by 12 feet, is vertical for 140 feet, and from there to the bottom, at 192 feet, is inclined 80° S.E. At 102 feet a drift was run 30 feet, and at 15 feet a crosscut, southeast for 16 feet. At 187 feet in the shaft a crosscut was run 9 feet southeast. The vein is described as a true fissure vein which is faulted "in the face of the southwest drift at 102 feet, and in the shaft at 140 feet." The fault plane is stated to dip 50°-60° E., with a northerly strike, the direction of movement being along an incline of about 45 degrees with a horizontal component of about 27 feet. The crosscut southeast from the bottom of the shaft was driven to tap the fault plane and the continuation of the vein. There is no record that the continuation of the vein was found. Work apparently ceased in 1902. Some of the ore mined was transported north to the Sawbill mine, where it was milled and a few gold bricks obtained.[2]

The quartz on the dump is white to glassy and shows abundant slickensided and striated surfaces, along which shearing has occurred. These are often mineralized with pyrite, though in most of the quartz on the dump few sulphides are found. One specimen shows clear evidence that the quartz is a fracture filling, crystals of quartz growing out from the schistose and mineralized granite with a central zone filled with rusty-weathering carbonate. A sample was found containing, besides pyrite, some arsenopyrite. A grab sample of unmineralized quartz from the dump gave on assay $7.60 in gold per ton. The size of the vein as now exposed is insufficient to warrant further mining development.

Claim R. 71.—On this old patented claim on Osinawi lake a 12-foot quartz mass was described by A. P. Coleman in 1896. It is contained in the coarse greenish-grey biotite granite.

Claim A.L. 202.—Along the Minto trail on this claim an old pit, 15 feet deep, was sunk on a quartz vein lying between medium to coarse grey biotite granite and a narrow lens of chlorite schist. The vein strikes N. 30° E. and ranges from 6 to 12 inches in width. It can only be traced for about 30 feet. Samples from the pit are heavily mineralized with pyrite in fine crystals. A grab sample of this quartz and pyrite gave $12 in gold per ton.

Minto Mine (Claims A.L. 200, 278).—The shaft of the Minto mine is situated on claim A.L. 278, about a quarter of a mile south of the Seine river above Island falls. It was reported on by W. E. H. Carter[3] in 1903 and by E. T. Corkill[4] in 1905.

These claims were surveyed several years before 1903, when work was first begun by the Little Rock Mining and Development Company, Limited, of Buffalo. At that time a shaft was sunk to 50 feet, inclined at 80° W.S.W. In 1905, it was deepened to 60 feet.

Carter describes the vein as outcropping on a hill, about 300 feet long, which rises from swampy land. The vein, which strikes N. 32° E. and dips 80° S.W., lies in sheared grey hornblende-biotite granite. At the east end the vein shows first at the shaft where it is 6 to 8 feet wide. To the southwest for 200 feet a width of 10 to 12 feet is maintained, and some trenching has been done here. The vein is mainly quartz and carries a little pyrite.

A pit was sunk 100 feet northeast of the shaft but has since been filled in. Along the strike of the vein low land intervenes for about 1,800 feet. Beyond, a strong vein is encountered for a length of 400 feet on claim A.L. 200. Three

[1]Ont. Bur. Mines, Vol. X, 1901, p. 106.
[2]Personal communication, Mr. McEwan, Assayer, Port Arthur.
[3]Ont. Bur. Mines, Vol. XIII, pt. 1, 1904, pp. 71, 72.
[4]Ont. Bur. Mines, Vol. XV, pt. 1, 1906, pp. 48-50.

pits expose a width of 10 to 13 feet of white quartz in sheared granite. The vein here strikes N. 37° E. and dips S. 75°. In one pit the quartz is well mineralized with pyrite along both foot and hanging wall. To the northeast a narrow band of green schist occurs in the granite, paralleling the strike of the vein.

A chip sample across the eastern extension of the vein gave only a trace of gold. Another taken across 12 feet of quartz to the west of the shaft gave none. Old reports, however, indicate that native gold was found in the vein.

Some machinery, including parts of a stamp mill, are stored in a shack near the lake on A.L. 200. From this lake, a pipe line runs back to the boiler-house at the shaft. The property is reported to be in the hands of J. R. Lumby, of Fort William.

Sunbeam Mine (Claim A.L. 282).—The Sunbeam mine on claim A.L. 282 was visited, but as this property was examined and reported on in 1924 no further examination was made. Most of the surface showings are either covered over by the dump or bush. The following account is given by E. L. Bruce[1]:—

> This mine produced some gold from a 10-stamp mill erected near the [Seine river] lake and about three-quarters of a mile from the mine. Work was discontinued in 1905. During operations, a vertical shaft was sunk on the side of the hill; 180 feet from it and 30 feet lower, an inclined shaft was sunk at an angle of 50° towards the vertical one, so that it should intersect it at 180 or 200 feet. Ore was apparently loaded from the incline on to cars by which it was taken along the tram-line to the mill.
>
> The rock is a coarse grey granite, which includes fragments of a darker coloured variety. A very dark-coloured granite outcrops 200 feet west of the shaft. No greenstone appears along the tramway to the lake, but at one place, thirty chains from the mine, a zone of dark granite is cut by a lighter coloured variety. The rock on the dump is much altered and iron-stained and contains a good deal of chlorite. Along slickensides, a deep-green micaceous mineral has developed that resembles chromium-bearing mica.
>
> The quartz on the dump is white and milky with some iron stains. The vein according to descriptions published was 4 to 5 feet wide and the values occurred in short shoots.

According to Carter,[2] the vein is a true fissure striking northeast and dipping about 50° N.W. He says:—

> The original faulting movement left well-defined walls with selvage at an average and fairly uniform width apart of about 8 feet and altered most of the granite between to a chloritic schist, although in places a badly weathered crushed granite is the only result. Embedded throughout this schistose band, and for the most part in or near the centre, lies the quartz vein which varies by lenticular expansion from less than a foot to 8 feet in width, but averaging underground in the northeast drift, first level, about 3 feet, and in the southwest drift an almost uniform width of 2 feet. In that part of the vein down which the shaft has been sunk, the quartz band is considerably narrower than in any other exposure, averaging above the level about one foot and a half, and below, varying from one foot to two feet and a half to within 15 feet of the bottom [207 feet at that time], where it pinches to a few inches followed by a separation into several smaller stringers. Besides this main vein there are other quartz bands lying on either side and along one or other of the true walls of the fissure, but seldom over a foot or so in width and not at all continuous. The immediate walls of the main quartz lead are composed of a mixture about one foot wide of finely banded quartz and schist stringers and brown calcite, the quartz both here and in the main bodies being white and barren, except for occasional pockets or seams of brown calcite and red and green chlorite fibres. The lack of all sulphides beyond an occasional sprinkling of pyrites and galena is noticeable.

On claim A.L. 283, Bow[3] reported in 1898 four test shafts sunk on a continuation of the vein on A.L. 282. In one of these, 6 feet of vein matter was encountered, mineralized with pyrite and galena. A second was sunk 42 feet, and a third 75 feet on an incline of 45 degrees. The latter showed 13 feet of quartz at the east end but played out to the west.

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[1]E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, pp. 33, 34.

[2]W. E. H. Carter, Ont. Bur. Mines, Vol. XI, 1902, p. 240.

[3]J. A. Bow, Ont. Bur. Mines, Vol. VIII, pt. 1, 1899, p. 93.

Claim A.L. 198.[1]—In 1899, a vein thought to be the southerly continuation of the Sunbeam vein on A.L. 282 was tested with a shaft, 49 feet deep. At the surface the vein was 8 feet wide; it pinched out at 13 feet, but came in again at the bottom of the shaft. This vein is reported as continuing southwest to the adjoining claim, H.P. 550.

Roy Mine (Claims A.L. 298, 299).—The Roy mine,[2] lies about 1½ miles northeast of the Sunbeam mine, from which an old winter road runs. Here in 1898-99 a shaft was sunk on a quartz vein to a depth of 105 feet on an incline of 50°-60° N. Drifts were driven along the vein at the 100-foot level, 71 feet west and 55 feet east.

On the surface the vein strikes at N. 52° E. and dips 55° N.W. It is exposed for 250 feet to the east and for 200 feet to the west of the shaft. In width the vein is quite uniform, ranging from 6 and 8 feet. A width of 14 feet is reported at depth. The vein lies in a narrow band of carbonated green schist, which is included in sheared and partly sericitized grey granite. Part of the schist is composed of bright-green chromium-bearing mica. The quartz is milky to white with practically no sulphides. Where stringers of quartz cut the schist, the latter carries abundant pyrite cubes. A chip sample across 6 feet of quartz gave no trace of gold.

Pettigrew Mine (Claims B.G. 24, 36, 37).—An account of work done on these claims in 1899 is given by Bow. The property was not examined by the writer. It lies near Kings lake, 2½ miles northeast of the Seine river in Ramsey Wright township. On B.G. 24 a shaft was sunk to a depth of 108 feet in the hanging-wall side of a vein striking northeast across the property and lying in a schistose zone of grey granite. The vein is 25 feet wide in places and carries coarse pyrite, chalcopyrite, galena, and native copper. It is said to resemble the Hammond reef.

Claims B.G. 43, 45.—Bow also reports in 1899 the sinking of a shaft on claim B.G. 43 to a depth of 113 feet, but work on this was discontinued. On B.G. 45 a shaft was sunk 55 feet. The ore body is a large quartz vein associated with a band of green schist in altered granite.

These locations lie along the strike of the veins of the Sunbeam and Roy mines, but it is not known that they are by any means continuous. This direction appears simply to have been one of a major set of fractures and faults developed in the granite prior to the introduction of quartz.

Claim A.L. 199 (Reserve Island).—Two shafts were sunk 20 feet on this claim on a "bedded vein containing white and greenish quartz with some galena and iron pyrites."[3] The vein at the second shaft, which is 9 or 10 feet wide, strikes N. 20° E., and lies in grey granite containing chlorite schist lenses.

Claim H.P. 498.—At the south end of Reserve island a vein was traced for half a mile from northeast to southwest. It lies in sheared granite and is very irregular in width, being in some places 2 or 3 feet wide and in others only a few inches.[4]

Claim S. 18 (Reserve Island).—In the central part of this claim a vein is exposed at intervals over a distance of 500 feet. It ranges in width from a few inches to 2 feet, and the strike is N. 55°-70° E. It lies partly in grey granite

[1]J. A. Bow, op. cit.; Vol. IX, 1900, p. 81.
[2]Ibid.
[3]A. P. Coleman, Ont. Bur. Mines, Vol. VI, 1896, p. 74.
[4]Ibid., p. 75.

and in places next to small chloritic schist inclusions. The quartz is coarsely crystallized and contains small amounts of galena and pyrite. The claim was staked by George Harris, of Fort William.

Claim A.L. 197 (East of Reserve Island).—On this claim a "vein of white quartz at times 4 or 5 feet wide, dipping strongly to the northwest" is described as containing native gold. In the early days, another vein of sugary quartz on the same property was stripped for 75 feet. They are both in granite and are associated with green schist lenses.[1]

Claim X. 277.—Veins on this claim were reported on by Coleman in 1897 as running N. 25° E. in a 10- to 12-foot shear zone in granite. The thickest vein noted was 15 inches wide and 200 feet long. Little sulphide occurred in either quartz or schist.[2]

Hawk Bay (Claims X. 324, 325).—In 1897 two shafts are reported to have been sunk, 432 feet apart, on an irregular quartz vein on claim X. 324. At a depth of 80 feet in one, the vein pinched to a width of 1 foot. It strikes N. 25° E. and is nearly vertical, occurring in an eastward-trending greenish-grey granite gneiss. To the northeast, on claim X. 325, a 50-foot shaft was sunk on a 2½-foot quartz vein associated with chlorite schist.[3]

THE ATIKOKAN IRON DEPOSITS[4]

Introduction

The Atikokan iron deposits are confined to a narrow belt, which extends for a distance of about 16 miles along the Atikokan river. This belt is known as the Atikokan iron range and can be traced from a point near Atikokan station to a place north of Kawene station on the Canadian National railway. The ore-bearing zone, which is only a few hundred feet wide, outcrops intermittently in a series of low narrow ridges separated from one another by drift-covered stretches. The deposits are geographically broken by Sapawe lake into an eastern and western portion. About a mile east of Sapawe lake, on mining locations Nos. E. 10 and E. 11, is located the Atikokan iron mine. The outcrop on which the mine is located rises as a ridge on the north side of the Atikokan river and is completely surrounded by swamp. A spur line, 3 miles long, connects the mine with the main line of the Canadian National railway at Iron Spur, 128 miles west of Port Arthur.

Development

Although the Atikokan iron deposits were known as early as 1882, very little development work was done until 1900. In 1905, the Atikokan iron mine was taken over by the Atikokan Iron Company, Limited, of Port Arthur. Development work was carried on until 1913, when all operations ceased. During the interval five tunnels were driven through the ridge and three exploratory shafts were started. Mining operations to supply the company's blast furnace at Port Arthur commenced in 1907, when a small output was shipped. The mine was again operated in 1909, 1910, and 1911. The total quantity of ore

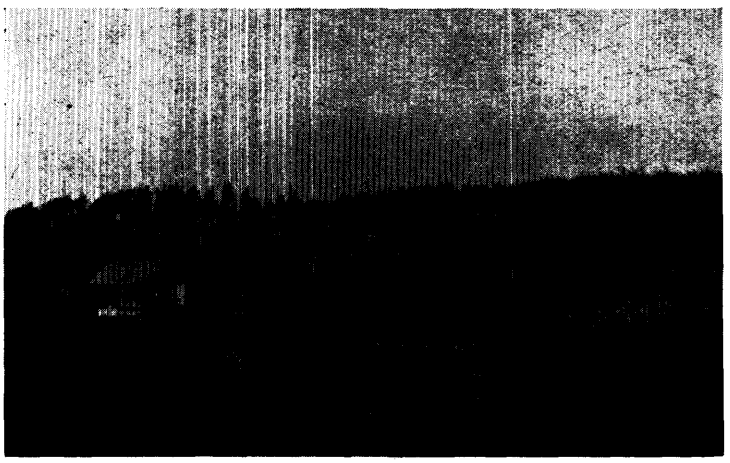
[1]A. P. Coleman, op. cit., p. 75.
[2]Ont. Bur. Mines, Vol. VII, 1898, p. 132.
[3]Ibid.
[4]These notes are largely the work of J. E. Thomson, graduate student, Department of Geology, University of Toronto.

shipped from the mine was 90,680 tons. This averaged 60 per cent. iron, 0.11 per cent. phosphorus, and 2.01 per cent. sulphur.

The existence of several ore bodies at the west end[1] of the range has been proved at different points by tunnels, shafts, and diamond-drilling; and magnetometric surveys[2] have demonstrated the extension of ore bodies beneath drift-covered areas. However, owing to the high sulphur content of the ore, no attempt has been made to utilize it.

General Geology

The Atikokan iron ores belong to a type of deposit that differs markedly from the typical banded iron formation of Northern Ontario. They are located north of the Atikokan river in a narrow zone along the contact of the greenstone belt and the "Seine" sediments. The iron ore, chiefly magnetite and pyrrhotite,



View of ridge on which the Atikokan iron mine is located.

occurs in lenses and irregular masses in a highly altered gabbro, which is found to a considerable extent associated with the Keewatin greenstone and which is post-Keewatin in age. The gabbro shows a variation from highly feldspathic to highly hornblendic phases, but away from the contact it contains practically no iron ore minerals. Locally, it has been severely schisted. When examined microscopically it is found to consist essentially of almost completely kaolinized feldspars (labradorite) and secondary fibrous amphibole. A large part of the amphibole has been altered to chlorite and serpentine. In the iron-bearing zone this gabbro shows the effect of intense igneous metamorphism and contains large amounts of secondary epidote and serpentine.

South of the iron formation are found the folded arkoses, quartzites, and their schistose equivalents, which form part of the Seine series. So far as is known, these sediments have not been intruded by the post-Keewatin gabbro. However, at Iron Spur, on the Canadian National railway, the Seine rocks are cut by an intrusive stock of biotite granite gneiss, which can be traced northeastward to

[1]Rept. Ont. Iron Ore Committee, 1923, Ont. Dept. Mines, 1924, pp. 169-72.

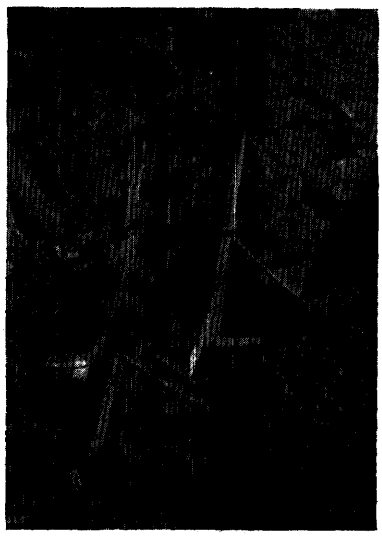
[2]E. Lindeman and L. L. Bolton, Iron Ore Occurrences in Canada, Mines Branch, Dept. Mines, Can., Vols. I, II.

F. Hillé, Mines Branch, Dept. Mines, Can., Sum. Rept., 1914.

A. H. A. Robinson, Mines Branch, Dept. Mines, Can., Sum. Rept., 1914.

a place about a quarter of a mile north of Whiskey Jack lake. Here the granite outcrops within a quarter of a mile of the Atikokan iron mine, where the highest grade ores of the range are found.

There is evidence of a fault along the contact of the greenstones and Seine sediments.[1] This has been traced along the north shores of Crooked Pine lake and Magnetic lake, north of Whiskey Jack lake, and at various intervals along the Atikokan river. At most places along this belt the actual contact is drift-covered, presumably owing to the easy erosion of the fissile schists of the fault zone. The Atikokan iron deposits are located with great regularity along this faulted contact. So far as is known no commercial ore has been obtained outside of this zone, which is only a few hundred feet wide. On the north side of the



View of old shaft at Atikokan iron mine.

ridge that comprises the Atikokan iron mine are found chlorite and sericite schists, which are highly sheared and dip almost vertically. These have apparently been formed by fault movements and have been sheltered from erosion by the hard magnetite and sulphide bodies of the ridge.

Description of Ore Bodies

The ore of the range is magnetite with varying amounts of pyrrhotite and pyrite. Chalcopyrite is also found but occurs only in small quantities. At the east end of the range, at the Atikokan iron mine, lenses of high-grade magnetite are found, but towards the western limits the sulphur predominates. The ore occurs throughout the enclosing country rock in bodies that are irregular both in outline and distribution, causing the relative proportion of rock and ore over a given width of the ore belt to vary greatly within even short distances.

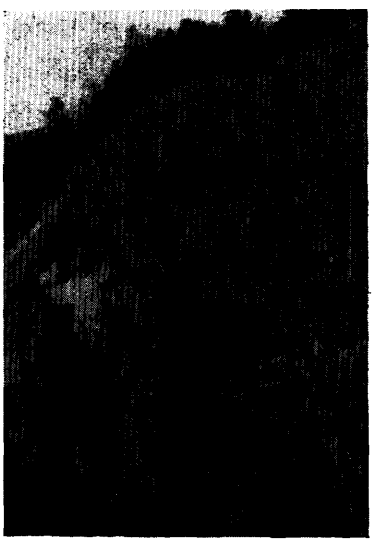
Atikokan Iron Mine

The ore as exposed in the workings at the Atikokan iron mine (Fig. 12) is a hard dense magnetite, difficult to mine and of a refractory nature. Associated with it are pyrrhotite and pyrite in varying proportions, also a little chalcopyrite.

[1]See page 16.

Phosphorus runs above the Bessemer limit, and nickel and copper are present in minute quantities. A sample across 35 feet of good ore, chiefly magnetite, from 135 feet to 190 feet from the south end of tunnel D, assayed 61.7 per cent. Fe and 0.13 per cent. TiO_2. Another sample, across 5 feet of the best magnetite ore, 180 feet to 185 feet from the south end of tunnel B, showed 64.4 per cent. Fe, 0.09 per cent. TiO_2, and 1.9 per cent. S. An analysis of a representative sample across 15 feet of pyrrhotite ore in the open cut at tunnel D was made for copper and nickel. No copper was present, but 0.38 per cent. nickel was found.

The bulk of the ore shipped by the Atikokan Iron Company came from an open cut on the south side of the hill at tunnel C. Smaller quantities came from a small open cut at the south entrance of tunnel D. Further details with regard



View of the open cut at the Atikokan iron mine, looking west.

to the mine workings may be found in reports already cited. Owing to the objectionable sulphur content, all this ore was roasted to prepare it for the blast furnace.

The average analysis of the ore shipped was as follows:[1]—

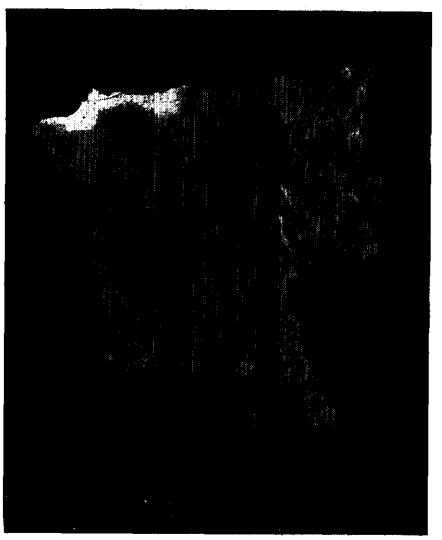
	Before roasting	After roasting
	per cent.	per cent.
Iron	59.85	60.24
Silica	8.68	8.54
Sulphur	2.01	.66
Phosphorus	.11	.11
Alumina	1.51	1.55
Lime	3.00	3.15
Magnesia	2.54	259
Manganese	.11	.11
Copper	.12	.12
Nickel	.11	.11
Titanium	none	none

[1]Rept. Ont. Iron Ore Committee, 1923, Ont. Dept. Mines, 1924.

In 1915, the owners estimated that they had 10,915,483 tons of ore in sight. This included 4,868,011 tons of low-sulphur ore (presumably less than 6 per cent.) and 6,047,472 tons of high-sulphur ore. However, the great irregularities of the ore bodies and the variable sulphur content, which seriously affects the value of the ore, makes the estimation of commercial ore almost impossible.

Western Deposits

On the western part of the range, ore bodies have been proved at different points. These, taken collectively, are estimated to contain roughly 6,500,000 tons of iron ore, ranging from 3.3 to 20 per cent. sulphur. Magnetite occurs with pyrrhotite on claims R. 400 and 401. On claim R. 403 the iron-bearing mineral



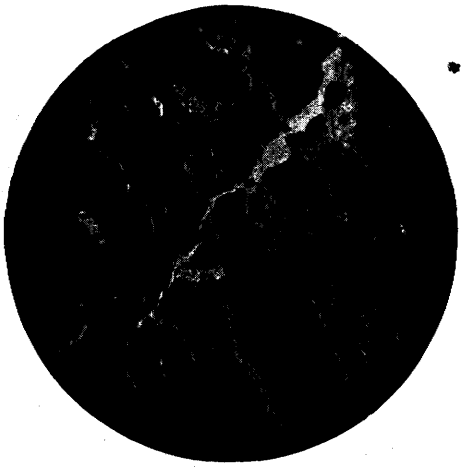
View in open cut at Atikokan iron mine. Magnetite ore continues on the west face.

consists almost exclusively of pyrrhotite. A channel sample taken across 21 feet of sulphides, in a trench on the latter claim, assayed 0.36 per cent. copper, but gave no gold or nickel. Here the ores occur in an altered gabbro as veinlets and irregular masses and consist chiefly of pyrrhotite and pyrite with a little chalcopyrite. Numerous rusty-weathered carbonate veins, probably ankerite, carry pyrite and chalcopyrite in varying proportions. These average from one-quarter to one-half inch in width and form an irregular pattern in the country rock.

Ore Relationships

The ores of the Atikokan iron range show evidence of replacement of gabbro and its schistose equivalents, evidently by hot aqueous solutions of igneous origin. Magnetite occurs in fine to coarse crystals and irregular masses which have replaced gabbro and schist in varying degrees. In certain zones at the Atikokan iron mine, the replacement by magnetite is almost complete. Here the unreplaced rock consists of very highly altered and distorted fibrous amphibole and serpentine. Chlorite schist, which is well developed on the north side of the ridge, when examined microscopically, shows replacement by magnetite in

parallel bands across the schistosity, which is rather striking evidence of its later age. Sulphides have been injected into the country rock and magnetite. These include pyrrhotite, pyrite, and chalcopyrite. The last two are genetically related to veins and irregular masses of carbonate and secondary quartz. At the Atikokan iron mine zones of this carbonate contain varying proportions of pyrite and chalcopyrite but no magnetite. In tunnel D, north of the small open cut, there is a carbonate zone 40 feet wide which shows no magnetite, although it is adjacent to a magnetite zone of commercial value. Tunnel A, which is cut through the west end of the outcrop, passes through 90 feet of carbonate and quartz associated with pyrite but contains no magnetite. Pyrrhotite in general replaces magnetite. Pyrite occurs in well-defined crystals and is later than magnetite



Magnetite ore, Atikokan iron mine. Magnetite (black) replacement shows banded arrangement with interstitial serpentine (grey). The white area is a crack in the section.

in mineral sequence, as many pyrite veins cut massive magnetite ore. Chalcopyrite replaces magnetite, pyrrhotite, and pyrite. Bornite occurs in traces on weathered surfaces and is evidently secondary.

Paragenesis

The source of the ores appears to have been the Algoman granite, although the evidence is incomplete. It has been suggested that this iron deposit is genetically related to the gabbro in which it occurs, the concentration of the ores being due to magmatic segregation in gabbro dikes.[1] There seems to be no evidence to support this theory. The ore is non-titaniferous, which is in marked contrast to the known iron deposits that are supposed to have been formed in this manner. Replacement of the country rock by magnetite followed by a fairly definite sulphide succession can be observed in the field and by microscopic examination. As previously mentioned there is a marked metamorphism of the gabbro in the ore-bearing zone, such as would be produced by the injection of hydrothermal solutions of igneous origin. These may be related to a period of granitic igneous activity which is later in age than the gabbro. In 1913, Lawson[2] observed that these iron ores occurred at the base of the Seine sediments where there is no conglomerate. The ore and conglomerate thus appeared to be comple-

[1]F. Hillé, Jour. Can. Min. Inst., Vol. 5, 1902, p. 56.
[2]A. C. Lawson, Can. Geol. Surv., Mem. 40, 1913, p. 66.

mentary features at the base of the Seine series. Boggy conditions were thought to have prevailed along this section of the contact with the result that bog iron ore was deposited instead of the usual basal conglomerate. This idea was supported by the large amount of carbonate along the ore-bearing zone. The above description of the Atikokan iron range seems to negative this theory. Even if the ores did not occur in a highly altered gabbro, it is highly improbable that ores like pyrrhotite and chalcopyrite would be formed under such conditions. The carbonate occurring with the ore, as stated above, is of later age than the magnetite and appears to be associated with the injection of pyrite and chalcopyrite.

Magnetite replacing chlorite schist, Atikokan iron mine. Magnetite (black) cuts across schistosity, and secondary quartz (white) associated with pyrite (P) cuts magnetite.

The simplest explanation of the genesis of the Atikokan iron formation would be that it is a metasomatic deposit derived from hot solutions of igneous origin, most probably from the Algoman granite which occurs in the immediate vicinity.[1] These hydrothermal aqueous solutions were injected along the lines of least resistance, the sheared and fissile schists formed by an earlier fault. Successive periods of injection of various differentiates of the parent magma led to a mineral sequence of magnetite, pyrrhotite, pyrite, and chalcopyrite. Replacement in a narrow belt along this fault zone would thus produce the irregular bodies of iron ore with the varying sulphur content.

Economic Possibilities

The present supplies of high-grade iron ore in the Lake Superior (American) district are still so great that mining of high-sulphur magnetite ore of irregular

[1]The age of the nearby granite has been fixed as Algoman, since it intrudes the folded sedimentary series on the south. The folding of the sediments, the faulting along their contact with the Keewatin and gabbros, and the northerly folding of the Steeprock Lake (Huronian) series have all been related to one major period of deformation, which was ended by the final injection of post-Laurentian granite. The gabbro in which the ores occur was schisted before the introduction of the ore and is older, therefore, than the folding, faulting, and granitic intrusions. The association in time of ore deposition and the faulting and granitic intrusions favour the theory that the ores are genetically related to the granites. Van Hise and Leith (U.S. Geol. Surv., Mon. 52, p. 562) from a study of this deposit suggested an origin similar to the above, and referred it to "pegmatitic intrusion or igneous after-effects, similar to those described by Spencer (U.S. Geol. Surv., Geol. Atlas, Folio 161, 1908, pp. 6, 7) for the New Jersey magnetites or by Leith (U.S. Geol. Surv., Bull. No. 338, 1908, pp. 75-89) for certain western magnetites.

distribution, such as the ores of the Atikokan iron mine, would at best be speculative, particularly in view of foreign competition.

The theory of origin of the magnetite-pyrrhotite deposits, set forth in the preceding section, that they are related to granitic intrusions, raises the question as to the possibility of some of the pyrrhotite deposits being a source of copper ore. Chalcopyrite is locally associated with pyrrhotite, but no concentration of this mineral has yet been found. Deposits of chalcopyrite, large enough to be worked at a profit, are known to occur with pyrrhotite and in association with granitic intrusions; hence, it is possible that further prospecting may reveal deposits here. The possibilities, of course, are just as great that no commercial copper ore bodies exist.

NOTES ON PROSPECTS AND MINES, ATIKOKAN TO RAINY LAKE

Steeprock Lake

Claim K. 413.—In the northwest corner of Steeprock lake on this claim a quartz vein lies in sheared grey chloritic granite and strikes N. 35° E. The greatest width of the vein is 4 feet and it has a visible length of 100 feet. Five feet to the north and paralleling the vein is a narrow fresh basaltic dike. Following its discovery in 1897, a shaft was sunk on this vein to a depth reported as 65 feet. The quartz is reported to carry native gold and is mineralized with some pyrite. Recent assays show good values in gold. Similar veins are reported on this and adjoining claims.

Banning

Law Syndicate (*Claims Nos. 1,230-33, 1,235-38, 1,240-44*).—On these claims, which lie north of the Seine river just west of Banning station on the Canadian National railway, several veins and mineralized schist zones have been opened up. The principal rocks consist of chloritic, hornblendic, and carbonated Keewatin schists, the strike of which curve from northeast to northwest. These have been derived from basic lavas. Interbanded with them are minor sericitic schists, probably derived from more acid volcanics. Near Niven's lake the Keewatin rocks are intruded by a grey biotite-hornblende granite and granite gneiss. Within the Keewatin are smaller intrusions of two general types: the one basic, consisting chiefly of hornblende gabbro, which locally is highly feldspathic and even porphyritic; the other acidic, consisting either of fine-grained felsite or quartz-feldspar porphyry. The hornblende gabbro occurs usually in small lenticular intrusions, the felsite as narrow dikes and the porphyry as somewhat larger lenticular masses in which are abundant lenses of green to rusty-weathering carbonated schist. The carbonate alteration is prominently developed about the borders of the porphyry intrusives.

The mineralized zones have all been test-pitted and have been numbered for convenience.

Pits Nos. 1 and 2 are on claim No. 1,244.[1] At the former, hornblende schist is cut by several small quartz veins paralleling the northerly strike. One of these is 4 inches wide. The schist is mineralized for a width of 1 foot with pyrite, in small cubes, and chalcopyrite. It dips at 75° E. At pit No. 2, a 2½-foot zone of similar schist is impregnated with grey quartz stringers striking N. 10° W. and dipping 75° E. Approximately 40 per cent. of this zone is quartz. Mineralization with pyrite and chalcopyrite occurs chiefly in the quartz and to a

[1]T. L. Tanton, Geol. Surv. Can., Sum. Rept., 1925, pt. C, p. 9.

lesser extent in the schist. Samples are reported to assay high in copper with a trace of gold, but a chip sample taken across 4½ feet gave no gold and only small amounts of copper. Pit No. 8 on this same claim may be on a continuation of the schist zone at pit No. 2; the schist has essentially the same strike and dip.

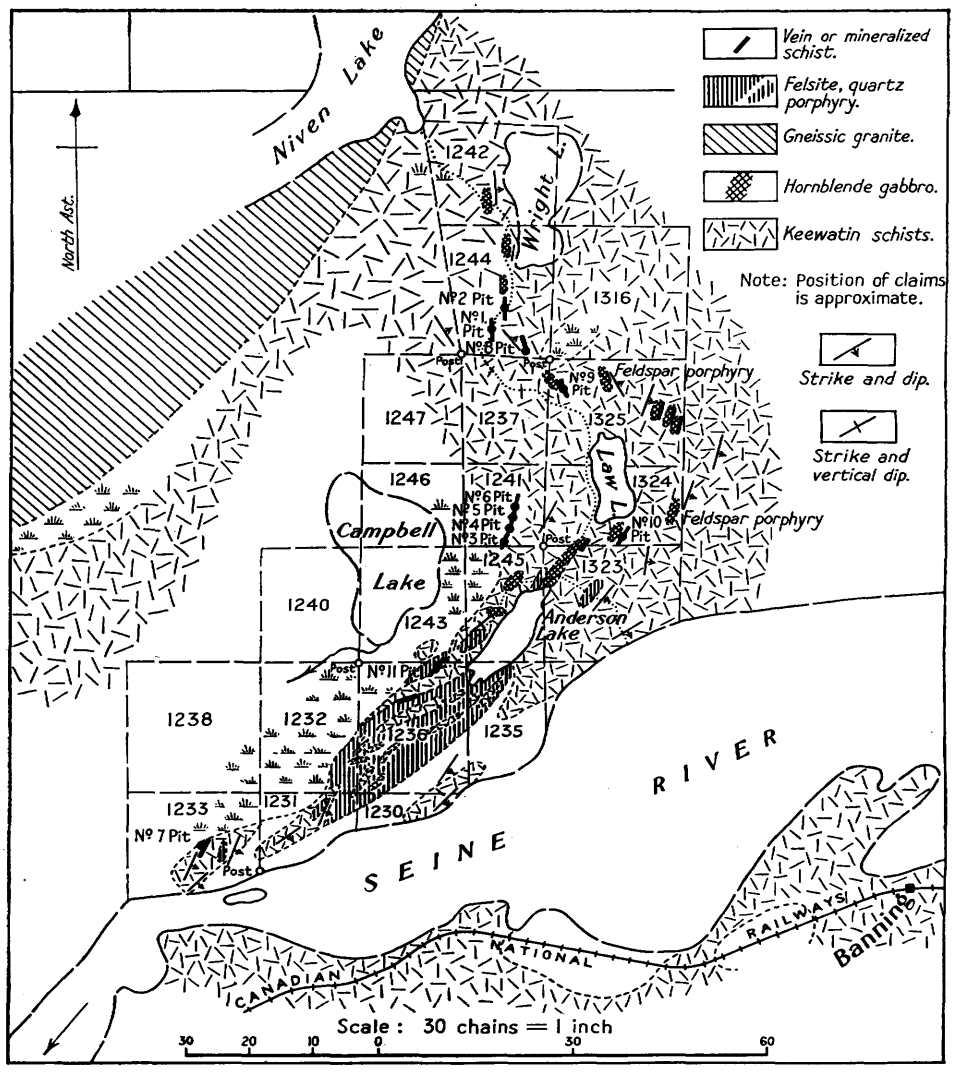


Fig. 13—Geological sketch map of Law claims, Rainy River district.

The mineralized portion here is 5 feet wide, and contains abundant quartz stringers with which pyrite and chalcopyrite are associated.

To the south, on claim No. 1,241, a series of pits (Nos. 3 to 6) have been sunk on a mineralized schist zone striking north. The mineralized portions of the schist here, however, are arranged *en échelon*, from west to east. This zone totals about 350 feet in length. The pits, which are from 3 to 5 feet deep, expose mineralized schist, 3 to 6½ feet wide, in which are only a few narrow quartz stringers. The sulphides are largely pyrite. Good values have been reported in

copper from pit No. 3. A chip sample across 6½ feet gave 0.8 per cent. copper, and very low values in gold. Between pits Nos. 3 and 4, the mineralized zone narrows to 5 inches but widens, at pit No. 4, to 4 feet. One chain to the west of pit No. 5, a similar schist belt is mineralized over a width of 1½ feet. A short distance to the east is a dike of felsite from 3 to 5 feet wide, striking N. 20° W.

Pit No. 9, on claim No. 1,325, is on another mineralized Keewatin schist zone carrying about 15 per cent. quartz and mineralized over a width of 3 feet with pyrite and chalcopyrite. To the southeast several sulphide sericite schist bands appear between small intrusions of hornblende gabbro or related rocks. The schists are probably acidic volcanics. The sulphide is chiefly pyrite, and

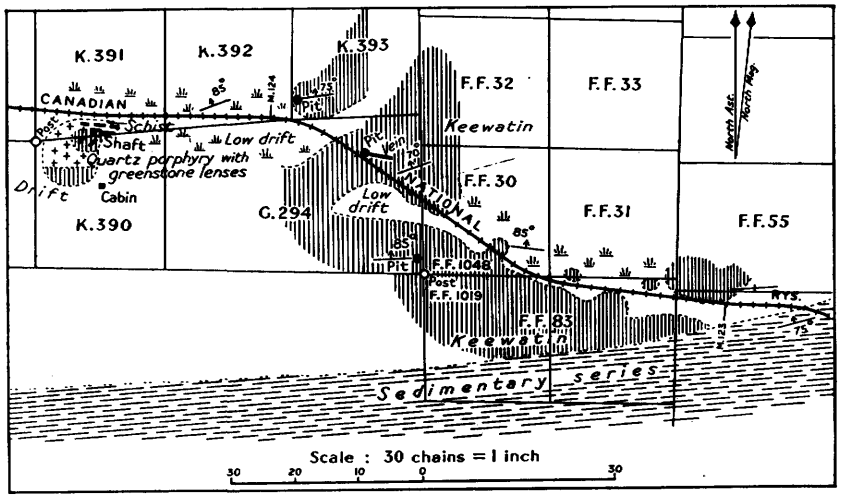


Fig. 14—Sketch map of geology in the vicinity of the Mayflower mine, west of Flanders Station.

their magnetic attraction suggests some pyrrhotite. They appear to be similar to other sulphide-bearing bands of Keewatin rocks which are of little value.

On the north side of claim No. 1,236, a pit has been made across a quartz vein lying along the contact of sericitized quartz-feldspar porphyry and highly carbonated greenstones. The main vein here is 1 foot wide, but increases to over 2 feet along the strike. To the southeast smaller stringers of quartz cut the sericitized porphyry, which is well mineralized with fine pyrite and locally with abundant chalcopyrite over a total width of 8 feet. The vein strikes N. 55° E. and dips 70° N.W., but cannot be traced for any considerable distance. To the southwest it appears to play out into several stringers penetrating the carbonated greenstone. Grab samples from the pit are reported as assaying $18 in gold and copper. A chip sample across 8 feet gave a trace of gold and low values in copper.

To the southwest, on claim No. 1,233, pit No. 7 is on a rusty-weathering 7-foot band of chlorite-hornblende schist, which is ribboned with fine quartz stringers and well mineralized with pyrite. This zone is exposed for 150 feet, striking N. 20° E.

Mayflower Mine[1] (*K. 390 and 391*).—The Mayflower mine is situated just south of the Canadian National railway, about 1½ miles west of Flanders

[1]A brief report on the Mayflower mine was made by Jas. Bow in 1905. At that time a shaft had been sunk to a depth of 90½ feet.

Station, on claims K. 390 and 391. A shaft has been sunk 100 feet in Keewatin schists close to several quartz veins. Short workings have been driven on the 50-foot level, 15 feet to the north and 35 feet to the west. On the 100-foot level, a drift has been driven 50 feet northeast and a crosscut has been made for 8 feet to the north. W. J. Hoover, of Fort William, is manager and owns the largest interest in the mine.

On the surface, considerable stripping and trenching have been done, exposing several quartz veins over short distances. The veins range from 1 to 10 feet in width and strike in a general direction of N. 85° E. They lie in and adjacent to an intrusion of quartz porphyry on the north and west of the shaft. To the east for 275 feet, trenches expose several small veins, 1 to 1½ feet wide, in 15 feet of greenstone, which is mineralized chiefly with pyrite. To the east of the small hill on which the shaft and trenches are located, low land intervenes for half a mile. Across this, a narrow vein has been picked up on the north side of the track. Here the Keewatin greenstone contains 3 or 4 stringers of quartz and heavy pyrite. The quartz stringers coalesce to make a 1-foot vein, which strikes east.

In the mine at the 100-foot level, the northeast drift was driven on a 6-foot vein with schist walls. To the north the crosscut reveals interbanded grey quartz and narrow schist lenses heavily mineralized with pyrite and chalcopyrite. A white quartz vein, 2 feet wide, is less mineralized. A chip sample was taken across the 8-foot crosscut and gave on assay $3.60 in gold and 0.6 ounces of silver per ton. The crosscut was being continued north to intersect a larger quartz vein appearing at the surface.

Mine Centre Area

To the south of Mine Centre on the Canadian National railway, in the vicinity of East Shoal and Bad Vermilion lakes, prospecting activities were renewed in the summer of 1928 following the discovery of rich seams of gold ore in a vein on the Isabella location adjoining the Golden Star property.

The general geology of this area appears on the map accompanying Memoir 40, of the Canadian Geological Survey, and is described by A. C. Lawson.[1] A recent report on the mines is given by E. L. Bruce.[2] Since only a week was spent in this area examining claims and properties little can be added to published accounts of the geology. The classification given by Lawson and Bruce is as follows:—

ALGOMAN:	Granitic gneisses, etc.
Lamprophyres.	
	Intrusive contact
SEINE SERIES:	Quartzites, slates, conglomerate.
	Unconformity
LAURENTIAN:	Granite gneisses, etc.
	Intrusive contact
KEEWATIN:	Chlorite and hornblende schists, etc.
COUTCHICHING:	Mica schists, quartzites, slates, etc.

To the north of Bad Vermilion lake Keewatin greenstones and schists are intruded on the south by a coarse hornblende gabbro or anorthosite. Many granitic and porphyritic dikes, as well as a long tongue of Laurentian granites, intrude these, the band of Laurentian shown to the southwest on Lawson's map

[1] A. C. Lawson, Can. Geol. Surv., Mem. 40, 1913.
[2] E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925.

extending for a considerable distance farther to the northeast. To the southeast of Bad Vermilion lake, in the vicinity of the Golden Star mine, Keewatin greenstones and grey felsites or rhyolites are intruded on the west by anorthosite gabbro and on the southwest by Laurentian granite, and both Laurentian and Keewatin are overlain unconformably by steeply dipping conglomerate beds of the Seine series. To the south of Shoal, Grassy, and Cliff lakes lies the wide band of mica schists and thin-bedded quartzites and slates of the disputed Coutchiching. A comparison between these and sediments in the Sapawe Lake area has been given above.

Gold deposits occur in veins both in the Keewatin and Laurentian granites Showings of native gold are very numerous in the area, and the Golden Star and Foley mines are reported to have produced about a quarter of a million dollars in gold.[1] No mining activities were in progress in this vicinity at the time of the writer's visit, and it is questionable whether ore bodies capable of supplying an average-sized mill for a very long time have yet been found on any one property.

MINES AND PROSPECTS

Golden Star and Isabella (Claims A.L. 113, 114).—A description of this property is contained in Bruce's report of 1925. The property at present is owned by W. E. Stone. Early in 1928 an option was taken by the Northern Red Lake Syndicate, which carried on some surface exploration and discovered rich lenses of ore in what is known as the old Isabella location, claim A.L. 113. A small 5-ton amalgamation mill was also constructed near the Golden Star shaft, and a little ore from an open cut on the main Golden Star vein was run.

The following account is taken from Bruce:[2]—

> The Golden Star mine . . . was the largest producer of gold of the area.[3] Veins were discovered on this property in August, 1894, and some development work was done by the original owners before it was turned over to the Golden Star Mining and Development Company in March, 1897. Work by this company was begun almost immediately and was carried on practically continuously until 1900. Further development work was done in 1901, and a total of about $30,000 was expended; but the mine was again closed, and nothing has been done in recent years. . . . What seems to have been a very thorough examination was made by James A. Bow.[4]

While Bow's report "indicates that the ore bodies were of sufficient grade and size to be workable under present conditions," the proved ore would probably not maintain an average-size mill for long. The finding and proving of additional ore deposits in this and adjoining territory is necessary before construction of a modern mill would be warranted.

The accompanying map is taken largely from Bruce's, to which a few additions, showing the most recent workings, have been made (Fig. 15).

The gold-bearing quartz veins lie in the Keewatin greenstones and felsites, both of which have been considerably altered either to carbonate or to sericite schists. The deposits have been related by others to the intrusive Laurentian granite to the south in which similar gold-bearing veins are found.

Immediately to the southeast of the old Golden Star shaft an open cut, 10 feet wide and 66 feet long, has been driven into the side of a hill along a vein striking at E. 40° S. and dipping 75°-80° S.W. The vein lies in sericitized felsite and has a total exposed length of 300 feet. At the end of the cut it consists of two quartz lenses, from 2 to 3 feet wide, with an 8-foot horse of felsite. This is cut by several quartz stringers and is mineralized sparingly with pyrrhotite,

[1] E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, p. 25.
[2] Ibid.
[3] $160,000 in gold recovered.
[4] Ont. Bur. Mines, Vol. VIII, pt. 2, 1899, pp. 263-71.

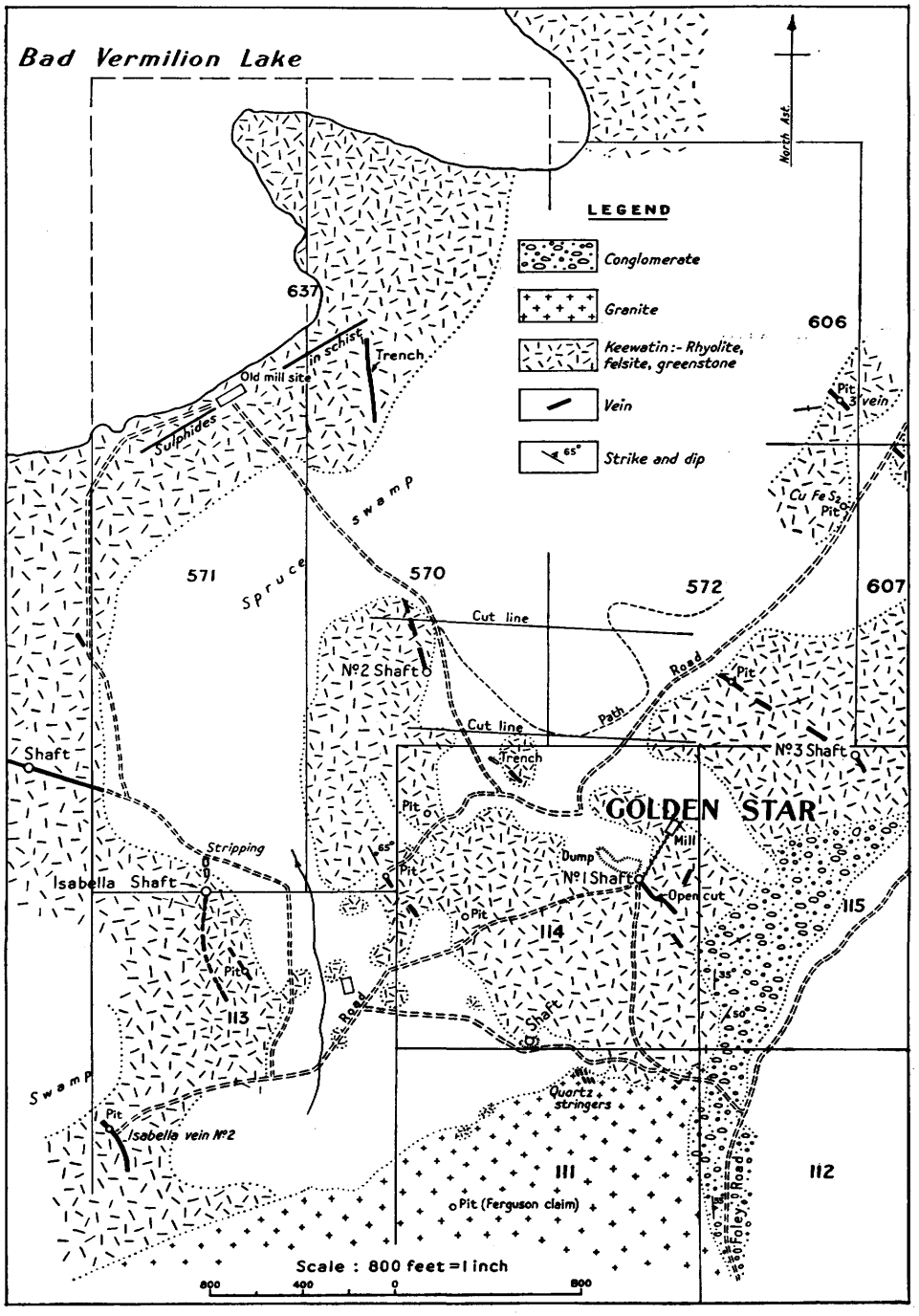


Fig. 15—Golden Star gold mine, showing location of Isabella vein No. 2, a recent discovery.

pyrite, and chalcopyrite. A chip sample of the 28-inch vein on the hanging-wall side and 4 inches of the wall and horse, gave $4 in gold per ton, on assay. A sample of 1 foot of quartz on the footwall side gave $1.40 in gold per ton. Half way into the open cut, on the floor on both sides, are exposed two 8-inch widths of quartz well mineralized with chalcopyrite, pyrite, fine galena, and dark sphalerite. A sample of these two gave, on assay, $38.40 in gold per ton.

Two other veins occur to the southeast of the shaft lying between and partly replacing felsite and greenstone schist. Both are relatively narrow and lenticular, having a maximum width of 1 foot. They are mineralized with pyrite, chalcopyrite and galena.

On the southwest corner of claim A. L. 113, southwest of the old Isabella shaft, the vein in which spectacular gold was found in 1928 lies in highly carbonated greenstone schists, a short distance north of the Laurentian granite. The vein has an exposed length of 300 feet, strikes from E. 60° S. to E. 85° S., and dips 60-65° S.W. At the northwest end, the vein is split into two quartz lenses enclosing a 3-foot horse of carbonated schist, which is highly impregnated with quartz veinlets. The footwall quartz is 18 inches wide; the hanging-wall quartz widens from 1 to 4 feet in a depth of 12 feet. Associated with the latter are lenses of coarsely crystallized grey ankerite. Both quartz and ankerite are mineralized with fine-grained mispickel, probably danaite, with which is associated some cobalt, cobalt replacing the iron of mispickel, and native gold. The vein at the pit has a maximum width of 7 feet. To the southeast it narrows and averages 2½ feet; to the northwest it runs into low ground.

The rich finds of gold are reported as splashy and occurring in seams along the footwall and in the centre. No native gold was visible at the time the vein was visited, but specimens could readily be identified by the typical ankerite-mispickel association. The gold appears to be the last mineral introduced in the vein, and may be found in fractures in the quartz and in cleavages in the ankerite. Assays of 49 inches of quartz along the hanging-wall side of the vein gave only a trace of gold, and across 15 inches of quartz on the footwall side, neither gold nor silver. The irregular distribution of values requires consideration, increasing as it does the risk in mining veins of this character.

Scranton-Ontario Consolidated Mines, Ltd. (Claims Nos. 570-72, 606-7, 637).—Exploration was being carried on under the direction of Major Powell on these claims. The work consisted of stripping and trenching of veins. On claim No. 570, part of old J.O. 41, what appears to be continuation of the main Golden Star vein has been traced at intervals as shown on the map (Fig. 15). This vein ranges in width from a few inches to 4 feet at the old shaft. Near the shaft it carries some sulphides. At the north end it widens and maintains a width of 2 to 6 feet, but here does not appear to be mineralized.

On the southern part of claims Nos. 570 and 571, a vein has been traced westward to K. 278, where an old shaft was sunk. This vein, on claim No. 571, lies in green rusty carbonate and chlorite schists and ranges in width from 5 to 11 feet. It is sparingly mineralized along one band of quartz, 3 inches to 1 foot wide, with pyrite and chalcopyrite. The quartz is white and vitreous and contains some intergrown carbonates. A sample from this vein, however, failed to give any gold on assay. Other veins have been stripped and trenched on claims Nos. 606, 607, and 572. These are mineralized with chalcopyrite and pyrite and resemble the other veins described.

Along the shore of Bad Vermilion lake, on claims Nos. 570 and 571, a schistose band of greenstone strikes northeast and is mineralized with pyrite and pyrrhotite.

This is similar to other Keewatin occurrences, the majority of which have never yielded appreciable values in gold. They are commonly known as sulphide dikes.

Investigation of the tailings, which lie under water in Bad Vermilion lake, from the milling of ore from the Golden Star has been carried on by this company. It is possible that these are sufficiently rich to warrant re-milling with a cyanide process.

North of Bad Vermilion Lake

Walter Stone (*Claims F.F. 556, 566, 567, 578, 586, 1,166*).—On these claims occur several quartz veins and mineralized schist zones, in most of which native gold may be seen. Good values in gold are reported over fair widths.

On claim No. 578, an 8-foot band of rusty-weathering carbonated chlorite schist is cut by several quartz stringers with a maximum width of 8 inches. The quartz is well mineralized with pyrite and chalcopyrite, and native gold is also present. Across the strike for 120 feet, highly schistose greenstones with occasional narrow quartz veins occur. These also carry fine specks of native gold. To the north of the schist lies a coarse-grained gabbro, and to the south massive greenstones. The schist belt may be traced for over 5 chains and is reported on claim F.F. 956 to the east, and undoubtedly continues some distance to the west beneath a light cover of drift.

Well-defined veins, striking about N. 65° E., occur also on claim No. 556 and have widths of 1 to 4 feet. These are mineralized with chalcopyrite, pyrite, and bornite, and contain native gold and some tourmaline. Many branch veins take off from the eastward-trending ones and strike either northwest or southwest. They may be traced westward across two or more claims, and lie in either greenstones or grey felsites, which are locally porphyritic.

On claim No. 566, a vein from 500 to 600 feet long, ranges in width from a few inches to 2½ feet. It strikes E. 35° S. and cuts across both chlorite and sericite schists. Minerals in the vein are tourmaline, chalcopyrite, pyrite, and native gold.

On claim No. 1,166 is a 55-foot width of chloritic and sericitic schist, trending east for 600 feet and containing two well-mineralized zones with quartz veins from 1 to 2 feet wide. The schist carries pyrrhotite, pyrite, and on the north side, chalcopyrite. The veins locally have dragfold shapes, as has the schist. At one locality cobalt bloom is present.

A. Johnson (*Claims Nos. 584 and 609*).—These claims lie west of the above-mentioned claims, and on them occur somewhat similar veins mineralized with chalcopyrite and occasionally with native gold. The rocks consist of schistose greenstones, intrusive anorthosite (gabbro), and quartz-feldspar porphyries, the latter probably closely related to the intrusive granite of Laurentian age. In width the veins are relatively narrow, reaching a maximum width of 1½ feet.

C. Maiers (*Claims A.L. 27, H.P. 96*).—On claim A.L. 27, a short distance north of a contact of granite and greenstone, which here lies relatively close to Bad Vermilion lake, a 6-foot vein occurs in highly sheared and sericitized granite. On this a shaft, called the Rainbow, was sunk to an unknown depth. At the shaft the quartz vein is 6 feet wide, but it narrows rapidly eastward to half a foot and breaks up into several small stringers. The quartz is fine and sugary, and is fairly well mineralized with pyrite and a few specks of galena. Visible gold is also reported.

Considerable prospecting and trenching have been done on these claims, but no other veins were examined.

Deposits near East Shoal Lake

McDonald (Claim No. 783).—Northeast of Shoal lake several veins of quartz occur in Laurentian granite. About half way north on the east line of this claim, a 15-foot quartz vein is exposed at intervals beneath heavy drift. The quartz is reddish to white. The vein strikes at E. 45° S. and has a well-defined northeast wall and a less definite one on the west, grading into altered and mineralized reddish porphyritic granite on this side for a width of 25 feet. In the central part of this zone a 4-foot band is well mineralized with pyrite, chalcopyrite, galena, and sphalerite. It is reported to give good values in gold and some silver. To the west is another 26-foot zone of altered granite cut by numerous quartz stringers. An assay across 70 feet of vein and granite is reported to give $4 in gold. To the northwest on the same claim, two parallel veins occur in

View looking north from the north shaft of the Foley mine, showing the recently enlarged dump.

granite and strike about due east. One has a width of 5 feet, the other 1½ to 3 feet. Both are of fine-grained quartz carrying pyrite and chalcopyrite. They can be traced only short distances owing to the heavy drift over this area.

Foley Mine (A.P. 74-76).—The geology of the Foley mine has been described and mapped by Bruce.[1] No further mapping has been done. At the time of the writer's visit the mine, which is owned by the British Canadian Mines, Limited, was closed. The latest work consisted of a diamond-drilling campaign, which was finished in June, 1925. The results are not available. Underground work was finished in January, 1927, and the mine was closed in July, 1927. A new building for a cyanide mill has been constructed 1,700 feet north of East Shoal lake on claim A.L. 76. At present only a crusher and tube and ball mill have been installed.

Within the last three years, underground work consisted of deepening the north shaft to the 850-foot level. Along the "Jumbo" vein, 46 feet of drifting was done. To the northeast the drift encountered a 13-foot shear zone in which small quartz veins occur. On the 725-foot level no drifting was done. At the 600-foot level a drift was driven 570 feet north and 250 feet south, on the Bonanza

[1]E. L. Bruce, op. cit., pp. 25-27.

vein. At 70 feet south of the shaft a crosscut was made. At the 500-foot level, 320 feet of drifting to the north and 90 feet to the south were completed. On the 400-foot level, 140 feet south of the shaft, a winze was sunk 450 feet to the 850-foot level. From the winze a drift was run 310 feet southeast to "A" vein, which lies 100 feet east of the Bonanza vein and which there carries only low values in gold. Crosscutting was continued 200 feet west from the Jumbo vein without encountering further veins.

From the winze, drifts north were driven along the Bonanza vein on the 400-, 500-, and 600-foot levels. An ore shoot has been reported in this vein with a length of 80 to 160 feet along the vein. On the 400-foot level this is from 3 to 40 inches wide. The shoot appears to dip north at about 60 degrees, widening downwards. No examination of this shoot was possible. Samples of ore reported from it, and others obtained from the dump are mineralized with chalcopyrite and sphalerite. On assay one of these gave low values in gold and 0.7 ounces in silver per ton.

From the south shaft, at the 200-foot level, a crosscut was made to the Daisy and Lucky Joe veins. Drifting was carried for 270 feet north and 80 feet south on the Bonanza vein. On the Lucky Joe vein fair values in gold are reported over narrow widths, but the Bonanza shows no good widths of ore here.

Bruce gives the following description of the veins:[1]—

> High values have been obtained from some samples, but the gold content is exceedingly variable. The lack of any extensive mineralization of the wall rocks leaves only the quartz as possible ore. Hence, with widths detailed above [as mostly narrow], it will be necessary to have high values in the veins proper to make mining profitable. Owing to the variability of values, assay results are unreliable, and only mill tests on considerable quantities of ore will give accurate data as to the return that may be expected.

[1]E. L. Bruce, op. cit., p. 27.

Lead and Zinc Deposits, Dorion and McTavish Townships, Thunder Bay District

By J. E. Hawley

Introduction

In the latter part of the summer of 1928 an examination was made of lead and zinc deposits in Dorion and McTavish townships in the unsurveyed territory immediately north of Dorion and in the vicinity of Ozone Siding, east of Nipigon

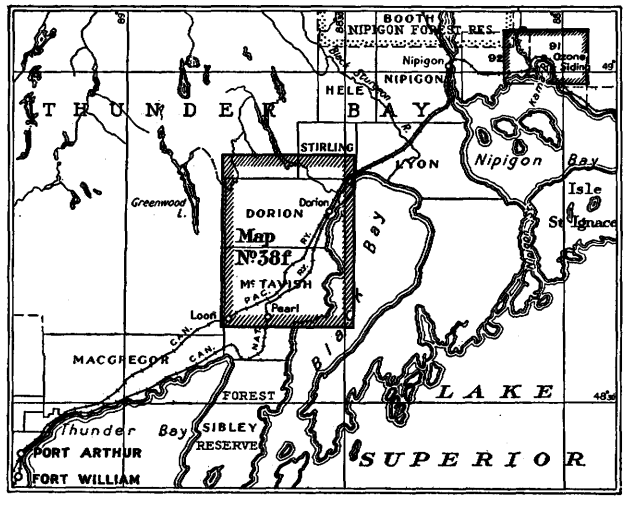


Fig. 1—Key map showing location of Dorion and McTavish townships, and of the Ozone Siding area, Thunder Bay district. Scale, 20 miles to the inch.

Station on the Canadian Pacific railway. Dorion and McTavish townships lie about 30 miles east of Port Arthur and are crossed by both the Canadian National and Canadian Pacific railways. Occurrences of lead and zinc have been known here for many years, and some development work has been carried on within the last few years. Several shafts have been sunk on mineralized veins, known as early as 1876, but no mining is at present being done. Near Ozone Siding are several showings of lead and zinc, and on one of these an old shaft was found.

Previous Work

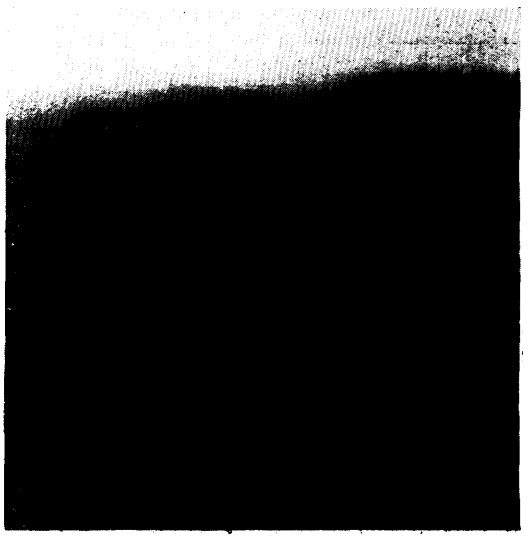
In 1906 the southern part of McTavish township was mapped and reported on by L. P. Silver.[1] The general geology of the vicinity of Ozone Siding appears on a map accompaning a "Report on the Region Lying North of Lake Superior between the Pic and Nipigon Rivers," by W. H. Collins.[2] Many of the lead and zinc deposits are reviewed by W. L. Uglow,[3] who has studied them in connection with similar deposits elsewhere. In 1919, and again in 1927, T. L. Tanton,[4] of

[1]L. P. Silver, The Animikie Iron Range, Ont. Bur. Mines, Vol. XV, pt. 1, 1906, pp. 156-72.
[2]Can. Geol. Surv., Report No. 1081, 1909.
[3]W. L. Uglow, Lead and Zinc Deposits in Ontario and in Eastern Canada, Ont. Bur. Mines, Vol. XXV, pt. 2, 1916.
[4]T. L. Tanton, Geol. Surv. Can., Sum. Rept., 1919, pt. E, pp. 1-7; memoir in preparation.

the Canadian Geological Survey, examined and reported on parts of Dorion and McTavish townships; he has prepared a map of the area to accompany a final memoir on this and adjoining districts. In view of the previous work by Tanton no great amount of time was spent in areal mapping, but sufficient work was done to show the general geology. Map No. 38*f*, which accompanies this report, is largely the result of this work. Parts of the geology are taken from a provisional copy of Tanton's map, through the kindness of the Canadian Geological Survey.

Acknowledgments

In the field the writer was ably assisted by J. E. Thomson, E. D. Johnson, and R. A. Young. Details regarding the Caribou and Silver Lake showings are largely the work of Mr. Thomson, who also mapped considerable portions of the areal geology. The writer is also indebted to the management of the Dorion and Ogema mines, to J. Dreany of Loon Station, and to Mr. Percy Barr of Pearl Station for many courtesies extended in the field.



Diabase sill scarp, northwest of the Dorion mine.

Topography

The topography of the region is distinctly related to the underlying rocks. Tanton[1] gives the following account:—

> The areas of pre-Huronian age show the mammillated surface such as characterizes the greater part of the pre-Cambrian shield. The areas of Animikie and Keweenawan sediments appear as slightly inclined planes at various elevations. Diabase sills and dikes are found throughout the district, and they form protecting mesa caps over the sediments or flat-topped ridges with precipitous cliffs at the sides.

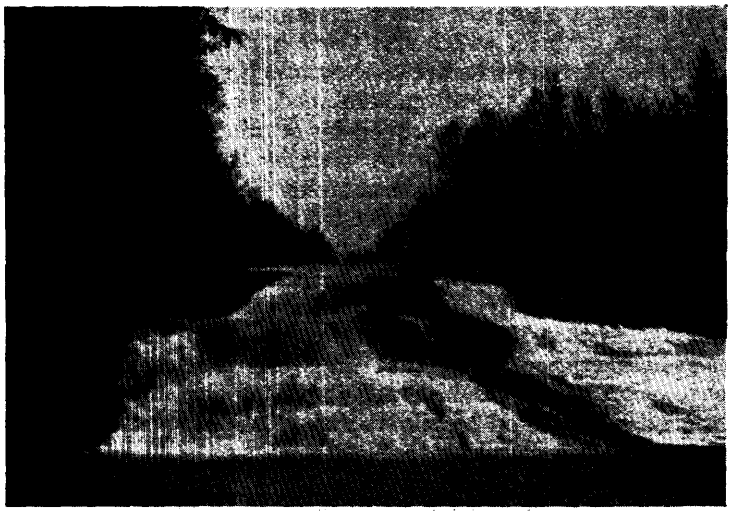
In the northern part of McTavish township rugged hills of granite protrude above the lower-lying Keweenawan sediment areas, and rise even higher than some of the diabase sills. In this region and within the diabase sill areas are many small lakes. In the diabase sill areas these lakes are elongated and are

[1]T. L. Tanton, op. cit., p. 2.

drained by small streams, with numerous falls and rapids, which run through narrow gorges with steep and talus-covered slopes. Northwest of Dorion township the only known canoe route is along the Wolf river beyond Wolf lake. Downstream are several falls; the larger, in Stirling township, has been surveyed for its power possibilities. In the Ozone Siding area a navigable stream, Jackfish river, flows southward to Lake Superior along the foot of a steep diabase-sediment scarp.

General Geology

The rocks of the area have been divided by Tanton into two main groups: an older pre-Cambrian group, consisting of a schistose complex derived partly from sedimentary rocks, and intrusive granites and granite gneiss; and a younger



Falls on Wolf river, lot 3, concessions V and VI, Stirling township.

group of Animikie and Keweenawan age consisting of conglomerate, sandstones, sandy shales, dolomites, and some iron formation and intruded by extensive dikes and sills of diabase, which have been known generally as the Logan sills.

The following is a generalized table of formations:—

LATE PRE-CAMBRIAN	
KEWEENAWAN:	Dikes and sills of diabase and related rocks. Nipigon sediments (Sibley): Conglomerate, sandstone, sandy shales, red dolomites, and cherty to sandy dolomites.
ANIMIKIE:	Conglomerate, iron formation, shale, greywacké (in part tuffaceous).
	Great unconformity
EARLY PRE-CAMBRIAN:	Batholithic intrusions: Granite and granite gneiss and pegmatite. Micaceous schist complex: Greywacké, conglomerate, altered lavas, iron formation.

SCHIST COMPLEX

In the southwestern portion of Dorion township, south of the Ogema mine, are remnants of dark-green to brown and grey schists, which strike N. 80° E. and dip nearly vertically, and have a width of two miles. The schists are clearly

derived from finely bedded clastic sediments and are identical in appearance with the southern series of sediments in the Sapawe Lake area. At the Ogema mine a mineralized fault zone occurs in these schists where they are intruded by pegmatite dikes. The rocks here are composed chiefly of quartz, feldspar, and biotite. The bedding, like the schistosity, dips steeply, and so much recrystallization has occurred that no attempt was made to unravel their structure.

Similar sedimentary rocks occur near Loon lake, McTavish township; these rocks have been mapped by Silver. In that area and to the west, the series are described as consisting largely of greywacké and conglomerate, the latter containing pebbles of quartz porphyry and jaspilite. Tanton[1] reports also the occurrence of altered lavas, pyroclastics, amphibolite, and iron formation within this schistose complex.

Near Ozone Siding along the shore of Kama bay, small inclusions of mica schists occur in the granite, which has there a distinct gneissic foliation. It seems probable that these schists are of the same type as those described above, but here the rocks are now mainly igneous.

The schistose sediments are intruded by granite and granite gneiss and by a few pegmatite dikes and are in part overlain by later diabase sills.

The major part of this schistose complex has been placed by Silver[2] as Lower Huronian in age or at least as post-Keewatin and pre-Algoman. Tanton has recently suggested that they are of Coutchiching age or pre-Keewatin, since they correspond in strike and dip, in degree of metamorphism, and in lithology to sediments west of Port Arthur to which he assigned a similar age. The present writer agrees that the two series are probably the same. It has been suggested elsewhere by the writer that the western series are post-Keewatin. The occurrence of porphyry, trachite, and jaspilite pebbles in the conglomerates of the eastern series suggested to Silver their post-Keewatin or Huronian age. They were not studied in detail by the writer.

GRANITE AND GRANITE GNEISS

Granite and granite gneiss are widely distributed in the northern and western parts of McTavish township, in the western, central, and northwestern portions of Dorion, and also in the central part of the Ozone Siding area. In the main it is a reddish biotite granite. It has been described by Silver[3] in some detail:—

> It really varies from pegmatite, containing tourmaline and muscovite on the one hand, through syenite to granodiorite on the other, and to the north even shades into what might be called true diorite.
>
> The more acidic sorts . . . contain a great deal of micropegmatite, quartz, and microcline, some plagioclase, and abundant garnet individuals. . . . In some of the granite dikes which cut the greywacké, hypersthene is abundant.

Associated with a pegmatite dike in McTavish township, north of Loon lake, is some molybdenite. Elsewhere, in fractures in the granite and pegmatite, galena, sphalerite, chalcopyrite, pyrite, barite, and quartz have been deposited. The fractures and vein fillings, however, are much later in age than the granite.

ANIMIKIE

The Animikie (or Upper Huronian) was studied in some detail by Silver,[4] and later by Tanton.[5] It contains flat-lying conglomerate, iron formation,

[1] T. L. Tanton, op., cit. p. 2.
[2] L. P. Silver, op. cit., p. 161.
[3] Ibid.
[4] Ibid., p. 168.
[5] T. L. Tanton, op. cit., p. 7.

impure limestones, black shale or slate, and greywacké, and is in part tuffaceous. Two horizons of iron formation are described by Silver. These consist of siliceous or cherty iron carbonate and hematite. They are similar to other Huronian iron formations and are exposed in the southern part of McTavish township.

Near Loon lake the iron formation has been extensively prospected. Locally, near fault planes, it is reported as concentrated to ores by the alteration of iron carbonates to hematite or limonite. Details regarding this series and the iron formation may be found in reports by Silver, E. Lindeman and L. L. Bolton,[1] and in the report of the Ontario Iron Ore Committee, 1923.[2]

The Animikie overlies older schistose sediments and granite and is overlain by Keweenawan sediments and diabase sills. The Keweenawan basal conglomerates locally contain fragments of the Animikie iron formation and are believed by Silver and others to be unconformably above the Animikie. Tanton[3] has found the Animikie and Keweenawan sediments in contact where no unconformity can be distinguished and groups both the Animikie and overlying Sibley and Osler sediments under the term Kaministikwia. He seems of the opinion that there was here no great time interval between the deposition of the upper Animikie and the lower Keweenawan. Elsewhere, however, in Michigan and other areas, unconformities at this horizon have been noted by Leith.[4]

KEWEENAWAN

Nipigon Sediments

The sedimentary rocks of Keweenawan age cover wide areas in Dorion and McTavish townships. They consist for the most part of flat-lying conglomerate, sandstone, and shaly to arenaceous dolomites, the dolomites being locally replaced by chert. These rocks are as much as 100 feet thick in places, but over most of the area, except where capped and protected by diabase sills, they have been largely removed by erosion. The sediments are known collectively as the Nipigon series. They have recently been subdivided by T. L. Tanton and renamed. Most of those exposed in the area covered by this report fall in Tanton's "Sibley" group. These are elsewhere overlain by the Osler series of sandstone and tuff. The sediments lie unconformably on top of all the older formations in this area, and are intruded by a few dikes and overlain by many thick sills of diabase. Within these rocks are found most of the lead and zinc deposits, which occur in brecciated fault zones.

The sandstones are red to buff or light-grey in colour. In Dorion township, lot 13, concession VII, is a prominent terrace and small escarpment in these rocks, which overlie granite. These may be utilized for building stone. In Stirling township, lot 2, concession VI, there is an old quarry from which sandstone was taken for building in Port Arthur. The stone is largely of rounded quartz grains in a quartzose and calcareous cement.

The calcareous sediments overlie the sandstones and vary greatly in composition. They are grey to red in colour. Some are largely of dolomite, as determined by X-ray analysis. Others may be of limestone. Many are somewhat replaced by grey to brown chert. Red dolomites were found containing small particles of carbon or carbonaceous matter around which the ferric oxide colouring has been reduced, resulting in paler buff spherical zones around

[1] Iron Ore Occurrences in Canada, Mines Branch, Dept. Mines, Can., Vol. II, 1917.
[2] Ont. Dept. Mines, pp. 181-82.
[3] T. L. Tanton, Geol. Soc. Am., Vol. 38, 1927, p. 739.
[4] C. K. Leith, Geol. Soc. Am., Vol. 38, 1927, p. 748.

a black centre. In many of these the reducing agent has entirely disappeared. Toward the top of the series the calcareous sediments become distinctly shaly.

It has been noted by others[1] that the lead and zinc deposits of the area where they occur in the Nipigon sediments are richer in the dolomites than in the sandstones or granite below. This is characteristic of other lead and zinc deposits in North America. It is unfortunate that this horizon has been largely eroded from many of the vein occurrences.

Typical gorge cut through the diabase sill and underlying Nipigon sediments, Dorion township.

Diabase Dikes and Sills

Diabase dikes and sills form the most prominent topographic features in the areas under discussion. In Dorion township they cover approximately 10 square miles. In McTavish township they are confined to the southern part and are of smaller distribution. In the Ozone Siding area they are again prominent, but only portions of sills there have been mapped. In a few localities in central Dorion and in the Ozone Siding area two or more sills have been found interlayered with Nipigon sediments. Large dikes of diabase occur in the northwestern part of Dorion township, on lot 14, concession XII, and in the southwestern part near Clegge lake, on lot 2, concession XII. At Cavern lake it is possible that the sill lying to the northeast and southwest is connected with a dike cutting the granite. The contacts here are obscured by heavy talus, and the diabase lying at lake level may be down-faulted. Smaller dikes of

[1]W. L. Uglow, Ont. Bur. Mines, Vol. XXV, pt. 2, 1916, p. 35 (Enterprise Mine).

diabase have been found in McTavish township; and at the Caribou mine, fractures in these dikes contain deposits of lead and zinc.

No detailed examination of the sills and dikes has been made by the writer. Thin sections of a few specimens have the composition of gabbro and a highly ophitic texture. Silver[1] reports that they vary from diabase (usually augite diorites) to gabbro and norite. All are dark-brown-weathering and of fine to medium grained crystals. The sills show a characteristic columnar jointing and everywhere are clearly intrusive.

Economic Geology

Deposits of economic interest in the area include building stone, iron, and lead and zinc. The building stone is chiefly sandstone in Dorion and Stirling townships and is at least of sufficient distribution to satisfy local demands.

Diabase sill, north arm of Cavern lake, Dorion township.

Deposits of low-grade iron ore occur in the southern part of McTavish township, where they have been thoroughly examined. These were not re-examined. No large high-grade deposits have been found.

The lead and zinc deposits are widespread. They all occur in fractured and faulted rocks, chiefly diabase, Nipigon sediments, mica schist, and granite. The ore minerals, galena and sphalerite, occur both in simple veins in fractures and as a part of the cementing material in brecciated fault zones. They have a characteristic mineral association: white to amethystine quartz, barite and calcite, and minor quantities of iron and copper sulphides. Near Silver lake, McTavish township, and locally elsewhere the veins are largely of calcite with small quantities of quartz and barite. In the others quartz predominates. At one locality, in the Ogema mine, fluorite is present. The values, however, are not co-extensive with the faults and fault breccias and vary greatly in the percentage of lead and zinc, both horizontally and vertically. The richer deposits of galena, so far as they have been explored by underground workings, occur near the surface, though at the Ogema mine a good width of zinc ore with lead coming in is reported at a depth of about 200 feet. It has been noted by

[1]L. P. Silver, op. cit., p. 171.

others[1] that galena occurs more prominently in the calcareous sediments of the Nipigon series than in the sandstones below. There is no evidence that the surface galena-rich zones are due to secondary enrichment, since they occur in quartz-calcite-barite gangue as do the deeper deposits. It is more probable that the concentration is due either to the nature of the wall rock or to a former level of the ground water at the time the sulphides were brought into the veins.

Mining has been carried on in Dorion township at the Dorion, Bishop, and Ogema properties. Shafts have been sunk at the Enterprise, Caribou, Arctic, Wright, and Silver lake properties in McTavish township. North of Dorion, in unsurveyed territory, the Thunder Bay Lead and Zinc Company have recently sunk a shaft on the continuation of the Dorion fault zone. Three mineralized zones have been explored on the surface in the Ozone Siding area, and one shaft has been sunk 50 feet. While small lots of ore have been shipped from a few of the older mines, no active exploration nor development work was in progress in the summer of 1928, and no commercial ore bodies of any size have yet been discovered.

The origin of the deposits has an important bearing on possibilities of finding ore bodies of economic value. The size and the horizontal and vertical extent of the fault zones in which the deposits occur is also a factor, as is the nature of the country rock. Many of the deposits occur in or near fault zones, which can be traced from three-quarters of a mile to several miles. At the Dorion mine the vertical component of the displacement, where measurable, is 100 feet; at Silver lake, it is reported as 400 feet. Other smaller breaks having a displacement of only a few feet are also known. The depth to which the larger faults extend is probably very great, while the smaller ones are likely shallow. In several cases where the faults have penetrated the widespread granite floor, on which most of the Nipigon sediments rest, the fractures decrease in size and number and the values on the whole are low. Within the overlying sediments the richer zones, as noted, occur in the upper calcareous or dolomitic horizons. Deposits in diabase, while locally rich, are of small extent. The origin of the deposits and its significance are discussed below.

Origin of the Lead and Zinc

W. L. Uglow[2] has made probably the most careful study of the origin of these and other similar deposits in Ontario. He points out that elsewhere similar faulting and ore deposition occurred in fractures cutting rocks as late as early Ordovician. In this particular area, no consolidated rocks younger than Keweenawan are present; hence it cannot be proved that, though the deposits occur in pre-Cambrian rocks, they are not of Ordovician age. Uglow has classified the Dorion-McTavish deposits as the low-temperature type, more or less independent of igneous after-action. Their general non-argentiferous nature, their great similarity to other better known deposits of this origin, and the general absence of any hydrothermal alteration in the wall rocks are all suggestive. The lead and zinc sulphides, along with the gangue minerals calcite, barite, and quartz, are believed to be derived from the adjacent sedimentary (Nipigon here) rocks by circulating surface (meteoric) waters. Where fluorite is present, it is thought to have been contributed by igneous emanations or hot ascending solutions from the deeper portions of the fracture zones. Where the deposits occur in granite or in the mica schist complex, it should be remembered that these were formerly overlain by the Nipigon sediments.

[1] W. L. Uglow, op. cit.
[2] Ibid, pp. 40-41.

Former reports on this area indicate that locally both gold and silver have been found with the lead and zinc ores. Silver has been reported at Lebel's showing northwest of Dorion township, at the Enterprise mine in McTavish township, and at Silver island in Silver lake. Gold has been reported at the Ogema and Enterprise mines. The manner in which the silver and gold occurred is not known, and no conclusion can be drawn as to the significance of their occurrence. Recent assays have all failed to show any trace of silver in any of the lead ores, and taking the deposits as a whole they are considered to be a non-argentiferous type.

The local occurrence of fluorite in the Ogema deposits may signify hot-water origin, as Uglow suggests; but even here no marked hydrothermal alteration has taken place, even in the pegmatite dikes in which some galena and sphalerite occur along with fluorite in fractures. Elsewhere the ores occur in rocks much younger than the pegmatite, so it is not possible that the ores and pegmatites have any genetic relation.

Were the deposits of high-temperature origin, distinct wall-rock alteration would be expected, particularly in the veins occurring in the granite. No sericitization of granite has been noted in any of the deposits.

In view of the above facts, the writer favours Uglow's hypothesis, that the lead and zinc are largely concentrations by meteoric waters in fracture zones, and derived from nearby or adjacent sedimentary rocks. In order to check this possible derivation of lead and zinc, samples were collected of the calcareous and sandy members of the Nipigon sediments, as well as from a diabase sill in McTavish township, and the following assays were made:—

Sample of Red Dolomite from C.N.R. Cut, South of Pearl:

	Per cent.
Lime	13.29
Magnesia	9.77
Carbon dioxide	17.52
Lead	none
Zinc	trace

Sample of Sandstone across 15 Feet, 6 Chains Southeast of Silver Lake:

	Per cent.
Lead	none
Zinc	trace

Sample of Diabase Dike across 13 Feet:

	Per cent.
Lead	none
Zinc	trace
Copper	0.02

The fluorite, where it occurs, and possibly the silver and gold reported may have had a more direct magmatic origin, but all three are of rare occurrence and do not negative the theory advanced for the formation of the lead and zinc sulphides.

Inferences drawn by Uglow,[1] as to the nature of the ore deposits under his theory of origin, are as follows:—

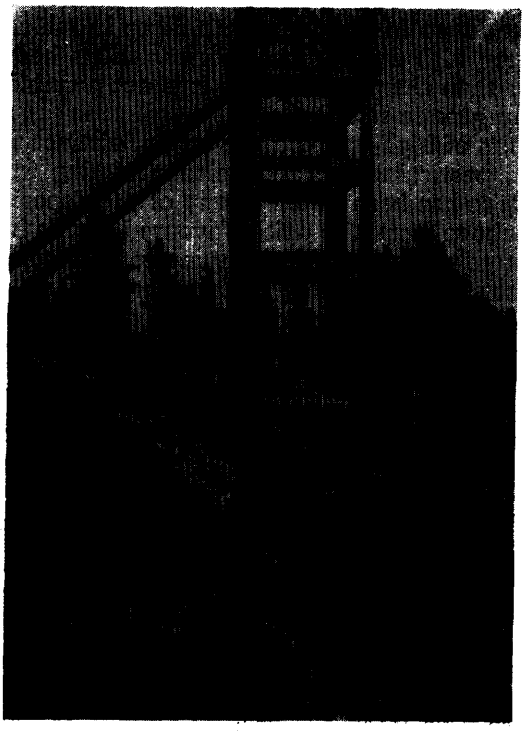
> If this hypothesis be correct, it is probable that the veins will show considerable vertical extent. Of course it is not suggested that the mineralization would extend to the bottom limits of the fracture zones, nor that it would be constant. On the other hand, there is every reason to believe that the mineral composition of the veins would vary considerably in depth.

Recent exploratory work shows the inferences, on the whole, to be correct.

[1]W. L. Uglow, op. cit., p. 41.

Summary

The known lead and zinc deposits are confined entirely to faults and fractures of at least post-diabase (Keweenawan) age. The greater the faulting is, the deeper the deposits may extend, but the ores probably do not continue to the very base of the fractures. Where vertical displacements of approximately 100 feet or less have occurred, the deeper-seated mineral, fluorite, is not found. The depth of the fractures and the occurrence of fluorite, and possibly gold and silver, may be related. In most cases the displacements along the faults are



Shaft of the Dorion mine, situated on a fault, the scarp of which is visible, with granite on the left.

probably not much more than 100 feet. The richest showings of lead ore occur near the surface and do not appear to be secondarily enriched zones. Lead ores are more common in the fractures in the upper calcareous sediments of the Nipigon series, and further prospecting over the areas where these have not been removed by erosion or intrusions of diabase may reveal richer deposits at this higher level. The sediments at the base of the diabase sills are usually of this type. In most instances where the fault zones are found in granite, they narrow considerably and values are not high. From lateral variation in values of the surface showings it is probable, as stated by Uglow, that the composition of the veins will vary as much at depth. This makes the mining of such deposits more speculative, and more exploratory work will be required to prove adequate deposits than would otherwise be the case.

Descriptions of Mines and Prospects

DORION TOWNSHIP AND UNSURVEYED TERRITORY

Dorion Lead and Zinc Mining Company.—This group of claims, T.B. 7,329, 5,807, 5,808, 6,032, 6,246, 6,247, 7,146, was staked in the winter of 1927-28 by Captain Nobel. They include location 7 L (T.B. 5,807 and 6,246) on which

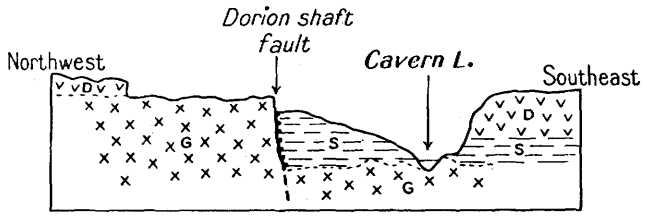


Fig. 2—Cross-section showing structure in the vicinity of the Dorion mine. Horizontal scale, 30 chains to the inch; vertical scale, 300 feet to the inch. D = Diabase. S = Sediments (sandstone and dolomite). G = Granite.

the old Dorion mine is located. Crossing these claims from Cavern lake and continuing northeast at least to Wolf lake is a mineralized fault zone in which some galena and sphalerite occur with quartz and barite. The fault zone strikes approximately N. 60° E. and dips 70° S. It is of the normal type. On the north is red biotite granite and pegmatite; on the south or downthrown side are

Fault breccia with quartz cement, Dorion mine. Note the rounded shape of some of the fragments and the still unfilled open spaces.

red to grey Keweenawan dolomites and sandstones. The width of the fault zone proper varies from 10 to 40 feet. The vertical displacement is approximately 100 feet, measured from the top of the granite on the north to the base of the sediments on the south. The underlying granite is exposed in the bottom of the shaft and along the shores of Cavern lake (Figs. 2 and 3).

The fault zone consists of both coarse breccia and fine gouge and numerous fractures in both the granite and the sediments. The breccia has a striking appearance and contains chiefly rounded rather than angular fragments partly cemented with coarsely crystalline white and amethystine quartz and locally some barite. The fragments are of granite, red and grey dolomite, brown chert, grey chert breccia, and sandstone. They show little alteration. In a few places the granite is much weathered, and the feldspars are kaolinized, indicating meteoric, cold-water alteration. Associated with the quartz in the breccia are rounded fragments of light-brown to yellow sphalerite, but elsewhere this is deposited as an incrustation, from a quarter to a half inch thick, around granite blocks or in fractures in the rock on either side of the fault. The sphaler-

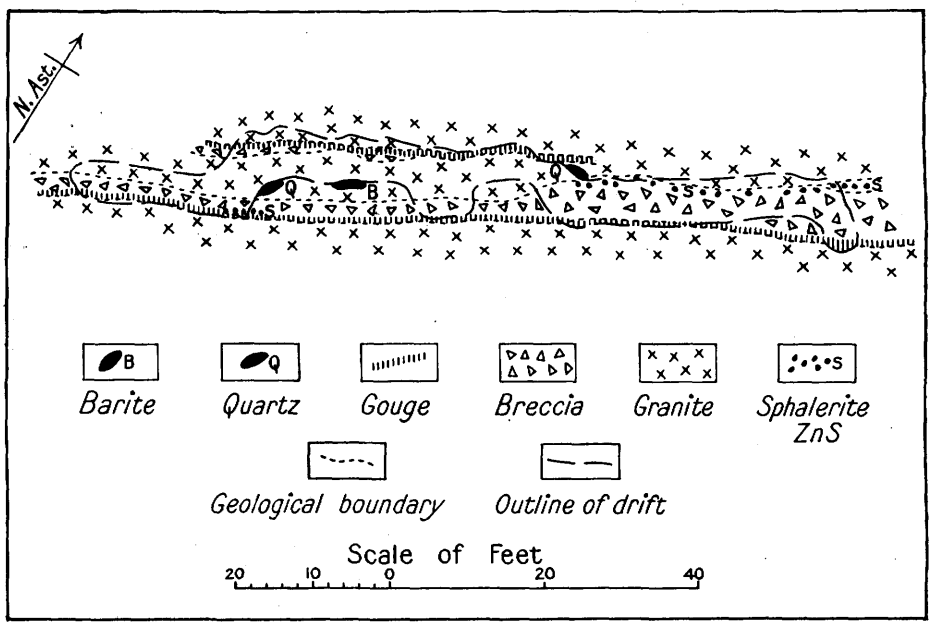


Fig. 3—Plan of drift at 90-foot level, Dorion mine.

ite is in many places associated with a secondary grey to brown chert. The rounded nature of the breccia fragments seem clearly due to replacement by quartz, which encrusts each fragment.

At the surface, the fault zone has been opened up by many test pits and shallow shafts. Local rich portions consist largely of vein material with either galena or sphalerite predominating as the sulphide. Twenty feet to the west of the shaft a 3-foot band of breccia and quartz contains abundant galena in crystals about a quarter of an inch in diameter, or finer. A sample across 26 inches gave 4.88 per cent. lead and no zinc or silver. Another sample across 4 feet in the first pit east of the shaft gave 11.48 per cent. lead, 0.6 per cent. zinc, and no silver. A grab sample of lead ore from the dump at the shaft gave about 35 per cent. lead.

Within the shaft (Fig. 3), the mineralization decreases downward; and at the bottom, 95 feet, only a scant mineralization of sphalerite is found along the 2½-foot zone on the footwall. Above, no good widths of ore were observed in the shaft.

On claim T.B. 5,808, a tunnel was driven west 210 feet to encounter the fault zone, and an 85-foot drift was run southwest along the brecciated zone (Fig. 4). The fault here is partly cemented by quartz, and stringers of quartz and barite penetrate it. In the vugs between fragments are beautiful geodes of amethystine quartz. The mineralization is chiefly sphalerite, but a little galena and chalcopyrite occur in the quartz and barite. On the footwall a well-defined vein occurs, varying from 4 inches to 1½ feet in width, the lower part of which contains a few brecciated fragments. In this, the order of deposition from the walls inward was galena-quartz, quartz-barite, and amethystine quartz in the centre. No good widths of either lead or zinc ore were encountered in the drift.

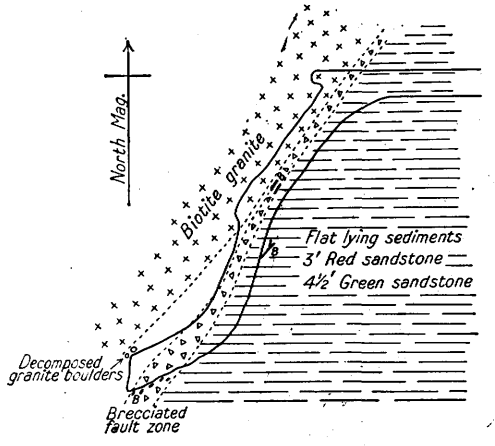


Fig. 4—Plan of tunnel and drift, claim T.B. 5,808, near Dorion mine. Scale, 40 feet to the inch. Sulphides, principally sphalerite, occur with amethystine quartz cementing the fault breccia. Barite (B) occurs as small stringers within the breccia.

Bishop (Claims 5 and 6 L).—Northeast of the shaft of the Dorion mine and along the same fault zone on the old location 6 L, a pit and trench expose brecciated chert and sandstone. In the pit a 1½-foot width of breccia is cemented with quartz and is fairly well mineralized with very light-coloured sphalerite, ite. In the centre of an 18- to 22-inch vein of reddish barite with one or two dolomite and reddish sandstone with fine stringers of quartz and a little sphalerite. In the centre is an 18- to 22-inch vein of reddish barite with one to two feet of calcite on either wall. On location 5 L the old Bishop shaft was sunk about 100 feet on the faulted contact between the granite on the northwest and sediments on the southeast. The brecciated zone here is over 6 feet wide, and the cement is almost entirely white, coarsely crystalline calcite with a few specks of chalcopyrite and galena.

Thunder Bay Lead and Zinc Company (Claims T.B. 6,683-90).—These claims lie along the northeasterly extension of the Dorion mine fault zone. A shaft was sunk 50 feet by this company on claim No. 6,686, and a crosscut was run 25 feet northwest to the granite contact.

On the surface the fault zone is approximately 20 feet wide and has been traced 205 feet to the southwest of the shaft and 200 feet northeast. Biotite granite lies 50 feet northwest of the shaft, and in the sediments on the south

are two bands of breccia which show minor displacements in the sediments themselves, grey cherty dolomite being downfaulted against brown sandstone. The breccia near the granite consists largely of sandstone fragments, and that near the cherty dolomite is mostly chert. The cement in the breccia is chiefly quartz, and fine stringers of quartz fill fractures in the sandstone and contain fine specks of galena, sphalerite, or chalcopyrite. At 110 feet southwest of the shaft, a 12- to 14-inch barite vein lies between a chert breccia and grey cherty dolomite and carries a little galena. Locally there are small 2-inch lenses of almost solid galena between the sandstone and chert.

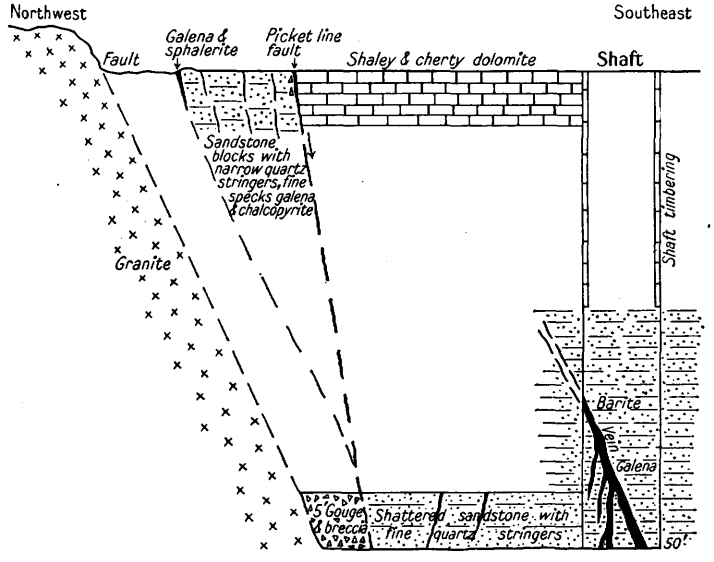


Fig. 5—Vertical section of the Thunder Bay Lead and Zinc Company's shaft and crosscut. Scale, 20 feet to the inch.

In the shaft the principal mineralization occurs in a well-defined barite vein (Fig. 5) which contains fine chalcopyrite and a little galena. The main breccia zone is not mineralized.

This fault zone is reported to have been traced northeast across the Wolf river into the Ferguson property, Stirling township.

E. Lebel (Claims T.B. 3,358 and 3,461).—T. L. Tanton[1] has given a complete account of this property. The claims lie in unsurveyed territory north of concession XII of Dorion township. "The claims are underlain by fine-grained, interbanded mica schist and gneiss, trending N. 65° E., and cut by numerous large and small dikes of granite and pegmatite." The mineralized zone is found on a low ridge surrounded by drift. It trends N. 35° E. and can be traced for 5 chains. "Blocks of mineralized material can be seen in the drift along the trend of the vein for a distance of 18 chains." Two pits have been sunk, one in granite and one in biotite schist. In the former is a 3-inch vein in which massive galena occurs with sphalerite and traces of chalcopyrite. It is reported as 13 inches wide at a depth of 20 feet. The vein in the schist includes numerous

[1]T. L. Tanton, Geol. Surv. Can., Sum. Rept., 1919, pt. E, pp. 4, 5.

veinlets within 12 inches. It carries chalcopyrite, galena, and sphalerite in a calcite-barite gangue.

The Quebec government assay office reported the following values in material taken across the simple vein where its width was 10 inches: silver, 1.05 ounces per ton; lead, 34.22 per cent; zinc, 21.23 per cent. An average sample of the mineralized material would show less lead and more zinc.

Claims T.B. 6,858, 6,859, 7,223, 7,224.—These claims, in lot 12, concession VI, are held by C. E. Anderson. Two veins were examined on claim No. 6,858 near the lower contact of a high diabase sill and Nipigon sandstones. They strike about N. 70° E. and dip 80° N.W. The sediments here strike at about N. 165° E. and dip 45° N.E. and apparently have been arched and possibly faulted by the intrusion of the diabase sill. The veins consist of a much fractured and brecciated zone in the grey sandstone (Fig. 6). One is 4 feet wide and is mineralized over 1 foot with galena and sphalerite. This may be traced northeast 140 feet to a point where it narrows and breaks up into numerous quartz stringers and one larger vein, averaging 3 inches in width of solid sphalerite.

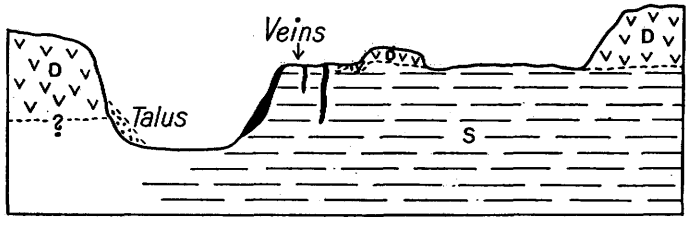


Fig. 6—Cross-section illustrating vein occurrence on the Anderson property, lot 12, concession VI, Dorion township. D = Diabase. S = Nipigon sediments. Scale, 60 feet to the inch.

Another 2-foot quartz vein occurs 20 feet away, parallel to the first, and is exposed on the west side of a sharp gully. It has an exposed length of only 10 feet but is heavily mineralized with galena and sphalerite (Fig. 6). Barite and some calcite are associated with the sulphides, and calcite-galena stringers may be found in fractures in red to greenish altered tongues of diabase which intrude the sediments. A grab sample of rich lead ore on assay gave 41 per cent. lead and no silver. Another vein is reported to the east of these, across a deep gorge cut through the diabase and Nipigon sediments.

Lots 9 and 10, Concession VII.—On this location, to the south of the high diabase sill in the central part of the township, a fault breccia zone occurs in reddish sandstones and strikes N. 50° E. The breccia now exposed lies largely along the side of a small bluff on the west side of a creek draining the lake on the east half of lot 9, concession VII. It was traced for 20 chains southwest to the lake, into which it strikes. Old pits have been opened in several places on the breccia, which ranges from 3 to 7 feet wide. At the north end diabase overlies the Nipigon sediments 5 feet to the west. At the southwest end diabase is adjacent to the breccia on the west.

The rock fragments in the breccia include sandstone, chert, dolomite, and diabase. These are cemented largely with white to amethystine quartz and are well mineralized with galena. A 10-foot pit at the lake contains a 16-inch barite vein in the breccia, which also carries abundant galena. A sample of galena ore on assay gave 62 per cent. lead and no silver. Other veins have been reported in this same locality and are shown on a map compiled by T. L. Tanton.[1]

[1]T. L. Tanton, op. cit., p. 5.

Ogema Mine

The Ogema mine is situated in the southwestern part of Dorion township on claim T.B. 4,447. The deposit was discovered by an Indian and first worked in 1890 by James Dickenson.[1]

> A tunnel driven 125 feet into the base of the hill reached the vein, and at the end of the tunnel a shaft was sunk to a depth of 25 feet on the vein. At the bottom of the shaft the vein was 5 feet wide and carried abundant galena with low silver values and finely crystalline pyrite. . . . The property was sold in 1892 to the Ogema Mining and Smelting Company, who put down a 40-foot shaft on the vein near the top of the hill, about 300 feet above and 800 feet to the northeast of the older workings. This part of the vein carried pyrite and very small quantities of galena and sphalerite.

A small quantity of gold was recovered from rock treated on the property. The mine was closed in 1892.

View of the Ogema shaft and hoist-house, Dorion township, showing the high granite ridge on the north (right).

Within recent years the Ogema property has been acquired by the North American Metals Corporation, and further development work was completed in 1927. D. C. Kemerer was manager. The new workings are apparently at the location of the first shaft mentioned above. They consist of a 133-foot tunnel and a shaft 196 feet deep, inclined steeply to the south. Drifts have been driven on the 125-foot level, 35 feet to the southwest and 33 feet to the northeast. At the bottom of the shaft a crosscut was made 90 feet northwest, and drifts to the east and west were begun.

The mine is located on a fault zone in a series of biotite schists of sedimentary origin, which are intruded by many small pegmatite dikes. To the south the biotite schists pass gradually into a series of slightly less schistose, finely bedded clastic sediments, which are standing practically on edge. To the north of the mine, 300 feet, rises a high ridge of red biotite granite and granite gneiss which is intrusive into the biotite schists and is cut by more pegmatite dikes. The faulting is clearly post-pegmatite in age and, like the others in this area, is probably post-Keweenawan.

The faulting here is indicated only by the coarse breccia cemented with vein quartz in which the lead and zinc occur. Since both walls are in schist it is

[1]T. L. Tanton, op. cit., p. 6.

not possible to determine the displacement. The breccia contains chiefly angular fragments of dark biotite schist, green chloritic schist or greywacké, and a few fragments of pegmatite. This is cemented with vein quartz, locally amethystine, and barite, and contains galena, light resinous sphalerite, dark sphalerite or blackjack, pyrite, chalcopyrite, and fluorite. Well-defined narrow quartz veins cut or lie alongside of the breccia and are mineralized locally. The width of the breccia zone ranges from about 2 feet to 10 feet. It may be traced for 12 chains southwest of the shaft to a point where it is mineralized with either fine galena or sphalerite. Mr. Kemerer reports finding the zone

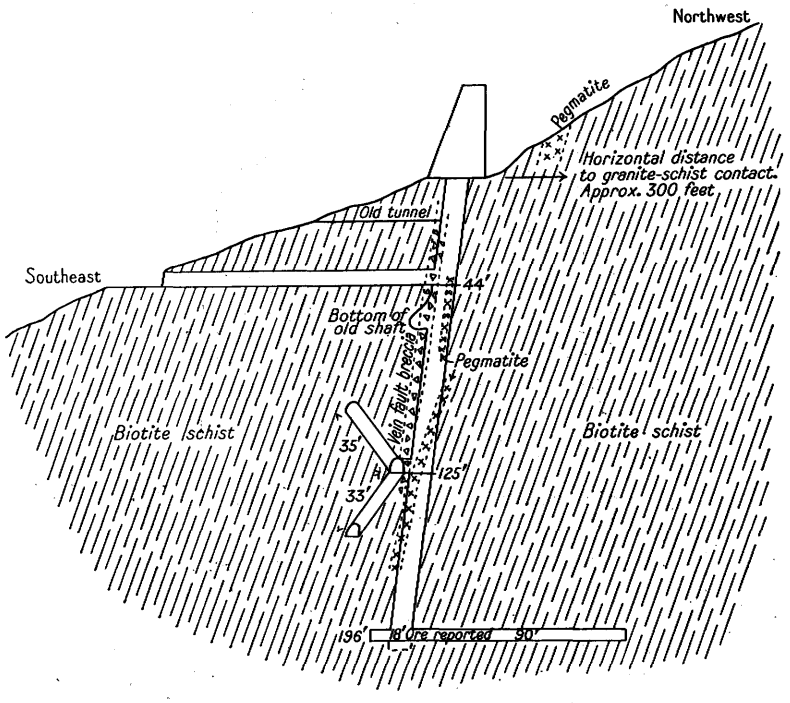


Fig. 7—Vertical section of Ogema shaft in a plane striking N. 130° E. Scale, 80 feet to the inch.

1,000 feet southwest of the shaft, where it is 5 feet wide and mineralized with zinc. Three chains northeast of the shaft are large blocks of breccia, 9 feet wide, containing large fragments of green and grey biotite schist which are cemented with quartz and barite, and heavily mineralized with galena over a width of 2 feet. About 1,800 feet to the northeast, a fractured zone, containing amethystine quartz, lies 250 feet north of the contact of the granite and schist, more or less along the strike of the fault. This may be branch or parallel break. There is an old shaft on this zone, which apparently contains no sulphides. Near Goodmorning lakes, Mr. Kemerer reports a 5-foot breccia zone carrying about 10 per cent. lead. It is possible that the fault continues eastward, but east of Goodmorning lakes a diabase sill covers the schists. On claim T.B. 6,006, a 50-foot breccia zone is reported along this strike.

On the 44-foot level in the mine a drift was run 32 feet southwest. At this point, a 9-foot width of brecciated schist is cemented with vein quartz

and cut by a 1-foot vein of quartz in the centre. This carries small lenses of galena. A sample taken across 4 feet on assay gave 4.88 per cent. lead, 0.3 per cent. zinc, and no silver. On the north wall of the drift near the shaft the same zone carries principally sphalerite. In the shaft a 1-foot pegmatite dike dips 75° S. at this level. At the bottom of the old shaft, 60 feet down, a 3½-foot rusty breccia zone is cemented largely with quartz and carries fine specks of galena and chalcopyrite. This zone narrows and is less well defined as it passes down into the pegmatite dike, where it is represented only by fractures. Fig. 7 shows the geology of the shaft. At the 125-foot level another pegmatite dike cuts up through the biotite schist and widens eastward from 1½ to 8 feet (Fig. 8). In the east drift an 8-foot width is exposed on the face. The pegmatite contains quartz, feldspar, and muscovite and is much fractured.

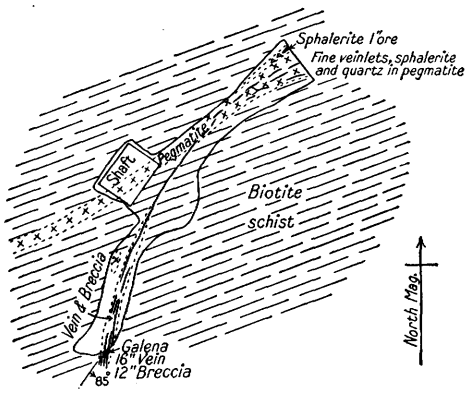


Fig. 8—Plan of workings on the 125-foot level, Ogema mine. Scale, 40 feet to the inch.

In the fractures have been deposited thin seams of sphalerite with quartz and some fluorite. The fluorite, which cuts the sphalerite, appears to be of slightly later origin. To the north of the dike a 1-foot breccia zone in the biotite schist is well mineralized with sphalerite. In the west drift a 30-inch vein occurs along the south side, striking N. 45° E. and dipping 85° S. On the footwall side 16 inches of the vein is heavily mineralized with galena. Below this is a 1-foot breccia zone cemented with quartz. The schists on either side are penetrated by stringers of quartz and calcite, which are barren. A sample across 30 inches gave 9.24 per cent. lead and a trace of zinc. The faulting or fracturing at this level has clearly varied in the schist and pegmatite, the main fracture being less well defined in the pegmatite than it is in the schist, in which the vein and breccia occur.

To the 160-foot level no ore is exposed in the shaft, but the pegmatite dike dips out of the shaft on the south. It is below this dike, at the foot of the shaft, that an ore zone, 18 feet 9 inches wide, running 10 per cent. combined lead and zinc, has been reported. This was under water at the time of the writer's visit.

It is to be noted that the main vein and breccia followed in the southwest workings strikes more south than the westward extension of the breccia zone on the surface. It seems probable that this is a branch vein and that drifting along the strike of the surface exposures will encounter another brecciated zone which is not visible in the shaft at the 44-foot level. The surveying of the mine workings should be checked and correlated with the surface data.

Specimens from the mine show an interesting sequence in the deposition of ore and gangue minerals. Sphalerite, both light and dark varieties, and galena occur in quartz or in silicified brecciated fragments. In the vugs in quartz veins, perfect cubes of fluorite are deposited on or intergrown with amethystine quartz, and on galena. Deposited on the fluorite cubes are later crystals of chalcopyrite and pyrite. Galena and sphalerite appear more or less contemporaneous. Fluorite and iron and copper sulphide appear to be slightly later in origin. Fluorite has also been deposited in small fractures in the pegmatite dike on the 125-foot level. While fluorine is associated with some pegmatite intrusions, it is not known to be genetically related to the pegmatites in this instance. Its presence is generally taken as an indication of hot, magmatic vapours or waters. It is clearly later than the lead and zinc; and if it came from a deep-seated source, the lead and zinc minerals may not necessarily have had the same origin. Uglow, as noted above, is of the opinion that the lead and zinc were mainly concentrated by meteoric waters. These locally may have been intermingled with hotter juvenile waters from below, which would bring about a redistribution, to some depth, of the ore minerals and their admixture with fluorite. The general absence of hydrothermal alteration, the vuggy nature of the vein deposits, and their general similarity to proven meteoric deposits favour this theory. The part played by hot waters must of necessity have been small.

A mile to the south of the Ogema fault zone, D. Kemerer reports a parallel zone, in which there is considerable galena as indicated by float. It is not probable that these two zones are connected at mineable depths, since their dip is usually over 70 degrees.

STIRLING TOWNSHIP

Lot 4, Concession VI.—T. L. Tanton[1] made the following notes regarding this lot:—

> Four well-defined brecciated zones, from 2 feet to 8 feet wide, and spaced at intervals of about 20 feet, trend parallel to each other N. 55° E. The Nipigon sandstone, which here forms a thin layer over the granite, has been step-faulted down on the southeastward, the total dislocation being about 5 feet. The brecciated zones are cemented with gash veins and vein stockworks composed of quartz and amethyst, carrying small specks of chalcopyrite. Nothing of economic interest is exposed in this locality.

The zones may be traced for about 400 feet. At the east end a small amount of galena and sphalerite occurs with the quartz.

Lot 2, Concession VI.—On the west side of the Wolf river, just below the falls, is the abandoned quarry from which sandstone was quarried for buildings in Port Arthur. The stone is well cemented with quartz and calcite, is buff to white in colour, and is exposed in a bluff 18 feet high. The upper layers are flat-lying, while those at the base dip 7° S., which appears to be an original dip or cross-bedding on a large scale. Near the top the sandstone is well jointed in blocks averaging 8 inches across; below it is more massive and in beds from 3 to 4 feet thick. To the west the deposit is overlain by a high ridge of glacial till.

McTAVISH TOWNSHIP

Caribou Mine.[2]—The old Caribou mine is located on lots 5 and 7 and can be reached from Ancliff section-house on the Canadian National railway by a

[1] T. L. Tanton, op. cit., p. 5.
[2] Notes by J. E. Thomson, field assistant.

wagon road, 1½ miles in length. Galena-bearing veins were discovered in this vicinity in 1863 and 1865.[1] The vein occurs at the contact of a dike of diabase and flat-lying Nipigon (dolomitic) sediments which rest upon granite. The diabase dike strikes E. 15° S. and cuts both granite and sediments. It ranges from 12 to 15 feet in width and can be traced across two outcrops with

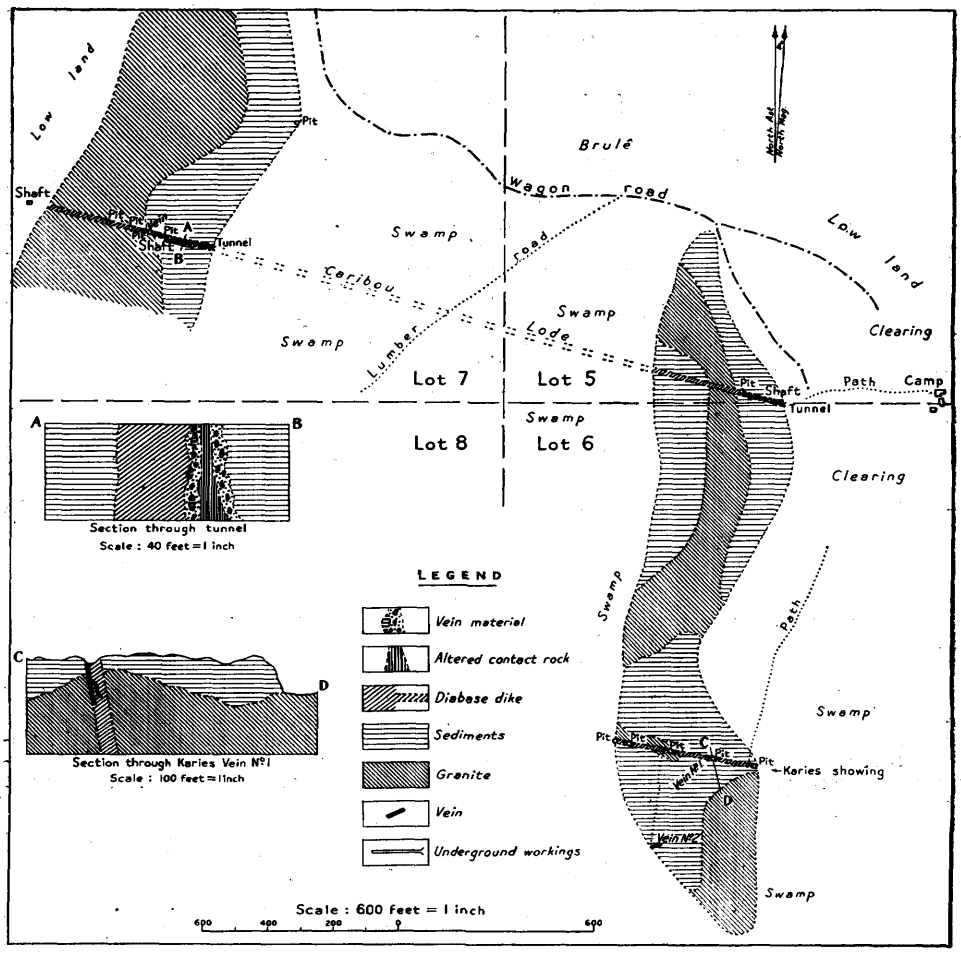


Fig. 9—Geological sketch map of the Caribou mine, McTavish township.

an intervening quarter-mile of swamp (Fig. 9). The dike is vertical and apparently occupies a fault fissure. The vein is small and irregular in size. It contains sphalerite, galena, traces of chalcopyrite and pyrite in a quartz-calcite-barite gangue. In places the ore occurs in a breccia cemented with quartz and calcite; elsewhere it is distributed in fine stringers in the adjoining country rocks.

In a recently worked pit two small lenses of almost pure galena, 1 foot in width, were observed. The galena carries no silver. Huge vugs, 3 feet in length, were found in the vein material at the diabase contact. Very little work has been done on this property for many years. In the summer of 1928 one of

[1]T. L. Tanton, op. cit., p. 6.

the old shafts was pumped out and deepened to 50 feet, at which depth 3 feet of good galena is reported. This property is now held by A. T. Paju of Nipigon.

Karies (Lot 6).—About 1,000 feet south of the old Caribou mine a vein occurs along a diabase dike which parallels the Caribou dike and cuts across the same outcrop of granite capped by Nipigon sediments. This diabase dike is 7 feet wide and has a general dip of 80° S. The vein occurs along the footwall side or in fractures in the centre of the diabase. It has a visible length of 6½ chains, disappearing on low land to the east and west. In width it ranges from 2 inches to 2 feet and in both the granite and the dolomite it is paralleled by numerous small veinlets, which are well mineralized. The ore minerals consist of galena and small amounts of sphalerite and chalcopyrite in a calcite, quartz, and barite matrix. In places about 80 per cent. of the vein is galena. An exposure on the west side of the outcrop shows the structural relationship. At this point the vein is split around a horse of diabase and has a width on either side of 1½ and 2 feet. The vein material consists of a network of veinlets in an altered and brecciated dolomite. A sample taken across 40 inches of vein material gave a trace of zinc and 12.8 per cent. lead.

Three hundred feet to the south of this vein, on the west side of the outcrop a vein, known as No. 2, is exposed on the side of a dolomite cliff, 30 feet high. It trends N. 70° E. and stands vertically. From the top to the base of the cliff it widens from 2 inches to 9 inches. The walls are sharp, being of Nipigon sediments, and show no mineralization. Along the north side there is from 2 to 3 inches of gouge. The vein is banded and consists of 2 inches of galena in calcite and 6 inches of barite in the centre. It has not been traced for any distance.

Wright Shaft (S.E. ¼ Lot 4, Concession IV).—The old Wright shaft lies about 1¼ miles northwest of Pearl Station on the C.P.R. It is reached by a trail that follows a pipe line from the upper part of the Pearl river. The shaft is situated on a mineralized fault-breccia zone, which trends N. 55° E. The fault and breccia dip steeply north, the north side having been down-faulted. The zone, which may be observed at intervals over a length of 53 chains, lies mainly in granite over which a thin layer of Nipigon sediments, dolomite, sandstones, and conglomerate, occur. It is similar in most respects to other deposits described, consisting of a stockwork of fine quartz stringers in much-fractured dolomite, sandstone, or granite, and cemented smaller angular fragments. In width the zone ranges from 2 to 10 feet, the average being about 3 feet. Throughout it is rather sparingly mineralized with fine galena, sphalerite, and occasionally chalcopyrite. Calcite, barite, and amethyst occur with the white quartz.

The shaft was sunk to a depth of 50 feet, but was only accessible to a depth of 25 feet. At this point the zone consists of an 8-inch vein of quartz carrying abundant galena and 6 feet of much-fractured sandstone with narrow half-inch quartz and calcite stringers, carrying galena in places. On the south footwall is a sandstone breccia with lenses and cement of quartz and fine galena. On the dump, samples of granite, granite breccia, and recomposed granite were found, indicating that the shaft ended in granite. A sample across 5 feet, at the 25-foot level in the shaft, gave less than 1 per cent. lead and no zinc or silver. Gold and platinum have been reported from this deposit in the early days, but it is questionable whether the latter was found.

Enterprise Mine.—The old Enterprise mine is situated just to the west of the Canadian National Railway, on lot C, 2½ miles south of Ancliff. In

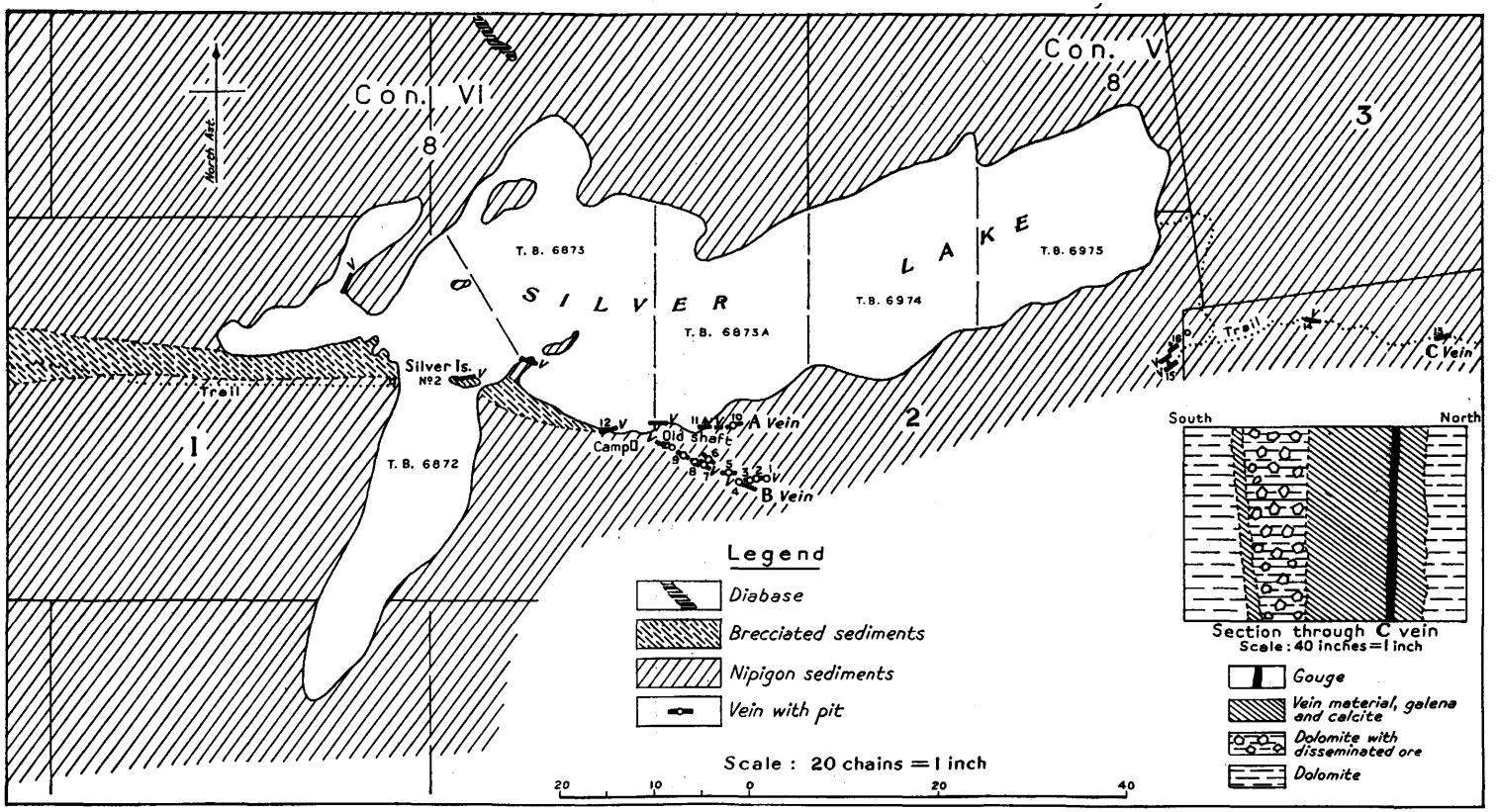
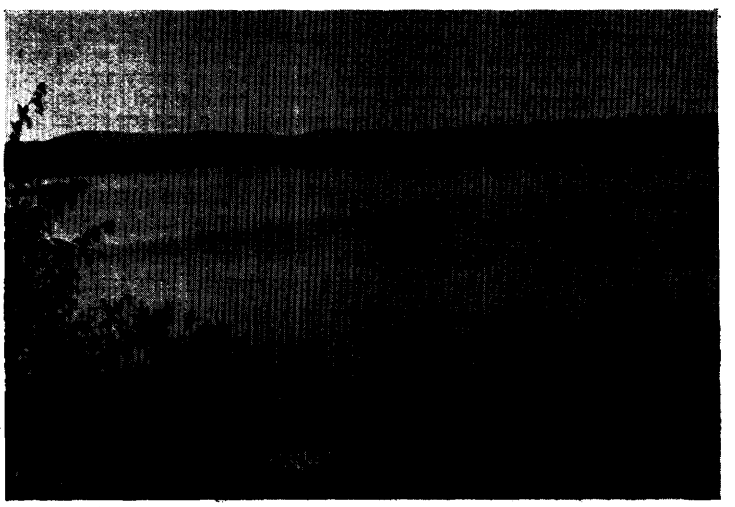


Fig. 10—Lead and zinc veins, Silver lake, McTavish township.

1875[1] the shaft was sunk on a brecciated fault zone in Nipigon shaly dolomites, which are downthrown on the southeast. The brecciated zone strikes N. 65° E. and dips 78° E. It may be traced for 210 feet and dies out to the northeast in several small fractures and veins. Three hundred feet north along the railway, granite is exposed beneath the sediments. Near the shaft the zone is 10 feet wide and contains a 12-inch quartz-amethyst vein, well mineralized with galena. This is followed to the south by 8 inches of fine breccia and 8 feet of fractured dolomite. Small pockets of rich galena with fine pyrite and chalcopyrite occur in the zone. Fifty feet to the southwest the zone is 15 feet wide and consists of a stockwork of veins, 3 inches to 3 feet wide, carrying galena, chalcopyrite, calcite, barite, and quartz.



View of Silver lake, McTavish township, looking north to the high granite ridges.

At the surface there was a thickness of four feet of solid ore. . . . According to Professor Chapman, of Toronto, this ore contains 47½ per cent. of lead and 10 per cent. of copper, together with an average of 17 pennyweight 12 grammes of gold, and 2 ounces 2 pennyweight of silver to the ton of 2,000 pounds. On entering the sandstone, the vein became smaller and poorer, but at 100 feet from the surface it had opened out to 7 feet in width and contained bunches of ore. . . . Several hundred barrels of ore were shipped from this mine in 1875.[2]

The shaft apparently reached granite, as brecciated fragments of this rock were found on the dump. It was recently pumped out but was filled with water at the time of the writer's visit.

Silver Lake (Mining Lots 1, 2, 3, T.B. 7,150; Lake Claims T.B. 6,872, 6,873, 6,873A, 6974, 6975).—The land claims in the vicinity of Silver lake were held recently by H. and J. P. Dreany but have since been sold. The water claims were formerly held by T. Delbridge, of Port Arthur, and associates.

Uglow[3] quotes a description of this area, written in 1876:—

SILVER LAKE LOCATION

Silver lake lies at a distance of about six miles northward from the head of Thunder bay, and at an elevation of about 500 feet above Lake Superior. A short distance to the west of it there is an enormous brecciated vein, some 250 feet in width, composed of masses of the country

[1]W. L. Uglow, op. cit., p. 35.
[2]Ibid
[3]Ibid, p. 34.

rocks cemented together with quartz and some barytes and calcspar, and holding small quantities of galena, copper and iron pyrites, and blende. This has been traced for about three miles. In approaching Silver lake it contracts rather abruptly, but sends out several branches to the east, of which four or five have been followed for considerable distances and are found to be much richer in galena and blende than the great vein. The latter is on a line of dislocation which increases in going west and appears to die out to the east. The downthrow is on the north side, and brings the indurated calcareous marls of the Nipigon series on that side down to the level of the iron-ore beds (at the base of the series) on the south side, amounting to 400 feet, or upwards, on this location. The specimens are taken from a shaft sunk on a vein on the line of the eastward continuation of the dislocation, at a point from one to two hundred yards south of Silver lake, and about eighty feet above its level. Here the vein runs N. 80° E. and may be about six feet wide, but its north wall is not well defined. The gangue consists of calcspar, with some quartz and barytes, and holds a good proportion of galena and blende.

ISLAND NO. 2, SILVER LAKE

Specimens of galena weighing about seventy-five pounds. The island known by the above description is traversed by one of the branch veins referred to under the last heading. The vein runs nearly east and west, and is described as being about six feet wide, with good walls. The gangue is chiefly calcspar, with some quartz, barytes, etc., carrying a fair proportion of galena, accompanied by blende. Two samples of dressed ore assayed by Prof. Chapman gave an average of 57.53 per cent. of lead and 202.6 pennyweight of silver per ton of 2,000 pounds.

In recent years many new pits have been dug and old ones opened up on the vein deposits, south and east of Silver lake. These are shown on Fig. 10. Between the deposits south of the central part of the lake and those to the east is a drift-covered gap of 42 chains. Two fairly continuous veins south of the lake have been explored. "A" vein is exposed intermittently along the lakeshore for 900 feet. The width of ore in pit No. 10 is from 1½ to 2 feet. It consists of a calcite stockwork in quartzose dolomite and carries good values in galena and sphalerite. This vein narrows to the west and is lost in the large breccia zone which continues westward. "B" vein swings to the southeast and has several branches for a length of 800 feet. It consists of one to three split veins and fine stringers of calcite or quartz in brecciated sandstone and dolomite. At the old shaft a 4-foot vein contains fragments of country rock and carries 4.71 per cent. lead and 2.84 per cent. zinc. At pit No. 5 the vein is rich in galena and is about 4 feet wide. Pits Nos. 1 to 3 show 2 or 3 veins of 3 to 10 inches in width, well mineralized with galena, sphalerite, and a little chalcopyrite.

On Silver island a 20-inch vein lies in a 35-foot breccia zone of sandstone and quartz. Assays of this yielded 1.17 per cent. lead and 3.96 per cent. zinc, but no silver. The vein is exposed for the length of the island.

To the southeast of Silver lake similar veins occur in brecciated Nipigon sediments. At pit No. 13, "C" vein is 42 inches wide, including 15 inches of dolomite cut by a stockwork of calcite-galena stringers. At this location stibnite was reported with the galena, but none could be found. On assay a sample across 36 inches gave 10.49 per cent. lead, 3.36 per cent. zinc, and no antimony or silver. At pit No. 16 to the west, there is a 26-inch vein of banded calcite and barite. Galena and sphalerite occur in a 6-inch calcite band.

On the east shore of the northwest bay in the lake a 1-inch vein carrying massive galena in quartz strikes N. 35° E. and dips 68° N.W.

The showings in this area are promising, and some widths of ore-grade have been uncovered. Another favourable feature is that these deposits occur well up in the Nipigon series of sediments, and some depth may be expected before underlying granites or schists are encountered. Further prospecting is, of course, required to prove the extent of the deposits.

N.E. ¼ Lot 5, Concession VIII.—In a pegmatite dike in this locality molybdenite occurs over a width of 1 foot for 250 feet. The pegmatite is very

coarse grained, consisting chiefly of reddish orthoclase and quartz and quartz stringers. Muscovite is present in crystals as large as 1½ inches across. The molybdenite occurs in thin tabular plates, some of which are 5 inches in diameter and lie in the pegmatite as well as in the quartz stringers. There appears to be no concentration of economic importance. Yellow molybdenite forms an alteration product at the surface.

OZONE SIDING AREA

The general geology in the vicinity of Ozone Siding is shown on the sketch map (Fig. 12). A diagrammatic section across the area is given in Fig. 11. This shows a wide northward-trending valley, the floor of which is red biotite granite and granite gneiss, 4½ miles wide. On either side, at slightly higher elevations, the granite is overlain by reddish shales, sandstones, and dolomites, and capping

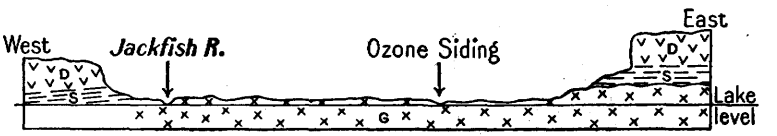


Fig. 11—Cross-section showing the general geology at Ozone Siding. Horizontal scale, 8,000 feet to the inch; vertical scale, 1,500 feet to the inch, approximately. D = Diabase. S = Nipigon sediments. G = Granite and gneiss.

these are large diabase sills on the east and west. Fire hill to the south of the Canadian Pacific railway appears as a prominent landmark, its name being derived from the bright red colour of the sediments. These are capped by an erosional remnant of diabase. On the east side of Kama bay, along the railway, intricate block faulting on a small scale is excellently displayed in the incompetent shaly members of the Nipigon sediments. Here smaller diabase sills are found intruding the sediments below the larger cap.

Lead and zinc deposits occur in fractures in both the granite and Nipigon sediments. Promising showings are exposed in the northwest portion of the area, 2½ miles from Ozone Siding, but no commercial deposits have yet been uncovered. The deposits examined are of the same type and mineralization as those in Dorion and McTavish townships to the southwest.

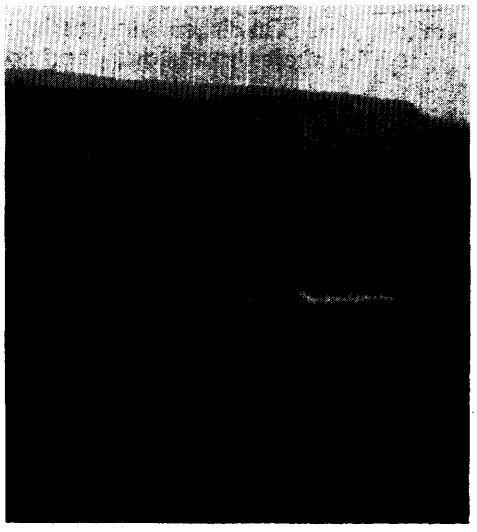
Claims T.B. 7,485 to 7,493, Inclusive.—These claims are held by a syndicate composed of H. M. Lewis, L. T. Seyler, J. Lawrence, D. Connor, and several others. They are reached by a trail leading north from the section-house at Ozone Siding. A camp has been built and some trenching has been done along a vein deposit that lies on the steep slope of Nipigon sediments, which to the east are capped by a sill of diabase from 50 to 75 feet thick.

The main vein system occurs on claims Nos. 7,492 and 7,493 and strikes approximately east, dipping vertically. It has been uncovered chiefly along a terrace in the sediments, a short distance below the diabase sill. It may be traced for approximately 800 feet. At the east end the vein consists of 6 inches of calcite lying in red cherty dolomite and carrying specks of sphalerite. Five chains to the west it widens to 12 inches and there lies in brecciated chert. It contains some quartz with dark sphalerite and small cubes of galena. A second 8-inch vein lies 3½ feet to the south and consists of barite with sphalerite and galena. This vein widens to 2 feet a short distance to the west. A sample across this gave, on assay, 12 per cent. lead, 2.24 per cent. zinc, and no

silver. Towards the west end a stockwork of small quartz and barite veins occurs in the dolomite and strikes W. 15° N. These veins have similar sulphides but are only from 1 to 3 inches wide.

Along the strike of the main vein, trenches failed to reveal its continuation, but near the road (25 chains west) a small 6-inch vein of quartz and calcite carries small amounts of galena. The disappearance of the vein on the easterly strike is probably due to a change in strike of the main fractures.

Lawrence (*Claims T.B. 4,737, 3,745*).—These claims lie entirely in granite. A brecciated zone striking east and west and dipping steeply north in places



Diabase scarp on the west side of the Ozone Siding area, looking northwest into the Nipigon Provincial Forest.

has been explored for about 30 chains. The zone includes brecciated fragments of granite and gneiss cemented with quartz, amethyst, and barite, and mineralized with either sphalerite or galena, or with both, which are very irregularly distributed along the strike. In the zone are also larger blocks of granite, which are fractured and penetrated by narrow quartz or barite stringers. The mineralized portion of the zone ranges in width from a few inches to 42 inches. The usual width of breccia is from 1 to 2 feet. On claim No. 3,745 a shaft was sunk to a reported depth of 50 feet. Just to the east of this two veins are exposed: One is from 2 to 6 inches wide; the other, 7 feet to the north, is a stockwork of several quartz-barite veins in brecciated granite. Sphalerite is the chief sulphide. A chip sample across a 42-inch mineralized zone on claim No. 4,737 gave on assay only 0.2 per cent. lead and 3.16 per cent. zinc.

Claim T.B. 4,588.—On the west shore of Kama bay, a brecciated zone occurs in massive reddish sandstone, striking east. The main mineralization is in a band 6 feet wide, which is penetrated by numerous stringers of quartz and barite carrying galena. These are under water. A few chains inland an old pit was sunk on brecciated grey to red sandstone cemented with vein quartz and barite, with local segregations of galena and sphalerite. No true vein could be seen, as the pit is largely filled in and drift covers the zone along its strike.

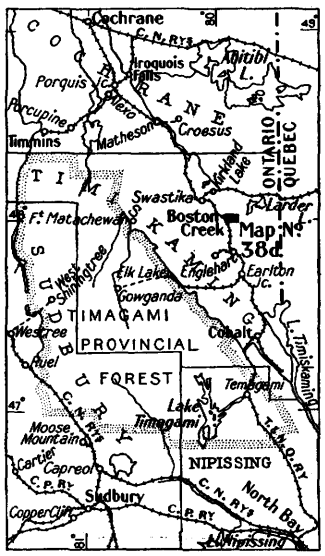
Gordon (*Claim T.B. 6,038*).—On the east bank of Jackfish river a vein of coarsely crystalline calcite rises 20 feet from the river and narrows from 4 to 2½ feet in this distance. At the base it includes a 1-foot horse of granite. The central foot is mineralized with both galena and sphalerite in small amounts. Forty feet to the east the vein divides into two eastward-trending branches. The vein on the south averages 12 inches and contains some barite. The one on the north has a width of 28 inches and is sparsely mineralized with galena and sphalerite in calcite and reddish barite, but locally contains lenses of solid sphalerite. To the north of this is a 20-foot width of much-fractured granite gneiss cut by a network of narrow calcite veins. The veins have a total length of 150 feet and die out to the east in several stringers. At the east end a 1-foot trap dike strikes across the veins and has been much faulted and sheared.

Boston-Skead Gold-Copper Area, District of Timiskaming

By L. V. Bell

Introduction

The Boston Creek area was the subject of a report and map by A. G. Burrows and P. E. Hopkins in 1916, and in 1921 a Second Report was issued by the same authors. The map accompanying the Second Report covered the townships of Pacaud, Boston, Catharine, McElroy, and Skead. Portions of this area, particularly in the vicinity of the working mines and prospects, were re-examined by the writer during the summer of 1928.



Key map showing location of the Boston Creek area. Scale, 70 miles to the inch.

Only a brief review of the general geology of the area will be given in the present report, which is chiefly concerned with the working mines and properties and those that have recently been worked. Until lately activity has been confined to the search for gold deposits and has been encouraged by the production of gold from one mine. However, the discovery of copper has resulted in a renewed interest in Pacaud and several nearby townships. A great part of the recent activity connected with the development of the gold deposits has centred in northern Pacaud and Catharine townships where the Barry-Hollinger, Miller Independence, Gold Hill, and Hilltop mines are situated. Numerous rock outcrops in this section of the area permitted detailed mapping (map No. 38*d*) which was carried out with the object of showing the geological relationships of these properties. Detailed maps have also been made around several mines in the area which are situated outside of this zone.

Able assistance in carrying out the work was rendered by Robert Bradley and Fred Towsley. Thanks are also due to mine officials and others who

extended hospitality to the party, and assisted the work materially by supplying plans of mine workings, assay plans, and maps. The writer also wishes to thank A. G. Burrows, Provincial Geologist, and Professor A. MacLean, of the University of Toronto, for many helpful suggestions in the preparation of this report.

Location and Access

The Boston-Skead area is situated in the district of Timiskaming about 45 miles northwest of Cobalt and about 10 miles south of the producing mines of Kirkland Lake. The Temiskaming and Northern Ontario railway passes through the southwest corner of the area, which may be reached from Boston Creek station. The eastern part, however, particularly Skead township, is best reached by wagon road from Englehart.

Topography and Timber

The following description is taken from the reprint of the Second Report by Burrows and Hopkins.[1]

> The area in general has an elevation ranging from 700 to 1,050 feet above sea-level. . . . While the difference in elevation is seldom more than 200 feet, the country is somewhat rugged and broken, particularly in the vicinity of Boston Creek station and along the north branch of the Blanche [Misema] river in McElroy and Catharine townships.
>
> The country is situated south of the continental divide and is drained by three branches of the Blanche [Misema] river and their tributaries, which flow southward into Lake Timiskaming. The magnetic declination is N. 8°–9° W.

Owing to the fact that forest fires have swept over the greater part of the area, timber is rather sparse and consists chiefly of second-growth poplar, jack-pine, spruce, and birch.

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A. G. Burrows and P. E. Hopkins, The Boston Creek Gold Area, Ont. Bur. Mines, Vol. XXV, pt. 1, 1916; Boston-Skead Gold Area, Ont. Dept. Mines, Vol. XXX, pt. 6, 1921 (reprinted February, 1928).

General Geology

The rocks of the area . . . are of pre-Cambrian age. The dominant formations are members of the Keewatin, while formations of later age occur in relatively minor quantity, with the exception of a batholith of Algoman granite, which covers the greater part of Pacaud township, and areas of conglomerate and greywacké of the [Timiskaming and] Cobalt series in the eastern and southern parts of Skead township.

The intrusive rocks, including granite and porphyry, which are believed to be associated with the gold mineralization, occur in small masses or narrow dikes through the older rocks.

Legend

QUATERNARY

Glacial and Recent: Boulder clay, sand, and gravel.

PRE-CAMBRIAN

Keweenawan: Quartz diabase, olivine diabase.

[1]Ont. Dept. Mines, Vol. XXX, pt. 6, 1928, p. 2.

	Intrusive contact
ANIMIKEAN: (Cobalt series)	Conglomerate, greywacké, quartzite.
	Unconformity
ALGOMAN:	Hornblende and biotite granite, syenite, feldspar porphyry, felsite, quartz porphyry, diorite porphyry, diorite, lamprophyre.
	Intrusive contact
HAILEYBURIAN(?):	Serpentine, hornblendite, diorite, diabase.
	Intrusive contact
TIMISKAMIAN(?):	Schistose conglomerate, greywacké, slate.
	Unconformity
KEEWATIN:	Grey schist (volcanic fragmental); ellipsoidal, amygdaloidal, and spherulitic lavas; diabase, felsite, andesite, dacite, iron formation, rusty-weathering carbonate.

KEEWATIN

The Keewatin consists in general of diabase and coarse-textured basalts, with pillow, amygdaloidal, and spherulitic lavas roughly interbanded with andesite and agglomerate, tuffaceous schist, and iron formation. Associated with the andesite and agglomerate is a dacite or quartz diorite porphyry. With the exception of the tuffaceous schist, the rocks are in general massive with local fractures and shear zones. The bands have a definite northwest-southeast trend throughout the area.

Basalt, Basic Lavas, Diabase

On the accompanying map an attempt has been made to differentiate the diabase and coarse-textured basalt from the finer pillow, non-pillow, and amygdaloidal lavas, with the hope that the tracing of these boundaries would indicate faulting. Only partial success was attained, since in many cases it was found that there is an irregular gradation of the lavas into a rock with diabasic texture, and consequently no well-defined contact between the two rock types. On the other hand, there is in general a distinct interbanding of the coarse basalts and diabase with the finer lava flows. This results in definite contacts, which emphasizes the northwest-southeast trend of the bands. While definite flow contacts were recognized, the succession of the flows as indicated by their tops was not successfully determined.

Although the Keewatin basalt frequently assumes a diabasic texture, with consequent indefinite contacts, there is evidence that much of the Keewatin diabase of the area is intrusive as dikes into the older lavas. On account of this it might be compared with the "older gabbro," which has been differentiated in western Quebec. The southwest contact of such a typical Keewatin diabase dike may be seen a short distance northeast of the main shaft of the Barry-Hollinger mine, where it is in sharp contact with pillow lava. The diabase along an apparently vertical contact is at some points eroded considerably below the surface of the pillow lava, thus forming a marked depression.

Andesite, Agglomerate, Dacite

Andesite and agglomerate occur in a light-greenish weathering band of rock running diagonally across the townships of Catharine, McElroy, and Skead, in which the two rock types are irregularly intermingled. The Telluride property in Skead township and the Gold Ridge and Gold Bank properties in Catharine township lie within this band of light-weathering rock, which outcrops also on the northern part of the Gold Hill and Hilltop properties. The andesite

is in part distinctly porphyritic owing to the presence of phenocrysts of plagioclase, with the result that it is sometimes with difficulty distinguished from feldspar porphyry of later age. Intrusive into both andesite and agglomerate, especially east of St. Anthony lake, is a coarse-grained dacite, which is probably also Keewatin in age. Chemical analyses of the andesite and dacite are given in the Second Report.[1]

Tuff (Volcanic Fragmental)

Along the periphery of the granite batholith in northern Pacaud township is a semicircular belt of greyish-weathering tuffaceous schist averaging 1 mile in width and 7 miles in length. The series is highly metamorphosed and schisted by the intrusion of the granite; the schist is almost vertical and strikes parallel to its contact with the granite. Conformable with the schist are several narrow iron formation bands, some of which consist essentially of pyrite. Intrusions of granite, feldspar porphyry, and felsite dikes are common in the tuff, becoming so numerous at some points, especially near the granite contact, as to assume a *lit par lit* structure.

Iron Formation

Narrow bands of iron formation are irregularly distributed in Pacaud, McElroy, and Catharine townships (west of the Misema river); there are much wider ones in Boston township, which have been described by W. G. Miller. The strike of the bands conforms to that of the other members of the Keewatin. They consist on general of interbanded granular or cherty silica, magnetite, black slate, and pyrite. The quantity of iron minerals present varies considerably, and many of the bands consist of little but silica and are thus rather difficult to distinguish from typical quartz veins. The occurrence of narrow bands of iron formation in the schist near its contact with Algoman granite in Pacaud and adjoining townships is a feature of economic importance, since the bands are in part replaced by copper-bearing minerals.

TIMISKAMIAN

Rocks of Timiskaming age within the general area occur chiefly in the northern part of Skead township. Similar rocks are also exposed as isolated outcrops along the Larder Lake road in Boston and McElroy townships. Of the several properties examined such rocks occur only on the Grace Lake and Manor claims. The rocks are in general highly sheared and schistose, which provides one means of distinguishing them from sediments of Animikean age. Another distinction is that the pebbles of the Animikean conglomerates are much more readily separated from their matrix than are those of the Timiskaming conglomerates.

PRE-ALGOMAN (HAILEYBURIAN?)

Included in the rocks that are classed as Haileyburian are diorite, hornblendite, diabase, and serpentine, the serpentine being by far the commonest. They are clearly post-Keewatin in age, but their relationship to the rocks of Timiskaming age is not known.

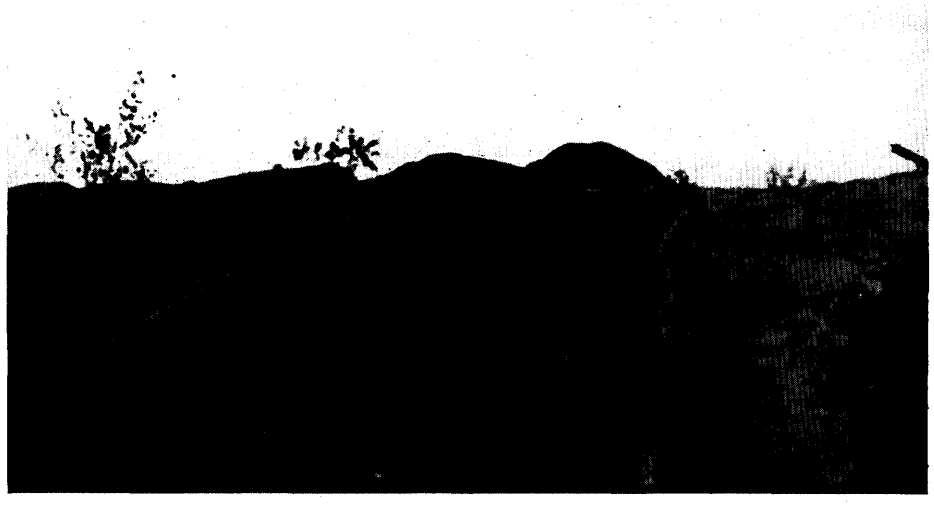
Serpentine, Hornblendite, Diorite

Serpentine is usually exposed as irregular patches in the northern part of Skead township and to a lesser extent in each of the other townships of the area. A well-defined serpentine dike may be traced without any evidence of displace-

[1]A. G. Burrows and P. E. Hopkins, Ont. Dept. Mines, Vol. XXX, pt. 6, 1928, p. 5.

ment from the northwest corner diagonally across the south half of lot 1, concession VI, Pacaud township (Miller Independence property). The dike has an approximate width of 150 feet, but the southwestern edge is usually obscured by low ground. The rock consists of secondary hornblende and serpentine, the latter comprising about one-fifth of the total.

Extending in a southeasterly direction from claim L. 5,023, near O'Donald lake, in Boston township to the Miller Independence property in Pacaud township is a compound dike with an average width of 400 feet. The dike is made up of three distinct rock types, which seem to have been injected at different times. These have been differentiated on the detailed map. Along the southwestern edge is a 75-foot band of dark, basic rock, which is essentially serpentine.



Dark hornblendite in contact with light-weathering diorite north of Barry-Hollinger mine, Pacaud township.

In sharp contact to the northeast of this is a 200-foot band of hornblendite, which is dark-greenish in colour and made up essentially of elongated hornblende crystals, but which at some points differentiates into a feldspathic rock consisting chiefly of plagioclase. Probably somewhat later than two of the components of the dike is a third less persistent, light-weathering diorite band or dike, whose position in regard to the other two varies somewhat from place to place, which suggests that it may be intrusive into them. The diorite is composed of altered plagioclase and secondary hornblende and is irregularly cut by tongues of feldspar porphyry.

The dike as a whole is clearly intrusive into the Keewatin basalt and diabase and is therefore post-Keewatin in age. Since it has been intruded by feldspar porphyry, it is regarded as pre-Algoman and is therefore classed as Haileyburian. It is not impossible, however, that all phases of the intrusion, including the feldspar porphyry, are but differentiates of the Algoman injected at different times.

Diabase

Across the Misema river from the Gold Hill mine is a 10-foot diabase dike, which parallels the river for a short distance. It is much more highly altered and older in appearance than the typical Keweenawan diabase, which also occurs as dikes in the vicinity.

ALGOMAN

Included in the rocks of this age are batholiths and stocks of granite and syenite, and dikes of feldspar porphyry, diorite, diorite porphyry, felsite, and lamprophyre.

Granite and Syenite

A batholith of red hornblende and biotite granite occupies the greater part of Pacaud township and extends, chiefly to the south and west, over approximately twelve townships.

The rock is massive except near its contact with the Keewatin, where it frequently assumes a gneissoid structure. The granite is cut by numerous felsitic dikes, pegmatites, and occasionally lamprophyre dikes and quartz veins. Under the microscope the granite is seen to be composed of microcline, orthoclase, albite, quartz, hornblende, and biotite, with smaller amounts of chlorite, calcite, sericite, and kaolinite.

Chemical analyses of two samples of the granite gave the following:—

	No. 1	No. 2
	per cent.	per cent.
Silica	70.79	71.07
Titanium dioxide	.05	.....
Alumina	15.90	16.21
Ferrous oxide	.64	1.00
Ferric oxide	.94	1.44
Manganese oxide	.03	.....
Lime	2.33	2.23
Magnesia	.90	1.21
Potash	2.44	2.14
Soda	5.10	4.06
Carbon dioxide	.15	.08
Water	.71	.90
Phosphorus	trace	trace
Total	99.98	100.41

Sample No. 1 was taken from a place north of the railway track, approximately 500 feet from the Keewatin contact on the Amity property (south half, lot 5, con. VI, Pacaud township).

Sample No. 2 came from a point on the same property within the gneissic border of granite, at the contact with the Keewatin.

The analyses were made by M. C. Haller, Department of Mineralogy, University of Toronto.

If the above analyses may be taken as representative of the rock as a whole, it might more properly be termed a granodiorite. A higher proportion of albite than in a typical granite is indicated by the preponderance of soda over potash and is also shown in several thin sections of the rock.

In addition to this large batholith, several granitic intrusions occur at various points in the area. In the Second Report[1] reference is made to a small stock of reddish biotite and hornblende granite with which is associated a pegmatitic quartz vein, carrying gold and a telluride, which is intrusive into the greenstones in McElroy township. The gold-bearing quartz veins at the Grace Lake property in Skead township occur in a dike which has been termed red syenite, with which the gold is probably genetically connected. Small granitic stocks occur also on the Miller Independence, Authier, and Bennett Pacaud properties. On the last two the granite is cut by narrow quartz veins, some of which carry gold.

[1]Burrows and Hopkins, op. cit., p. 17.

Feldspar Porphyry, Felsite, Diorite

Numerous intrusions of red and grey feldspar porphyry occur over the whole area. They usually appear as narrow dikes and probably represent apophyses of the granite masses. In addition to the porphyry, there are rather common intrusions of diorite, syenite, and felsite. The diorite is non-porphyritic and light-weathering with a fairly high proportion of altered hornblende, chlorite, and biotite. The affinity of these intrusive rocks is doubtful, but the term diorite has been applied to them.

Intrusions of the diorite are rather common on the Gold Hill and Hilltop properties, where they usually occur as dikes with a strike corresponding to that of the major flows of the Keewatin. They may also occur as irregular, stock-like masses. A diorite dike in part altered to chlorite schist forms the hanging wall of No. 1 vein of the Gold Hill mine, and is intruded by feldspar porphyry and syenite. A highly sheared diorite dike parallels the main fracture near the Hilltop shaft. It was not found possible to satisfactorily separate these intrusions, which are in some cases distinctly older, from those which are clearly Algoman in age. On the other hand a like appearance in the field and a similar mineralogical composition would suggest a relationship between the diorite and the andesitic rock classed as Keewatin, which outcrops on the northern part of the two properties. The diorite is frequently just as highly sheared as the Keewatin rocks which it intrudes.

Felsite dikes occur rather commonly, particularly in Catharine and Pacaud townships. On the Ostrom property in Catharine township are a number of pink felsite dikes, some of which are intrusive into, and therefore later than, a gold-bearing quartz vein. Felsitic dikes are intrusive into the large granite mass in Pacaud township, of which they are a differentiate, and into the associated volcanic tuff, where they have a strike parallel to that of the schist. The chemical composition of the felsitic rock was shown[1] to be similar to that of the granite which it intrudes, except that it is somewhat lower in silica and alumina and richer in iron, magnesia, and lime, and therefore slightly more basic.

Lamprophyre

Lamprophyre dikes are not common in the area as a whole and with some exceptions are very narrow. A few narrow, fresh-looking lamprophyre dikes occur near the Barry-Hollinger mine in Pacaud township, and a much wider one on the Grace Lake property in Skead township. Several old-appearing, narrow lamprophyre dikes, some of which have such low dips as to appear sill-like, outcrop near the Telluride shaft in Skead township. Some of these have been encountered underground. In thin section the lamprophyre of the property is seen to be made up of chlorite and plagioclase, the chlorite preserving the outlines of the biotite from which it was derived.

A hornblende lamprophyre dike with an average width of 10 to 12 feet may be traced at intervals from the southeast corner of the north half of lot 12, concession VI, Catharine township, across the Hilltop property, and on to the Gold Hill property, on the east side of the Misema river, the strike remaining remarkably constant.

Near the contact of the granite and volcanic tuff in Pacaud township, and intrusive into both, are a number of small lamprophyre dikes. The minerals composing the lamprophyre are essentially hornblende, biotite, plagioclase, and orthoclase, with hornblende predominating.

[1]Analysis by M. C. Haller, University of Toronto.

An analysis of a typical specimen of the lamprophyre that intrudes Keewatin tuff on the Amity property is given below:[1]—

	Per cent.
Silica	49.36
Titanium oxide	.91
Alumina	13.29
Ferrous oxide	6.58
Ferric oxide	2.86
Manganese oxide	.25
Lime	7.86
Magnesia	10.72
Potash	2.50
Soda	3.24
Carbon dioxide	.80
Water	1.34
Phosphorus pentoxide	.01
Total	99.72

ANIMIKEAN

Rocks of this age in the area examined occur only on the Grace Lake property as a continuation of the prominent ridges of Cobalt conglomerate and greywacké in the eastern and southeastern parts of Skead township. The sediments consist of massive greywacké, quartzite, and conglomerate, and are nearly flat-lying. They were deposited subsequent to the formation of the gold-bearing veins, and in this area do not carry minerals of economic importance.

KEWEENAWAN

Diabase dikes and sill remnants are the only representatives of Keweenawan time, and these occur rather sparingly throughout the area. A diabase dike with an average width of 12 feet has been traced across the Bennett Pacaud, Hilltop, and Gold Hill properties. Ten chains south of the dike on the Gold Hill property is a second diabase dike with an approximate width of 18 feet. Although this dike outcrops on the east bank of the Misema river, it apparently does not extend to the west side. The two dikes tend to converge to the east of the Gold Hill mine. Several small, irregular dikes of diabase also occur to the east of the mine, where they are occasionally intrusive into Algoman porphyry.

An outcrop of fresh quartz diabase, which intrudes the granite, may be seen a few yards south of the railroad track near Boston Creek station. In thin section it appears similar to the diabase dikes already described except that they apparently contain neither quartz nor olivine.

GLACIAL AND RECENT

The region has been heavily glaciated, and is covered in places by stratified clays, sands, and gravels. Glacial striae are frequently well preserved on rock outcrops, as for instance along the rocky banks of the Misema river. Ice movement was in general S. 10° E. to S. 20° E.

Structural Geology

With the exception of the tuffaceous schist, which occurs on the margin of the granite batholith in Pacaud township, the rocks are in general massive, shearing and schisting being confined to relatively narrow zones.

Reference has already been made to the definite northwest-southeast trend of the bands of Keewatin rocks throughout the area. This same general strike

[1]Analysis by M. C. Haller, University of Toronto.

is found in most of the narrow shear zones, fractures, and veins in that portion of the area adjacent to the large granite batholith, a part of which has been mapped in detail. Fracturing has probably been caused by the intrusion of the granite and may be connected with the banded structure of the older rocks. The gold-bearing veins show considerable diversity in their strike. Among those which follow the general northwest-southeast strike are veins Nos. 1 and 2 of the Gold Hill and the vein on which the Hilltop shaft has been sunk. On the other hand, No. 7 vein of the Barry-Hollinger, No. 12 vein of the Ostrom, and the Independence vein of the Miller Independence strike at approximately right angles, or in a northeasterly direction. The dip of the gold-bearing veins varies from 20 degrees to vertical, the steeper dips being commoner.

The compound hornblendite-serpentine-diorite dike previously described shows considerable evidence of faulting, particularly near O'Donald lake and on the Barry-Hollinger and Boston-McRae properties. From northwest to southeast the dike is progressively faulted to the east or slightly north of east. Horizontal fault movements vary from a few feet to a maximum of 600 feet. The Keewatin diabase dike near the Barry-Hollinger shaft is similarly displaced by the same faults. Most of the faults now occupy low ground or valleys, so that the actual faulted contacts are seldom seen. These faults have been indicated on the accompanying detailed map.

From the fifth concession to some distance beyond the south boundary of Catharine township the Misema river flows almost due south. The valley of the river is relatively narrow and exceptionally straight, with steep rock banks, and strongly suggests a fault valley. North of the fifth concession the river swings to the south in lower, soil-covered ground. Little information is available as to the displacement that may have resulted from the faulting. In concession V, two diabase dikes outcrop on the east side of the river about 600 feet apart, but on the west side of the river there is only one dike, which appears a short distance to the north. If the dike on the west side of the river is the continuation of the north dike, a horizontal displacement of 200 feet has resulted, the east side of the fault moving to the south. If, on the other hand, the dike on the west represents the continuation of the south dike a horizontal displacement of approximately 1,000 feet is indicated. Movement would be in the same direction in either case. Outcrops of what is apparently the same lamprophyre dike on each side of the river show little or no evidence of displacement; however, the dike may have been intruded subsequent to the supposed faulting.

On the whole it may be said that appreciable faulting throughout the area has preceded the deposition of the mineral-bearing veins.

Economic Geology

Until the present time activity in the area has largely been confined to the search for gold; however, the recent discovery, and the resulting small production of copper, has resulted in a renewed interest in the area as well as in nearby townships.

GOLD

Gold, which is genetically associated with acid intrusions of Algoman age, usually occurs native in quartz veins and veinlets in the Keewatin lavas, diabase, and andesite, and in later intrusions of granite and porphyry. The veins are dominantly of the fissure type, and the vein walls may or may not be well defined. In general, two types of auriferous veins may be recognized:—

1. Veins with considerable quartz and sometimes calcite as gangue, in which the associated minerals are usually pyrite, chalcopyrite, sometimes

molybdenite, galena, gold, and telluride. The Barry-Hollinger, Gold Hill, Hilltop, Grace Lake, Miller Independence, and Ostrom are examples of this type.

2. Heavily mineralized, dominantly sulphide veins, with relatively little quartz or calcite as gangue. Pyrite is usually most abundant with chalcopyrite and generally specularite and molybdenite. Examples of this type are: Telluride, Skead Gold, Gold Bank, and Kalyniuk.

Rock formations, except for relatively narrow shear zones, are massive and non-schistose, so that there is little opportunity for the impregnation of country rock with mineralizing solutions. The result is that mineralization is largely confined within the walls of the veins, and usually there is not very much evidence of replacement of country rock. Gold values are largely dependent upon quartz being present in the fractures; the fractured zone, unless well silicified, is usually barren; low values may be found in the schist ribboned with quartz, and the best values occur where there are wider lenses of quartz in the vein. An exception may be noted, however, where there is heavy sulphide mineralization in which gold is found in association with chalcopyrite, and little or no quartz present.

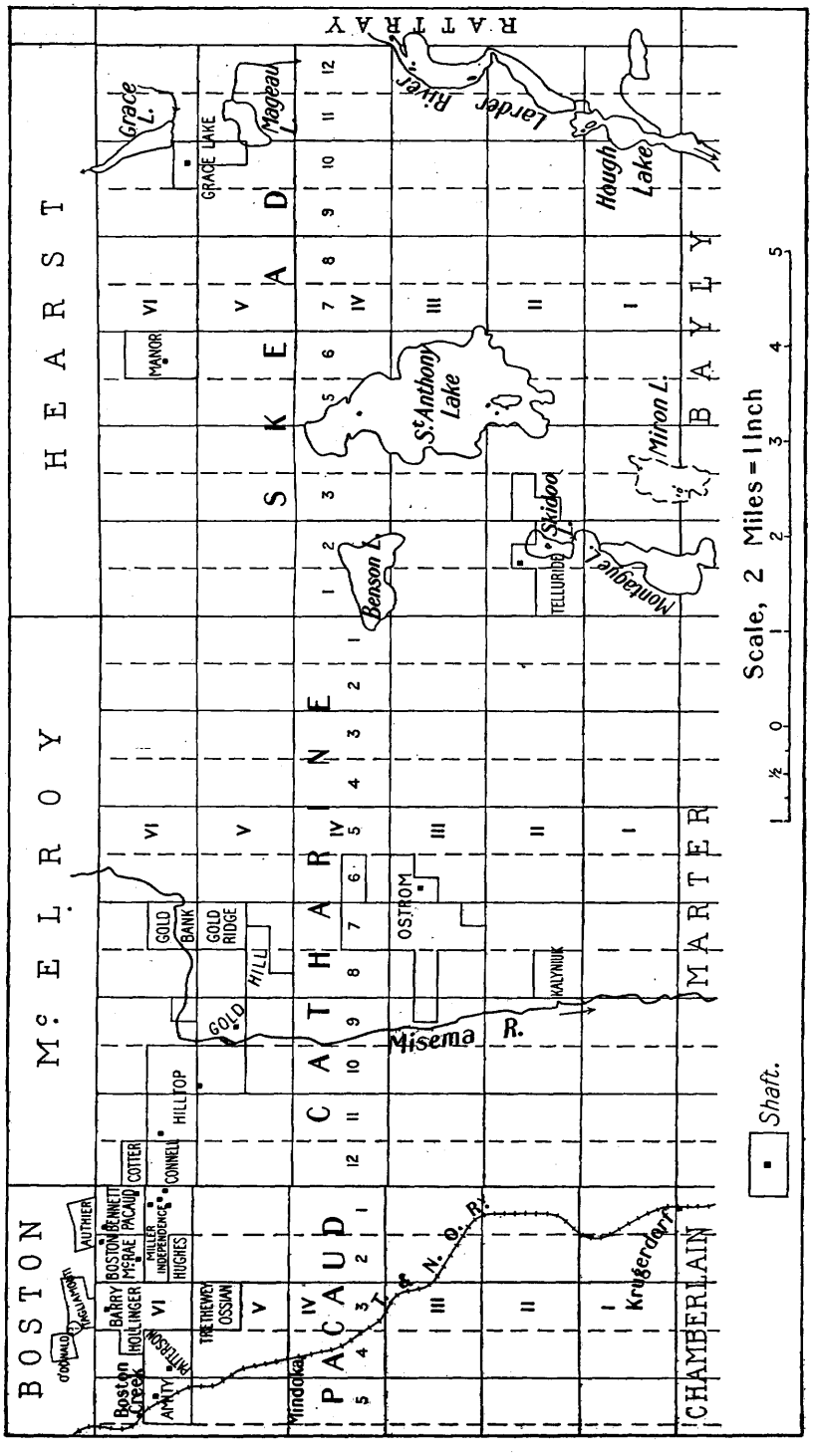
As in other localities in Ontario and in other parts of the world, gold is the latest phase of mineralization. Where visible it frequently has the form of minute veinlets, which have resulted from the fracturing of the older quartz, and it may be introduced with a later generation of quartz. Visible gold frequently occurs along dark chloritic streaks in the enriched vein matter.

Minerals which characterize deposits formed at high temperature are not abundant in the veins of the area, although specularite is common in some of the veins, and tourmaline has been noted in quartz veinlets on the Boston-McRae property. A scarcity of typically high-temperature minerals in the veins at the depth attained in the mines indicates that the veins might be expected to persist to much greater depths.

Since the Boston-Skead area is on an average only 10 to 12 miles distant from the producing mines of Kirkland Lake, it seems probable that the gold is genetically related in the two areas. There is not very much similarity shown structurally, nor in the nature of the associated rocks. The most marked difference between the two areas is to be found in the country rock, which in the Boston-Skead area is usually Keewatin greenstone. At Kirkland Lake the gold is believed to be associated with feldspar porphyry of Algoman age. At Boston Creek, it is similarly associated with feldspar porphyry, which sometimes occurs as apophyses of granitic masses, but it seems likely that the gold is also genetically connected with the granitic intrusions, some of which approach syenite or diorite in composition. The fact that tellurides are rather common in some of the veins in the Boston-Skead area, and more so at Kirkland Lake, suggests a common source for the gold.

COPPER

The pioneering work at the Amity mine in Pacaud township, which has disclosed a copper-bearing band close to the granite contact, has resulted in recent extensive prospecting. It is said that as a result somewhat similar copper-bearing bands have been found in the Keewatin rocks near the contact of the same granite batholith in the townships of Eby, Otto, Marquis, Chamberlain, Dack, Robillard, Truax, and Smyth, forming a narrow semi-circular zone paralleling the granite contact and extending in a northwest and southwest direction from eastern Pacaud township.



Key map showing the location of mines and prospects in the Boston-Skead area.

One of the principal bands, which attains a maximum width of 11 feet on the Amity property, along with several narrower bands occurs in the schisted Keewatin tuff about 100 feet, on an average, north of the granite contact. The bands, which on the surface weather to a gossan, are made up essentially of interbanded quartz and magnetite with pyrite, hornblende, and calcite, and therefore correspond fairly well to the typical iron-formation bands. Two such bands, consisting chiefly of pyrite, may be seen in the first railway cut north of Boston Creek station. One of these may be the continuation of the one that is being worked at the Amity mine.

The copper-bearing solutions that have replaced some of the constituents of the iron formation bands have a genetic connection with the large granite mass along the border of which the bands occur. Copper occurs in the form of chalcopyrite, but bornite was found to be rather plentiful at the depth attained by the Amity, and both must be regarded as primary replacement minerals. Sphalerite, galena, secondary bornite, and malachite are present in small amounts, the last two being derived as alteration products. Assays up to 80 cents in gold and 2 ounces in silver per ton are reported. Copper enrichment seems to be controlled by the presence of cross-fractures, which displace the bands to a small extent, usually not more than a foot or two. Narrow veins of barren quartz usually occupy these cross-fractures and are assumed to have provided a path for the mineral-bearing solutions that resulted in the replacement of some of the constituents of the iron-formation bands. The replacement may be largely confined to the fibrous hornblende or actinolite, which is fairly common in the bands.

The fact that iron formation bands are capable of replacement by ore minerals is significant in this as well as in other pre-Cambrian areas. If these are typical iron-formation bands, as they appear to be, it would seem that similar conditions might be found in other areas, since iron-formation bands occur so commonly in rocks of Keewatin age. The most promising conditions appear to be the occurrence of narrow bands, which are more easily fractured, in close proximity to granitic intrusions.

The nearness of the railroad, which runs through several of the properties, including the Amity and the Patterson, provides excellent facilities for transportation. The Amity mine has shipped several cars of high-grade copper ore to the customs smelter at Noranda.

GALENA AND SPHALERITE

Several veins containing galena and sphalerite, usually in a calcite gangue, occur in the eastern part of Skead township. For example, on claim No. 2,597, lot 12, concession IV, a 2-foot vein containing these minerals may be traced for 500 feet in Keewatin schist and serpentine. Most of these veins appear to be very narrow.

Description of Mining Properties

The propertes describied in the following pages are all gold properties except Amity, Patterson, Trethewey Ossian, Mindoka, and Tough in Pacaud township.

PACAUD TOWNSHIP

Barry-Hollinger

The property of Barry-Hollinger Gold Mines, Limited, formerly known as the Patricia mine, comprises a block of 9 claims, 8 of which are in lot 3, and one in lot 4, concession VI. The mine shaft and buildings are on claim No.

1,793, lot 3. The mine has been operated intermittently since 1917. Mine buildings and mill were destroyed by fire in 1919. A small test mill was operated in 1925-26, which was later, in 1926, replaced by a 150-ton cyanide mill; an Ingersoll-Rand compressor capable of development to 1,500 feet has been installed. The production for 1927 totalled $175,692 in gold, and a total gold production of $329,047 to the end of 1927 is recorded. This accounts for virtually the entire output of the area to that time. In September, 1928, the mine had been developed to the 1,250-foot horizon. A two-compartment shaft extends from surface to the 1,000-foot level, and a three-compartment winze from the south crosscut on the 1,000-foot level to the 1,250-foot horizon. The winze intersects the southward-dipping vein between the 1,000- and 1,250-foot levels.

The entire output of the mine has been derived from one vein, known as No. 7, which strikes N. 57° E. and dips 70° S.E. On all levels, the hanging wall of this vein is a well-defined fault plane. Ore shoots in the vein have been more or less continuously stoped from the surface to the 1,000-foot level, where the ore shoot had an approximate length of 150 feet. In September, 1928, stoping values were indicated in the west drift on the vein on the 1,250-foot level. With depth the ore has a definite pitch to the east. The vein varies considerably in width from hanging to foot wall; at one point on the 1,250-foot level it is 14 feet wide. The vein has been stoped over an average width of 6 feet, although two parallel stopes about 10 feet apart were opened up for a short distance on the 875-foot level, which would give a total width of about 30 feet to the vein zone at this point. The presence of gold is largely dependent on the quartz, which occurs as irregular lenses in the vein, with the result that values are not very consistent, causing a considerable dilution of ore in stoping operations.

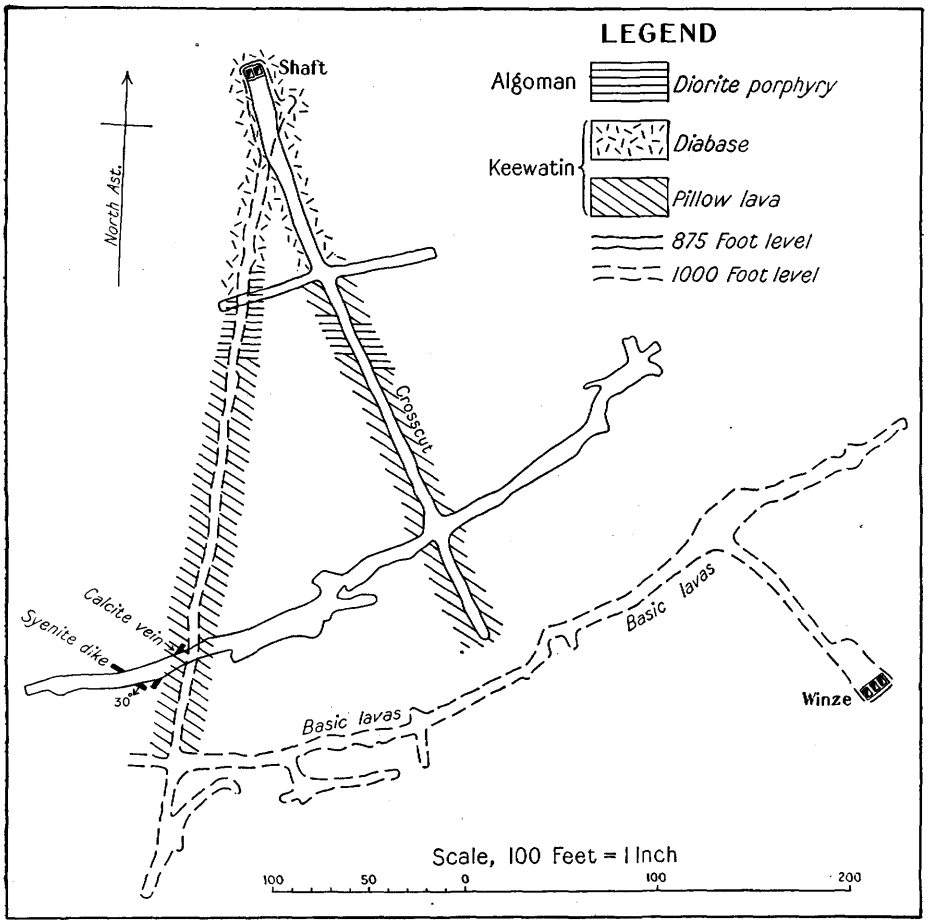
At one of the best faces in the west drift on the 1,250-foot level, the vein near the hanging wall was made up of 8 feet of green schist with a ribboned structure of parallel veinlets of quartz, carrying pyrite with a little chalcopyrite, but on the whole low in gold. The ribboned schist merged into more highly silicified vein matter with lenses and kidneys of quartz forming a 5-foot zone along the footwall. Visible gold was common in the quartz, and chalcopyrite much more abundant; a little calcite was noted and gold values were very much higher than in the schist. It is believed that, on the whole, gold is associated with chalcopyrite rather than with pyrite.

Calcite is very common, particularly in the upper levels of the mine, but does not carry appreciable amounts of gold. Several veins, consisting chiefly of calcite, some of which are later than No. 7 vein, have been intersected in the drifts. Just above the 200-foot level of the mine a calcite vein comes in along the foot wall; the vein has been completely stoped out to the east of the calcite vein, but no appreciable values were found west of it. This seems to indicate that the calcite came in first, and acted as a dam to the gold-bearing solutions of No. 7 vein.

There is considerable evidence of faulting, all of which has preceded ore deposition. The major fault, which is marked by No. 5 vein, strikes in an easterly direction. Near the shaft the fault intersects and displaces a diorite porphyry dike. On the south side of the fault the dike has been displaced 200 feet to the east. The fault is earlier than No. 7 vein, since no displacement of the vein can be seen at their intersection. The dip of the fault could not be ascertained from the surface or underground. Some 300 feet south of this fault is a second fault occupied by No. 8 vein, which has further displaced the

diorite porphyry dike for a distance of approximately 100 feet in the same direction. No. 7 vein may also represent a fault, since the hanging wall shows indications that a movement has taken place along it. There is no information available as to the amount of displacement which may have resulted.

The mine workings are chiefly in Keewatin basic lavas, but the shaft is in Keewatin diabase. Pillow lava was encountered in the crosscut 105 feet south



Geology of the 875- and 1,000-foot levels of the Barry-Hollinger mine.

of the shaft on the 875-foot level; a drift was carried from here for a short distance along the sheared contact. The diorite porphyry dike was cut in the crosscuts on the 1,000- and 875-foot horizons. A few narrow syenite and feldspar porphyry dikes occur in the mine; two of these may be seen in the west drift on the 875-foot level. One of them has a steep dip to the south, and at one point above this level it intersects the vein and forms the roof of a stope, the ore being apparently limited by the dike. Several narrow porphyry dikes with large phenocrysts of feldspar intrude the greenstones near the mine; they are locally termed "bird's eye porphyry." The surface geology of the mine is shown in the detailed map accompanying this report.

Richard Treloar was succeeded by J. Houston as manager of the mine in January, 1929. H. C. Crow is president of the company.

Boston-McRae

Bordering the Barry-Hollinger on the east is the Boston-McRae property, consisting of four claims in the north half of lot 2, concession VI, Pacaud township. The rocks are chiefly Keewatin lavas and diabase as shown on the accompanying map. The compound hornblendite dike already described may be traced completely across the property on to the adjoining Miller Independence claims.

Diamond-drilling was carried out during the winter and spring of 1928, chiefly on the extension of the fault which forms No. 5 vein on the Barry-Hollinger and strikes here slightly to the south of east. Very little vein matter was found in the fault, although there is considerable brecciated material and gouge present. There are several old prospect pits and shafts on mineralized zones, which have been described in previous reports; none of these have been recently reworked.

Miller Independence

The Miller Independence property is made up of six claims, four of which lie in the south half of lot 1 and two in the south half of lot 2, concession VI. The compound dike traced from north of the Barry-Hollinger disappears into low ground south of the serpentine dike near the boundary between lots 1 and 2. Bordering the serpentine dike for a short distance is a 2½-foot vein with the same strike as the dike and made up of contorted bands of green schist, calcite, and quartz, with pyrite and chalcopyrite. It is said to assay $4 to the ton in gold. No. 1 vein is a quartz vein averaging only a foot in width and traceable for about 600 feet in an easterly direction; it has a low dip to the north. The vein carries native gold with tellurides. The Independence vein, which carries native gold and the gold telluride calaverite, was formerly explored to a vertical depth of 500 feet. It strikes N. 22° E. and dips 55° S.E.

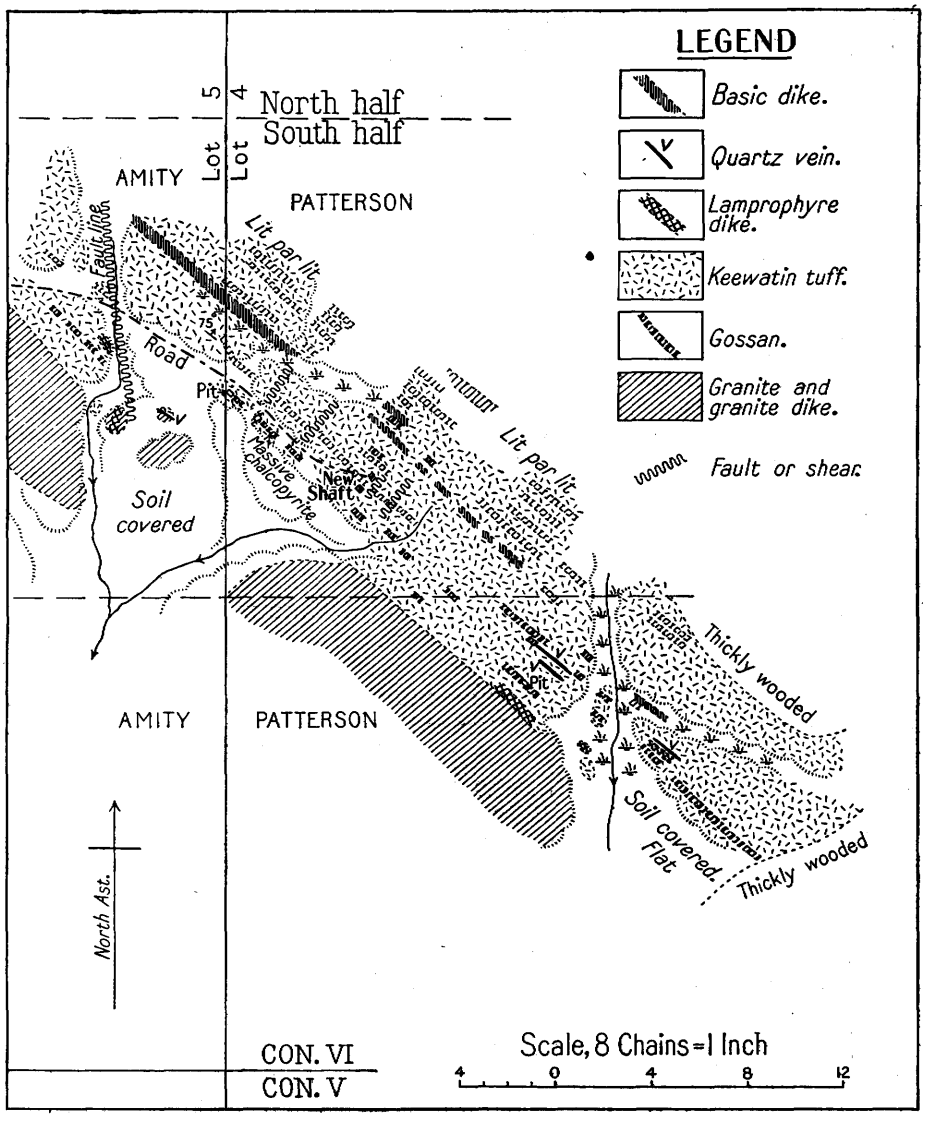
Earlier developments consisted in the sinking of four shafts and several pits on No. 1 and the Independence veins, from which a very small production was derived. More recent work has been confined chiefly to diamond-drilling in an effort to trace the continuation of No. 1 vein along the dip. Although the vein was intersected in several drill-holes and visible gold was seen in one of the cores, it could not be traced for any great distance to the north; this may indicate a steepening in the dip.

Bennett-Pacaud Mines, Limited

Lying adjacent to the Boston-McRae on the east is the Bennett Pacaud property, formerly controlled by the Allied Mining Company. The property consists of four claims in the north half of lot 1, concession VI. The rocks are chiefly Keewatin pillow lavas, coarse basalt, and diabase, which have been intruded by a stock of Algoman granite and numerous dikes of red and grey feldspar porphyry, some of which are offshoots from the granite. Two narrow dikes of Keweenawan diabase may be seen in the central part of the property, and one of these may be traced to the east on to the Gold Hill claims.

Extensive trenching and diamond-drilling have recently been done, especially near the central part of the property, where there is a series of narrow quartz veins, which have a general strike of N. 40° W. One of these veins is distinctly a narrow iron-formation band consisting of interbanded silica and slate with some magnetite and pyrite. At one point it is cut by, and is therefore older than, a feldspar porphyry dike. On the southwest corner of the property there occurs a 60-foot mineralized zone, made up of narrow bands of quartz with pyrites and chalcopyrite, in basalt. Diamond-drilling on the north side

of the outcrop picked up the underground extension of this zone as a series of quartz stringers with a very low dip to the north. Several veins of quartz, some of which are almost flat lying, occur in the granite and in the basalt near



Geological plan of the Amity and Patterson copper properties, Pacaud township.

its contact with the porphyry, near the east boundary of the property. Rather high assays in gold were obtained from some of these narrow veins.

Amity

A description of the geology of the Amity copper mine accompanied by a geological plan of the property appears in a recent report[1] of the Ontario Department of Mines. Recent work at the mine, which is located on the south half of

[1]Ont. Dept. Mines, Vol. XXXVII, pt. 3, 1928, pp. 41-43.

lot 5, concession VI, includes the sinking of the shaft to the 600-foot level, from which lateral work will be carried out. A section of the copper-bearing band, which has a steep dip to the northeast, is reported to have had a width of 11 feet, showing a grade of 7 or 8 per cent. copper on the 350-foot level. Chalcopyrite is the principal ore mineral, although bornite becomes more abundant on the 350-foot horizon. Several cars of high-grade ore have been shipped from the mine.

Patterson

The Patterson Copper Mines, Limited, which is controlled by the Barry-Hollinger Gold Mines, Limited, owns the south half of lot 4, concession VI, Pacaud township, which adjoins the Amity property on the east. A three-compartment shaft is being sunk in Keewatin schist about 200 feet north of the margin of the granite and a short distance north of the copper-bearing sulphide band.

Intruding the schisted tuffaceous Keewatin rocks are a series of narrow granite and felsite dikes, which parallel the strike of the schist. These become so numerous to the north of the shaft as to assume a *lit par lit* structure. A number of basic dikes are also intruded with the same general strike. Several lamprophyre dikes have a somewhat more irregular strike. Hematite is quite abundant in the schist near its contact with the granite.

In addition to the main band there are several other sulphide bands similarly enriched in chalcopyrite. All of these have the same general strike of N. 50° W., which roughly parallels that of the schist. The bands may be traced without much difficulty, since there is usually a surface capping of gossan. Several trenches and pits have been opened up on the principal band, which has been traced completely across the property.

The shaft has been sunk to a depth of 250 feet, and lateral work was carried out on the 125-foot level, the band being cut 93 feet south of the shaft, which indicates a steep dip to the southwest, in contrast to the Amity where the band dips steeply to the northeast. Several cross-fractures, which may have some influence on copper enrichment, have been indicated on the accompanying geological plan, which was supplied by T. L. Gledhill.

An electrically equipped plant has been installed, and accommodation is provided by good camp buildings. J. C. Houston is mine manager.

Trethewey Ossian

On the Trethewey Ossian, which is located on the north half of lot 7, concession V, and corners on the Patterson property, the same geological conditions and the apparent continuation of the same principal sulphide band are to be found. This band, which strikes N. 50° W., has been traced for 2,000 feet on the property, paralleling the granite on the north at an average distance of 120 feet from the contact. The band has been explored by a number of trenches and pits, some of which reveal high-grade chalcopyrite. The property was idle during the summer of 1928, but the company is planning to carry out underground exploration. J. L. Trethewey is president and managing director.

Mindoka and Tough

In addition to the three copper properties mentioned, the Mindoka Mines, Limited, and the Tough interests are carrying on development work in a zone paralleling the granite contact. Three and a half miles southeast of the Amity shaft, the Mindoka Mines, Limited, has sunk a two-compartment shaft 100 feet after having completed a diamond-drilling campaign that indicated a copper-

enriched band. The company controls eight claims a mile and a half east of mileage 149½ on the Temiskaming and Northern Ontario railway.

George Tough has secured control of several claims in the vicinity of Round lake, immediately west of the Amity, where recent trenching a short distance west of Boston Creek station has revealed the probable continuation of the south or main band from the Amity. The apparent extension of the north band appears in the first railway cut west of the station, where it is made up of massive pyrite.

BOSTON TOWNSHIP

Authier

Considerable trenching and stripping have been done on the Authier claims, L. 5,025 and L. 4,737, Boston township. Mineralized quartz veins occur in the Keewatin basalt and lavas as well as in a stock of Algoman granite. Most of these veins strike north of east and have a low dip to the north. Visible gold is common in rather numerous veinlets and narrow veins in the granite and has also been noted in some of the veins that cut the Keewatin rocks. Near the south boundary of claim L. 4,737 a quartz vein in carbonated greenstone strikes north and dips 35° W. The vein has been displaced by a left fault for 20 feet. It is well mineralized with plentiful pyrite. On the southwest corner of the property there is a pyritized zone in Keewatin basalt, striking east and traceable for about 15 chains.

CATHARINE TOWNSHIP

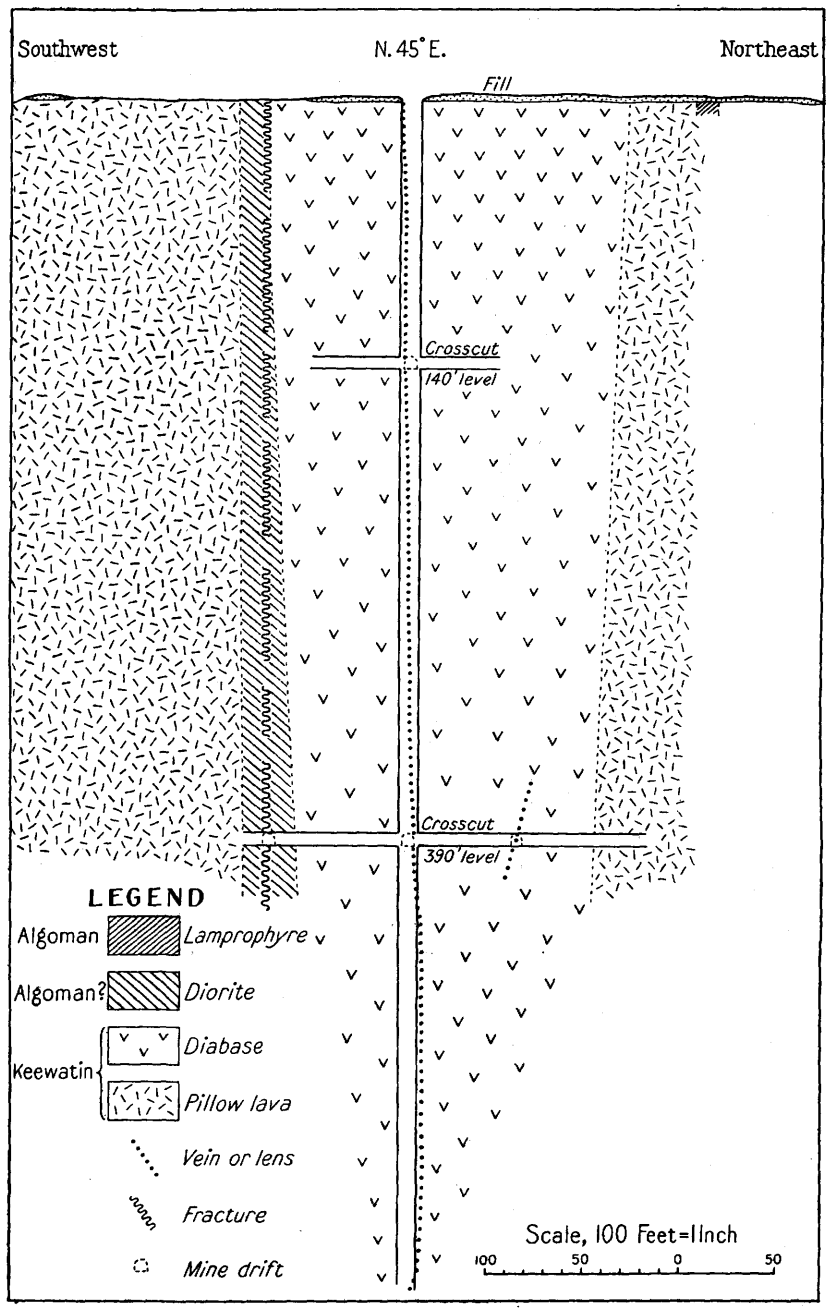
Cotter

The Cotter property consists of the two southern claims in the north half of lot 12, concession VI, Catharine township. A quartz vein dipping 80° S. can be traced in an easterly direction from the Bennett Pacaud claims on to the Cotter property 400 feet north of the south boundary; it is apparently not well mineralized. Nine chains north of the south boundary of the claims, a well-defined fracture can be traced from the Bennett Pacaud east for some distance on the Cotter claims. There is little quartz in the fracture, and the adjoining walls are altered to carbonate. Near the north-south line separating the two claims there is a well-defined fault, of which the east side has apparently moved to the north. The fault has a strike of N. 10° E. and lies along the east contact of a feldspar porphyry dike with Keewatin diabase interbanded with pillow lava; the porphyry is at some points highly sheared. The fracture contains no quartz and is not mineralized. Diamond-drilling near the south boundary of the western claim was done during the summer of 1928.

Hilltop

The property of the Hilltop Gold Mines, Limited, is made up of a group of twelve claims situated in the south halves of lots 10 and 11, concession VI, and the north half of lot 10, concession V, and includes the former Kennedy-Boston property. The rocks consist chiefly of interbanded Keewatin lavas, basalt, diabase, agglomerate, and andesite, the last two being exposed on the northern part of the claims. Intruding the Keewatin rocks are diorite and feldspar porphyry dikes in addition to a dike of lamprophyre and one of Keweenawan diabase. The strike of the intrusive dikes is usually northwest, corresponding roughly to that of the bands of Keewatin rocks.

A shaft, which is in part three-compartment, has been sunk to a depth of over 600 feet in Keewatin diabase on a narrow quartz lens that closely parallels a well-defined fracture, which can be traced from the shaft in a northwesterly



Section showing geology of the Hilltop mine, Catharine township.

direction diagonally across the south half of lot 11. This fracture was formerly explored to a depth of at least 150 feet by a shaft on the Kennedy-Boston property. East of the Hilltop shaft the fracture may be definitely traced for 400 feet. Beyond this there are a number of fractures and shear zones with the same general strike as the vein, but there is not a sufficiently satisfactory correspondence in position to identify any one of them as the extension of the vein to the west Near the shaft the fracture, which dips vertically, is along the north contact of a highly sheared diorite dike, while on the 390-foot level it intersects the dike which has widened considerably. There is very little quartz present, but some pink calcite was noted along with pyrite.

The lens on which the shaft is sunk can be traced for only a short distance on the surface and shows local variations in strike. The dip is practically vertical, as shown by its intersection with the shaft. The lens is within the

Hilltop mining plant, 1928.

shaft on surface and on the 390-foot level. Below this level the lens leaves the shaft to the north, but at 612 feet it is again in the shaft, and is therefore practically vertical for 612 feet. Where encountered it had a width of 14 inches and consisted of banded quartz with pyrite and chalcopyrite, sometimes with enclosed bands of green Keewatin country rock. Very fine visible gold with plentiful chalcopyrite was noted in one specimen.

The mine is well equipped with an electric plant and good buildings. George Tough is managing director, and V. Ronaldson is mine manager. The shaft was sunk to a depth of 680 feet before operations were suspended late in the fall of 1928.

Gold Hill

Adjoining the Hilltop on the east but lying chiefly on the east side of the Misema river are nine claims in lots 9, 8, and 7, concession V, Catharine township, which comprise the property of the Gold Hill Mines, Limited. Mine workings and buildings are confined to the central part of the north half of lot 9. In September, 1928, a two-compartment shaft had been sunk to a depth of 1,000 feet, and in January, 1929, the 1,200-foot horizon had been reached. In addition, a total of 6,000 feet of crosscutting and drifting has been done. A 100-ton mill was installed in the fall of 1927 and was operated during the winter of 1927-28. From this period of mill operation a small production is recorded.

Intruding the Keewatin lavas and diabase is a complex series of intrusions classed as Algoman but differing considerably in form, composition, and age relationships. These rocks, which are particularly abundant in the vicinity of the mine, occur usually as narrow dikes and as irregular stock-like masses, and range from diorites and hornblende syenites to syenite and feldspar porphyries. Some of them are highly altered and sheared along veins and fractures, while others are relatively fresh and unaltered and frequently intersect the veins, and

are thus clearly younger in age. The mine shaft and drifts are in Keewatin basic lavas. Keewatin diabase was encountered in a crosscut to the north on the 800-foot level, and two Keweenawan diabase dikes were intersected in crosscuts to the north and south of the main vein on the same level. On all levels, a diorite dike, at some points altered along the vein to chlorite schist, forms in part the hanging wall of the No. 1 or south vein. Outcrops of this dike may be seen on the surface to the west of the shaft. On the 700-foot level the vein was cut off by a sill of feldspar porphyry near the shaft, and it was found necessary to cut a raise for a short distance in order to drift on the vein above the sill. A pegmatite dike outcrops on the surface to the southeast of the shaft, and was encountered in a crosscut to the south on the 800-foot level. The crosscut was driven as a result of diamond-drilling, which indicated values in or near the dike.

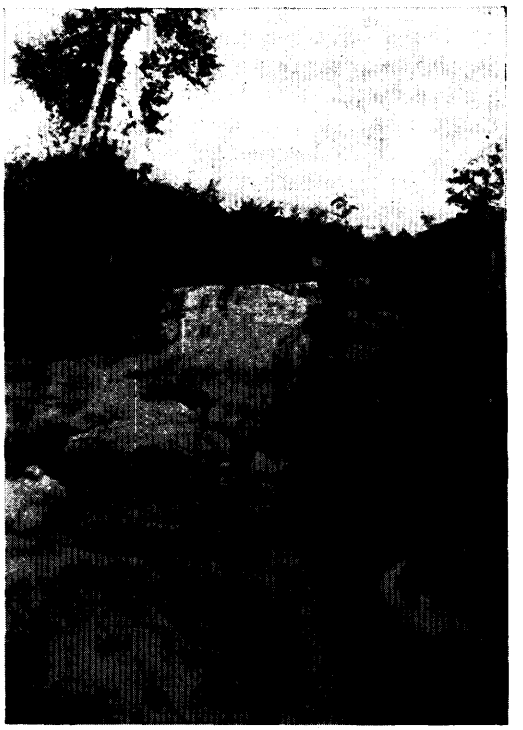
The major development has been confined to No. 1 vein, which strikes N. 60° W. and near the shaft has a steep dip to the north. West of the shaft, however, the dip tends to become vertical. No. 1 vein can be traced on the surface for a distance of only about 500 feet, chiefly to the west of the shaft. It has been drifted on underground for a maximum distance of 900 feet. No. 2 vein is 70 feet northeast of No. 1 vein on the surface and has the same general strike and a similar steep dip to the north. Drifting on this vein has been done only on the 300- and 800-foot levels. It occupies a fairly well-defined fracture on the surface, which can be traced for some distance, principally to the east of the shaft. There have been a few minor displacements of both veins due to faulting but not sufficient to cause any serious difficulty in tracing them underground. No. 1 vein carries good values over narrow widths, averaging about 14 inches, with the result that stopes were made as narrow as possible to avoid dilution of the ore. It has not been found commercially possible to mill ore of the grade obtained from the narrow shoots in the veins, even with the practice of hand-sorting which has been employed at the mine. A certain amount of stoping of No. 1 vein has been done on all levels, and a very small stope was opened up on No. 2 vein on the 800-foot horizon. No. 1 vein has been stoped over a total distance of 250 feet on this level. It is the hope of the management that the veins will widen, or possibly converge at greater depth.

The enriched vein matter consists of banded quartz and sulphides with parallel bands of green chloritic schist, which is in part replaced by quartz and sulphides; pyrite, which is the most abundant; chalcopyrite, molybdenite, and smaller amounts of galena. Gold is usually associated with chalcopyrite, and is occasionally visible in fine grains. Gold values are largely restricted to the quartz, although the wall rock shows a certain amount of mineralization, chiefly of pyrite. Calcite occurs sparingly with the quartz as gangue, and epidote was noted in a drift on the 500-foot level.

Gold Ridge

The Gold Ridge syndicate controls the north half of lot 7, concession V, Catharine township. Very little rock is exposed on the claims except where stripped of overburden, and since these claims lie within the belt of Keewatin andesite and agglomerate little else is to be seen in the trenches. Near the centre of the north half of the lot there is a narrow east-west shear zone in the andesite which can be traced for 400 feet. A pit has been sunk to a depth of 9 feet on this fracture, but was full of water when visited. Very little quartz was to be seen in the material from the pit, although native gold may be panned from the oxidized and rusty-weathering material on the surface. Pyrite with molybdenite was noted in some of the fresher specimens. A short distance southeast of the

main pit is a second narrow shear zone striking N. 60° E. with a 3-inch quartz vein dipping 70° N. Apart from the erection of splendid camp buildings, very little work has been done on the property.



Massive quartz vein in altered Keewatin basalt on the Canoro (Ostrom) property.

Gold Bank

The south half of lot 7, concession VI, Catharine township, has been optioned from the staker, H. Bedford, by the Gold Bank syndicate. The rocks, exposed only by stripping, are Keewatin andesites. There is a well-defined shear zone in the south central part of the property which has a width of approximately 30 feet and strikes N. 58° W. It is apparently not well mineralized. Near it, however, at one point are a series of narrow, irregular veinlets made up largely of massive sulphides with a little quartz. The chief sulphide is pyrite, and there is considerable molybdenite and a smaller amount of chalcopyrite. Some of these little sulphide stringers tend to merge into the main sheared zone. The country rock is mineralized to some extent in the vicinity, and there is much rusty-weathering material. Samples of massive sulphides from some of the narrow stringers yielded on assay $2.40 in gold per ton. Considerable trenching and stripping have been done, and several pits have been sunk on the property.

Canoro Gold Copper Mines, Limited

A group of 19 claims, most of which are in lots 6 and 7, concessions III and IV, Catharine township, is owned by Canoro Gold Copper Mines, Limited (formerly the Ostrom Gold Mines.) The rocks are Keewatin pillow lavas,

basalts, and diabase, with minor intrusions of diorite, feldspar porphyry, and felsite dikes. Surface exploration has revealed over thirty veins with various dips and strikes, but a northwest-southeast strike predominates. Some of the veins are very wide; others are just fractures with a little quartz. The commonest type are massive, usually milky quartz veins. Some of the veins are well mineralized and others contain only barren quartz. Pyrite is the commonest mineral; chalcopyrite and specularite occur in smaller amounts. Visible gold is common in No. 12 vein, and a spectacular occurrence of gold was seen on the margin of vein No. 14. Crossing the two northern claims in the south half of lot 7, concession IV, is a wide mineralized zone striking northwest. The rock is much altered to rusty-weathering carbonate and is cut by numerous quartz stringers. The walls of some of the veins show extreme alteration to carbonate, the iron in which is oxidized on the surface to rusty-weathering material. The altered zone adjacent to the veins has an average width of 12 to 15 feet. The altered rock is grey or reddish in colour and may be mistaken for porphyry. Alteration is very marked on the margins of veins No. 12, 14, and 4, but several other veins show relatively little alteration of the wall rocks.

An inclined shaft has been sunk to a vertical depth of 500 feet on No. 12 vein, which dips 65° S. and strikes N. 50° E. Some 1,200 feet of drifting and crosscutting has been done on this level. The vein dipped below the shaft at a depth of 110 feet. Crosscutting to the north on the 500-foot level failed to intersect it, although a fault which may represent the vein was found a short distance to the north of the shaft. A crosscut was driven 270 feet to the south on the same level to No. 14 vein, which was drifted on for a short distance. This wide vein is made up chiefly of massive, milky quartz. It strikes east and dips 50° S. On the surface it is seen to be intruded by narrow dikes of pink felsite.

Several veins on the property have been explored by diamond-drilling, which usually indicated a dip to the south; considerable trenching has been done, and several pits have been sunk. Steam power is utilized and plentiful timber is available on the property as fuel. Operations were suspended, and the shaft was full of water when visited in August, 1928. G. E. Silvester is managing director of the mine.

Kalyniuk

On the south half of lot 8, concession II, Catharine township, a test pit has been sunk by D. Kalyniuk on two closely spaced mineralized veins in Keewatin diabase, which strike east. Both veins are exposed about 4 feet apart in the one pit; the southern vein consists of about 1 foot of banded dark quartz, heavily mineralized with pyrite and a little chalcopyrite. The other vein is somewhat narrower. A sample from the wider vein yielded, on assay, $4.80 in gold per ton.

McELROY TOWNSHIP

Judge

J. Judge is working a group of nine claims in the southwestern part of McElroy township, four of these being bordered by the southern boundary of the township. In this group are the claims of the former Jimgo mines, including patented claim L. 4,409, on which is a vein, 8 to 10 feet wide, in Keewatin greenstone. The vein has an exposed length of about 50 feet but is said to be traceable for about half a mile in a northeasterly direction. The walls of the vein, which are fairly well defined, indicate a steep dip to the south. Pyrite and chalcopyrite with secondary bornite, chalcocite, and malachite occur usually as somewhat

irregular pockets in a gangue consisting of about equal proportions of quartz and calcite. Assays show some values in gold. A second vein, striking northeast and carrying pyrites with chalcopyrite and molybdenite, occurs on claim L. 20,554. Considerable trenching has been done, and several test pits have been sunk.

SKEAD TOWNSHIP

Telluride

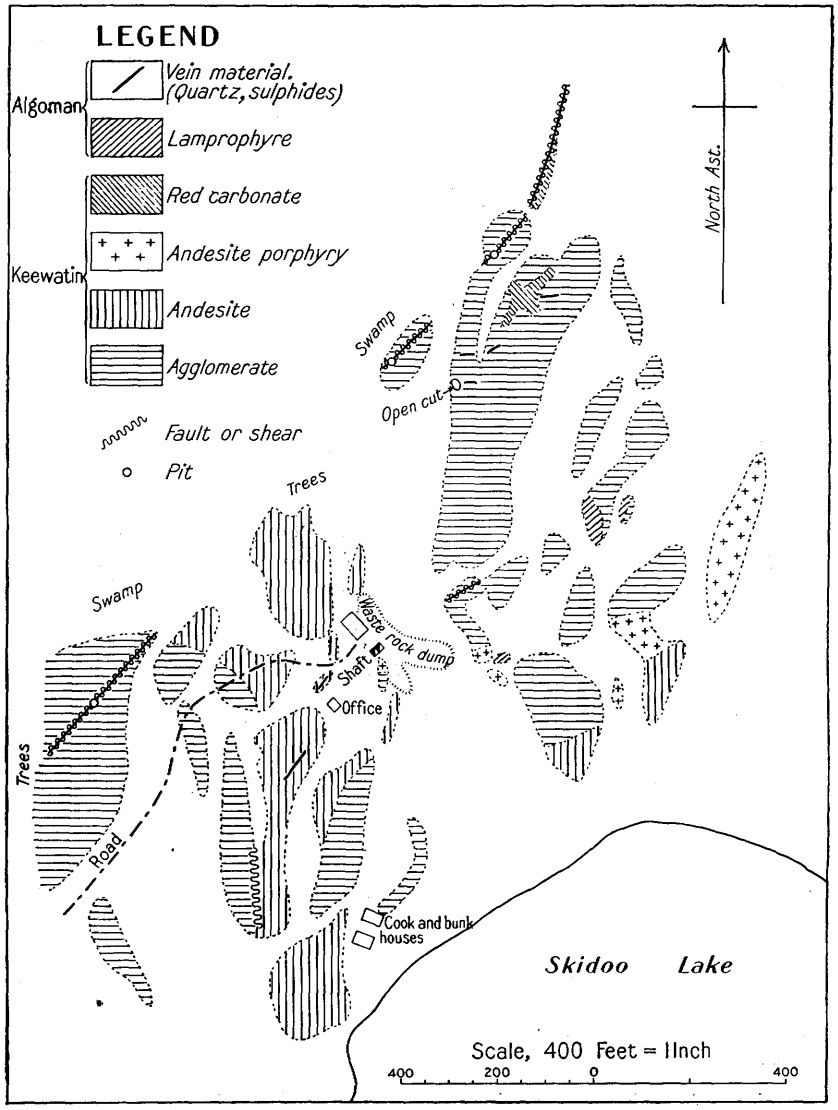
The Telluride Gold Mines of Canada, Limited, consist of 12 claims in lots 1, 2, and 3, concession II, Skead township. Development is confined chiefly to the southwestern claim in the north half of lot 2. The rocks are light-weathering Keewatin andesite and agglomerate, which are at some points, chiefly along veins and fractures, highly altered to reddish carbonate rock resembling porphyry.

Headframe, boiler-house, and blacksmith shop,
Telluride mine, Skead township.

Several small dikes of lamprophyre outcrop on the surface and have been encountered underground. Some of these dikes have such low dips as to be sill-like in character.

A shaft has been sunk to a depth of 370 feet, and lateral exploration has been carried out on the 150- and 250-foot levels. A vein with an apparent vertical dip and a strike slightly north of east has been drifted on to the east of the shaft on the 150-foot level. Approximately 50 feet of enriched vein matter, which carries fair values in gold over rather narrow widths, is disclosed in the drift. It is made up of parallel bands several inches in width and a few inches to 3 or 4 feet apart in the drift. These consist either of banded sulphides, chiefly chalcopyrite with specular hematite, or of banded quartz and calcite highly mineralized with chalcopyrite, fine-grained pyrite, and specularite; chalcopyrite is relatively very abundant. This portion of the vein is bounded on the west by a fault which dips 55° W. and strikes N. 25° E. The fault also intersects the shaft. On the east the vein tends to split up and in part swings off to the south. Vein walls are usually not well defined and do not show much shearing. Although several veins and fractures, some of which are mineralized, were encountered on

the 250-foot level, the downward continuation of the main vein has not been definitely established. Drifting to the west of the fault on the 150-foot level, failed to give encouraging results, although specular iron occurs along the contact of a narrow sill-like dike of lamprophyre with porphyritic andesite



Geology in vicinity of the Telluride mine, Skead township.

west of the shaft on this level. It is stated in recent reports from the mine that a crosscut to the north on the 250-foot level has cut a well-mineralized vein along the contact of lamprophyre with what is termed red feldspar porphyry, but which may be altered and reddened porphyritic Keewatin andesite.

The mine is at present operated by steam power, but it is the intention of the company to bring in electric power from the Quinze-Rouyn power-line. D. M. Gilpin of Toronto is president, and H. Hollands-Hurst mine manager.

Skead Gold

Adjoining the Telluride property on the north is claim L.S. 30. The geology of a part of both properties is shown on the accompanying geological plan. This claim was formerly worked by the Skead Gold Mines, Limited, and several narrow sulphide veins striking east were explored in a small open cut. Pits were also sunk on a banded quartz vein in a shear zone striking east of north. The vein is well mineralized with pyrite and molybdenite.

Manor Gold Mines

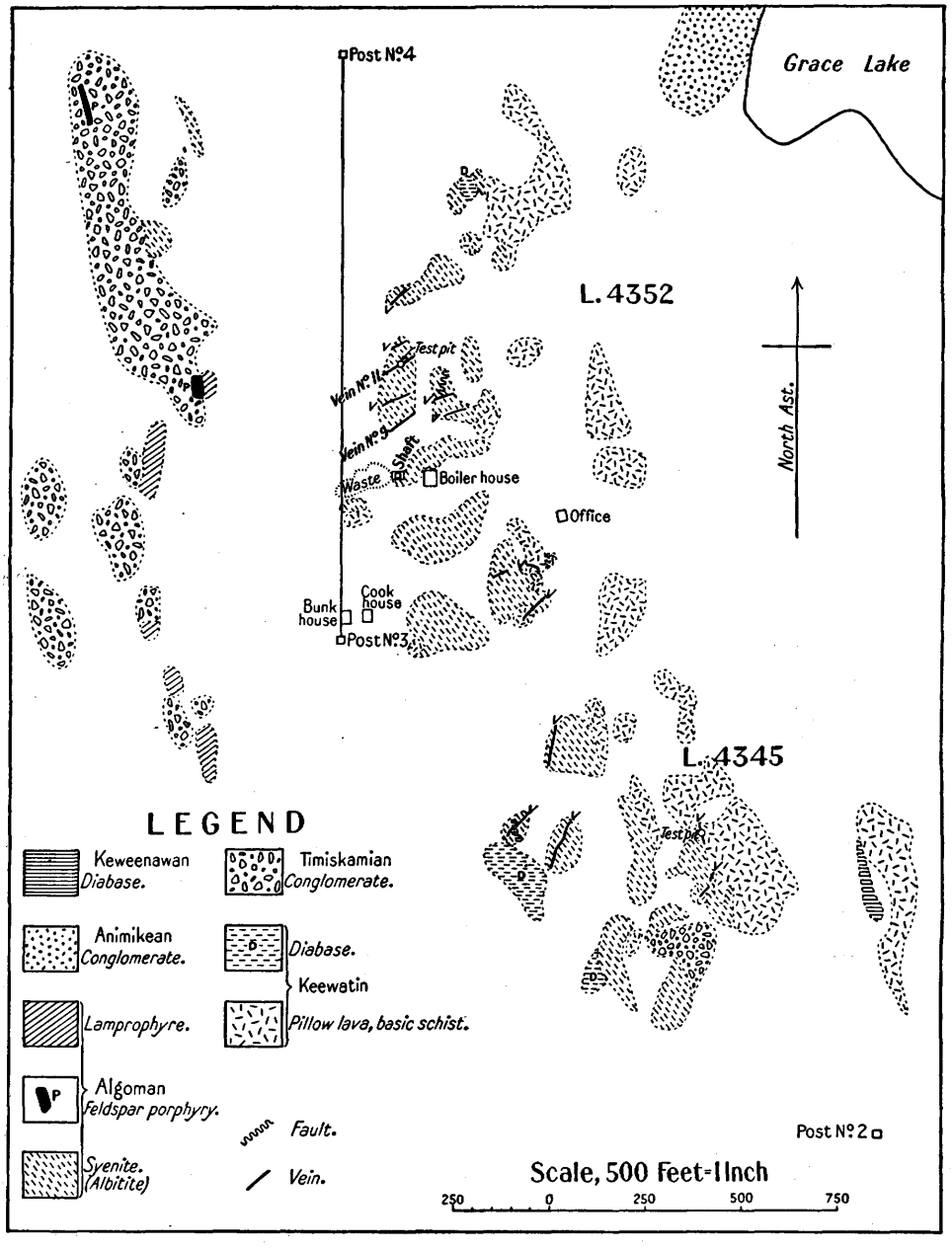
The property of the Manor Gold mines in Skead township is on lot 6, concession VI. On claim L.S. 128 a two-compartment shaft was sunk to a depth of 500 feet; about 1,000 feet of lateral work was done on the 225-foot and about 400 feet on the 475-foot horizon. There is a well-equipped steam plant and 4-drill compressor capable of working to a depth of 1,000 feet. The mine was closed down late in the fall of 1927.

Keewatin lavas, at some points highly serpentinized, are the most widespread rocks on the property. Timiskaming sediments are found on the northern part. Two hundred feet east of the shaft a fault with a northerly strike displaces the contact of a porphyry dike with Keewatin basalt for a distance of 12 feet. Southwest of the shaft is an extensive outcrop of pink felsite or rhyolite. Little quartz was noted on the dump, but some calcite, chlorite, and scattered cubes of pyrite were seen, together with much talcose and serpentinized material. There is apparently no well-defined vein. This property, once known as the Manley-O'Reilly, was originally staked owing to a spectacular surface showing of visible gold.

Grace Lake

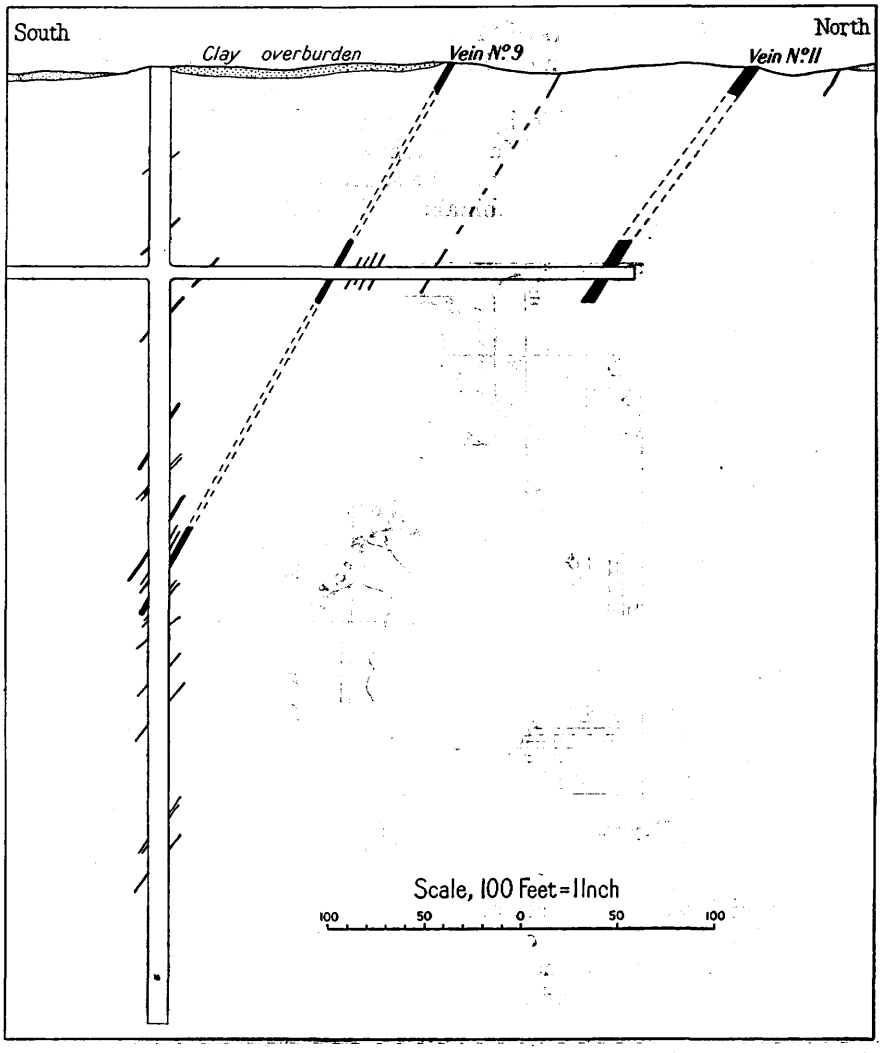
The Grace Lake property, formerly known as the Wisconsin-Skead, comprises four mining claims in lot 10, concession V, and lot 10, concession VI, Skead township. Exposed on the claims are Keewatin greenstones, in part altered to schist, metamorphosed Timiskaming sediments, and rocks of Algoman age represented by a wide dike of pink syenite, a dike of mica lamprophyre, and several smaller dikes of feldspar porphyry. Cobalt conglomerate is also exposed along the western edge of Grace lake, and there are a few outcrops of Keweenawan diabase. Numerous quartz veins, some of which carry gold, occur in the syenite, with which they are probably genetically connected. The syenite dike has an average width of 350 feet and crosses three of the claims in a northwesterly direction. Keewatin greenstone and Timiskaming sediments form the country rock of the dike. Although termed a syenite dike, the rock does not correspond mineralogically to a typical syenite, being composed essentially of albite feldspar and lacking in ferromagnesian minerals. The albite feldspar, which is much altered to sericite and calcite, occasionally shows a perthitic intergrowth. The texture of the rock is usually granitic, although it may become porphyritic in places. The term albitite has been applied to rocks with a similar mineralogical composition.

Cutting the dike transversely are a series of parallel quartz veins, which dip from 40° to 50° S. With a few exceptions these veins are quite narrow. On claim L. 4,352, where most of the veins occur, a two-compartment shaft has been sunk to a depth of 500 feet in the syenite (albitite). Lateral work is confined to the 112-foot level, where drifting has been done on No. 9 vein, which has a width of 3 feet, and on No. 11 vein, which has a width of 5 feet. What is apparently No. 9 vein was cut in the shaft at a depth of 270 feet, where it has a width



Geological sketch map of Grace Lake gold mine, Skead township.

of 2 feet and is well mineralized. No. 14 vein does not appear in the shaft, which may indicate a steepening in its dip. A number of narrow quartz veins and veinlets, which are usually well mineralized, and all of which dip to the south, occur in the shaft below the 112-foot level. Some of these are rather



Section showing veins in shaft and crosscuts of the Grace Lake mine, Skead township.

closely spaced over a vertical distance of 25 feet. Visible gold is very common in the veins and veinlets along with pyrites, molybdenite, chalcopyrite, and a telluride.

Steam power is augmented by a gasoline-driven compressor. The mine was closed down during September, 1928, but the shaft was kept dewatered. A. E. Costello is the managing director, and Theo. La Fond is mine foreman.

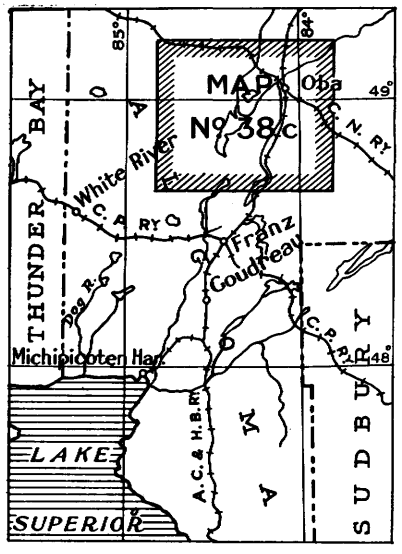
Oba Area, District of Algoma

By J. E. Maynard

Introduction

Oba map-area includes parts of 12 townships adjacent to the village of Oba, which is situated at the junction of the Canadian National and Algoma Central and Hudson Bay railways.

The area is easily accessible by canoe routes from Oba and by the two railways mentioned above. The Mattawitchewan river furnishes access to the northeastern part, and the Oba river to the southern and southwestern parts of the area. The Oba empties into Kabinakagami lake, a beautiful body of water



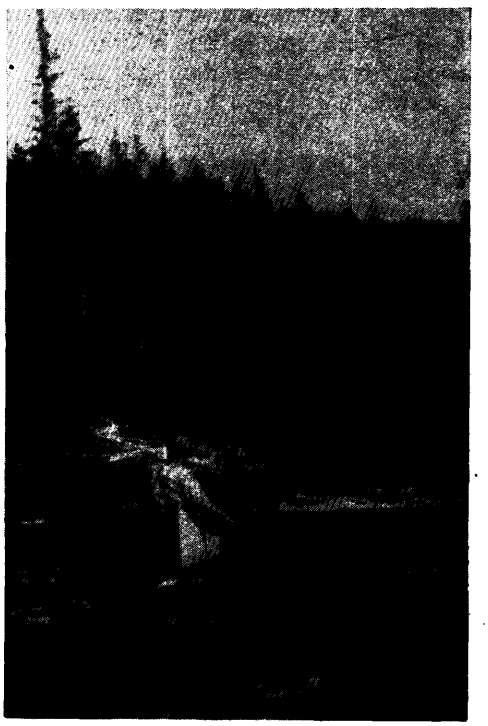
Key map showing location of the Oba area.
Scale, 50 miles to the inch.

16 miles long with wooded shores and many islands, which also receives the waters of Kabinakagami river from the southwest and is drained to the north by the same river. The Algoma Central and Hudson Bay railway traverses the area from north to south and the Canadian National railway from southeast to northwest.

In 1916, T. L. Tanton examined and mapped the belt that is traversed by the Canadian Northern railway between Gogama and Oba.[1] Sheet 2[2] of his map covers the section between Oatland and Penhurst. With the exception of this work no geological mapping had previously been attempted. Tanton's work consisted of a reconnaissance of the geology along the railway and along the adjacent waterways. T. L. Gledhill,[3] however, paid a short visit to a portion of the area in 1926, and E. S. Moore in 1927.

[1]Geol. Surv. Can., Sum. Rept., 1916, pp. 179-81.
[2]Geol. Surv. Can., Pub. No. 1698.
[3]Ont. Dept. Mines, Vol. XXXVI, pt. 2, 1927, pp. 85, 86.

The writer wishes to thank S. C. Perry, A. A. Hildebrand, and L. J. Sutton, assistants, for their very efficient aid in carrying on the work of the survey. Acknowledgment is also due to B. Wilson, Chief Forester, and members of the Forestry Branch, Oba, for many courtesies. Thanks are especially due to S. Culbert, J. Dubroy, and F. Brown, of Oba, for furnishing information and assistance. The writer is also indebted to H. Lajeunesse and party, and W. Penly, who were prospecting in the area, for a great many kindnesses.



Trout pool at the foot of High falls,
Kabinakagamisis river,
Nameigos township.

General Character of the Area

Topography

The topography of the Oba area exhibits the typical low monotonous relief of the pre-Cambrian shield. It has been modified, however, by the retreating Labradorean ice-sheet, which has filled up the pre-glacial depressions with glacial and fluvio-glacial deposits of clay, silt, sand, and gravel, leaving large areas of relatively flat-lying land now covered with spruce swamps.

The general elevation of the surface is from 1,200 to 1,300 feet above sea-level with a few hills and ridges rising here and there from 100 to 200 feet above the surrounding country. The greater number of these hills and ridges are south of the Canadian National railway. In general the higher hills consist of greenstone cut by massive diabase dikes. In the southern and eastern part of the area, however, granite is the most prominent ridge-forming rock.

Although lakes are not as numerous as in other pre-Cambrian areas, they are of the same general types: (1) those occupying unfilled parts of swamps in

drift-covered areas, (2) those occupying irregularly shaped depressions in drift-covered areas, and (3) those with rock rims. Lakes of the first-named type are scattered throughout the area, but are relatively more numerous in the northern part. They are, in general, small, rarely being more than two miles across. Edison lake, just south of Albany Forks, is one of the largest. Lakes of the second type are quite numerous, especially just south of the Oba river where it empties into Kabinakagami lake. Kabinakagamisis lake, in the northeast corner of Lipton township, is one of the large lakes of this class. Kabinakagami lake, the largest in the area, is typical of the third class, being irregular in outline and having many islands. Nameigos lake is a long, narrow, rock-rimmed lake, with few islands. It appears to have been a pre-glacial valley which was deepened and altered by glacial action.

Camp on the Oba river, showing the low, flat topography so characteristic of a great part of the area.

As mentioned previously the depressions in the rock surface of a large part of the region are filled with glacial drift. Consequently this material forms the channels through which the rivers of the region flow. Where the streams have cut through to the rock below, rapids and falls have resulted, and in general it is only at these spots along their courses that rock outcrops may be seen. The clay banks of the streams are, for the most part, quite low; as a result the greater part of the surrounding territory is very flat and covered with spruce swamps.

Forests

The trees of the region include white and black spruce, tamarac, jackpine, red pine, white birch, balsam, balm of gilead, cedar, and poplar. Although a large portion of the area has been burned there is still much timber valuable for pulpwood. During the construction of the railways considerable jackpine was cut for railway ties, but at present the chief industry is in spruce, which is used for pulpwood. A large portion of the area, however, especially in the vicinity of the Algoma Central railway, has already been logged. The only red pine noticed was a small stand on Pine portage, which is too small to be of value for lumber.

Game and Fish

The area is especially noted for moose, fifteen having been seen at one time by members of the party. Deer and caribou are quite plentiful, although less numerous than moose. Rabbits and partridges are very scarce.

Among the fur-bearing animals are fox, beaver, bear, mink, otter, fisher, and muskrat. Owing to the fact that part of the Chapleau game preserve is in the area, these animals are again becoming quite numerous.

The large lakes are well stocked with pike, pickerel, and whitefish. The small streams, especially near their headwaters, contain large numbers of speckled trout.

Water Power

There are several waterfalls throughout the courses of the rivers, but the volume of water is not sufficient for the development of hydro-electric power on any considerable scale. On the other hand, Kabinakagami lake may become quite important as a storage basin.

Agricultural Possibilities

Throughout the northern part of the area extensive areas of lacustrine and fluvio-glacial clays form a soil quite suitable for agricultural purposes. Unlike other parts of the pre-Cambrian the large undrained swamps in this area have only a very shallow layer of peat above the surface of the underlying clay. Although some of the townships have been subdivided the only agricultural development is in the villages along the railways, where a small amount of garden produce has been raised.

General Geology

The rocks of the Oba map area are similar in their broader characteristics to those of the Michipicoten and Missinaibi map areas, which are situated at some distance to the south. They can be separated into five main groups: early pre-Cambrian older batholithic intrusive, early pre-Cambrian schist complex, early pre-Cambrian younger batholithic intrusives, late pre-Cambrian dikes, and Pleistocene glacial deposits. The older batholithic intrusive appears to be similar in age to the granite gneisses that Collins and Quirke[1] have included in the early pre-Cambrian schist complex.

Table of Formations

RECENT: Swamp, river, and lake deposits—peat, sand, gravel, and clay.

PLEISTOCENE:
Glacial drift; fluvio-glacial deposits of gravel, sand, silt, and clay; stratified clay deposits.

LATE PRE-CAMBRIAN:
Intrusives: Diabase in dikes and bosses, porphyritic and non-porphyritic, olivine and quartz varieties.

EARLY PRE-CAMBRIAN:
Batholithic intrusives: Granite, granite gneiss, granodiorite, granite porphyry; associated aplite, lamprophyre, and pegmatite dikes.

Schist complex: Ellipsoidal greenstones; biotite, chlorite, sericite, and hornblende schists.

Batholithic intrusive: Well banded and granulated quartz, biotite, and hornblende. gneiss (possibly older than the schist complex).

[1]Michipicoten Iron Ranges, Geol. Surv. Can., Mem. 147, 1926.

Older Batholithic Intrusive

Evidence has been produced by Collins and Quirke[1] to indicate that there were at least two periods of batholithic intrusion in the early pre-Cambrian of the Michipicoten region. They state that "the granite gneiss in the northern and western parts of the map area is . . . composed partly of rocks younger than the post-Dorean volcanics and partly of rocks older than the Doré series." Although the Doré series and probably the post-Dorean are lacking in the Oba map-area, there is quite definite evidence in support of two periods of batholithic intrusion. Outcropping in a cut on the Algoma Central railway at mile-post 236 is a pale-grey well-banded granite gneiss, which has been highly folded and squeezed and dips steeply to the north. This ancient gneiss is exposed at numerous points along the Trout and Kabinakagami rivers, and in Hawkins township. in the vicinity of mile-post 1½ on the west boundary. In hand specimens, it resembles a fine-grained rhyolite or porphyry, but it is not so well banded. Under the microscope the rock was found to consist essentially of well-granulated quartz and feldspar. Biotite and hornblende are the chief ferromagnesian minerals, some sections showing a predominance of biotite, others of hornblende. The porphyritic appearance of the rock is due to some of the quartz and feldspar crystals being able partially to withstand the forces that produced the granulation; as a consequence, to the eye they appear to be crystals set in a definite groundmass. The contact of the grey granite gneiss with the younger more prevalent granite of the region was found only at one place, namely, just west of the Oba river, opposite mile-post 235½, on the Algoma Central railway. At this point the banded granite gneiss, which strikes E. 30° S. and dips 60° S.W., is in definite contact with a massive coarse-grained biotite granite. There is no doubt that the massive biotite granite intruded the old granite gneiss at some period after the gneiss had been folded. The contact was clear-cut and resembled that of a diabase dike. Further evidence of two granites is mainly lithological, the older being much more shattered, granulated, and recrystallized than the younger, although the metamorphism has not developed to such an extent that it hides the plutonic origin. Since there is no conglomerate in the map area carrying boulders of this older gneiss and also since its contacts with the schist complex are commonly hidden, it is very difficult to determine its exact age. All that can be said is that there is an older granite gneiss which may or may not be older than the schist complex but which is definitely older than the more prevalent granites and gneisses of the area.

Schist Complex

Although these rocks are among the oldest in the region they constitute a relatively small fraction of the rock formation. Three belts of these schist complex rocks, varying from one-half to two miles in width, pass in a westerly direction through the central part of the townships of Walls and Hawkins. The northern belt crosses the Canadian National railway at mile-post 107 and ends one mile west of mile-post 243 on the Algoma Central railway. The central and southern belts join just east of the west boundary of Hawkins township and then pass in a northwesterly direction through the township of Derry, crossing the Kabinakagami river just at the outlet of Kabinakagami lake. A fourth belt crosses the southwest corner of Hawkins township, makes a sharp break to the southwest in Derry township, and continues southwestward through the townships of Ermine, Lizar, and Nameigos. A fifth belt crosses the west boundary of Irving township, passes westward through Ermine township, and turns south-

[1]Geol. Surv. Can., Mem. 147, 1926, p. 36.

westward through Lizar and Mosambik townships, where it converges at the west boundary of the latter township with a sixth belt that crosses Mosambik township from east to west. These combined belts continue southwest into Nameigos township where they converge with the fourth belt mentioned above. A further belt extends through the central part of the township of Franz, passes northeast along the valley of the Mattawitchewan river through the township of Roche and into the townships of Talbott and Scholfield.

These ancient rocks have been variously classified as greenstones, volcanic complex, or schist complex. In the Oba map area the most appropriate term is schist complex, since 90 per cent. of the formation is composed of intensely folded and highly schistose rocks. This schist complex is composed essentially of biotite, chlorite, hornblende, and sericite schists, and they are believed to have originated from a complex series of lava flows and sediments through intense folding and shearing with the concomitant formation of the principal secondary minerals.

By far the greater portion of the schist complex consists of highly stratiform or even delicately laminated dark-coloured mica schists. There is little to indicate the nature of these schists except the occasional occurrence of small fragments like those in volcanic tuffs. They appear to correspond, lithologically, with the lower part of the pre-Dorean of Collins.

Intercalated with the mica schists are numerous bands of hornblende schist. These bands are more massive than the mica schist and show relatively less schistosity. The rock is quite coarse in texture and consists essentially of large crystals of hornblende, which are intergrown at various angles. Some carbonate and chlorite are present. It appears to have been derived from a basic volcanic lava by the contact action of the intruding granite. Exceptionally fine exposures can be seen on the Trout river in Nameigos township.

Chlorite schists are abundant. They are intercalated throughout the undifferentiated schist complex. They appear to be developed where shearing has been effective but where the contact action of the granite has not been sufficient to change the original lava into a hornblende schist.

Acid phases of the schist complex occur sparingly. In no place is there a zone of massive acid rocks, but occasionally there are small bands of sericite schist.

Good examples of typical ellipsoidal greenstone occur at only a few places throughout the map area. A small exposure was seen at the outlet of Nameigos lake. There are also exposures along the township line between Nameigos and Mosambik. On Windy point, in Kabinakagami lake, there is a rock exposure that is composed of lenticular masses of rock that appear to be flattened pillows.

The schist complex in the northern part of the area, especially north of Oba and along the Mattawitchewan river, is markedly different from that described above. The formation consists of a thick series of fine to coarse grained, banded mica schists and gneisses with here and there a small amount of hornblende schist, which is always in close proximity to the granite contact. It is quite possible, also, that minor amounts of highly altered tuffs and agglomerates may occur throughout the formation. No attempt was made to differentiate the various components.

Younger Batholithic Intrusives

This group with its associated dike phases underlies the greater part of the map area. There is no doubt, however, that areas of the older granite gneiss have been included with this group; for, as mentioned previously, it was only possible at one point to distinguish absolutely between the two. The rock

exposures show both gneissic and granitoid types, the former being the more abundant.

The individual rocks are chiefly granites and granodiorites and their corresponding gneisses. Porphyritic granite also occurs. Biotite granite and gneiss are the most prevalent and widespread of these rocks. They occur abundantly in the vicinity of Oba, Kabinakagami lake, and at numerous other localities. Although not so abundant, more basic differentiates occur at numerous points. About a mile south of the high falls on the Kabinakagami river, in the township of Nameigos, the schist complex is cut off by high hills of hornblende granite, which is quite fresh and massive and shows little evidence of a gneissic structure. It is cut by numerous diabase dikes. In the eastern part of the area, especially in the southeast corner of the township of Walls, the prevailing rock is massive and gneissic granodiorite. In places it is almost a hornblende gneiss. The principal occurrences of porphyritic granite lie along the central part of the east boundary of the township of Walls. It is not a true porphyry, as it does not consist of phenocrysts in a groundmass of finer crystals, but rather it is a granite in which some of the feldspars are idiomorphic and of considerable size. The pink feldspar crystals attain a diameter of one inch, but the average is only about half this size. Hornblende is the dominant ferromagnesian mineral.

As mentioned previously, the schist complex in the northern part of the area is intruded by a complex stockwork of granite and pegmatite. The bulk of this intrusive is more of the type of a pegmatitic granite. It is almost white or light-grey in colour and varies from medium to coarse in grain.

The greater part of the rock is made up of quartz and feldspar, the feldspar being the most abundant constituent, in places forming almost the entire rock. Biotite is an abundant ferromagnesian mineral; here and there it gives place in whole or in part to white mica, crystals up to 4 inches in diameter occurring in the pegmatites along the Mattawitchewan river in the township of Roche.

Pegmatite dikes are the most numerous of the associated dike phases. They are found within the main granite masses, in the marginal contact zones of the schist complex, and as apophyses cutting across the belts of schist complex.

Aplite dikes are found cutting the granite and the schist complex. Those cutting the schist complex in the townships of Walls and Hawkins are of especial interest. The dikes have intruded the schist complex parallel to the strike of its schistosity and have formed a *lit par lit* structure. The dikes range in width from a few inches to several feet and in places may form as much as 25 per cent. of the country rock. In hand specimens the rock has the appearance of a fine-grained quartz porphyry or of a rhyolite. Under the microscope, however, it was found to be holocrystalline, consisting of quartz, plagioclase feldspar (oligoclase), microcline, orthoclase and small amounts of white mica (muscovite) or hornblende, depending on the location from which the sample was taken. It, therefore, is more correctly called an aplite.

The aplite dikes, as well as the enclosing schists, have undergone considerable shearing, although it is more marked in the former than in the latter. This fact indicates that the dikes have been subjected to at least part of the deformation that the country rock has undergone, and it is probable that they were intruded towards the end of the mountain-building period that produced the folding in the schists, and that they belong to a fairly late stage in the igneous activity which produced the granite batholiths. The aplites, in places, have been wholly or partially replaced by gold-bearing quartz veins. Massive fresh pegmatite dikes cut across the schist complex, aplites, and quartz veins, which shows that the pegmatites were the final phases of the deep-seated igneous activity.

Lamprophyre dikes are quite rare throughout the map area. The only occurrence noted was at mile-post 236 on the Algoma Central railway. At this point a highly contorted, fine-grained, light-grey granite gneiss is cut by an 8-inch dike of mica lamprophyre. Both the gneiss and the lamprophyre are cut by a 5-inch dike of fresh red biotite granite.

Late Pre-Cambrian Dikes

Numerous diabase dikes occur throughout the area. They are the youngest pre-Cambrian rocks in the region, for they cut across all the early pre-Cambrian formations. The intrusion of these dikes produced exceptionally little effect on the rocks penetrated, for they are nowhere fractured and broken or noticeably altered along the borders. They range in width from a few feet to more than a hundred feet.

As in other pre-Cambrian areas these dikes can be divided into two types: a slightly schisted and considerably altered type containing quartz; and an exceptionally fresh, massive type, which may or may not contain olivine. Nowhere in the area was the latter found cutting the former, but their lithological variation and evidence outside the map area indicate that the quartz diabase is the older, although just how much older is an undecided question. No attempt was made to differentiate these two types on the accompanying map.

The younger diabase is by far the more common. Under the microscope it is seen to consist of lath-shaped plagioclase, embedded in augite, some brown mica, and black iron ore. Occasionally olivine is present. Phenocrysts of feldspar, as much as one inch in diameter, were seen at a few places in a porphyritic variety of this rock.

Under the microscope the quartz diabase shows augite and plagioclase, some black iron ore, and a few patches of quartz.

From the economic standpoint, the diabase dikes in the area appear to be useless, for no mineralization was noticed in connection with any of them.

Pleistocene and Recent

The pre-Cambrian rocks of the area are nearly everywhere overlain by Pleistocene deposits of boulder clay, associated fluvio-glacial gravels, sands, and silts, and stratified lacustrine clays, silts, and sands that were left by the retreating Labradorean ice-sheet. Owing to the flatness of the country and to the large spruce swamps which occur everywhere throughout the area, it is very difficult to obtain information with regard to the character of these deposits.

Boulder clay is not very common in the northern part of the area, but it is more prevalent in the southern portion, especially in the height-of-land section.

Fluvio-glacial deposits of gravel, sand, and silt occur at various points along the Canadian National railway. In Ermine township, south of the Oba river, extensive areas of sandy clay may possibly have originated in this manner. In places this sandy clay forms rolling hills, which have somewhat the topographical aspect of a terminal moraine.

Stratified fresh-water clays are only exposed at a few places. A few sections occur along the river valleys in the vicinity of Oba, but owing to the prevailing high water of the rivers it was impossible to make a full examination.

There is little doubt, however, that portions of the northern part of the area were once covered by an immense glacial lake, in which were deposited the clays and silts that make up the great clay belt of northern Ontario and Quebec. These clays will ultimately furnish the best lands for agricultural purposes in the area.

Glacial striae and grooves and other evidences of glaciation, such as *roches moutonnées*, are not very common. The trend of the few striae that were seen was west of south.

The only evidences of recent deposits are ice-shoved boulder shores, lakes gradually being filled up by sediments, and the filling of swamp areas with peat and other organic material.

Economic Geology

GOLD

Gold is the only metal that up to the present time has created any considerable interest in the Oba area, although previously some attention was attracted to the molybdenite prospects on the old Seagers claim near the east bank of the Oba river, 2 miles south of Langdon, on the Algoma Central railway.

At the present time gold is the only mineral that is known to occur in deposits of possible economic value. The first discovery was made by G. Taylor in 1923 while he was timber-cruising in the township of Hawkins. It was not until September, 1925, however, that the discovery claim was staked. This discovery stimulated interest in the area, and in June, 1926, a group of claims was staked in Walls township. Since then further staking has been done in Walls and Hawkins townships, and a few claims have been staked in Lizar township.

Chalcopyrite, molybdenite, galena, and muscovite occur at a number of points throughout the area, but in no case were deposits of any considerable magnitude noticed.

Prospecting has been largely confined to the narrow belts of schist complex that traverse the area. Most of the investigation has been done in Walls and Hawkins townships, although, more recently some attention has been directed towards Lizar and Nameigos townships.

Culbert, Peterson, and Dubroy Locations

This group is made up of several claims that were staked for gold in Walls township in June, 1926, the discovery being made on claim S.S.M. 4,687. They can be reached by a trail 100 chains long which leads south from a point on the Canadian National railway one mile west of Neswabin.

These claims comprise the only group in the map area upon which any considerable amount of work has been done. Development, in general, has been confined to stripping and trenching, although a shaft has been sunk on No. 3 vein on claim S.S.M. 4,687 to a depth of 15 feet.

The extensive surface work on this claim has exposed a system of seven parallel quartz veins, which strike E. 12° S. The approximate distances between the veins are: No. 1 to No. 2, 25 feet; No. 2 to No. 3, 63 feet; No. 3 to No. 4, 30 feet; No. 4 to No. 5, 110 feet; No. 5 to No. 6, 40 feet; and No. 6 to No. 7, 132 feet. The total mineralized zone is about 400 feet wide. The veins range in width from 1 to 12 inches, and their dip is 85° N.

The country rock in which the veins are situated is well-banded mica and hornblende schist, which has been intruded along the strike of the schistosity by narrow dikes of slightly banded aplite. This aplite in the field has the appearance of an acid fine-grained porphyry, but under the microscope it was found to be holocrystalline and to be composed of quartz and feldspar with a small amount of muscovite. Both the basic schists and the aplites have been replaced by quartz veins. In some places the quartz-bearing solutions have replaced the basic schists, in others the aplite dikes, and in still others the replacement has

been along the contact between the aplite and the basic schist. The quartz of the veins shows distinct evidence of fracturing and shearing since deposition. The direction of movement in the case of the shearing was parallel to the walls of the veins, while that in the case of the fracturing was at right angles, as indicated by the numerous small faults that traverse from north to south all the formations so far mentioned. This fact indicates that the faulting was much later than the shearing. At no place on this claim does the displacement exceed 8 inches. On the claim just to the east, however, a displacement of 350 feet has taken place. Owing to drift the actual fault plane cannot be seen, but its trend is well indicated by Culbert creek. The drag, which can be seen on the east side of the creek, indicates that the block to the west has been pushed north.

The basic schists, aplites, and quartz veins are all cut by massive north-south pegmatite dikes, and all four are traversed by late pre-Cambrian diabase dikes.

Native gold can be seen or panned at many places along the veins. No. 3 vein, called the Paymaster, and No. 5 vein, called the North vein, show the highest values. Assays taken from the bottom of the 15-foot shaft on the Paymaster vein were said to indicate quite high-grade ore at this point. The gold is associated with pyrite, chalcopyrite, galena, and occasionally a little pyrrhotite. The richer gold-bearing vein sections appear to depend upon the presence of galena, for it is there that the coarse gold appears to be more heavily concentrated. The vein walls are quite clear-cut and show little evidence of mineralization.

The other claims in this group have been staked to the east and west of the one described and are situated along the strike of the mineralized zone. Stripping and trenching on the higher ground has shown the vein system to be continuous, and the geological conditions and mineralization are similar.

Taylor Location

This group of claims is located in the township of Hawkins, one mile west of the Culbert group. They are situated along the strike of the same narrow band of schist complex as the Culbert group, and there appears to be but little doubt that the gold-quartz veins exposed are a continuation of the same vein system. Access to the claims is furnished by a trail which leads eastward from Langdon on the Algoma Central railway.

The discovery claim, S.S.M. 4,310, is the only one upon which any work has been done, and this consists of a small amount of stripping and a test pit about 4 feet deep.

Three veins situated along the face of a steep bluff have been uncovered for a distance of 50 feet. The veins strike E. 10° N. and dip 80° N. The distances between the veins are: No. 1 to No. 2, 101 feet; No. 2 to No. 3, 128 feet.

The country rock of the claim is a well-banded biotite schist, which has been intruded parallel to its strike with small dikes of light-weathering aplite. The veins are all replacements of these rocks, cutting here into the one, there into the other, the strike and dip being parallel to the structure of the enclosing rocks.

No. 1 vein is 2 feet wide and is exposed for 50 feet. The vein material is quartz well mineralized with pyrite, chalcopyrite, and galena. No native gold can be seen, but it can be panned without difficulty. Two small veinlets occur just to the north of this main vein and are similarly mineralized. Both walls of this vein, where exposed, are in biotite schist. Just 5 inches to the south, however, a 5-inch dike of aplite occurs. Where this same vein is exposed to the west on the top of the hill the north wall is an aplite dike 5 inches wide.

No. 2 vein, upon which a test pit 4 feet deep has been sunk, consists of a series of quartz stringers in a sheared zone in the biotite schist, which is about 2 feet wide. It is mineralized with quartz, pyrite, and galena. Visible gold is quite abundant.

No. 3 vein is exposed on the east side of the bluff. It varies from 8 to 12 inches in width. A more highly schisted zone of the country rock, 4 inches wide, occurs on each side of it. The vein minerals are quartz, pyrite, and gold. Native gold is not abundant, but it can be panned without difficulty.

Other Claims

The belt of schist complex on which the claims described above occur has been staked from the Canadian National railway on the east to the Derry-Hawkins township line on the west; a considerable number of claims have also been staked on the belt of schist complex that occurs one mile to the south. Most of these undescribed claims, with the possible exception of the Hall group, have not even been prospected. This retardation of development is due to the fact that the territory is reserved for its timber, and as a consequence it is not necessary to do work on the claims in order to hold them.

During the summer of 1928, 21 claims were staked by A. Junea, S. Vatella, L. Coumont, and C. Vish in the township of Lizar on the west shore of Kabinakagami lake. Little work has been done. The country rock is massive greenstone, in places altered to amphibolite and chlorite schist, which has been intruded by porphyritic granite. The mineralization is confined to a shear zone in the greenstone about 8 feet wide, and it is only exposed for a short distance. This shear zone is mineralized with quartz, pyrite, and some chalcopyrite. There was no evidence of native gold.

COPPER, LEAD, AND ZINC

Small deposits of chalcopyrite, galena, and sphalerite occur at numerous places throughout the area.

At mile-post 93, west from Foleyet, an 8-inch quartz calcite vein cuts a porphyritic diabase dike which has intruded a hornblende chlorite gneiss. The vein is mineralized with a small amount of galena and sphalerite. The gneiss carries a few segregations of chalcopyrite.

A small quartz vein containing a little chalcopyrite occurs on a hill of schist complex, 20 chains south from the railway bridge over the Pichogen river.

Small amounts of chalcopyrite occur in rock-cuttings along the Algoma Central railway. At mileage 236¾, a sheared zone 2 feet wide in well-banded mica schist is mineralized with quartz, pyrite, and some chalcopyrite. At mileage 234½, the schist complex is cut by numerous small dikelets of pegmatite, which are well mineralized with pyrite and chalcopyrite; and at mileage 234⅜, a well-banded grey granite gneiss is cut by pegmatite dikelets containing pyrite and chalcopyrite. Similar pegmatite dikelets containing chalcopyrite occur near the border of the schist complex at mileage 248½.

Numerous small deposits of galena and chalcopyrite occur in the vicinity of Kabinakagami lake. A 12-inch quartz vein containing some chalcopyrite and galena occurs in the schist complex three-quarters of a mile northwest from the portage at the outlet of the lake. Small chalcopyrite lenses occur in the schist complex at the east side of the lake just south of Pine portage. A 4-inch quartz vein containing a little galena and chalcopyrite occurs in the schist complex on the north side of the large island opposite the main northern peninsula. John

Douchamai has staked a claim in the schist complex close to the granite contact at the toe of Boot bay on the west side of the lake. The mineralization occurs in a narrow zone and consists of quartz, pyrite, pyrrhotite, chalcopyrite, and galena.

MOLYBDENITE

A few crystals of molybdenite occur in the schist complex at the edge of a pegmatite dike one mile north of mileage 96½ on the Canadian National railway, west from Foleyet. A similar deposit occurs 2½ miles south of mileage 102, west from Foleyet.

Molybdenite occurs at two points near Langdon on the Algoma Central railway: on a hill between the Oba river and mileage 236½, and on the west bank of the Oba river opposite mileage 236.

The only molybdenite seen in the vicinity of Kabinakagami lake occurs in a 3-inch pegmatite dikelet cutting the schist complex on the southeast point of the main northern peninsula.

ASBESTOS

A few small veins of asbestos occur in an altered peridotite dike on the west bank of the Oba river just south of the township line between Hawkins and Irving.

MICA

Muscovite is very abundant in the pegmatite dikes of the northern part of the area, crystals as much as 4 inches in diameter occurring in the dikes along the Mattawitchewan river in the southern part of Scholfield township.

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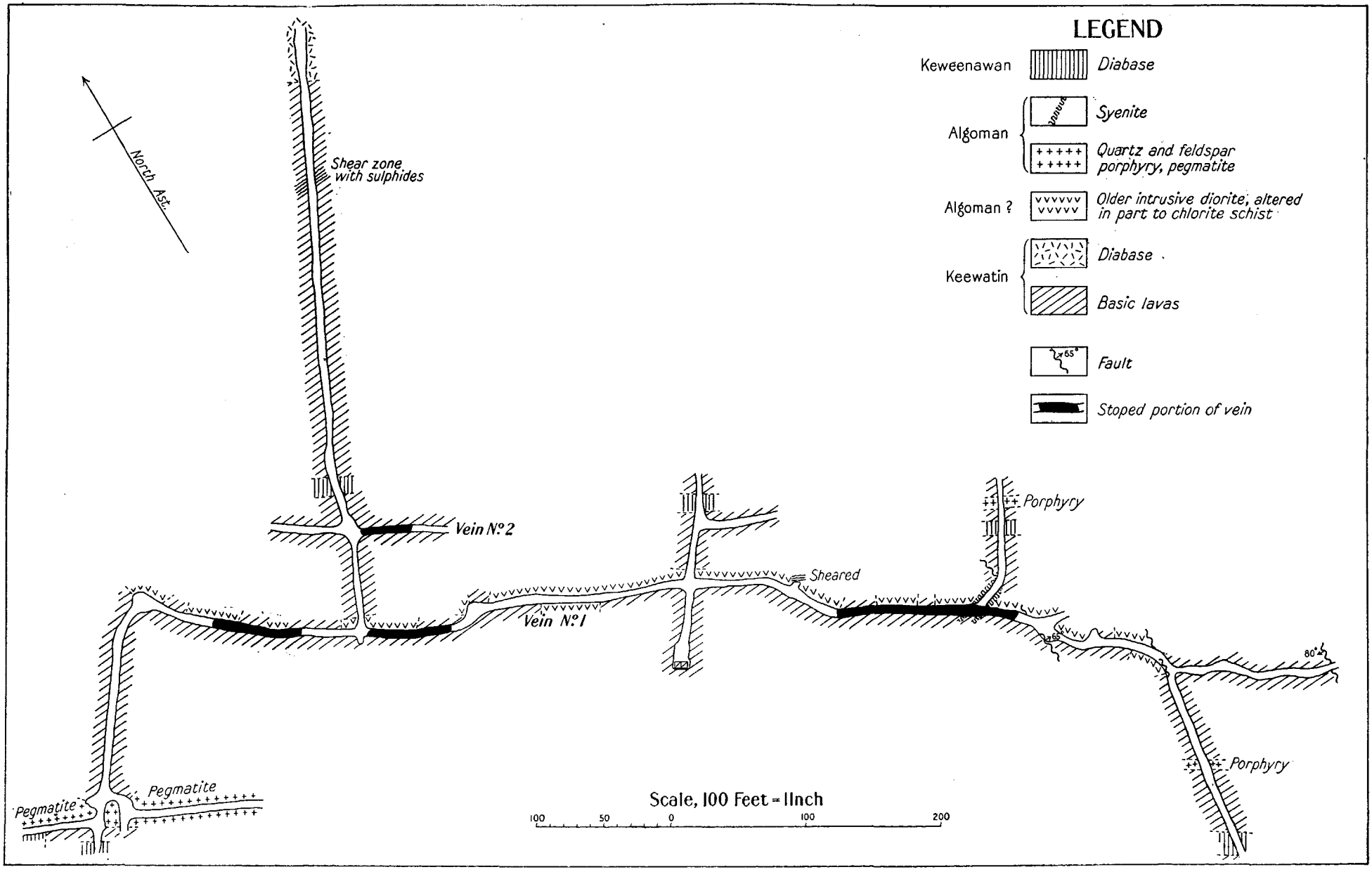
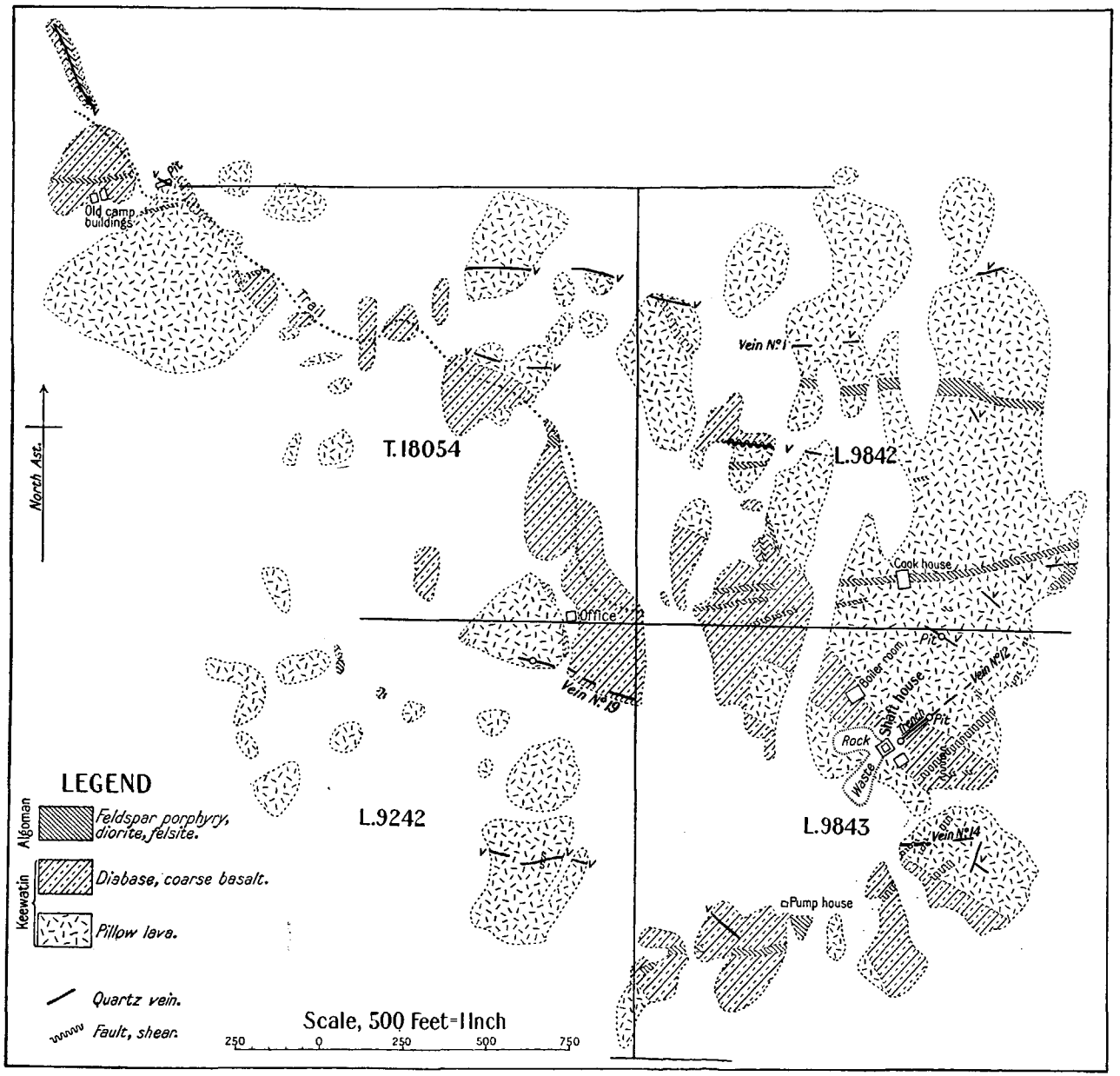


PLAN SHOWING GEOLOGY OF THE 800-FOOT LEVEL OF THE GOLD HILL MINE. (INFORMATION CHIEFLY FROM PLANS SUPPLIED BY D. ANGUS.)



GEOLOGICAL PLAN OF PART OF THE PROPERTY OF THE CANORO GOLD COPPER MINES, LIMITED.

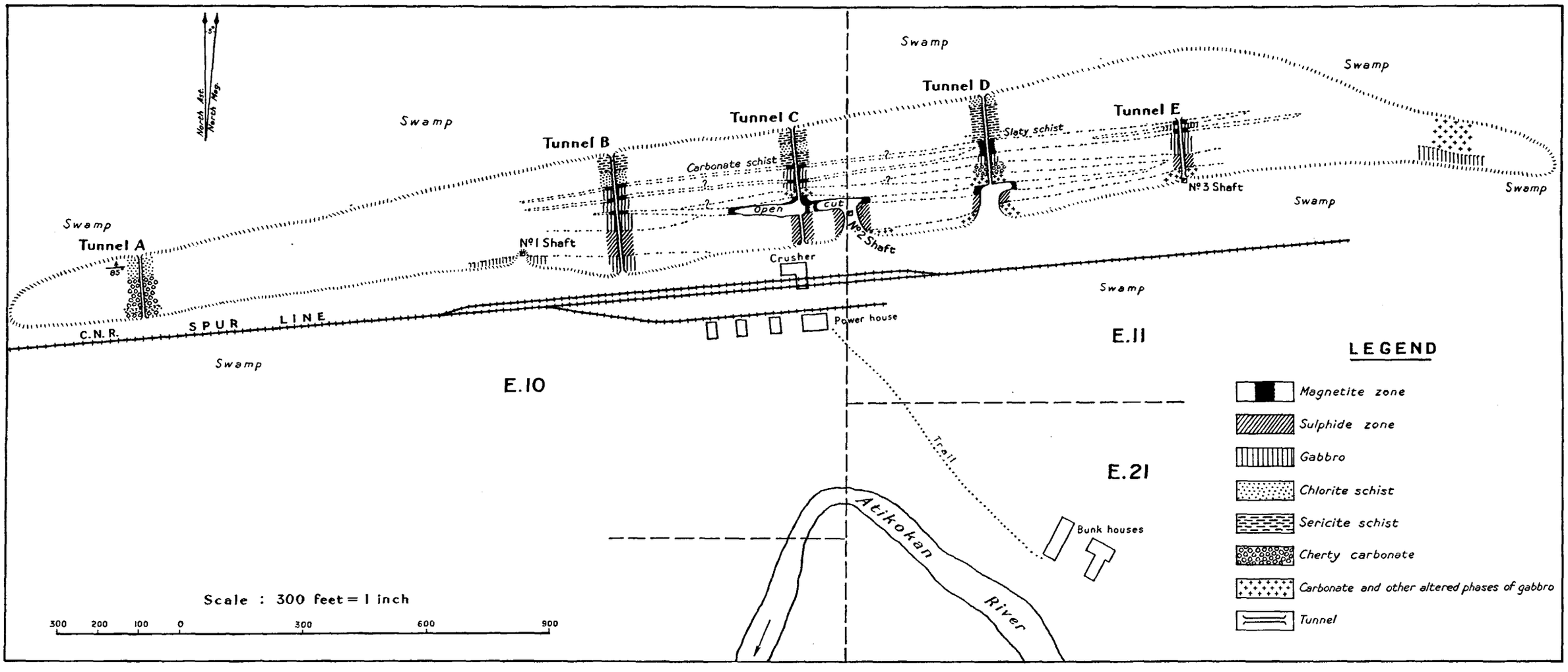
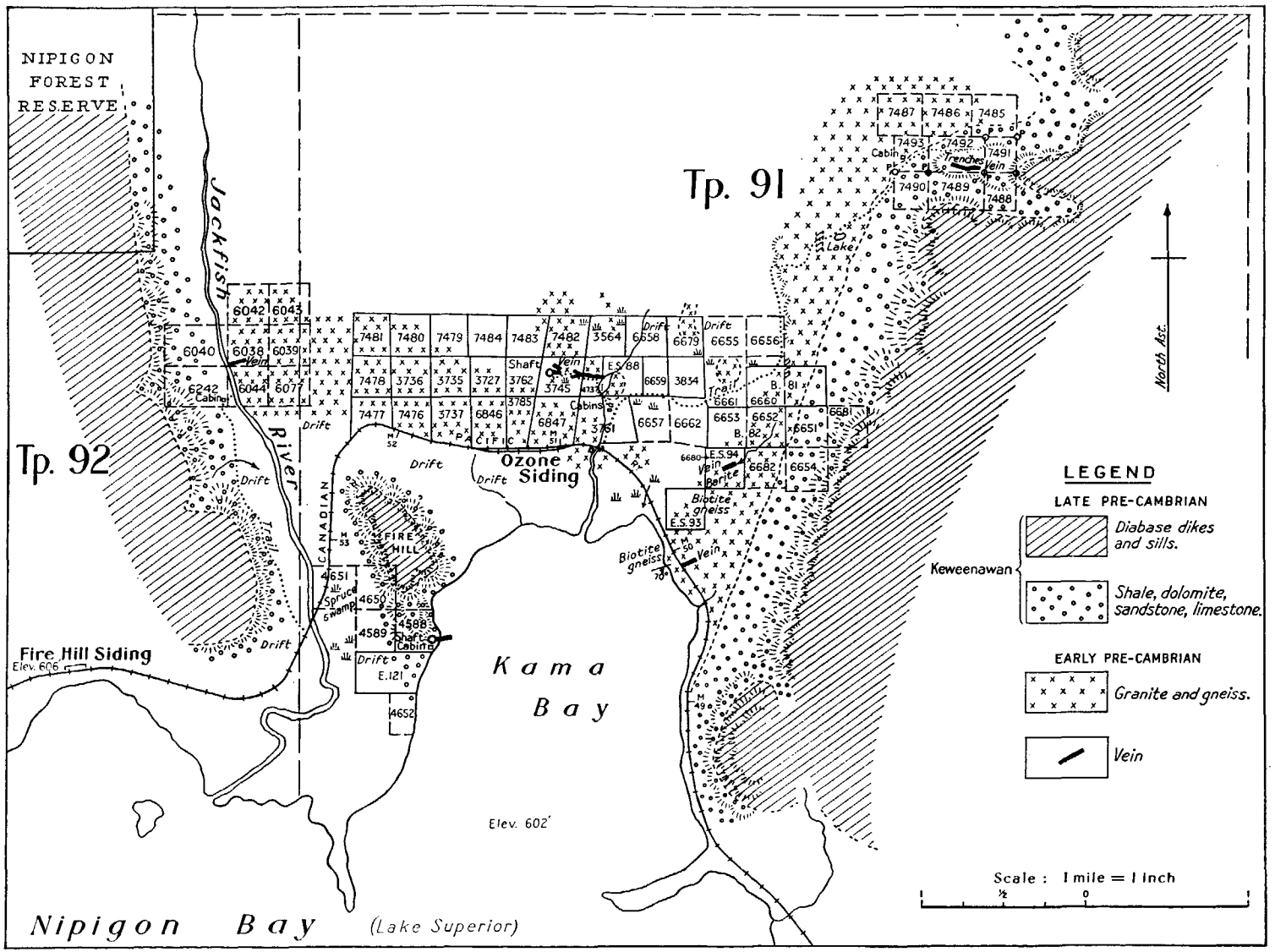


FIG. 12—PLAN SHOWING GEOLOGY AND WORKINGS OF THE ATIKOKAN IRON MINE, RAINY RIVER DISTRICT.



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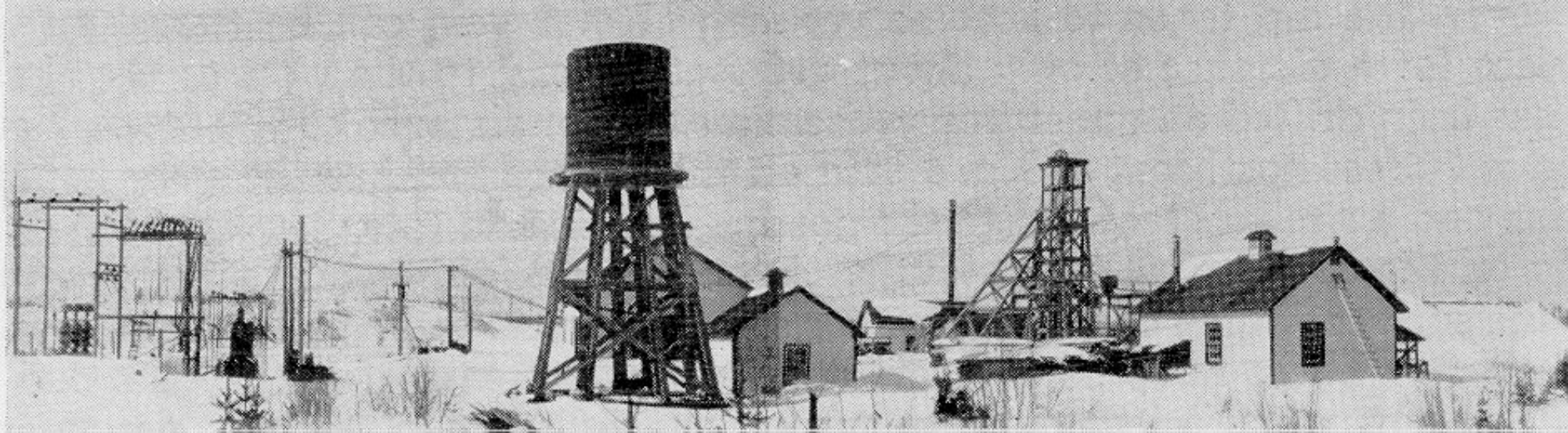

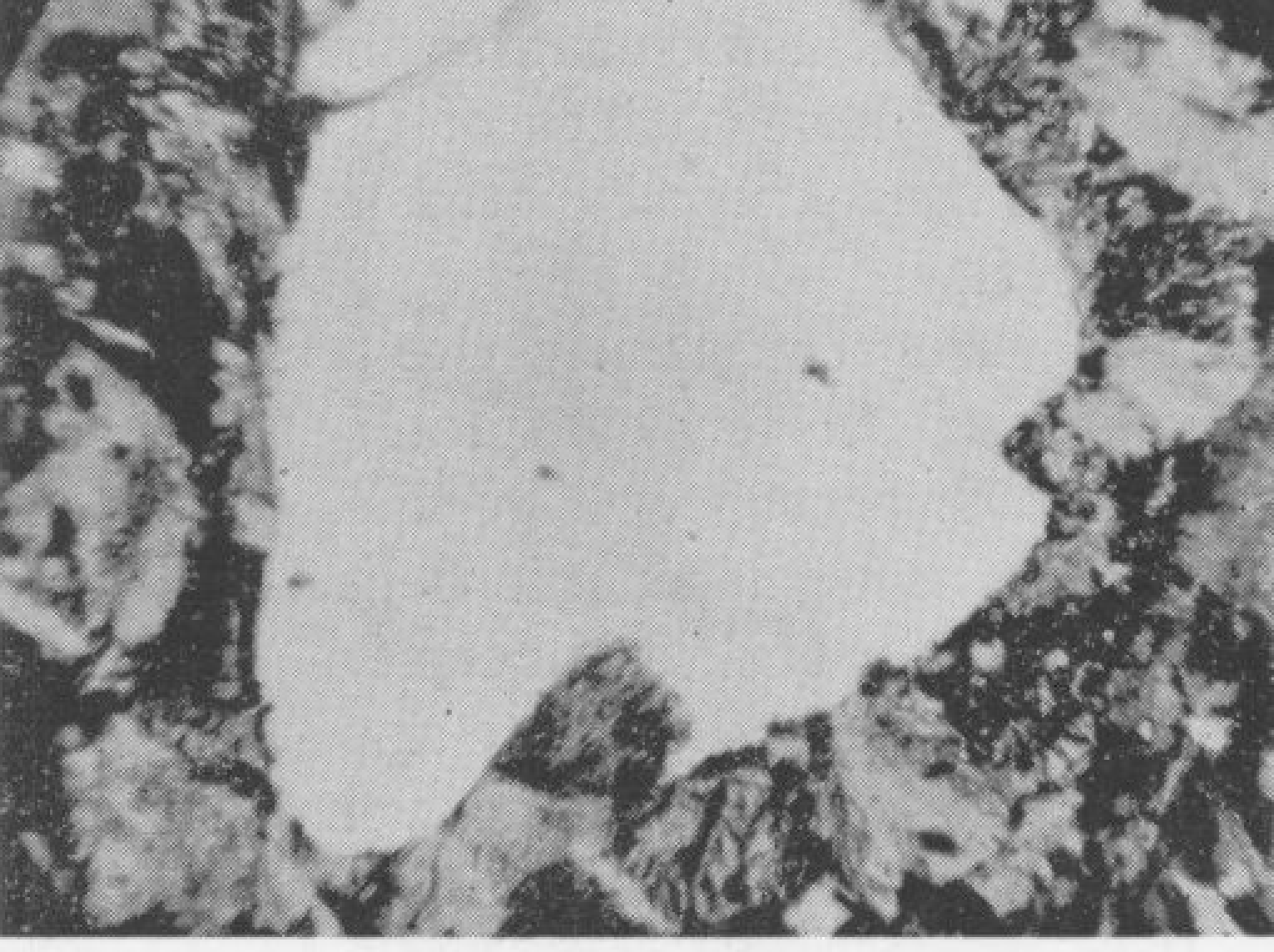

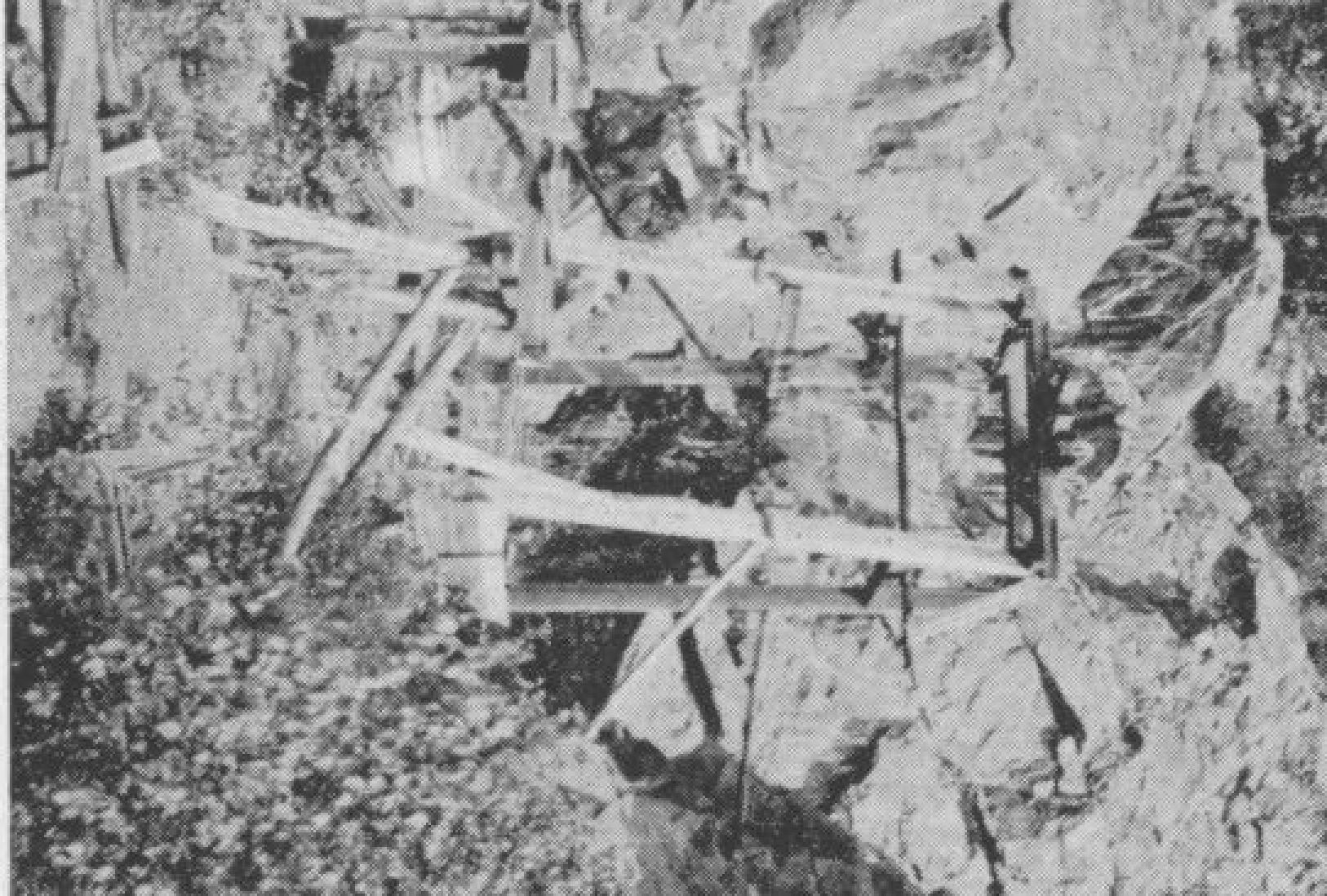

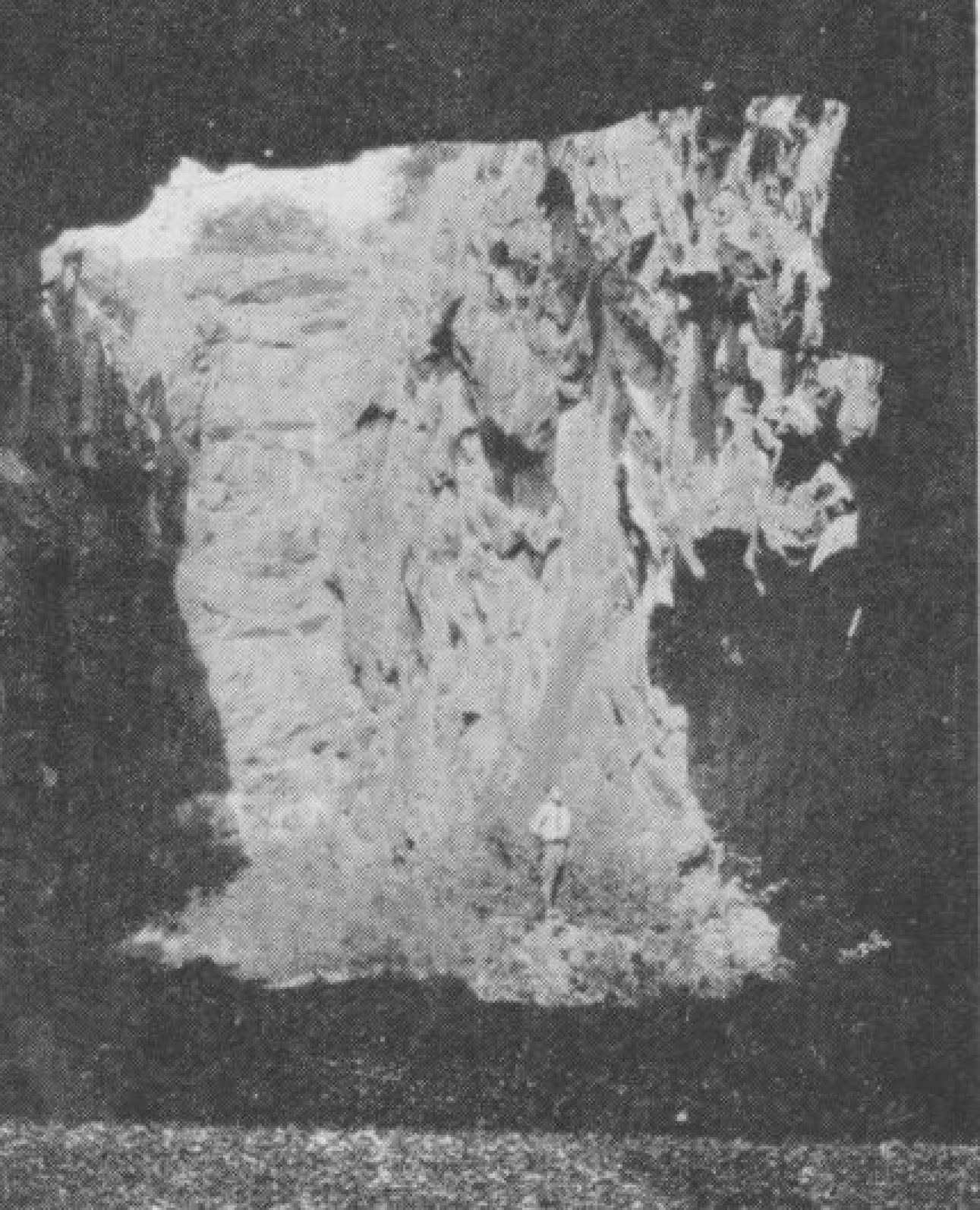

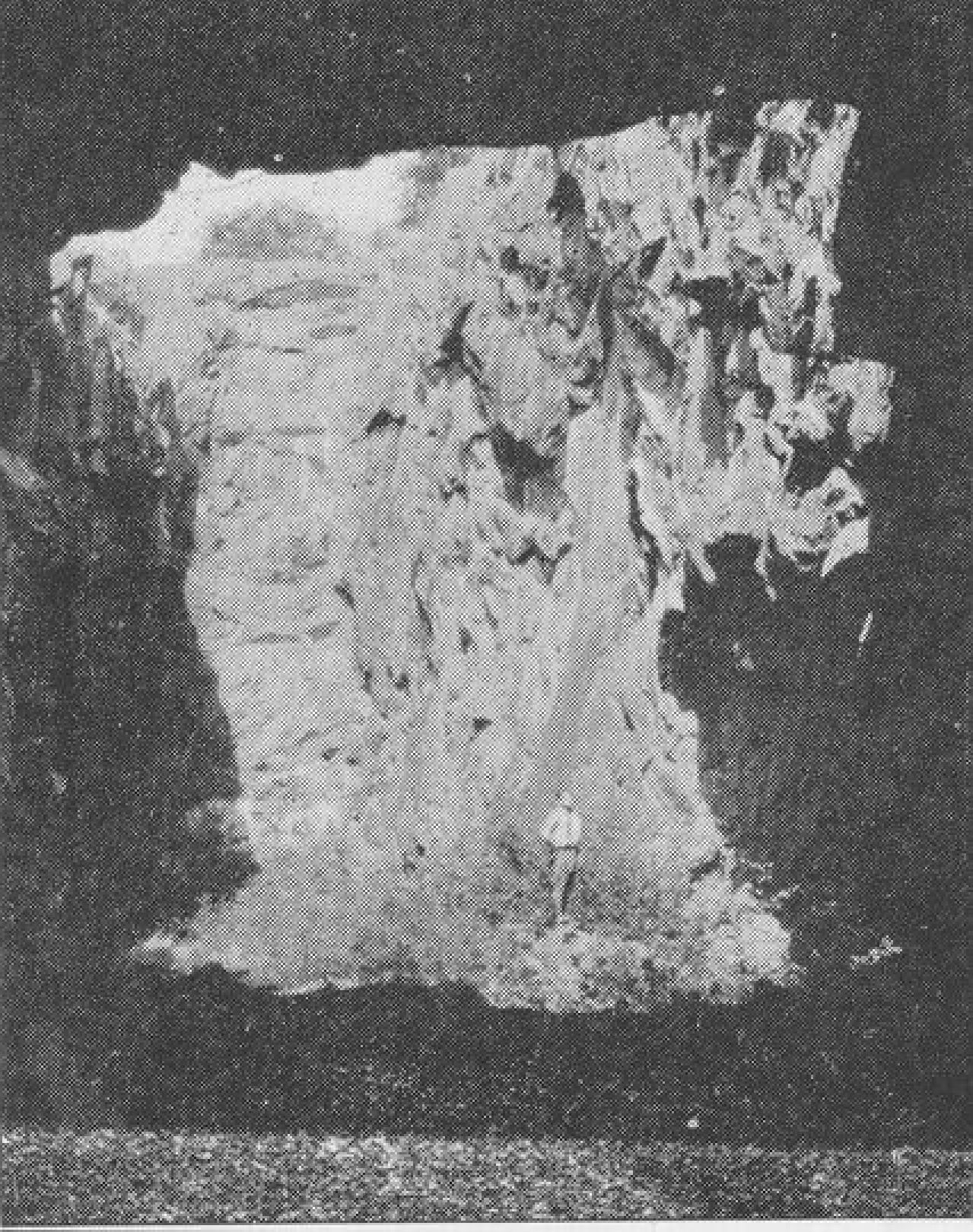

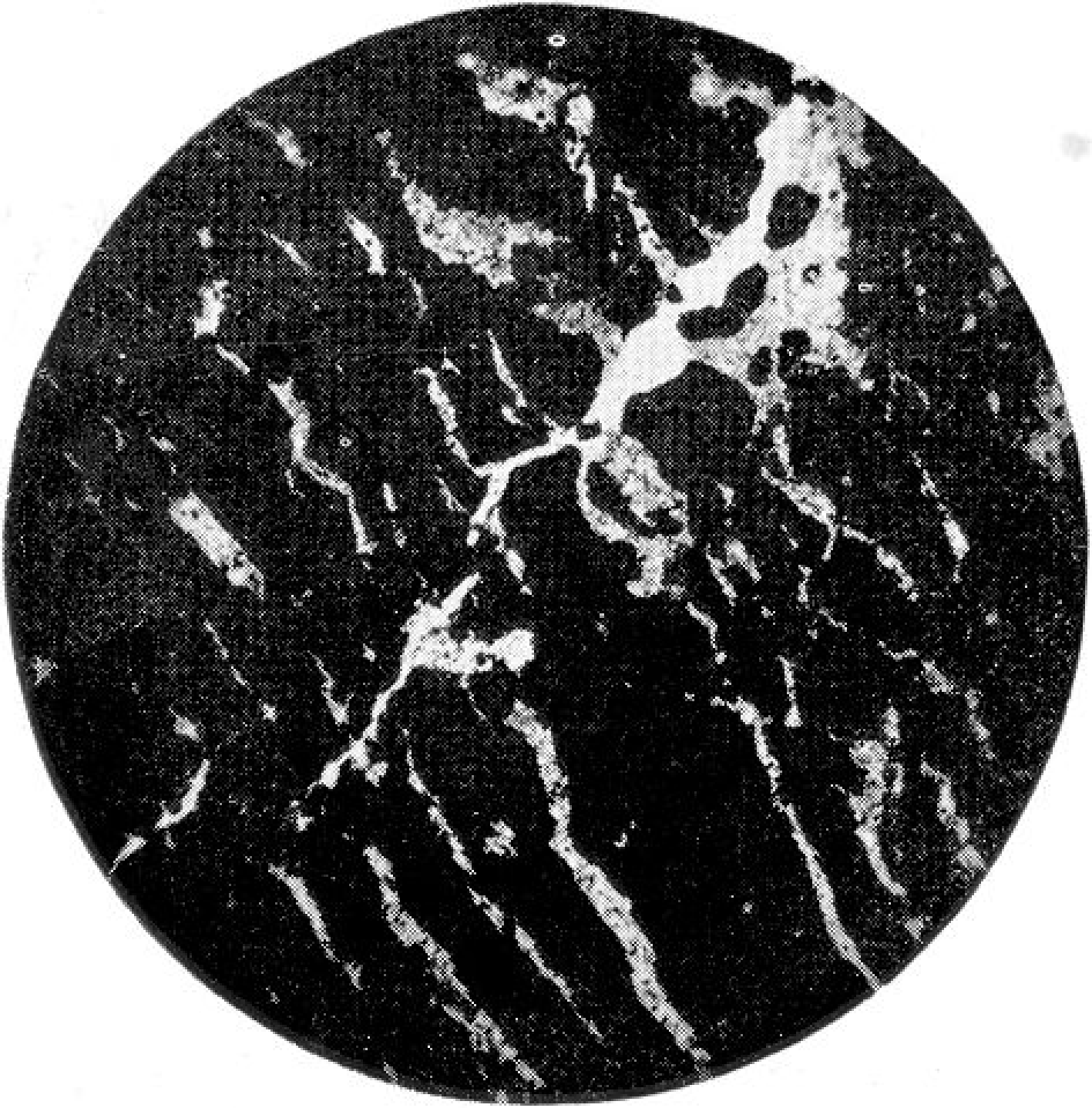

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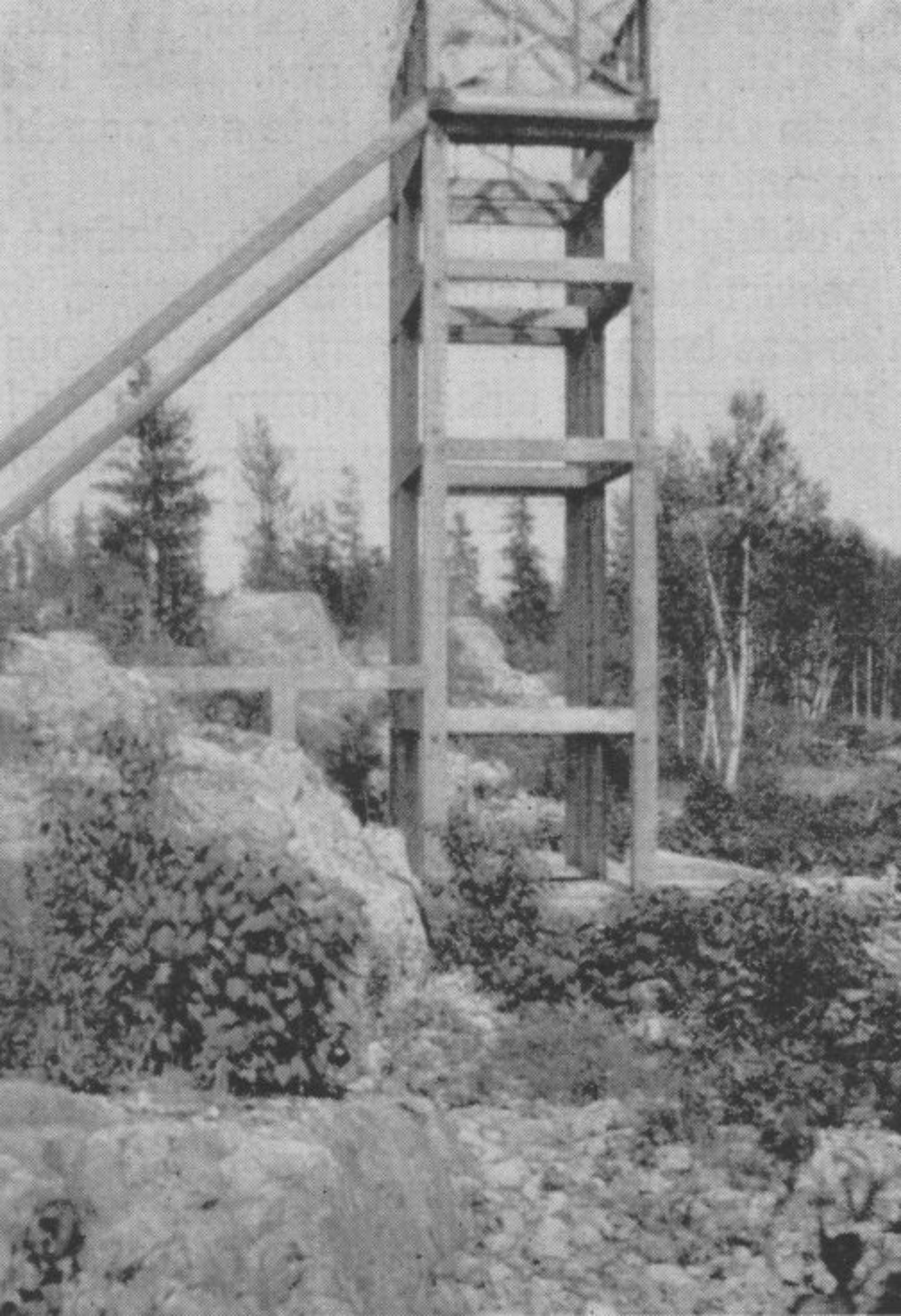

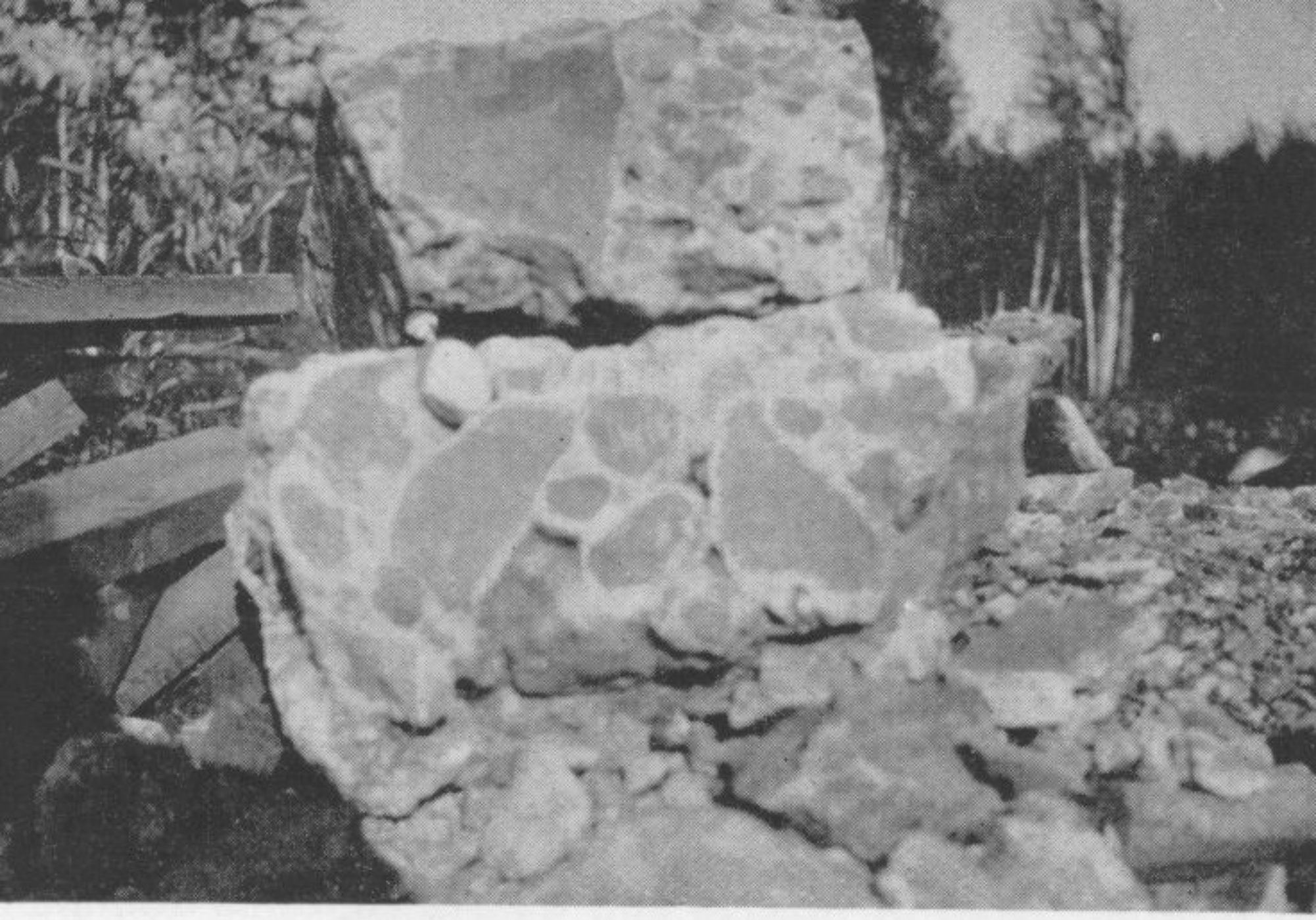

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. CHAS. MCCREA, *Minister of Mines* THOS. W. GIBSON, *Deputy Minister*

THIRTY-EIGHTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

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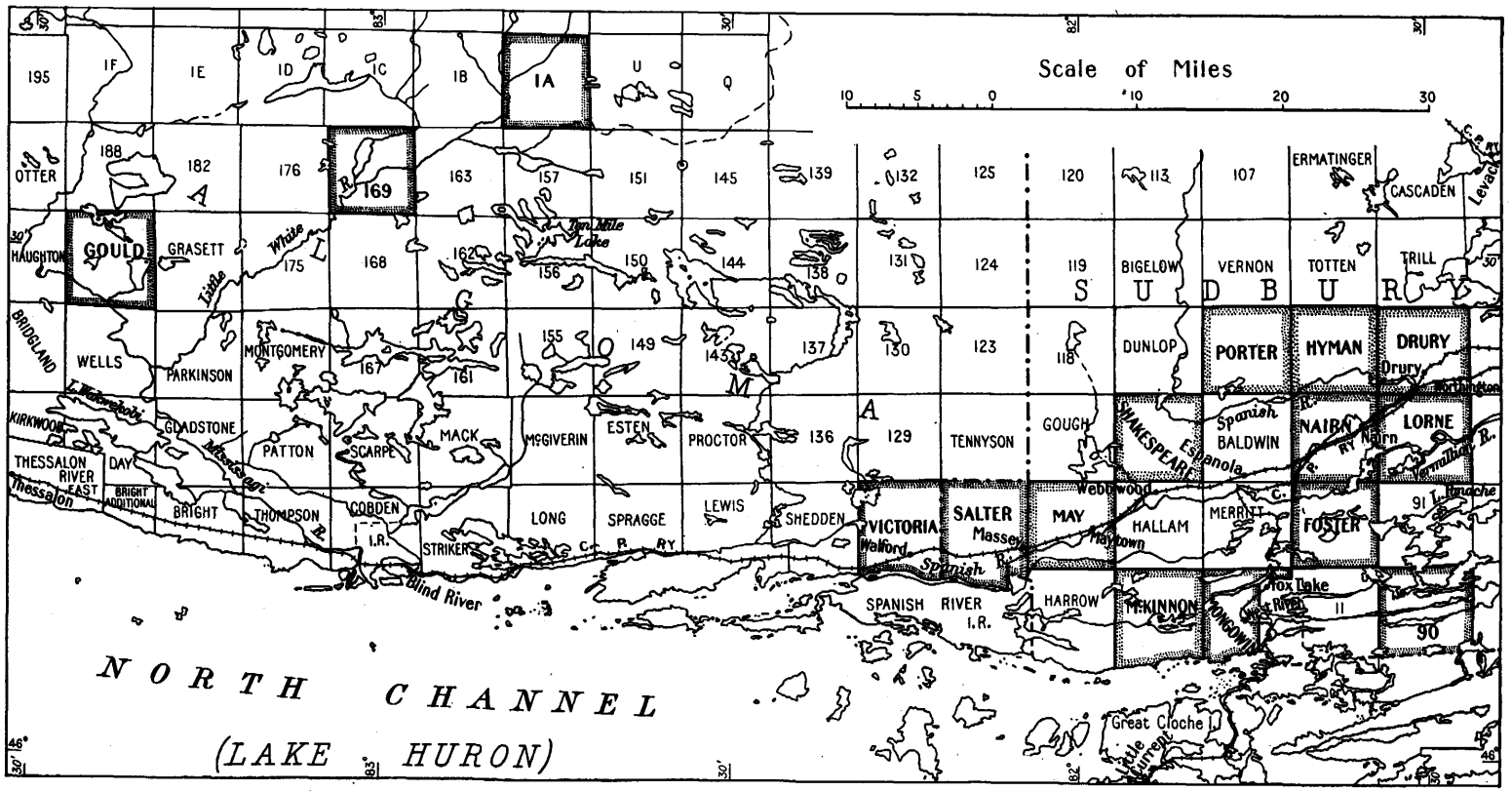
COLOURED GEOLOGICAL MAP

(In pocket at back of report)

Map No. 38*h*—Cartier-Stralak Area, District of Sudbury. Scale, 1 mile to the inch.



INDEX MAP SHOWING LOCATION OF TOWNSHIPS (STIPPLED), NORTH SHORE OF LAKE HURON.

Ore Deposits near the North Shore of Lake Huron

By E. S. Moore

Introduction

The area lying immediately north of Lake Huron is one of the classical pre-Cambrian areas of this continent. Owing to the great diversity in its stratigraphic, structural, and economic geology this area has been studied by many able geologists since Logan and Murray began their work in the forties of the last century. It includes the most complete section of the Huronian system so far found in Canada, as well as excellent exposures of Keweenawan igneous rocks and many other formations. Ore deposits are numerous, and evidences of mineralization, chiefly copper, are widespread. In addition, gold, silver, lead, zinc, and nickel have been found in a number of places. In some areas whole townships have been staked by prospectors.

Accessibility by water and rail made this area one of the earliest in Ontario to be prospected, although the hinterland of the north shore, has for various reasons, remained almost unknown geologically until comparatively recently, when the boom in the mining industry in Canada led to a renewed interest in the North Shore area resulting in the restaking of hundreds of old claims, the staking of thousands of new ones, and the active development of a considerable number of properties. In the summer of 1928, the writer, assisted by E. E. Russell and James Butterill, undertook the task of investigating these properties for the Ontario Department of Mines. It was impossible in one season to visit all the claims on which work was being done, but a large number were studied. These are scattered between Thessalon on the west and Worthington on the east and southward along the Algoma Eastern railway.

Acknowledgments

It would be impossible to make proper acknowledgment individually to all prospectors and others who generously gave of their time to aid in the geological investigation of this area. The writer wishes, however, to express particular appreciation of the assistance rendered by Joseph Errington, president of Sudbury Basin Mines, Limited; Joseph Travers, superintendent of the Cheney and White River mines of the same company; John Spellman, Webbwood; Charles G. Hyatt, Worthington; and Dr. John Banks, of New York, president, and E. J. McMillan, Sudbury, superintendent, of McMillan Gold Mines, Limited. Alexander G. Haultain, chief of the party doing topographic work in the area for the Geological Survey of Canada, very kindly extended the hospitality of his camp to the writer's party while they were engaged in work in the vicinity of Worthington. The writer also expresses his sincere thanks to his assistants, Messrs. Russell and Butterill, for faithful service rendered in the field, and to D. R. Derry, class assistant in the University of Toronto, for laboratory tests on rocks and ores.

Previous Work in the Area

This area has claimed the attention of many geologists since 1847, when Alexander Murray published the results of his first work on the north shore of Lake Huron. The thick series of sediments which he discovered was called Huronian by Logan after Lake Huron, and the adoption later of this term in

Canada and the United States as one of the standard names for a system of rocks in the pre-Cambrian group has led to much controversy over matters of correlation. The discovery of ore deposits, of which the Bruce Mines copper deposit has been the most important, has caused the economic geologists also to take a keen interest in the area. An extensive literature has grown up, and Collins in his recent work for the Geological Survey of Canada, entitled "North Shore of Lake Huron"[1] gives a complete bibliography of this literature. It is unnecessary in this report, which is concerned particularly with the economic aspects of the geology, to refer to all the papers published, since many of them deal chiefly with matters of correlation. The following should, however, be mentioned in connection with any geological study of the area:—

ALEXANDER MURRAY, Geol. Surv. Can., Rept. of Progress, 1847-48, pp. 93-124; 1848-49, pp. 7-46.
W. E. LOGAN, Report on the North Shore of Lake Huron, Geol. Surv. Can., 1849; Geology of Canada, 1863, pp. 50-66.
ALEXANDER WINCHELL, Observations in the Typical Huronian Region of Canada, Geol. and Nat. Hist. Survey of Minnesota, Vol. 16, 1887, pp. 145-171.
N. H. WINCHELL, The Original Huronian, Geol. and Nat. Hist. Survey of Minnesota, Vol. 16, 1887, pp. 12-40.
A. E. BARLOW, On the Contact of the Huronian and Laurentian Rocks North of Lake Huron, Amer. Geol., Vol. 6, 1890, pp. 19-32.
ROBT. BELL, The Laurentian and Huronian Systems North of Lake Huron, Ont. Bur. Mines, Vol. I, 1891, pp. 63-94.
R. PUMPELLY and C. R. VAN HISE, Observations upon the Structural Relations of the Upper Huronian, Lower Huronian, and Basement Complex on the North Shore of Lake Huron, Amer. Jour. Sci., 3rd Series, Vol. 43, 1892, pp. 224-232.
A. P. COLEMAN, Copper Regions of the Upper Lakes, Ont. Bur. Mines, Vol. VIII, pt. 2, 1899, pp. 121-174; The Sudbury Nickel Field, Ont. Bur. Mines, Vol. XIV, pt. 3, 1905; The Nickel Industry, with Special Reference to the Sudbury Region, Ontario, Mines Branch, Dept. Mines Can. No. 170, 1913; The Whiskey Lake Area and The Massey Copper Mine Area, Ont. Bur. Mines, Vol. XXII, pt. 1, 1913; The Pre-Cambrian Rocks North of Lake Huron, Ont. Bur. Mines, Vol. XXIII, pt. 1, 1914, pp. 202-236.
E. D. INGALL, Geology of the Bruce Mines District, Geol. Surv. Can., Sum. Rept., 1902, pp. 244-254.
E. D. INGALL and T. C. DENIS, Geology of the Country around Bruce Mines, Geol. Surv. Can., Sum. Rept., 1904, pp. 179-190.
C. R. VAN HISE and C. K. LEITH, Pre-Cambrian Geology of North America, U.S. Geol. Surv., Bull. 360, 1909, pp. 403-447.
C. W. KNIGHT, The North Shore of Lake Huron, Ont. Bur. Mines, Vol. XXIV, 1915, pp. 216-241.
T. T. QUIRKE, Espanola District, Ontario, Geol. Surv. Can., Mem. 102, 1917.
W. H. COLLINS, North Shore of Lake Huron, Geol. Surv. Can., Mem. 143, 1925.
G. VIBERT DOUGLAS, The Whiskey Lake Area (District of Algoma) and La Cloche Area (District of Sudbury), Ont. Dept. Mines, Vol. XXXIV, pt. 4, 1925.
R. C. EMMONS, Wakomata Lake Map-Area, Algoma District, Ontario, Geol. Surv. Can., Sum. Rept., pt. C, 1926, pp. 1-15.
R. G. MCCONNELL, Sault Ste. Marie Area, District of Algoma, Ont. Dept. Mines, Vol. XXXV, pt. 2, 1926.

Topography

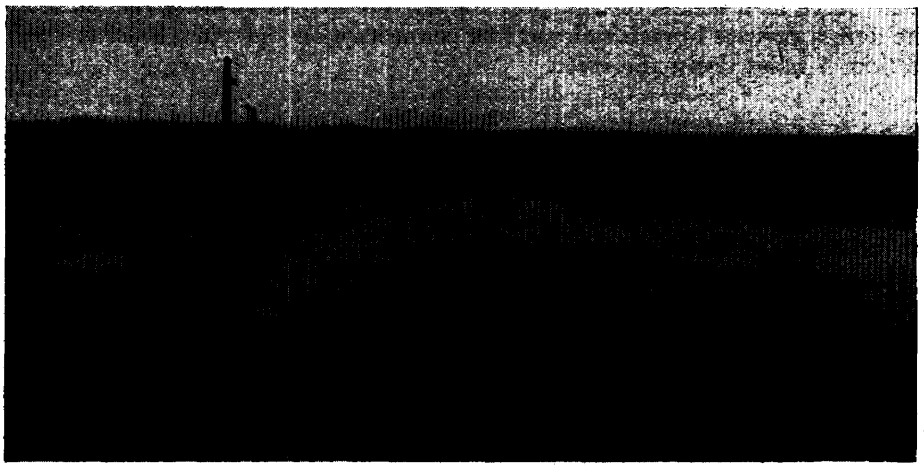
The North Shore area is rugged in character and of varied relief. The topography of part of it differs greatly from that of the majority of the areas in the pre-Cambrian shield because of the large proportion of sedimentary rocks. These, when folded and eroded, form long narrow ridges where the more resistant quartzites stand out in relief, producing a type of scenery more like that of the Appalachian region than the characteristic surface of the main part of the shield. The white Lorrain quartzites form the most prominent ridges, and these stretch along the north shore giving the impression, when viewed from Lake Huron, of snow-capped mountains. These ridges, which constitute La Cloche mountains, lie north of the Bay of Islands and McGregor bay, and in Carlyle township culminate in the highest point in the North Shore area, said to be 1,760 feet above sea-level or 1,180 feet above Lake Huron. These same quartzites form

[1]W. H. Collins, Geol. Surv. Can., Mem. 143, 1925.

less prominent ridges northwest of Thessalon and northeast of Endikai or White lake in Township 169.

The Mississagi quartzite is also a prominent ridge-former in some sections of the area, and the Nipissing diabase forms high relief in many places, particularly along the Spanish and Little White rivers. The sills and dikes of this rock constitute the high points in some of the quartzite ridges. A prominent granite scarp rising in places to over 200 feet above the plain runs across Shakespeare township along the north side of the Murray fault.

South of La Cloche mountains the pre-Cambrian rocks underlying the numerous islands in Lake Huron are overlain by Paleozoic sediments, which have a very low dip. The surface of this Paleozoic area in places resembles a coastal plain in topographic features.



The new power plant of the International Nickel Company at High Falls on the Spanish river.

Pleistocene lake beds occupy large sections of the North Shore area and extend a considerable distance inland along some of the rivers. These sections are very flat, and they are farmed extensively except where too sandy for agricultural purposes. There is a large area of these beds overlying the Sudbury series along the Spanish river around Walford, Massey, and Webbwood, and another covering various formations near Thessalon. Considerable areas of lake beds also occur near Blind River and at other points along the shore and scattered inland in the valleys of the Mississagi and other rivers. The plain formed on these beds usually lies at an elevation of less than 100 feet above Lake Huron and slopes gently towards the lake.

Drainage and Hydro-Electric Power

The area is drained by a large number of rivers flowing southward into Lake Huron. The Spanish is the largest of these, and important water-power plants have been developed on this river. The International Nickel Company has a plant at High Falls, 4 miles above Turbine station on the Canadian Pacific and Algoma Eastern railways, which is the largest hydro-electric plant in this section of Ontario. It furnishes power for all the operations of this company as well as considerable power to the Abitibi Pulp and Paper Company at Espanola.

The Abitibi company has a small plant of its own on the Spanish at Espanola. The Mond Nickel Company has a hydro-electric plant on the Spanish at Nairn and one on the Vermilion river at Wabageshik falls 4 miles from Nairn. On Birch creek, at the outlet of Birch lake, the Lloyd-Deagle and Son Power Company has a plant developing 4,400 volts of electric power for use in Massey and Webbwood. Plenty of power could be developed on the Mississagi river at the "canyon" for mining purposes in that vicinity, and most of the larger streams are capable of furnishing considerable hydro-electric power, since they are broken by numerous falls before reaching Lake Huron.

Very few of the streams are navigable, except for canoes, above the stretches of Pleistocene lake beds near the shore of Lake Huron. Tugs, towing scows, are, however, operated for more than 25 miles on the Spanish river above High Falls, where the water is impounded by a dam nearly 100 feet high. This water could serve as a means of transport for any ore produced along its course. At the dam a private branch railroad line connects with the main lines at Turbine station, 4 miles down the river.

Industries

This region has been for decades important in the lumbering industry. Pine at one time covered the greater part of it, but this has been almost entirely removed by fire and lumbering operations, so that it has become necessary to go far inland, 30 miles or more, to obtain supplies of this timber. Practically every village and town along Lake Huron at one time or another has had saw-mills, but very few of these mills remain. The Carpenter-Hixon Company has a large mill at Blind River and operations are still carried on at Spragge, but the mills at Thessalon are closed at present and Massey and Cutler, once famous centres for lumbering, have been abandoned by the lumberman. Cutler is almost completely destitute of inhabitants, and the mills and dock have been burned. Hemlock and hardwoods are still fairly abundant in some sections, but there are large areas in which fire has removed practically all timber, and others where, owing to the very rocky character of the quartzite ridges, little timber of importance has ever grown.

The Abitibi Pulp and Paper Company has a large pulp mill at Espanola, but for some months only part of it has been in operation and a splendid town built by the Spanish River Pulp and Paper Company several years ago has been on the decline. The pulp, like the pine, has been almost entirely removed from the greater part of the area under discussion, and it is now brought down from the headwaters of the Spanish and other streams.

Farming is the only other industry of importance, and it is practised on a considerable scale around Thessalon, Blind River, Massey, Webbwood, Nairn, and a few other towns or villages. Sheep-raising has been carried on successfully by a few farmers, and it could no doubt be extended in favourable localities.

With the decline of the lumbering and pulp operations it is hoped that mining may be initiated on a sufficient scale to provide a new industry for the inhabitants. There are large trap rock quarries at Bruce Mines, and the Lorrain quartzite contains great quantities of material suitable for the manufacture of ganister and silica brick, which will be required in increasing quantities as our metallurgical operations in Ontario increase the demand for them. No doubt manufacturing, through the use of water power and the utilization of excellent facilities for shipment of manufactured goods by rail and water, will in time become important. Farming should receive an impetus from the development of industries at Sudbury and Sault Ste. Marie, where larger markets will be

provided for farm produce than have formerly existed. Considerable trade already results from the great influx of tourists into this very attractive region and this trade has almost unlimited possibilities.

General Geology

There have been great differences of opinion regarding the stratigraphy of this region, and many views have been expressed regarding the age of its formations. Owing to the fact that the sections studied by the writer are so widely scattered, it has been impossible to trace the various formations from one section to another or to form an independent opinion regarding their correlation. The table of formations given by Collins in his memoir on the North Shore of Lake Huron proved quite satisfactory in most respects; although minor changes have been made in some areas, his classification has been adopted in this report. Collins' table is as follows:—

Table of Formations

QUATERNARY		
RECENT:	Swamps, etc.	
PLEISTOCENE:	Lacustrine clay, sand, and gravel beaches. Glacial deposits.	
	Unconformity	
PALEOZOIC		
ORDOVICIAN:	Lowville and Black River limestones.	
	Great unconformity	
PRE-CAMBRIAN		
Igneous Intrusives: (Keweenawan in part at least)	Olivine diabase dikes. Killarney granite batholiths. Basic intrusives (chiefly sills and dikes, but including the basalt flow at Thessalon, which may be much older).	
HURONIAN:	Cobalt series:	Upper white quartzite and cherty quartzite. Banded cherty quartzite. Lorrain quartzite. Gowganda formation (boulder conglomerate, etc.)
	Unconformity	
	Bruce series:	Serpent quartzite. Espanola limestone. Espanola greywacké. Bruce limestone. Bruce conglomerate. Mississagi quartzite.
	Great unconformity	
PRE-HURONIAN:	Granite gneiss batholiths. Sediments (Sudbury series). Schist complex (mainly volcanic).	

Many of the data in the brief descriptions of the formations in the following pages are taken from Collins' report.

PRE-HURONIAN

The oldest rocks in the area are green schists derived for the most part from basic to intermediate igneous rocks. They are found in patches and bands in the granite gneiss, which is intrusive into them. These rocks probably belong to the Keewatin series; they are not extensively exposed in the area.

The Sudbury series, which is generally regarded as equivalent to the Timiskaming in age, consists chiefly of metamorphosed sediments. It forms a

long band extending from the Sudbury area to a point near Blind River and is of considerable economic interest because of the numerous veins and mineralized zones scattered through it. The formations constituting the series consist chiefly of alternating bands of quartzite and greywacké with all gradations from one rock to the other. Conglomerate occurs in a few places with well-rounded boulders of granite gneiss. In portions of the area these formations are much schisted and highly crystalline and they are everywhere greatly folded so that they present steep dips, usually approaching the vertical. Staurolite schists are well developed in some of the metamorphosed greywacké. On the whole the series is rather monotonous in character.

HURONIAN

Bruce Series

The Mississagi quartzite, which constitutes the basal member of the Bruce series, consists chiefly of quartzite with lenses and bands of conglomerate and argillite or greywacké scattered through it at several horizons. In some places there is a well-developed basal conglomerate, but this is lacking in many sections of the formation. The quartzite is purer and less metamorphosed than that of the Sudbury series, but on the whole it is inclined to be highly feldspathic. It is also much less tilted and folded than the Sudbury quartzite, but in some places the beds stand nearly vertical. This is particularly true where the formation lies against the Murray fault. The thickness of the Mississagi formation, according to Collins, ranges from 1,000 to nearly 12,000 feet.

The Bruce conglomerate, a formation ranging from 20 to 400 feet in thickness, overlies the Mississagi quartzite, from which it is separated by a disconformity. Above this conglomerate lies the Bruce limestone, a formation varying greatly in character from point to point. It consists of silty, siliceous limestone with thin bands of magnetite and hematite near its base.

The Espanola greywacké, a less calcareous, more argillaceous and silty formation than the Bruce limestone, lies above it and grades upward into the Espanola limestone; it is often difficult to completely separate these formations from one another. The Espanola limestone is not over 75 feet thick, and yet it is widely distributed over the North Shore area.

The Serpent quartzite at the top of the Bruce series is well exposed in several sections of this area. It was given this name by Collins from its distribution in the area around the headwaters of the Serpent river. It is a white, feldspathic quartzite with numerous bands of greywacké and argillite in some sections. Where the greywacké is relatively abundant and the quartzite impure, it is difficult to distinguish it from the Gowganda formation, which contains many zones of quartzite, unless there is a distinct conglomerate at the base of the Gowganda. This was found to be the case in Mongowin township where the two formations grade into one another, and the writer's interpretation of the position of the contact between the formations differs somewhat from that of Quirke.[1] The lower portion of the formation is thin-bedded, laminated, and greenish-white in colour. Higher up it is a dense white quartzite, and the upper portion may be pink like the Gowganda quartzite. Feldspar is a common constituent throughout, and the formation is, on the whole, much less pure than the Lorrain quartzite. It is not suitable for the manufacture of silica brick. The average thickness of this formation is about 1,200 feet.

[1]T. T. Quirke, Espanola District, Ontario, Geol. Surv. Can., Mem. 102, 1917.

Cobalt Series

The Cobalt series includes the Gowganda formation, the Lorrain quartzite, which is a heavy-bedded, white quartzite, and two thinner quartzite formations. The thinner formations are cherty and banded in contrast to the coarser, more massive Lorrain formation.

The Gowganda formation consists of conglomerate, greywacké, argillite, quartzite, and a few thin bands of impure limestone. There is great diversity in the composition and arrangement of the materials composing the Gowganda formation. Conglomerate alternates with quartzite, and quartzite with greywacké, and it is not uncommon to find large masses of quartzite of irregular form included in the greywacké or the conglomerate. This makes it very difficult to postulate what may be expected in mining in a formation of this sort since a shaft or crosscut may pass suddenly from one type of rock to another without any explanation being found in the stratigraphic succession. The formation is believed to be largely a glacial deposit. The greywacké in many sections is varved. There is no sign of stratification in the conglomerate and very little evidence of assortment; some of the boulders are very large. Collins reports at least one ice-scratched boulder from the conglomerate. The thickness of the Gowganda formation, which is estimated by Collins at 2,500 to 3,500 feet, is an important factor in mining, because a number of deposits in this formation are under development and the question which the miner and prospector naturally ask is whether the formation is likely to change in a short distance from the surface. In many sections of the area this formation is nearly horizontal, but in the southeastern part the beds are steeply tilted as a result of the Killarnean mountain-building.

The Lorrain quartzite is a fairly homogeneous formation, although there is a transition in its lower portion from the Gowganda formation. Impure quartzite with bands of greywacké occur in this portion, but the upper part is a pure, heavy-bedded, well-cemented white quartzite, containing in places as much as 99 per cent. of silica. This part of the formation is suitable for the manufacture of silica brick.[1] A large exposure of this type of quartzite occurs on the Algoma Eastern railway near Whitefish Falls and it has been quarried for a number of years near Killarney for ganister and ferro-silicon. The Algoma Steel Corporation uses this quartzite for silica brick at Bellevue on the Algoma Central and Hudson Bay railway.

KEWEENAWAN

The Keweenawan formations are economically the most important in the area. The ore deposits studied in this region apparently are practically all related to intrusions of this age, if it be admitted that the Cutler and Killarney batholiths belong to the Keweenawan system, as Collins contends. The writer did not have an opportunity to study the age relations of these batholiths, since they do not occur in the areas investigated; but he favours placing them in the Keweenawan because of what was seen of apparently related granite intrusives and of the structural features of certain parts of the North Shore area. Knight considered the granites near Thessalon and at Killarney as Algoman,[2] and Coleman[3] had previously mapped them as Laurentian.

[1] E. S. Moore and G. B. Langford, Ontario Quartzites Available for the Manufacture of Silica Brick, Can. Min. Jour., Dec. 4, 1925.

[2] C. W. Knight, The North Shore of Lake Huron; Ont. Bur. Mines, Vol. XXIV, pt. 1, 1915, p. 228.

[3] A. P. Coleman, The Pre-Cambrian Rocks North of Lake Huron, Ont. Bur. Mines, Vol. XXIII, pt. 1, 1914, p. 205.

The basic rocks of the Keweenawan are mostly typical of this system elsewhere in Ontario. They are of two main types: Nipissing quartz diabase grading into gabbro; and olivine diabase. The olivine diabase, which is the youngest pre-Cambrian rock found in the area, forms dikes, which are numerous in some sections. These dikes bear no important relation to the ore deposits, but the Nipissing diabase magma is, on the other hand, the main ore-producer of the whole region. The olivine diabase cuts some of the ore deposits and disturbs mining operations, as, for example, at the Cheney mine. The Nipissing diabase, which forms innumerable dikes, sills, and irregular intrusions, shows evidence in some places of considerable differentiation, giving rise to small veins of more acid rock such as syenite and micropegmatite. The differentiation is believed to have a bearing in this area, as in the Cobalt area, on the origin of the ores associated with this formation.

Granite scarp on the north side of the Murray fault, Shakespeare township.

Structural Geology

The North Shore area presents a variety of structural features. The pre-Huronian formations have been greatly folded and metamorphosed. The Huronian sediments are little disturbed in some places, particularly north of the Murray fault; but in other places they have been folded into mountain ridges, as in La Cloche mountains. Here the beds stand on edge and show much evidence of mountain-building movements. Little definite evidence of faulting on a large scale was found in the area studied, except for the large fault that crosses May and Shakespeare townships, which is probably an extension of the Murray fault as described by Murray and Collins.[1] North of the old Shakespeare mine and just south of Birch lake, evidences of this fault are seen in the high granite scarp, which is one of the dominant topographic features of this portion of the area. Along the fault the Sudbury series is brought into juxtaposition with the younger granite, and a creek follows the line of the fault for several miles.

[1]W. H. Collins, Geol. Surv. Can., Mem. 143, 1925.

It is probable that considerable faulting has occurred along the lines followed

It is claimed that there is still considerable ore in the mine. The copper content of the ore mined has been estimated at an average of 4½ per cent. The ore mineral was chalcopyrite carrying a little gold, with a gangue of quartz and small quantities of calcite and barite. The veins occur in Nipissing diabase, which may be in the form of either a sill or boss. The main or No. 1 vein is about 8,000 feet long, although it is not well developed for more than 5,000 feet of this distance and is divided into several sections by barren ground with only traces of the vein in these sections. No. 2 vein is separated from No. 1 by a horse of rock. Parallel to No. 1 vein are two others, the South vein, which has been traced for about a mile, and the North vein, which is some distance from

Shaft-house and boiler-house at Cheney mine.

the others and apparently of little economic importance. No. 1 vein averages 5 feet in width where workable, and the deepest workings have been carried to a depth of about 450 feet.

This deposit is of much interest to the geologist and prospector at the present time because it is a type that is more or less characteristic of this region. The occurrence of chalcopyrite carrying traces of gold in quartz veins with barite and calcite is duplicated on other properties. The veins are of the fissure type with little replacement of the wall rock, and like the others in this area they are associated with the Nipissing diabase. They are later than the diabase itself, but they have resulted from movements that apparently occurred when adjustments in the earth's crust followed the intrusion of great quantities of diabase. The solutions forming the veins escaped at depth from the underlying magma, from which the diabase rose at an earlier stage of the igneous activity. There was not enough differentiation *in situ* in the diabase itself to produce the ore as there was in the Sudbury nickel eruptive.

GOULD TOWNSHIP

Cheney Mine

The Cheney property is situated in Gould township, lots 6, 7, and 8, concession V, about 25 miles by road from Thessalon. The property was formerly owned by the Cheney Copper Mines, Limited, but it is now controlled by Sudbury Basin Mines, Limited. It consists of 6 patented claims and 16 claims recently

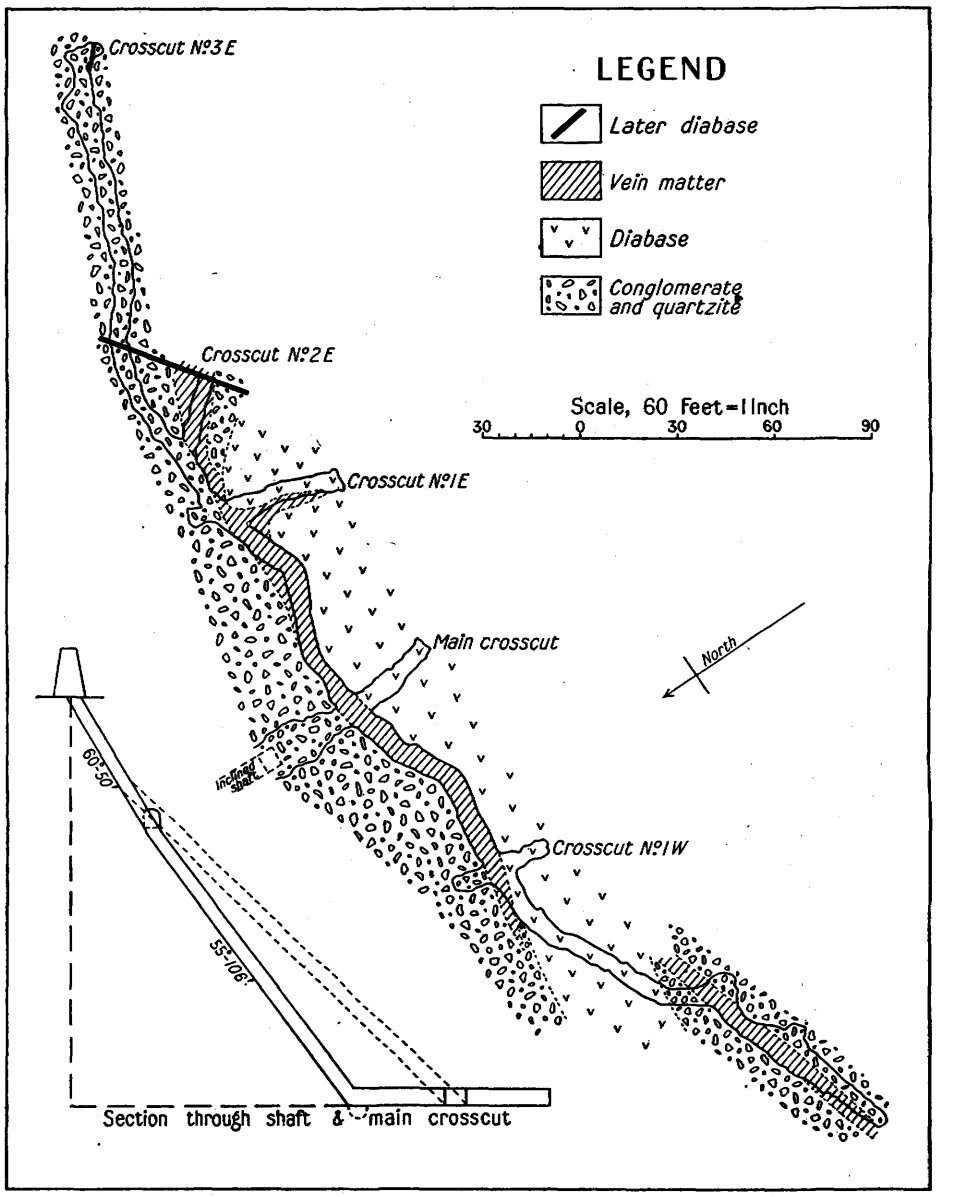
staked. Sudbury Basin Mines, Limited, was carrying on extensive development operations during the summer of 1928 with about 70 men employed in prospecting, underground development, wood-cutting, surveying, and diamond-drilling. Considerable diamond-drilling was being done to test the vein by a line of holes along the strike. A shaft was down to 150 feet, and about 450 feet of drifting and 140 feet of crosscutting had been done at this level up to July 4, 1928. The shaft was sunk to about 70 feet and some drifting was done on the 50-foot level during the former development operations on the property, and some hundreds of tons of ore was hauled for shipment from the shaft and open cuts at various points on the vein during 1916, when the price of copper was high. The accompanying

Polished section of vein from Cheney mine. Brecciated greywacké (black) is cut by quartz and barite (white). The grey mineral is chalcopyrite.

maps and photographs show the layout of the plant, the situation of the vein, and the geology of the surrounding area. The writer is greatly indebted to Joseph Travers, superintendent of the property, for the data regarding underground operations and for his hospitality during the investigation of the property. E. M. McQuarrie, surveyor, Sault Ste. Marie, who was surveying the property at the time, generously placed at the writer's disposal the results of his surveys of claims.

The Veins.—The main vein on the Cheney property has been traced for 4,780 feet. There are some blank stretches in this distance and over considerable sections it is only a few inches wide. In other sections it widens to several feet, where it is well mineralized with chalcopyrite, which is the only ore mineral. The main gangue mineral is quartz, but there is a little calcite and siderite or ankerite, and in one pit there is a band of barite 18 inches to 3 feet in width, of which 6 inches is solid barite. There are small quantities of pyrite with the chalcopyrite, and specular hematite is found in the main vein but it is much more abundant in some of the smaller parallel veins, in which in places it constitutes the chief metallic mineral. In the veins rich in specularite, which is usually micaceous in form, there are generally vugs lined with quartz crystals. The deposit is in most places a lode consisting of parallel stringers of quartz and chalcopyrite, and there are numerous angular fragments of the wall rock enclosed in the ore. The sequence of events in mineralization has been: (1) fracturing of the country rock, (2) deposition of quartz gangue, (3) deposition of barite

and pyrite, (4) formation of chalcopyrite in fractures in the earlier minerals, and (5) deposition of calcite. This indicates that movement and fracturing within the lode occurred at several different stages.



Plan of the 150-foot level, Cheney mine, Gould township.

The strike of the main vein varies from east to a few degrees north of east, and the dip averages between 45° and 60° south. The shaft was started with a dip of 60° S., but below 50 feet in depth it was sunk at an angle of 55 degrees. It followed the vein fairly closely to the 50-foot level, where the vein flattens to 45 degrees and the shaft swings away from it making it necessary to crosscut a

considerable distance to reach the vein at the 150-foot level. At this level the west drift followed the vein west for some distance along a diabase dike where the vein pinched out; it was then swung southward to pick up the vein on the south side of the dike. To the east of the shaft the vein followed the north side of the dike for 80 feet where the dike apparently ends or swings southward, and the vein also beds in this direction in the quartzite. East of the shaft on the surface where the lode is exposed in pits for 130 feet it is 17 feet wide with quartz stringers projecting into the country rock for 13 feet. Beyond these pits it is covered by a ridge of gravel, in which several large pits have been dug without exposing the vein. The next exposures are in pits near Lamb lake, about 10 chains east of the shaft. In these pits the lode, which ranges from 10 to 20 feet in width and dips 55° S., is irregular and tends to break into stringers with streaks of chalcopyrite in the quartz gangue. The last trace of the vein in this direction is found on the small island in the lake where a number of quartz stringers outcrop.

On the west side of the road near the shaft-house the vein is exposed in two pits, from which some high-grade ore has been shipped. In the larger of the pits the lode, which is made up of stringers of quartz and chalcopyrite in diabase and conglomerate, is 20 feet wide. There is one lens of quartz 8 feet wide, well mineralized and containing a streak of practically solid chalcopyrite 6 inches wide. The vein pinches out on the surface, as it does underground, and reappears on the south side of the dike a short distance farther west. No further trace of the vein is found on the north side of the dike to the west, but it is barely possible that the short vein exposed in pits a quarter of a mile northwest of these is a prolongation of the same break. This short vein contains much specularite. That the vein exposed in the pits near the shaft continues to a considerable depth is indicated by diamond-drill hole No. 1, which was started 450 feet to the south and cut the vein at about 460 feet in depth. At this depth the vein is 5 feet wide and contains a band of chalcopyrite a foot in width.

To the west, the vein leaves the diabase dike, which makes a bend northward and then swings southward again, so that the vein crosses the dike near the road leading to hole No. 2. The vein is of good width and well mineralized between the shaft and the creek, but between the creek and the road it is not well developed. Farther west it widens, and there are some good sections in the area lying north of drill-hole No. 2. In the large pit just east of the road leading south to this hole, a barite vein 18 inches to 3 feet wide cuts the quartz. This vein carries bands of chalcopyrite from 3 to 14 inches wide and practically solid sulphide from 3 to 4 inches wide. There are other pits farther west; one 50 feet long by 6 feet wide exposes a vein about 6 feet wide consisting of quartz and barite. In the vein there is a band of good ore 2 to 3 feet wide and containing sheets of nearly solid chalcopyrite up to 4 inches in width. Some ore has been shipped from this pit. Another pit still farther west shows 2 to 3 feet of good ore. At its west end the vein narrows and disappears under drift.

The main vein is one of much interest. It has a length of nine-tenths of a mile and contains excellent ore in some sections, carrying between 5 and 15 per cent. copper for a width of 2 to 4 feet. It continues to several hundred feet at least in depth, and there is no apparent reason why it may not continue to great depth. The ore, however, is irregularly distributed and near the shaft it is difficult to follow because it breaks up on striking the diabase dike, with which it is associated. The vein is cut in the workings by narrow dikes of fine-grained olivine diabase 2 to 10 inches wide. These have caused a little trouble

in mining, because in their weathered condition they give the impression of being slips in the sedimentary rocks, and have led to the belief, by those who are not familiar with the fact that there are diabases of two ages in the area, that faulting has displaced the vein. One of these dikes, 8 inches wide, cuts the shaft at the 50-foot level and another crosses the east drift and crosscut No. 2 E. No displacement of the vein has occurred along these dikes.

In addition to the main vein there are several others, the position of which is shown on the map of the property. With one exception these are too small to be of interest. In the southwest quarter of lot 4, concession V, Gould township, just south of Chub lake, there is a short vein on what was formerly known as the Copper Range property. A shaft, which is said to be 30 feet deep and is now full of water, has been sunk on the dip of the vein, which is 60 degrees. The vein, which consists chiefly of calcite with bands of chalcopyrite, is about 4 feet wide and contains one lens of nearly solid chalcopyrite 2½ feet by 5 feet. The country rock is a varved argillite lying nearly flat. The vein is exposed by pits and trenches for 140 feet, but it probably does not maintain its width much beyond this distance to the west as it splits up into stringers before running under drift. It may be prolonged to the east beneath the drift. It appears to owe its origin to a diabase dike that enters the claim from the east but ends before reaching the shaft.

Rock Formations.—The rocks on the Cheney property are conglomerate, quartzite, argillite, Nipissing diabase, and olivine diabase. The sediments belong to the Gowganda formation, the basal member of the Cobalt series. The diabases are Keweenawan in age. These formations have been mapped by Emmons[1] for the Geological Survey. The Gowganda formation, which varies greatly in character from place to place, is composed for the most part of conglomerate filled with granite boulders. One of these boulders, 7 feet in diameter and very little waterworn, was seen in the area between Chub and Lamb lakes. The matrix of the conglomerate, as seen under the microscope, is a coarse arkose with poorly assorted quartz and feldspar fragments. The conglomerate is interbedded with feldspathic quartzite, usually of a reddish colour and varying greatly in purity. These rocks are not well stratified, and masses of quartzite occur scattered indiscriminately through the conglomerate. It is thus difficult to postulate the nature of the rock that is likely to be encountered any distance ahead in mining operations. The argillite is varved or highly laminated in coarse and fine bands and it grades into an imperfect slate. The minerals are quartz, feldspar, carbonate, magnetite, and pyrite with an aggregate of very fine grained constituents. The Gowganda formation, which has gentle dips varying from 5 to 20 degrees, is much jointed, and the joints have served for water channels. In the Cheney mine, surface water courses through these joints even in the workings at a vertical depth of 127 feet.

The thickness of the Gowganda formation in this area is not determinable. Judging from other areas it is probably over 2,000 feet. Its thickness has a certain bearing on mining operations, since the character of a vein passing into another formation below might be affected. It is probable that no particular change will occur within a couple of thousand feet of the surface.

The Nipissing diabase forms a number of important dikes on the Cheney property. The main vein is very closely related to one of these dikes, and the intrusion is responsible for opening up a channel along which the ore-bearing solutions could deposit their load of metals. Near this shaft the vein lies partly

[1]R. C. Emmons, Wakomata Lake Map-Area, Algoma District, Ontario, Geol. Surv. Can., Sum. Rept., 1926, pt. C.

in the shattered dike itself and partly on either side. Farther west where the dike bends southward, the vein does not seem to have been strong enough to break through the dike, which separates it into two sections.

There has been considerable speculation regarding the form of the Nipissing diabase intrusions. Many of them have been regarded by geologists as sills. On the Cheney property the intrusions are all dikes, as no sign of conformity to bedding can be found and vertical dikes may be seen cutting sediments dipping 20 degrees. The Nipissing diabase is found to be greatly altered when studied under the microscope. The feldspars are partly altered to sericite and kaolin, and the ferromagnesian minerals are chiefly in the form of secondary hornblende, uralite, and chlorite. There is considerable quartz present, part of which is primary and part secondary. Magnetite is a common original constituent of the rock.

Olivine diabase was found only in the vicinity of the mine. On the road, at a point 300 feet north of the shaft, a 25-foot dike of this rock may be seen. It consists of labradorite, augite, olivine, biotite, magnetite, and apatite. The olivine, which appears to have crystallized later than at least part of the feldspar, is much altered to serpentine and magnetite. A short distance farther along the road, the dike pinches out. Towards the shaft the dike runs under drift and what may be regarded as a fingering out of this dike to the south is found in the mine where a fine-grained olivine diabase or basalt dike 8 inches wide cuts the shaft at the 50-foot level. Another one, 2 to 10 inches wide, cuts the east drift and the No. 2 E crosscut. Where the miners struck the dike on the crosscut it was taken for a vertical fault, and the crosscut was abandoned until the geology of the mine was worked out and it was proved that this dike was later in age than the main dike found in the workings. The ore was found again on the other side of the dike.

Thin sections from these dikes indicate that they were olivine diabase, although the olivine is now altered to serpentine. The rock is porphyritic with a groundmass partly dense and almost glassy and partly fine-grained and full of crystallites. The primary minerals were feldspar, titaniferous magnetite, olivine, and probably augite. The olivine is so completely altered to serpentine that it can be recognized only in the serpentine which fills the spaces occupied by the phenocrysts of the porphyry. At first glance these phenocrysts resemble those of hornblende or pyroxene in form, but under higher power the microscope reveals the reticulated form of serpentine so typical of altered olivine. These olivine diabase dikes are the latest consolidated rocks in the area.

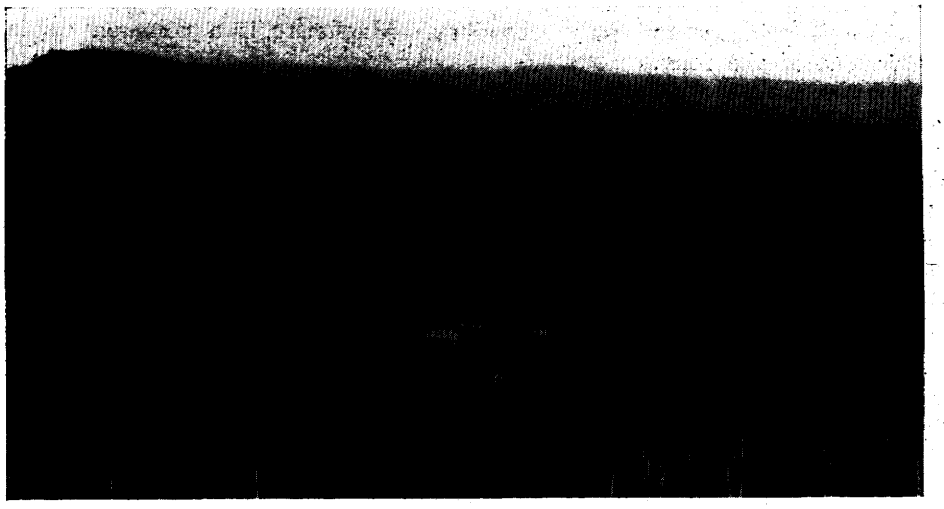
TOWNSHIP 169

White River Lead Property

The White River lead mine, as it is commonly known, is being actively developed by Sudbury Basin Mines, Limited. This property is reached by automobile road from Blind River or Thessalon, and the company maintains communication between it and the Cheney mine by way of Iron Bridge. The writer is greatly indebted to Mr. Joseph Travers, superintendent of these properties, for transportation of his party and camp equipment from one property to the other and to Mr. Travers and Mr. Horrigan, foreman of the White River property, for hospitality during the party's investigation of the property, which was made under very unfavourable weather conditions. The main road to the property is maintained by the Carpenter-Hixon Lumber Company and follows the valley of the Little White river and the East Branch of this stream. The branch road leading to the mine leaves the main road

at a point on the East Branch about a mile east of the south end of Endikai lake. It ascends by steep grades to the camp, which is situated on a small lake nestling among large hills of quartzite and diabase, on the top of one of which the veins are located.

The country through which the Little White river flows is exceedingly rugged and picturesque—the most rugged seen in the North Shore area. The river has cut gorges through Gowganda conglomerate and Nipissing diabase, leaving large cliffs of conglomerate and hills of diabase, which rise 500 to 700 feet above the bed of the stream.



Camp at White River lead mine.

The property consists of 16 claims, which were staked in the autumn of 1927 and the spring of 1928. A number of claims were staked adjacent to this property by another company, but they have not shown anything of much interest.

The stratigraphic geology of the region around the property has been worked out by Emmons,[1] and the writer is indebted to his report for information regarding the general geology of the area. The formations exposed on the property are conglomerate, greywacké, and quartzite of the Gowganda formation (Cobalt series) and Nipissing quartz diabase of Keweenawan age. There is an inclusion of limestone in the diabase, about 5 chains northeast of the mouth of the tunnel; this probably belongs to the Espanola formation, which Emmons shows on his map in the valley farther east. The hill of quartzite east of the workings is mapped as Gowganda by Emmons, but the writer does not feel certain of its relation to the other formations. It may belong to either the Gowganda or the Serpent formation, but does not in any way affect the occurrence of the ore deposit, which is entirely in the Nipissing diabase.

The Veins.—The main vein is situated on a divide which is on a large hill of Nipissing diabase at an elevation, calculated from careful barometer readings, of 130 feet above the lake on which the camp is located. The diabase hill southeast of the camp rises 240 feet above the lake. At the time of the

[1]R. C. Emmons, op. cit.

writer's visit to the property, a tunnel was started into the east side of the hill at a point 35 feet above the lake at the camp and 95 feet below the divide. This tunnel was intended to cut the vein at a depth of about 90 feet below its outcrop on the hill. An Ingersoll-Rand 3-ton gasoline compressor was brought in to operate the drills in this tunnel.

The vein is exposed in several pits extending over a total distance of about 500 feet in a general north-south direction. Near the most northerly exposure there is a mass of quartz about 10 feet in diameter in brecciated diabase with stringers running off into the diabase in various directions. At a point about

Tunnelling at White River lead mine.

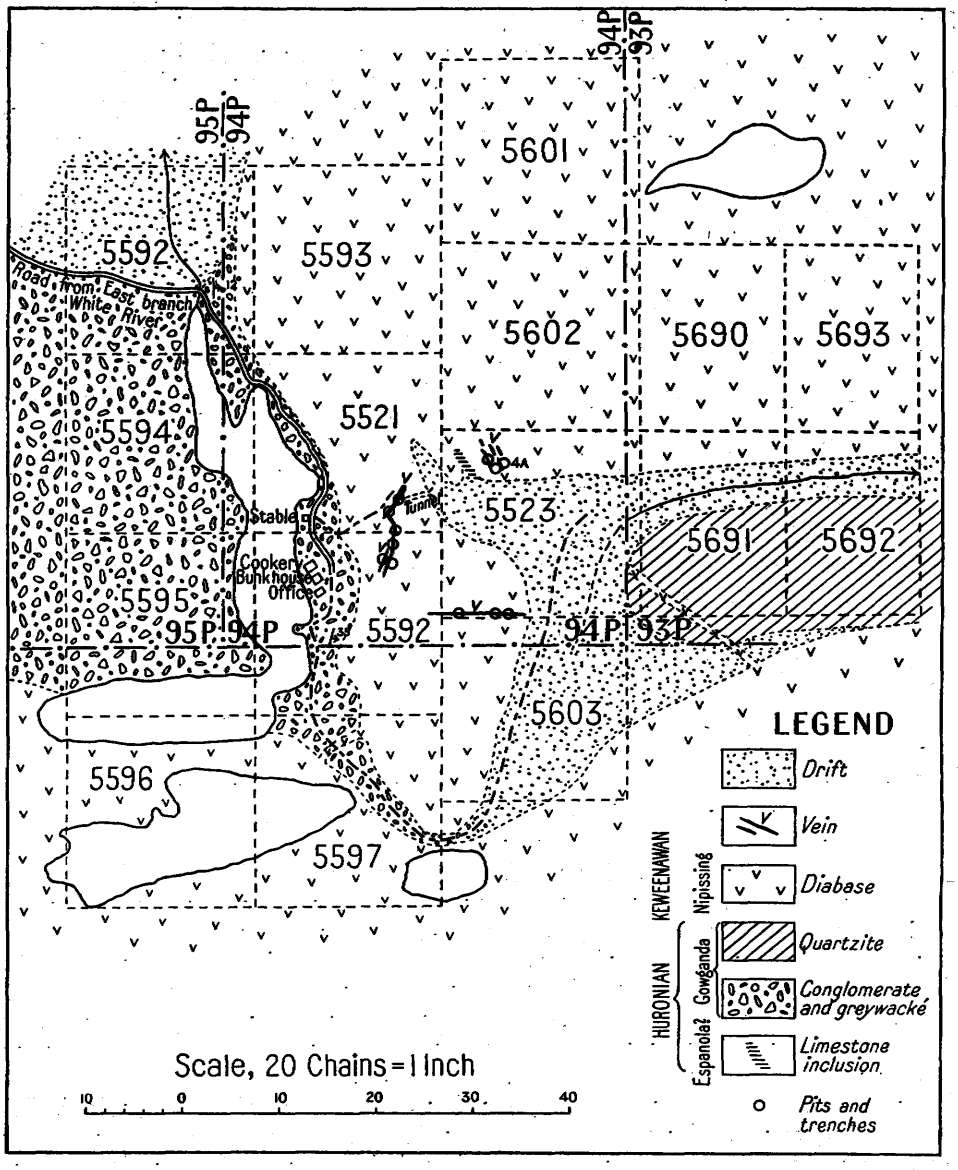
65 feet south of this exposure a trench in drift exposes part of the vein, which runs under drift on the hanging-wall side and at the ends of the trench. The diabase footwall dips 45 degrees into the hill.

The ore consists of pyrrhotite, considerable chalcopyrite, and some galena in a quartz gangue. Ninety feet along the vein southwest of the trench there is a large pit showing two veins, one of which is about 2 feet wide and branches off the main vein to the southwest. The main vein, which is 6 feet wide and highly mineralized, narrows to about 3 feet in a distance of 20 feet and branches again. The 2-foot vein is exposed for about 65 feet in a trench and pit and it widens to about 6 feet at the end of the trench. It is well mineralized with pyrrhotite, chalcopyrite, and galena.

At a distance of 70 feet south from this trench and pit there is a stripping on a vein 4 inches to a foot wide, and 40 feet farther along the vein a pit 14 feet deep exposes a vein 3 to 4 feet wide carrying chalcopyrite and pyrite in a quartz gangue. The vein dips at 45 degrees and between the pits mentioned is quite narrow. The last exposure of the vein is found at a point about 135 feet along the strike from the 14-foot pit. Here the vein, which is 2 feet wide, carries a little chalcopyrite. The vein apparently dies out in the diabase along the face of the hill.

A specimen of the better ore from different parts of the big pit near the northern end of the vein was analysed by the Provincial Assayer and gave: gold, none; silver, 2.60 ounces per ton; copper, 3.10 per cent.; and lead, 20.60 per cent.

This is excellent ore and, although such mineralization is confined to a limited portion of the relatively short and irregular vein, it is worthy of exploration.

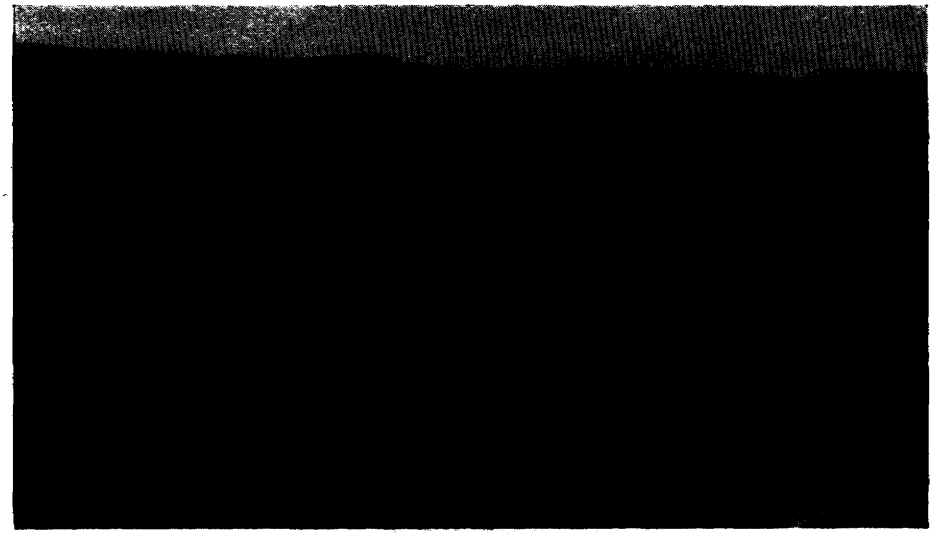


Geological sketch map of the White River lead property, Township 169.

The vein is too small to be of much importance as a vein, but it was thought that the rich ore body exposed at the surface might take the form of a chimney of considerable vertical extent although of relatively small horizontal dimensions. To test this possibility the tunnel was driven into the diabase at the foot of the hill to tap the main ore body. According to reports the results have been disappointing, as relatively little ore was found.

In addition to the main vein a smaller one runs east and west through the diabase hill 650 feet to the southeast of the main vein. It is exposed in several test pits and carries chalcopyrite in a quartz and carbonate gangue. Its width ranges from that of a mere stringer to 4 feet. It is not heavily mineralized and appears to be of little economic importance.

The Diabase.—The great mass of Nipissing diabase that forms the large hills on the White River property may be an irregular intrusion, or it may be a sill dipping eastward beneath the quartzite and overlying the conglomerate, but this could not be settled from the evidence available. The rock varies from a rather fine grained, dark diabase to a coarse, light-coloured gabbro.



Large diabase hill on which the White River lead mine is situated. The compressor may be seen in the lower right-hand corner.

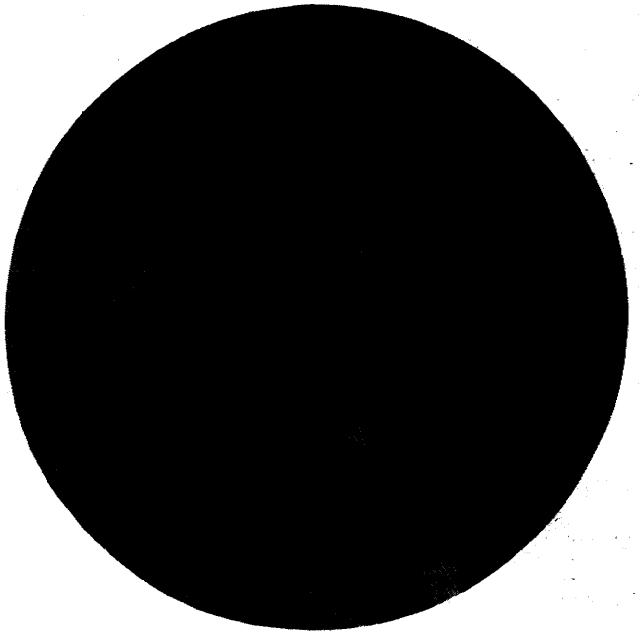
The coarser, ligher-coloured portions of the intrusion appear as irregular segregations in the normal diabase. There are also some areas of coarse acid pegmatitic rock containing orthoclase and plagioclase intimately intergrown with quartz. A specimen taken near the ore body on the divide contains orthoclase, labradorite, and ilmenite and shows a micrographic intergrowth, as do a number of the more acid differentiates of the Nipissing diabases in the North Shore area where they are associated with mineral deposits. All the specimens of the diabase collected on the White River property show at least some quartz. In addition to plagioclase they contain augite and ilmenite as primary minerals and hornblende, sericite, leucoxene, and zoisite or epidote as secondary minerals.

TOWNSHIP 1A

White Lake Mines, Limited

In the southwest corner of Township 1A and about two miles from the road along the East Branch of the Little White river, there is a copper property which was formerly known as the Mills-Burke property and which is now controlled by the White Lake Mines, Limited. The main ore deposit on the property is a large quartz and calcite vein carrying chalcopyrite and, in one sec-

tion, considerable bornite and a little chalcocite and malachite. This vein runs from a small lake up the face of a hill of quartzite and diabase about 100 feet high. The quartzite is believed to be Lorrain, and the diabase Nipissing in age. A thin section shows that the quartzite is incompletely recrystallized and that it consists of grains of quartz, albite, and magnetite, and flakes of chlorite. Most of the particles are angular in form. The diabase is an altered quartz diabase containing quartz, orthoclase, labradorite, augite, and ilmenite as primary minerals. The secondary minerals are sericite, zoisite, carbonate, chlorite, leucoxene, serpentine, and amphibole. There is some intergrowth of feldspar and quartz.

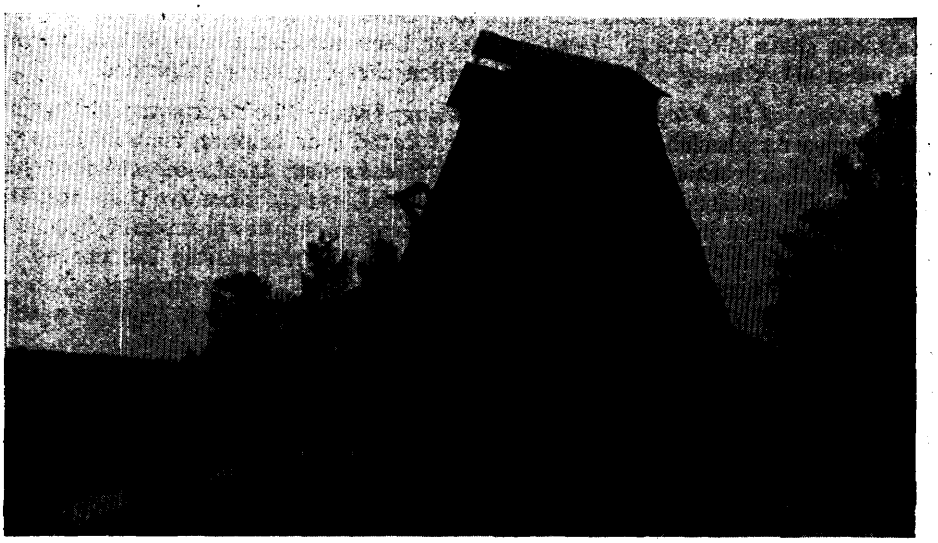


Photomicrograph showing bornite as a secondary mineral developing in cracks in chalcopyrite, White Lake mine.

The quartzite has a gentle dip of 10 to 15 degrees and is cut by the diabase, which outcrops on the south side of the vein. At one place the diabase is in contact with the vein and contains a little copper; at another place it cuts across the course of the vein, so that a portion of the vein traverses the diabase. The maximum width of the vein is 48 feet, but it is not mineralized throughout its width. It contains very little country rock, and the ore zone is 4 to 6 feet wide in one place. In one section of the vein there is rich chalcopyrite ore across 3 feet, and in several places nearly solid chalcopyrite is exposed in bands 6 to 10 inches in width. This vein is a very interesting one on account of its size and mineralization.

At one point on the hillside the vein changes its course about 30 degrees, and here considerable bornite and a little chalcocite is exposed. There has been a good deal of discussion among geologists who have visited the property and others who have studied polished specimens of the ore as to whether these minerals are primary or secondary. In the opinion of the writer there is no doubt about their secondary character and their formation from the chalcopy-

rite, which is the primary mineral in the vein. The evidence in favour of their secondary origin is seen in the rapidity with which the fractured chalcopyrite changes character when it is exposed. If a mass of the ore is broken it immediately begins to change to a brownish or bronzed colour on the surface and along all cracks, and it gradually develops the typical purplish and blue colours of bornite. In the quartzite close to the upper side of the vein on top of the hill is a remarkable sink hole, about 14 by 18 feet and 12 feet deep, which is due to the solution of calcite in the vein permitting the collapse of the quartzite; it indicates a large amount of underground circulation along the vein. Such a sink hole has never before been observed by the writer outside of a limestone



Shaft-house at Shakespeare mine.

region. The writer has also been informed that, since the property was visited, a tunnel driven into the vein at the foot of the hill struck chalcopyrite below the bornite.

This vein, which runs down to the lake at the east end and under drift at the west end, has been stripped along its strike for a distance of 450 feet. Near the west end there is a smaller parallel vein, possibly a branch of the main one, which contains considerable specularite but little copper ore.

SHAKESPEARE TOWNSHIP

Shakespeare Mine

The Shakespeare property, which is situated in lot 5, concessions I and II, Shakespeare township, about 3 miles by road from Webbwood, is said to contain 80 acres. The mine has not operated since 1905. The property has changed hands several times, and considerable interest has been manifested in it during the past year. According to Thomas Trotter, Echo Bay, Ont., who was superintendent of the mine when it was operating, it was worked during the years 1903 to 1905. A mill with tables was built but no cyaniding was done, as the ore was free milling. The shaft, which is now full of water to the level of a tunnel driven into it on the southeast side of the hill on which the shaft is located,

is 300 feet deep. A tunnel has also been driven about 60 feet into the hill from the northwest side; but it does not reach the shaft or the ore. About 100 feet of drifting and a small amount of stoping was done. On the adjoining property to the east a tunnel, commonly spoken of as the Avon tunnel, was driven from the northwest side about 300 feet into the ridge but did not encounter ore (see detail map on page 24).

The main shaft is sunk in a ridge of quartzite running northeast and rising about 150 feet above the road. It is near the southeast side of the ridge, and a 60-foot tunnel running N.28°W. connects the shaft with the valley on that side of the ridge. Forty feet directly east of the main shaft there is a smaller one which appears to be connected with the main shaft underground and to have been sunk on a siliceous, schistose band parallel to the vein on which the main shaft is located. Four pits have been sunk in a line running through the main shaft along a band of rusty silica carrying some sulphides.

Geology of the Property and Surrounding Area.—The rock constituting most of the ridge on which all the workings are located is an impure, vitreous quartzite of the Sudbury series interbedded with streaks and bands of schistose greywacké. The quartzite is highly recrystallized, much more so than the later quartzites, and in many places it is difficult and sometimes practically impossible to distinguish it from vein quartz, a fact that is responsible for the opinion held in some quarters that the whole ridge is gold-bearing quartz capable of being mined. The minerals in the rock are quartz, muscovite, chlorite, apatite, and possibly leucoxene.

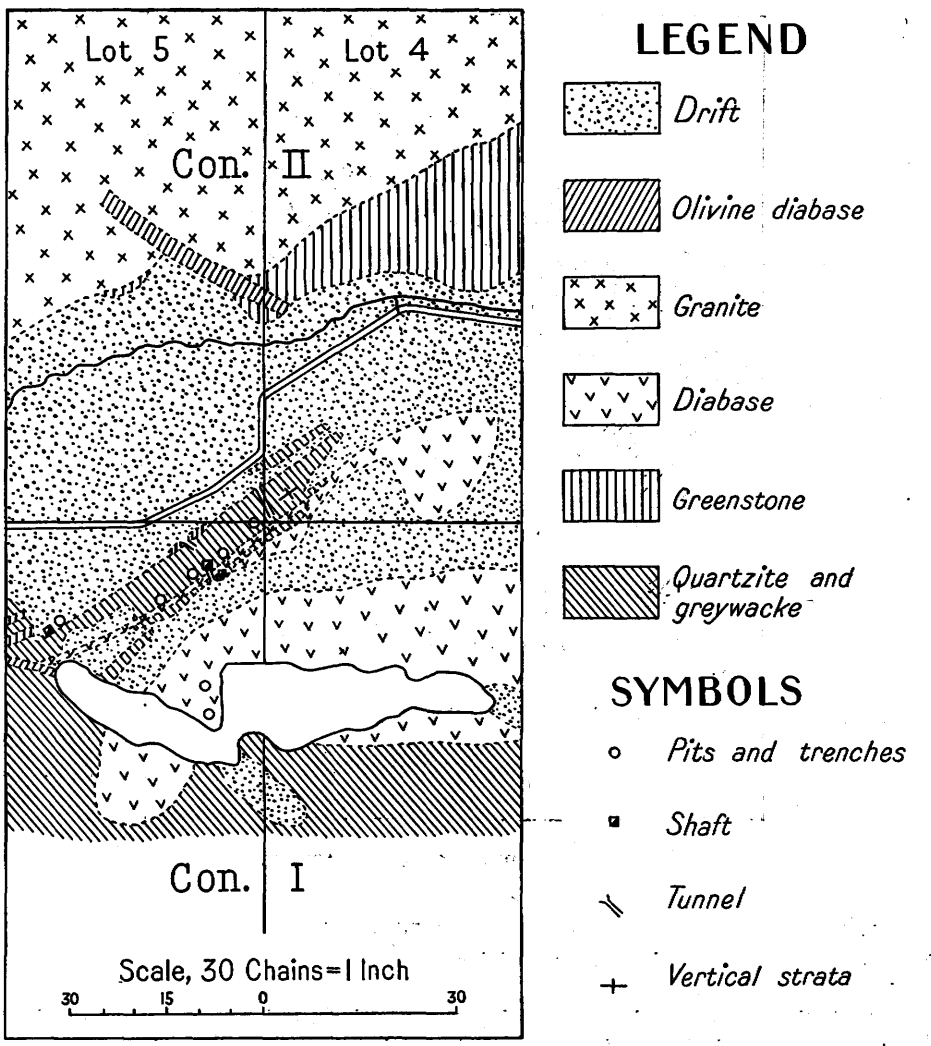
At the mouth of the 60-foot tunnel there is an 8-foot dike-like mass of basic rock which is highly altered and schistose. The minerals, which are practically all secondary, are quartz, chlorite, carbonate, epidote, zoisite, and leucoxene. The original feldspathic constituents are replaced by zoisite, carbonate, and epidote, and the ferromagnesian minerals by chlorite. The rock is so much altered that its determination is uncertain, but it is believed to have been diabase.

The diabase on the southeast side and around the small lake south of the mine is highly altered. It intrudes the rocks of the Sudbury series but appears much older than the Nipissing diabase of Keweenawan age. It contains a little sericitized orthoclase and some ilmenite, apparently as primary minerals. The secondary minerals are quartz, serpentine, sericite, amphibole, and leucoxene. It is possible that the original rock was more acid than a diabase. A narrow dike of this rock runs through the quartzite ridge between the shafts and is apparently an offshoot from the main mass to the east of the shafts.

Northeast of the mine property, on the north side of the creek flowing through a wide valley filled with sand and drift, there is a hill of greenstone, the age and relations of which are uncertain; it may be Keewatin in age. On the north side of the greenstone there is a large area of granite which Collins has called the Birch Lake granite and which is regarded by him as equivalent to the Killarney granite of Keweenawan age. It is a coarse-grained, pink, fresh, somewhat porphyritic biotite granite. This granite forms a prominent ridge which is believed to be the scarp on the northwest side of the Murray fault.

The latest pre-Cambrian rock in the vicinity of the Shakespeare mine is olivine diabase, which forms two dikes. One of these cuts the granite and greenstone north of the property, and the other cuts the quartzite at the west end of the lake south of the mine. This rock is quite fresh except for a little epidote, chlorite, and iron oxide as secondary minerals. The primary minerals are labradorite, orthoclase, augite, olivine, and magnetite.

As already indicated it is very difficult to distinguish gold-bearing quartz from the quartzite of the ridge on which the shaft has been sunk. The lode apparently consists of stringers of dark quartz running parallel with the strike of the quartzite, which has been folded and bulged into a lens between the main shaft and the mouth of the tunnel leading into it. There are also streaks

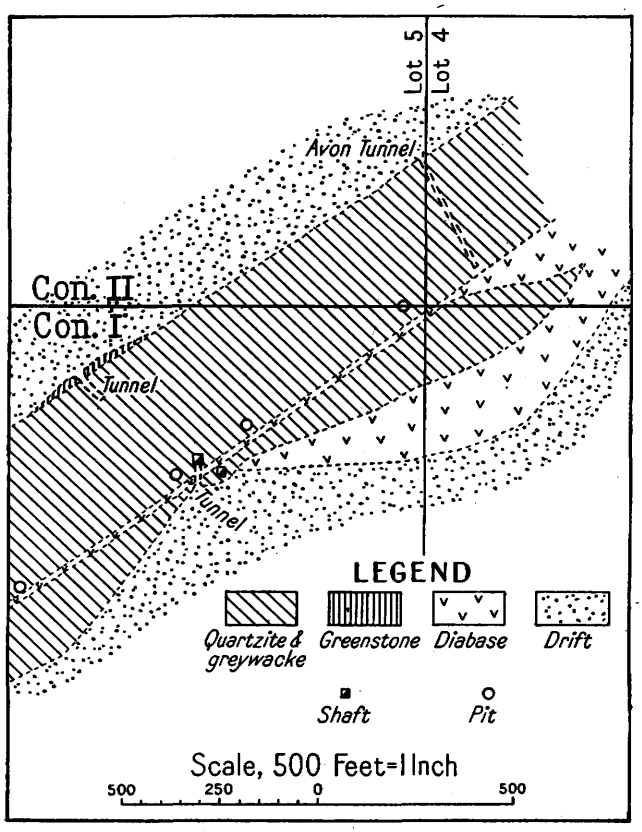


Geological sketch map of the Shakespeare property, Shakespeare township.

of rusty schist in the quartzite near the shaft. Many stories are told about the native gold that has been found in the mine, but none was found on the surface by the writer. A few samples were collected for assay. A specimen taken from a rusty, schistose band outcropping in the tunnel on the southeast side of the ridge and running through the smaller shaft was assayed by the Provincial Assayer and showed no gold. Another was collected from a pit about 100 feet along the strike east of the shaft on what appears to be the lode on which the

main shaft was sunk. It was mineralized with chalcopyrite, pyrrhotite, and a speck of arsenopyrite, but on assay gave not a trace of gold.

An assay was also made of a specimen of well-mineralized quartz taken from the dump at a 50-foot shaft on the property adjoining the Shakespeare property on the west. This shaft was sunk at the foot of the quartzite ridge on its northwest side. The lode consists of quartz stringers in greywacké and



Detail map of Shakespeare mine, Shakespeare township.

quartzite carrying considerable chalcopyrite. It is much more mineralized than any rock seen on the surface at the Shakespeare mine. No gold was found in this specimen.

As to the source of the ore on these properties, nothing is certain. It may have come from the granite lying north of the creek or from the older, more basic rocks, a dike of which runs through the quartzite ridge past the shaft.

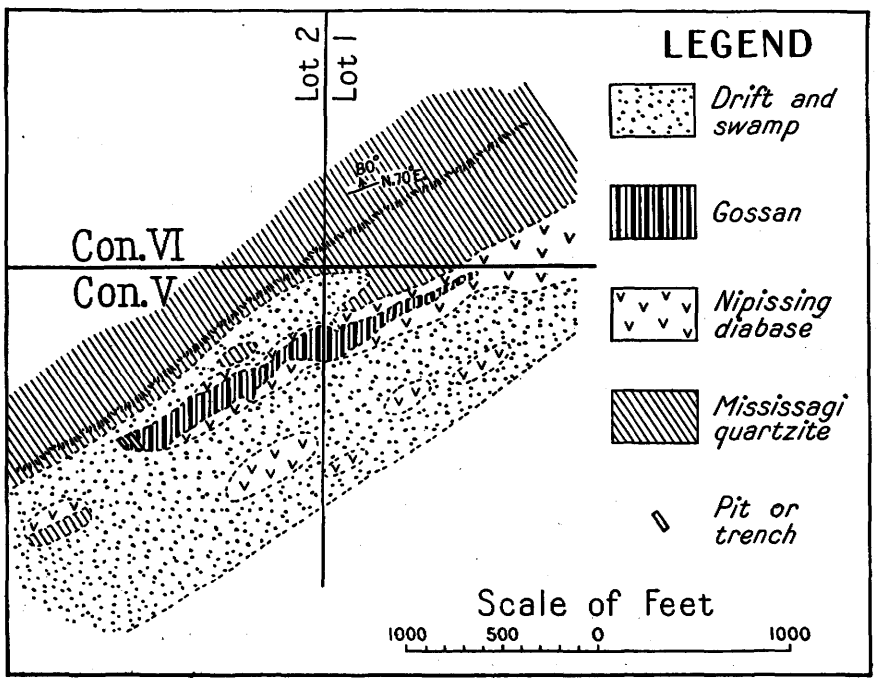
Harmer Property

In lot 2, concession III, Shakespeare township, Percy Harmer, of Webbwood, has done a little work on some quartz veins in gabbro and mica schist. The schist is metamorphosed greywacké of the Sudbury series. The lode, which consists of lenses, small veins, and stringers of quartz carrying chalcopyrite, is exposed for 15 chains along the strike and doubtless extends farther under the drift. In one section it is as much as 25 feet wide, and one stripping exposes a

band containing chalcopyrite across a width of 12 to 15 inches. The lode is wide enough to be of importance, but the mineralization is inclined to be irregular in distribution.

Sudbury Shakespeare Gold Copper Syndicate

The Sudbury Shakespeare Gold Copper Syndicate controls a number of claims in lots 1, 2, 3, 4, and 5, concessions IV, V, and VI, Shakespeare township. The property is situated on the Spanish river a short distance below the large bend in the river where it swings to the east. It is easily reached by an auto road from Webbwood that leads to the river and from there by boat.



Sudbury Shakespeare Gold Copper Syndicate property, Shakespeare township.

The property is managed by J. B. Spellman, of Webbwood, and the writer is indebted to him and Charles Belisle, discoverer of one of the deposits, for their hospitality during an investigation of this property. The ore deposits are of two types: a nickel-copper deposit in diabase and copper veins in quartzite.

The Nickel-Copper Deposit.—On lots 1 and 2, concession V, north of the Spanish river, there is a large intrusion of Nipissing diabase, which is impregnated with chalcopyrite and pyrrhotite, which carries nickel in small quantities. The rock in a hand specimen strongly resembles some of the spotted norite from the Creighton mine, Sudbury area, but under the microscope it is recognized as an altered quartz diabase, which is rather more acid than a typical diabase. It contains as primary minerals quartz, andesine, hornblende, apatite, and titaniferous magnetite. The secondary minerals are serpentine, biotite, epidote, zoisite, sericite, and leucoxene. Some magnetite has been formed in the rock during its hydro-thermal alteration. There is some evidence of micrographic intergrowth of quartz and feldspar. Cutting the normal phase of the rock there

are irregular patches of a coarser, ligher coloured rock, which are segregations of the main mass. One of these patches is as much as 65 feet in diameter. These segregations consist of a pegmatitic intergrowth of quartz and feldspars, orthoclase and oligoclase, accompanied by augite and titanite. The diabase has been considerably schisted, and the sulphides have not resulted from magmatic segregation from the liquid rock but have been introduced by hot solutions along cracks and cleavage planes and replace the rock minerals. They have impregnated the diabase over a large area and on weathering have given rise to an extensive gossan cap, as shown on the accompanying map. The exposed portion of this rusty capping, which is about 2,100 feet long with a maximum width of 200 feet, is the most extensive gossan capping that has been seen in this part of the province outside of the Sudbury area. It probably extends beneath the drift farther west than is indicated on the map.

The pyrrhotite and chalcopyrite are quite uniformly distributed through the country rock in blebs, and the chalcopyrite also forms films along the joints in such a way as to make it appear as if it were much more abundant than the pyrrhotite. Specimens for assay were taken from the trenches, which have been blasted across the western end of the sulphide-bearing rock, and were assayed by the Provincial Assayer. Specimen No. 1 is an average sample picked from a trench 75 feet long, running across the strike of the formation. Specimen No. 2 is an average sample from a trench 15 feet long, running across the west end of the gossan ridge 50 feet from the 75-foot trench. The rock between these trenches is covered with gossan. The assays gave the following results:—

	No. 1	No. 2
	per cent.	per cent.
Copper	0.44	0.80
Nickel	.32	.56
Gold	none	none

These assays indicate that the ore exposed is too low grade to be worked under present conditions, but the deposit is very interesting because of its large size and the fact that it contains considerable nickel. The eastern part of it is not as promising as the western part, but there is reason for believing that a considerable body of material similar to that assayed extends under the drift at the west end of the diabase mass, because the samples were collected across the end of the ridge where it drops down under drift. There is also the possibility of richer deposits at depth in the diabase, but their presence could only be determined by diamond-drilling. The dip needle was tried on the gossan, but only in one spot was a vertical dip obtained and the pyrrhotite did not affect the needle to a great extent. A careful magnetometer survey should be made of the deposit before drilling is done.

There is no evidence of any concentration of ore along the contact of the diabase and quartzite, which lies on the north side of the intrusion, as the sulphides lie entirely within the diabase. The quartzite rises as a steep hill to 250 feet, and the diabase ridge to about 65 feet above the low land at its base. The quartzite, which is regarded as the Mississagi formation, dips steeply northward and has been intruded by the diabase, which is distinctly later in age.

Copper Veins.—South of the nickel-copper deposit there are veins carrying copper. It is claimed that they also contain gold, but assays of two well-mineralized samples collected by the writer failed to show even a trace of gold. A vein

running from the north side of the river eastward across lots 2 and 1, concession V, shows mineralization across widths of 4 to 20 feet, although it is patchy and not continuous. Chalcopyrite is the most abundant sulphide, and there is pyrrhotite and pyrite in a quartz gangue. The vein lies in quartzite of the Sudbury series and in places it grades out into the walls with no sharp line between the vein and quartzite. This vein crosses the river to the west and, after extending through the quartzite for about 460 feet, is cut off by a mass of Nipissing diabase that lies along the south side of the quartzite. North of the diabase another vein is exposed in a pit in which a width of 14 feet of vein matter is seen. It contains chalcopyrite and pyrite, and a sample across this pit assayed by the Provincial Assayer gave: copper, 0.36 per cent.; gold, none.

At a point 115 feet north of the pit mentioned and between it and the river there is still another vein, or possibly the same vein duplicated by faulting, as there are many small faults in the quartzite in this area. A pit shows 15 feet of vein matter, part of it well mineralized with chalcopyrite. A sample taken across 6 feet of the pit assayed: copper, 2.92 per cent.; gold, none. In addition to the 6 feet assayed, there is a band 2½ feet wide which was estimated to contain as much as 10 per cent. copper. There is thus considerable copper in some sections of these veins, but the mineralization is spotty and like many other chalcopyrite veins in the North Shore area the veins do not maintain a uniform width for more than a few yards.

The source of the ore in these veins is believed to be the Nipissing diabase, although granite outcrops near them along the river.

MAY TOWNSHIP

In May township there are a large number of small deposits of copper, but most of those so far found are of more importance geologically than economically. A vein crossing the farm of S. W. Scott, lot 3, concession VI, is 100 feet wide in one section and occurs in quartzite and arkose of the Sudbury series and in old diabase near the contact with granite. The granite along the contact has been changed to a dioritic rock by reaction with the Sudbury series, which it intrudes. This vein is sparsely mineralized with chalcopyrite, and a sample taken across 2¾ feet of the mineralized portion gave on assay: copper, 0.54 per cent.; gold, none.

On John McCauley's property, which is part of lot 5, concession VI, a dike of coarse-grained gabbro, cutting greywacké conglomerate of the Sudbury series, lies along the north side of an old shaft about 12 feet deep. Near this dike there is a stringer, which is about an inch wide at the surface and widens out to about 4 inches in the shaft. It is well mineralized, and there are many fragments of copper sulphide on the dump.

On the same property there is another shaft of about the same depth in which two small veins are exposed on one side. Each has a maximum width of about half a foot. These apparently came together within the shaft and were pinched off by movement in the country rock, as many small faults were observed near the shaft, one of these having a displacement of 18 feet. Fragments 3 or 4 inches in diameter and composed almost entirely of chalcopyrite were found on the dump, but the veins did not appear to be large enough to be of importance.

On the property of Dougal McKee, east of Mr. Scott's farm, there are two old shafts, which were sunk about 20 years ago. They were full of water, but the main one was estimated at about 60 feet and the other at 15 feet in depth. The shafts are 75 feet apart across the strike of a silicified zone, about 100 feet

wide, in quartzite of the Sudbury series. At the main shaft there is a mineralized band 8 to 10 feet wide with streaks of chalcopyrite, and at the other shaft a band 5 to 6 feet wide not highly mineralized. The ore mineral is chalcopyrite in a quartz gangue, and near the surface the vein contains many vugs and is quite open in texture. A hole has been drilled toward the shaft at a dip of 30 degrees. This is one of the most promising exposures in this section, but apparently the work already done did not justify further development of the property.

SALTER TOWNSHIP

Massey Mine

The old Massey copper mine is about 4½ miles from Massey by road. The first shaft on the property was apparently sunk in 1900, and in 1902 it was operating under the control of the Massey Station Mining Company, of which J. J. Thompson was president and Joseph Errington superintendent. The head office was in Copper Cliff. In all, three shafts were sunk and a tunnel was driven into a hill about 4,500 feet west of the main shaft. A concentrator was operated, and over the narrow-gauge railroad connecting the mine with Massey the concentrates were hauled by a horse. The mine was worked for six or seven years and then closed. The ownership apparently changed at least twice, and the mine was owned for a time by the Kenyon Copper Mining Company. An attempt was made to operate it again in 1915-16, and it was again abandoned. It is reported that Joseph Errington has recently purchased the property. The rails have been lifted from the railroad, although the grade remains. The concentrator has been dismantled and the machinery removed from the property. A number of buildings still remain in a fair state of preservation, and Edward Brown, who worked in the mine, is caretaker.

In 1913, Coleman prepared a short report[1] on this property for the Ontario Bureau of Mines, and there are several descriptions of the workings in the reports of the Bureau of Mines for the years 1901 to 1907.

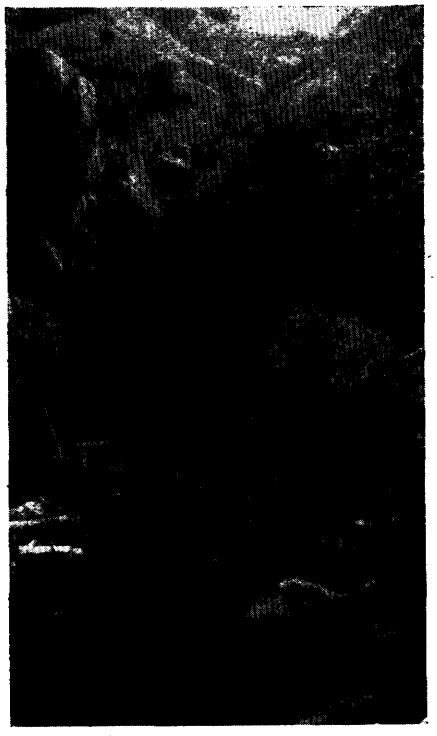
A further brief account of the mine is published by Collins[2] in his report on the North Shore of Lake Huron. He states that according to the report of a consulting engineer 60,000 tons of ore still remain in the mine.

The pre-Cambrian formations exposed on this property are quartzite, greywacké, arkose, diabase or diorite, and granite. The ore deposits are found in bands of greywacké and arkose that run through the quartzite. These rocks are believed to be part of the Sudbury series, although some of the more massive quartzite may represent bands of the Mississagi formation folded into the Sudbury series. Cutting these formations there are intrusions of a much altered igneous rock for the most part resembling diabase but in thin section more like a diorite. It is believed to be an altered diabase because what is apparently the same formation farther west is less altered and can be identified as diabase. In some sections the original minerals are completely decomposed, but in others quartz, ilmenite, magnetite, and traces of feldspars remain. The secondary minerals are hornblende, zoisite, epidote, carbonate, sericite, serpentine, and leucoxene. This rock may correspond in age to the older diabase found in Shakespeare township. It cuts a finer grained greenstone, which occurs in small patches in a few places on the Massey property, and is cut by and altered by the granite, which occupies a large area north of the mine. Drift

[1]A. P. Coleman, The Massey Copper Mine Area, Ont. Bur. Mines, Vol. XXII, pt. 1, 1913, p. 155.

[2]Geol. Surv. Can., Mem. 143, 1925, p. 129.

and sand cover much of the property, and a sand plain stretches away to the south, obscuring all solid rock in this direction. The main shaft is said to be 700 feet deep, and considerable drifting and stoping has been done on several levels. The shaft dips 60° N. on formations that strike east and west and have a vertical dip. It must, in a short distance, have passed through the formations exposed at the surface and run under the drift that covers everything for a long distance northward. About 45 feet from the main shaft, there is another shaft about 20 feet deep. A section across the formation near these shafts,



Tunnel and trench, No. 3 working, Massey mine.

beginning 57 feet north of the second one and running south across the strike, shows 25 feet of greywacké with a little quartzite; 70 feet of somewhat rusty, brecciated greywacké and arkose with disseminated pyrite and chalcopyrite and streaks of quartz; 47 feet of less rusty rock with brecciated quartzite and streaks and blotches containing sulphides, but very little vein quartz, the widest band being 3 feet in width; 122 feet of greywacké, grading into arkose, which in turn grades into a pink to white feldspathic quartzite. Apparently part of this section has been brecciated and there is some evidence of replacement of the country rock by quartz after brecciation. The greywacké is squeezed around fragments of quartzite. The rusty zone contains streaks of disseminated pyrite and chalcopyrite, one of which attains a width of 2 feet. There are also streaks of specularite. A specimen of the heavier sulphide found near the shaft was assayed for gold, but none was found. To the east and west of the shaft the solid rocks are covered by drift and sand, so that the lode cannot be traced for more than a few rods from the shafts.

On the west side of the creek flowing past the buildings there is another shaft, known as shaft No. 4, a trench, and a number of pits on a small vein. The depth of the shaft is variously estimated at from 110 to 200 feet. The vein at this shaft does not line up with the lode at the main shaft. There is a possibility that it is part of the same lode and offset by faulting beneath the drift cover, but it is probable that it is a separate vein like the one farther west on which the tunnel is driven at working No. 3. The vein, which is from 2 to 4 feet in width, occurs in quartzite adjacent to a band of greywacké and consists mostly of quartzite impregnated with silica and chalcopyrite oxidized to a gossan cap containing malachite, azurite, and a little bornite. Some 265 feet south of this vein on the side of the quartzite ridge there is a zone 25 feet wide full of stringers of barren quartz, which is in line with a diabase dike near which there is mineralization farther west.

The vein on which No. 4 shaft is sunk can be traced for only a few chains before it is lost in the quartzite.

At about 2,000 feet a little south of west of No. 4 shaft a tunnel has been driven into the hillside on a vein carrying some good ore. Near the inner end of the tunnel, which is 130 feet long, there is a winze, and some stoping has been done. Chalcopyrite occurs in stringers across 4 feet of the roof, and one of these is 6 to 8 inches wide and 10 feet long. A trench above the tunnel shows conditions similar to those in the tunnel. Considerable ore has been shipped from these workings. The vein lies in rusty greywacké impregnated with sulphide for several yards across the strike, but it dies out to the east near the end of the tunnel. What appears to be a continuation of this vein is found in a pit near the dike 300 feet east of the trench. It is like scores of other chalcopyrite veins in the North Shore area which widen out into lenses with stringers of chalcopyrite forming rich ore and then completely disappear through long sections of country rock; there is much copper in this area, but it is so widely distributed in irregular veins that it does not pay to mine them. Where this vein is strong at the tunnel it drops off abruptly into low land, and the natural place to look for its continuation would be to the west, were it not for the observed fact that these more mineralized spots generally stand up better in weathering than areas without quartz veins. There is still some ore in the hill above and below the tunnel, but the amount is relatively small. Very little can be said from the surface indications about probable ore reserves in the deposit at the main shaft, as so much of the surrounding area is drift-covered. Drilling is necessary to prove further deposits. As already stated the report quoted by Collins indicates that there is 60,000 tons of reserves in the mine. The ore is low grade, and to be handled to advantage must be treated in a neighbouring smelter where this siliceous ore could be used to advantage with a more basic type. It would then serve as a flux, and the copper could be recovered at a relatively low cost.

Hermina Mine

The Hermina property lies nearly 4,000 feet west of the Massey. Some of the same formations extend from one property to the other, but the main vein at the Hermina mine is in granite and diabase. There are two shafts: No. 1, near the east side of the property, is sunk on a few stringers of slightly mineralized quartz cutting diabase; and the main shaft is on a large quartz vein which lies mostly in granite but also cuts through a mass of diabase that is exposed close to the shaft. The diabase varies from a normal quartz diabase to a diorite and a porphyritic anorthosite and is intruded by the granite.

The mine has been idle for many years, and the rails have been removed from the railroad which connected it with the Canadian Pacific Railway line near Walford. The main vein extends a quarter of a mile northwest of the main shaft, where it dies out suddenly in the granite. Within a distance of 15 feet, a 15-foot vein pinches out entirely. It is a strong quartz vein for over 2,000 feet along its strike with a maximum width of 30 feet. On the whole it is not highly mineralized, as only a few pits show much chalcopyrite. The ore is quite low grade, and the only possibility of utilizing it is in the smelting of other ores that require mixing with a siliceous ore. For this purpose there is a

Quartz veins in diabase, shaft No. 1,
Hermina mine.

large quantity of ore available, the copper in which might yield a return for mining costs. The ore from this property was formerly shipped to the smelters at Victoria mines and Copper Cliff.

VICTORIA TOWNSHIP

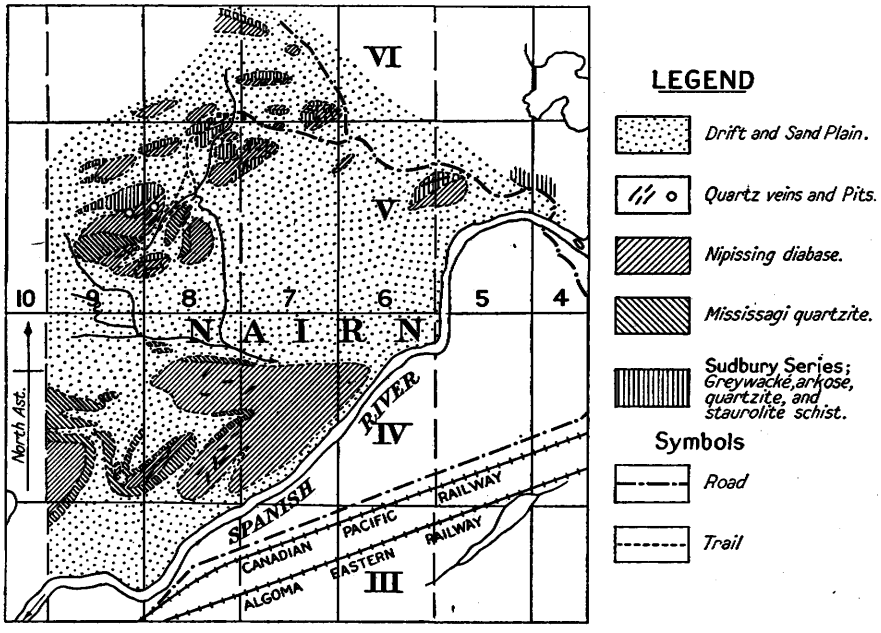
During the summer of 1928, considerable diamond-drilling was being done in the Sugar Lake area, in a zone about 4 miles long. Throughout this region there are a number of exposures of chalcopyrite in quartz veins that are typical of those in many other parts of the North Shore area—lenses of well-mineralized quartz in veins, most of which lack continuity and are too scattered to make mines. Such deposits are very numerous in the sedimentary rocks of the region around Walford and Spanish.

NAIRN TOWNSHIP

A number of claims were staked in Nairn township in the winter previous to the writer's investigation of this area. The mineral deposits, however, proved to be of little economic importance. Most of the veins are in the Nipissing diabase, and while there is a large quantity of quartz in the area the veins are poorly mineralized. They are of interest in showing the relations between the ore deposits and the enclosing rocks of the North Shore area. A gradation was found between the quartz veins and pegmatitic segregations of more acid rock in the diabase.

Claims were investigated in lots 4, 5, 6, 7, 8, and 9, in concessions III, IV, V, and VI. Part of this area is very rugged with cliffs of diabase and hills of quartzite rising 250 feet above the surrounding low lands. Most of the other part is covered with sand plain, and there are few exposures of bed rock.

The rock formations are drift and post-glacial lake deposits, Nipissing diabase of Lower Keweenawan age, Mississagi quartzite of Lower Huronian age, and greywacké, arkose, staurolite schist, and quartzite of the Sudbury series. The diabase is a quartz diabase containing a little primary quartz, labradorite,

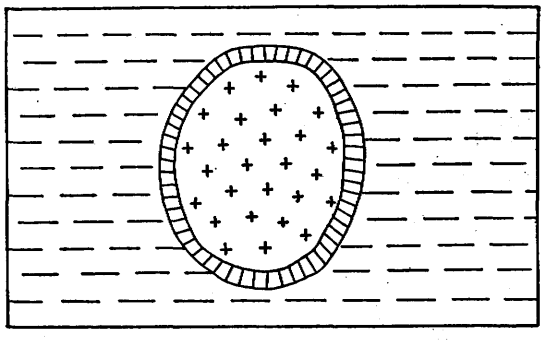


Geological sketch map of part of Nairn township.
Scale, 1 mile to the inch.

andesine, apatite, and ilmenite. The secondary minerals are hornblende, epidote, and leucoxene. The ophitic texture is well developed. Augite has practically all altered to hornblende, but the feldspars are relatively fresh. There are many lighter coloured, coarser grained patches of anorthositic rock in the diabase and also more acid patches and irregular veins, some of which are pegmatitic in character and approach a granite in composition. It is quite probable that some of these patches are due to the inclusion of fragments of quartzite in the diabase and their digestion by this rock. Most of the included fragments of quartzite do not, however, show much reaction between the two rocks at the border, as the majority of the pieces of quartzite show sharp boundaries, but in some cases there is evidence of assimilation. Near the northeast corner of lot 8, concession V, some interesting relations were observed between apophyses of diabase and a paragneiss formed from the arkose and quartzose greywacké. These tongues of diabase are injected into a breccia of paragneiss and form rounded masses up to 4 feet in diameter. Around their borders are reaction rims from half an inch to 3 inches in width. The outer portion of the rim is biotite gneiss, and the inner portion consists chiefly of crystals of

hornblende. In the same area there are zones in the diabase along the contact with a garnetiferous paragneiss that contain garnet.

The acid segregations in the diabase present quite a variety of rock types. One irregular mass 50 feet in diameter consists of quartz, orthoclase, albite, hornblende, biotite, apatite, and magnetite. The hornblende is in large prisms and contains parallel streaks of magnetite grains, and the quartz is often in large crystals segregated in bunches, so that the texture of the rock is very irregular. Another of these segregations in the large diabase hill overlooking the Spanish river is a quartz monzonite consisting of quartz, orthoclase, albite, biotite, hornblende, apatite, and ilmenite; and still another shows pegmatitic texture in a quartz-feldspar rock.



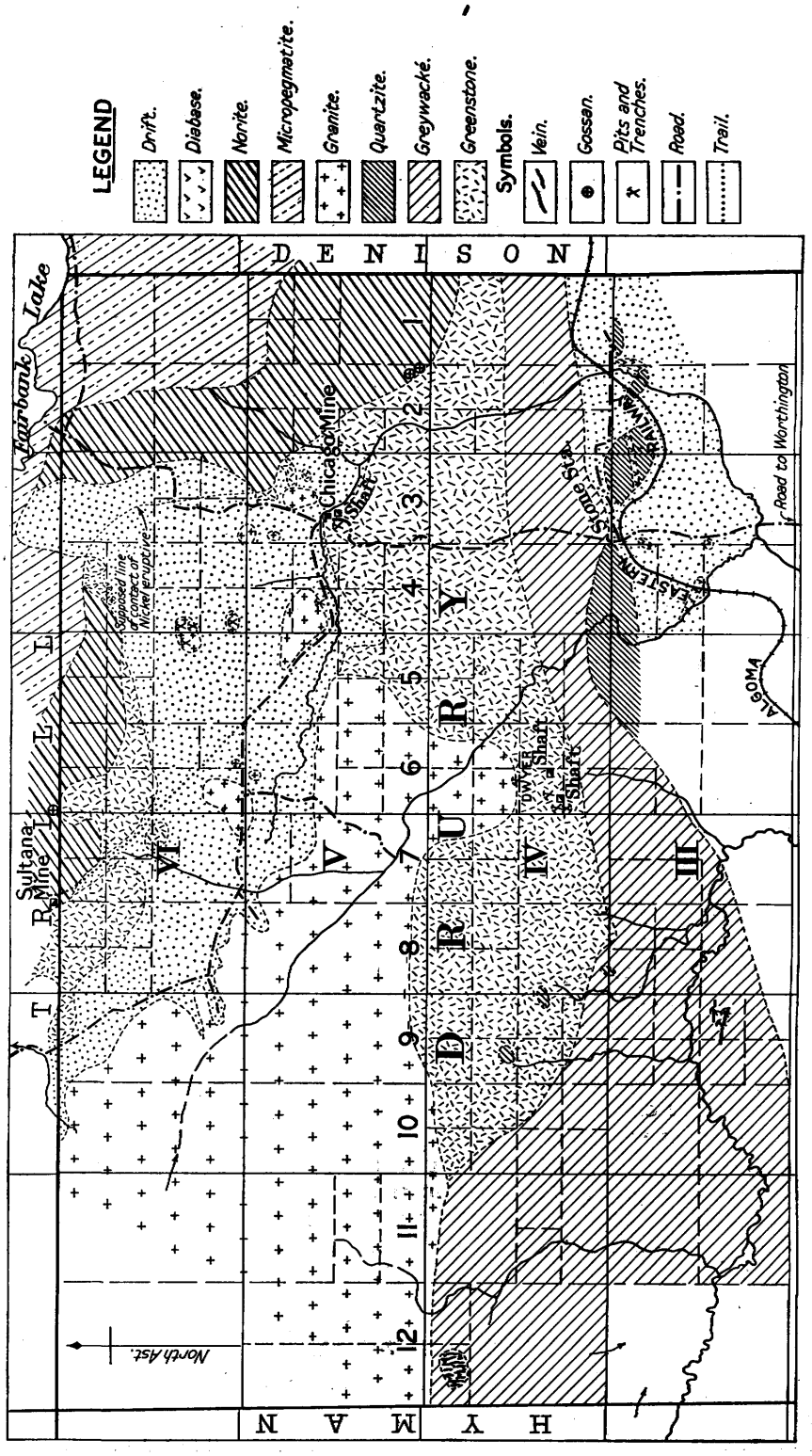
Diabase intrusion in paragneiss surrounded by reaction rim of hornblende and biotite, Nairn township.

The most interesting differentiation of the diabase is seen near the centre of the boundary between lots 8 and 9, concession V. On a large diabase hill pits have been sunk and some stripping has been done on a group of quartz veins in the diabase. In one of these veins, which is exposed for 60 feet, the northern 15 feet consists of a pegmatitic rock carrying sulphides. This portion of the vein is believed to have been injected after the quartz came in. The quartz has been fractured and impregnated with solutions depositing feldspar, amphibole, and sulphides. The rock in the walls is a quartz diorite consisting of quartz, andesine, biotite, hornblende, apatite, ilmenite, and pyrite. In the vein the rock varies from apatite to quartz monzonite containing quartz, orthoclase, albite, hornblende, pyroxene, biotite, apatite, titanite, and magnetite. The sulphides are chalcopyrite, pyrrhotite, and pyrite. An assay of the vein, which is 14 inches wide at the top and pinches off at a depth of 10 feet, was made by the Provincial Assayer and gave: copper, 0.82 per cent.; gold, none.

It is evident that the sulphides in the veins in this section have come in from a late phase of the diabase magma and that they are derived from a more acid differentiate than the typical diabase. This relation is probably true of most, if not all, of the veins associated with the Nipissing diabase in the North Shore area.

HYMAN TOWNSHIP

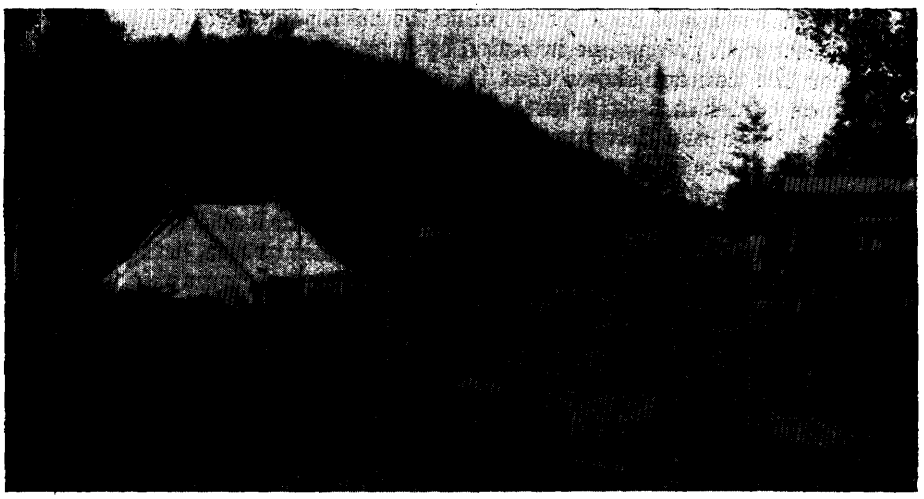
The Spanish Basin Mines Syndicate holds 13 claims along the boundary between Hyman and Nairn townships. On this property there is a large intrusion of quartz diabase extending along the North side of a creek. In two



GEOLOGICAL SKETCH MAP OF PART OF DRURY TOWNSHIP. SCALE, 1 MILE TO THE INCH.

sections about a quarter of a mile apart and separated by low land there is a rusty gossan cap covering the hillside. In the eastern section the gossan extends 200 feet along the face of the hill in a band about 50 feet wide. The diabase is somewhat spheroidally weathered, and around the spheroids and filling cracks in the rock there is pyrrhotite and a little chalcopyrite. A specimen of the sulphide-bearing rock was assayed for nickel and gold and yielded: nickel, 0.68 per cent.; gold, none.

The diabase in places resembles the norite of the Sudbury nickel intrusive, and it is generally called norite by the prospectors. It is, however, an altered



Camp of Spanish Basin Syndicate with diabase hill in the background on which work is being done on a nickel-copper deposit.

quartz diabase similar to the Nipissing diabase found elsewhere in this region. Plans were under way for drilling in the low land between the two sections of gossan-covered diabase.

PORTER TOWNSHIP

On the Charles Duret property, lot 3, concession II, Porter township, a small shaft was sunk by Joseph Errington over 20 years ago to a depth of about 30 feet. On the surface very little can be seen of the vein, which lies along the contact between quartzite and conglomerate; there is considerable chalcopyrite in the quartz of the dump. On the Macpherson property to the northeast of this shaft a number of pits have been dug and a tunnel has been driven into the hillside; there is one lode consisting of quartz veins and stringers exposed for over 100 yards along the strike and 50 feet in width. Irregular bands of chalcopyrite run through the quartz. The lode as it occurs at the surface is too low grade to mine and does not show much sign of strength along the strike; but it is wide, and drilling might show more concentration at depth.

DRURY TOWNSHIP

There have been several operating mines in Drury township, the Worthington, Totten, Howland, and Chicago, and many claims have been restaked during the past year. The writer's investigations have, however, been confined chiefly to the northern four concessions of the township. The area studied includes a portion of the Sudbury nickel eruptive as well as parts of several

other formations. The rocks of this area consist of greenstone, probably of Keewatin age, greywacké of the Sudbury series, quartzite of the Mississagi formation, granite, the age of which is not definitely fixed, the nickel eruptive, olivine diabase of Middle Keweenawan age, and Pleistocene drift and lake beds. The granite is a relatively fresh, red granite resembling the "younger" granite of the Sudbury nickel region, but it was not found definitely intruding the nickel eruptive, although it comes in contact with it and may possibly be younger. Both the norite and micropegmatite phases of the nickel eruptive are exposed in this area, and they grade into each other without any sign of a distinct contact between them. It was found necessary to revise Coleman's map of these rocks a little, because north of the Chicago mine the micropegmatite swings southward to the contact with greenstone intruded by granite. A thin section of this rock taken near the contact shows that it is quite typical micropegmatite. The norite which comes in a little farther west is more acid than typical norite; it grows more basic and becomes true norite before the Sultana mine is reached. On account of the acid character of the nickel eruptive little nickel ore may be expected to occur along its border in lots 4 and 5, concession VI.

In lot 2, concession VI, there are a number of small acid dikes cutting the norite. These are granitic in composition and contain quartz, orthoclase, albite, hornblende, magnetite, and ilmenite. There is some micrographic intergrowth of the quartz and feldspars, indicating that these dikes are apparently offshoots from the micropegmatite, which is not far away.

The greenstones in this area are of two types: One type outcropping along the norite contact is a medium-grained, old, basic rock; the other occurring around the Chicago mine is a much altered porphyritic, anorthosite-like rock.

Chicago Mine

The Chicago mine has been described by Barlow and Coleman in their reports on the Sudbury area. It has been closed since 1897, and it never produced much ore, although roast beds, smelter, and a monorail tram line for hauling out matte were in operation when the mine was working. Practically all buildings and equipment have disappeared. An open cut through a rusty hill on the east side of the road is from 4 to 25 feet wide and 250 feet long. In the bottom of it there is a shaft, which is reported to be 160 feet deep. On the west side of the road there is a trench on a sulphide zone running up the hillside and a shaft 8 to 10 feet deep dipping 60 degrees into the hill at the base. The ore minerals found on the dump are pyrrhotite and chalcopyrite, the latter in very small quantities.

This deposit is a peculiar one. It is apparently some distance from the main norite body and occurs in a porphyritic, anorthositic greenstone, which covers a large area south and southwest of the mine. Specimens of the fresher looking rock associated with the ore indicate that it is probably a much altered norite, although practically none of the original minerals remain.

The surface is drift-covered east of the shaft, and it is impossible to get a good idea of the geological conditions existing between the shaft and the main body of norite. It is possible that drilling east of the shaft near the main norite contact might disclose further deposits of ore, as this offset of the norite should connect with the main intrusion of the nickel eruptive

Dwyer Mine

In lot 6, concession IV, Drury township, Charles G. Hyatt, a farmer living near by has restaked the old Dwyer property and has been doing development

work on it. Two shallow shafts were sunk many years ago, and at the southwest shaft there is quite a large vein formed of stringers of quartz running through a dike of granite. This vein, which is exposed for 5 chains up the side of a hill and has a maximum width of 20 feet, ends rather abruptly at the west end and disappears under drift to the east, where a shaft has been sunk. The quartz contains specks of galena. An average sample taken from the vein was assayed by the Provincial Assayer and showed neither gold nor silver.

The other shaft is on a vein that starts as blotches and stringers of quartz in a squeezed and brecciated greenstone. It widens out to 40 feet but maintains this width for only about 60 feet, and this lens is followed by a section of barren rock with only stringers of quartz, until the shaft is reached. The total length of the vein exposed is about 400 feet. In the bottom of the shaft, which is 38 feet deep, the lode is about 8 feet wide, and at the top from 12 to 15 feet. Much interest has been attached to the vein in this shaft because an old report by Aaron Slaght for the Ontario Bureau of Mines[1] states that values up to $24.00 in gold per ton were obtained from the bottom of the shaft, which was then not so deep as it is now. Other assays from this property are reported to have run as high as $26.00 a ton in gold and over $2.00 in silver. The quartz is greenish in colour and contains a small quantity of chalcopyrite. A sample containing some chalcopyrite was taken across the lode near the bottom of the shaft and assayed by the Provincial Assayer but gave no gold or silver.

There are several other veins on this property, but they are either practically unmineralized or of limited extent and not of economic interest. One of these is a large lens of slightly mineralized quartz occurring at the granite contact northwest of the shaft.

Other Properties

A number of claims were visited in lot 9, concession III, and lot 12, concession IV, Drury township. The veins occur in Nipissing diabase and greywacké of the Sudbury series. Some of them are of good size and they mostly contain a little chalcopyrite. Development work has been done on some of the veins, and they are regarded by prospectors as gold properties. Several samples were collected by the writer as representative of these veins, and they were assayed by the Provincial Assayer. No gold was found in any of them, and since the veins do not carry enough copper to be of interest they cannot be regarded as having economic importance.

South of Turbine station on the Canadian Pacific railway there is a large hill of Nipissing quartz diabase on the farm of E. W. Robb in lot 7, concession I. This hill rises about 275 feet above the creek at its base, and on top there are two pits. These pits are on short, irregular, vein-like segregations in two diabase intrusions separated by a band of crush breccia of arkose and greywacké of the Sudbury series. The deposits are too limited in extent to be of economic importance but they contain pyrrhotite and chalcopyrite, and a sample of the ore assayed: copper, 0.26 per cent.; nickel, 0.49 per cent.; gold, none.

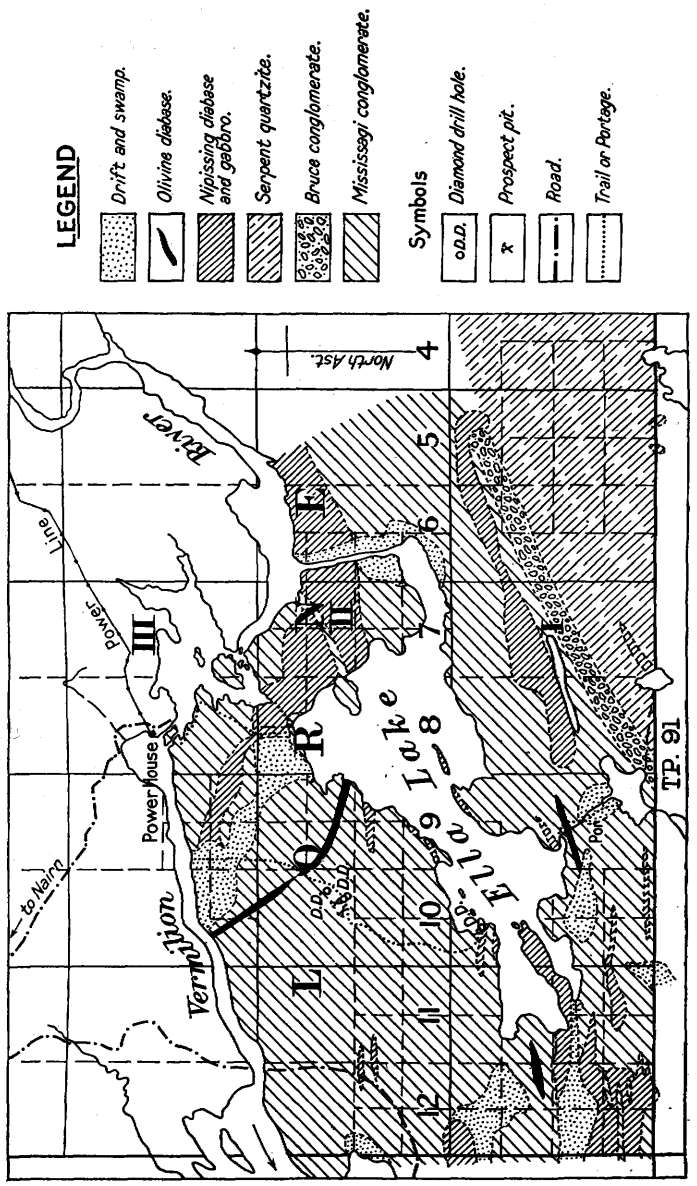
These deposits are of interest because they show new occurrences of nickel-copper ore in the Nipissing diabase

LORNE TOWNSHIP

Interest was aroused by the discovery of copper-zinc ore in lot 10, concession II, and considerable staking was done in this township. In the spring of 1928, Sudbury Mines, Limited, began drilling on the deposit after a number of rock

[1]Ont. Bur. Mines, Vol. VII, pt. 1, 1897, p. 87.

trenches had been cut across the vein that runs through a low oval hill. This deposit is the most attractive seen in the township. The vein is exposed for 185 feet, and a trench 45 feet long and 6 feet deep in the centre has been cut clear across the hill. On the surface near the centre of this trench there is a vein of sphalerite and chalcopyrite 3½ feet wide, but it splits



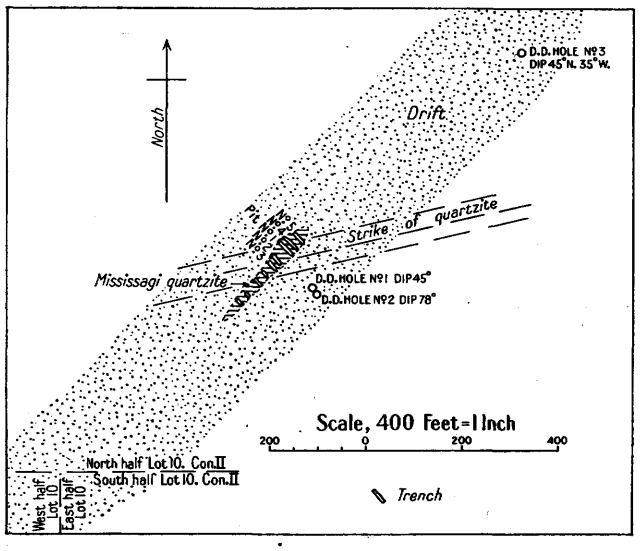
Geological sketch map of part of Lorne township. Scale, 1 mile to the inch.

up into stringers near the bottom of the trench and also fingers out towards both ends. Two diamond-drill holes were put down near the centre of the deposit at angles of 45 and 75 degrees, respectively, and the steeper hole struck the vein at about 400 feet below the surface. It is reported that about 8 feet of vein matter was struck, but the ore was in too small quantities to be of importance. Another hole drilled 650 feet northeast along the strike of the vein where the

formation is drift-covered failed to reveal a vein of any appreciable size. The drill was then moved south to the shore of Ella lake, and a hole was drilled in the quartzite, apparently to satisfy requirements for assessment work.

There is a wide band of brecciated Serpent quartzite containing a little chalcopyrite in vein quartz in lot 5, concession I of this township, but no ore was seen.

On the northwest shore of Ella lake, about 10 chains from the west end, a large mass of Onaping tuff, similar to that in the Sudbury nickel region, extends back from the shore beneath glacial drift. Whether it is in place or not could not be determined: It may be a large boulder. Its presence in this locality is



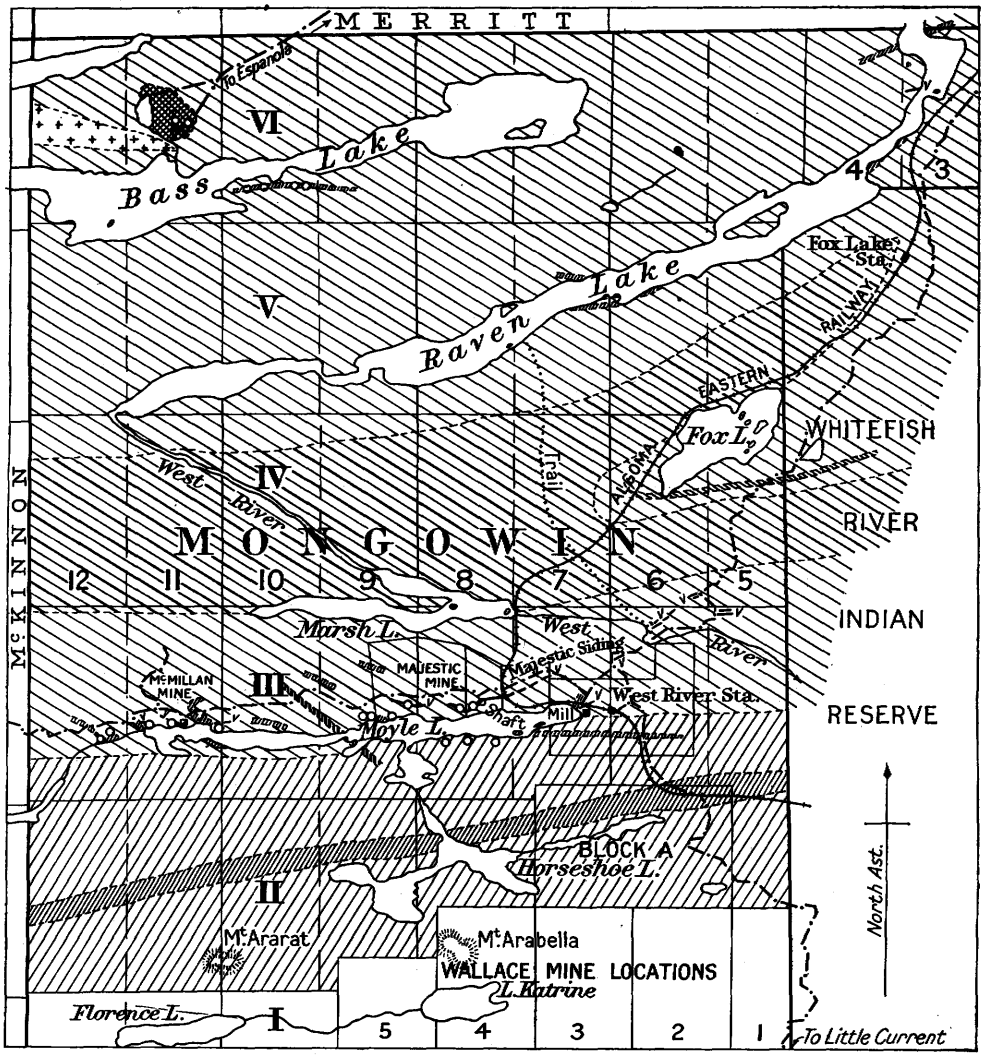
Detail sketch of diamond-drilling and trenching, lot 10, concession II, Lorne township.

mentioned because of the interest manifested by geologists in the peculiar fact that such a thick formation as the Onaping tuff should be, so far as is known, entirely confined to the Sudbury basin.

MONGOWIN TOWNSHIP

There are two mines in Mongowin township, the McMillan, which is under development by McMillan Gold Mines, Limited, and the Majestic which has not been worked for some years. These properties adjoin one another. Much of the township has been staked, but little of economic importance has been found outside of these two properties.

The geological formations in this township are, from oldest to youngest: Serpent quartzite, which occurs as a broad band running through concession IV and part of V, the Gowganda and Lorrain formations of the Cobalt series, the Nipissing diabase, granite, and olivine diabase. The Gowganda formation is one of variable character. It contains conglomerate, greywacké, argillite, quartzite, and a thin band of impure, cherty limestone, which may be seen near Fox lake. Its character changes suddenly, and argillite, greywacké, or conglomerate may be found in irregular bands or masses in quartzite, or the quartzite may occur in the other rocks. Since the main ore deposits in the township are



LEGEND

GOWGANDA FORMATION

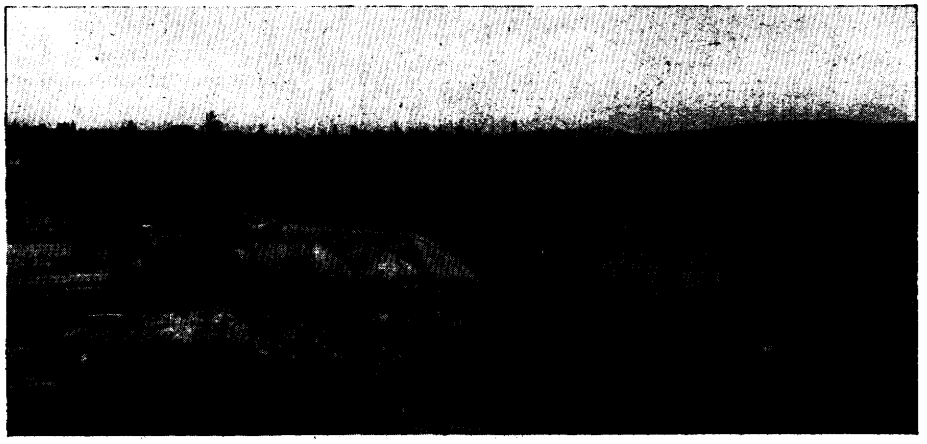
- Cherty limestone.
- Conglomerate, argillite, and quartzite.
- Serpent quartzite.
- Peridotite.
- Nipissing diabase.
- Lorrain quartzite.
- Olivine diabase.
- Quartz veins.
- Granite.

Symbols

- Test pits, trenches, and strippings.
- Road.

Geological sketch map of part of Mongowin township.
Scale, 1 mile to the inch.

in this formation, these facts are of much interest to the miner because the formations vary so much in underground workings and often differ greatly from what would be expected from surface exposures. This is well illustrated at the McMillan mine. The quartzite is an impure, feldspathic rock and resists shearing fairly well, whereas the greywacké and argillite shear readily, particularly along diabase dikes where they have been thrust against this more resistant rock. Where quartzite occurs near the base of the Gowganda formation, it is difficult to distinguish it from the Serpent quartzite, which, although a purer, whiter rock, contains many streaks of greywacké. The Gowganda formation also grades upward into the Lorrain quartzite, which forms the high, white ridges south of Moyle lake.[1]



View looking southeast over Moyle lake from McMillan mine; Lorrain quartzite hills in the background.

The writer's interpretation of the position of some of the formations in Mongowin township differs slightly from that of Collins and Quirke, who have mapped this area for the Geological Survey.[2]

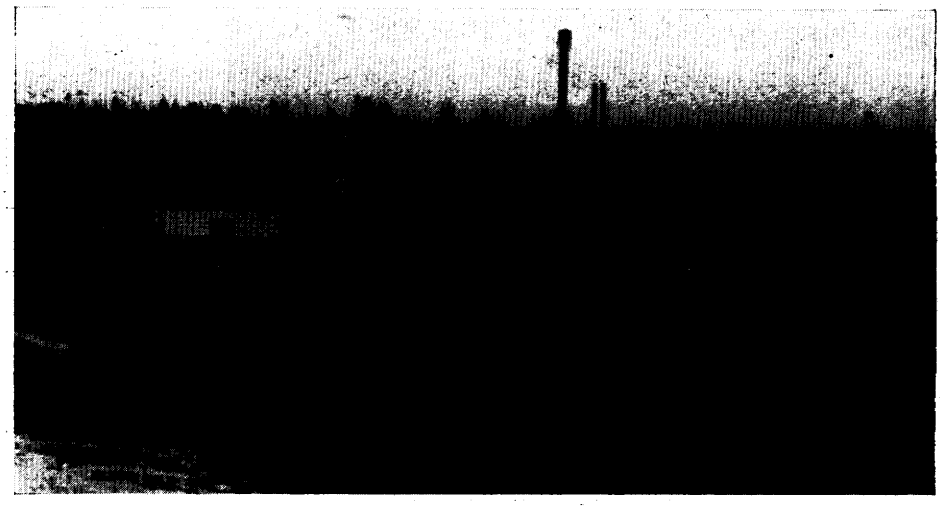
The Lorrain quartzite, while impure, argillaceous, and feldspathic near the base, is a very pure, massive quartzite higher up in the formation. It is sufficiently pure in many places to be used in the manufacture of silica brick.

The Gowganda and Lorrain formations are intruded by the Nipissing quartz diabase, which plays an important rôle in the mines. The diabase magma may be the source of the ores in this as in so many other regions in the North Shore area, but the arsenical gold ores found here differ so much from the copper and nickel deposits found in other parts of the area that the evidence points to the granite as the source of the gold ores. Their association with the diabase dikes might be due to the ore-bearing solutions moving up along these dikes, which would form barriers to their lateral movement and cause shearing of the formations that lie against these resistant masses. Such conditions are found in the McMillan mine, where the schistose argillite is bent at right angles to its regular course by a mass of diabase running across the main drifts. It may be contended that there is no granite near the mines, but there are granite batholiths not far away to the east and west and there is a granite intrusion in the northwest corner

[1]This lake is generally known as House lake in this region; it is also known as Miles lake.
[2]Map No. 1971, Geol. Surv. Can., Mem. 143, 1925.

of Mongowin township that is probably connected with these batholiths beneath the surface.

There is some difference of opinion among geologists regarding the age of this granite. Collins has classed it as Keweenawan, and Knight as Algoman. The writer has not studied the Cutler and Killarney batholiths, but the granite in Mongowin township cuts a mass of peridotite, which in turn intrudes the Gowganda conglomerate. The writer considers this granite as late Lower or early Middle Keweenawan and later than the Nipissing diabase. The olivine diabase, a later formation than the Nipissing diabase, forms a few dikes in Mongowin township, but it has had no influence on the origin of the ore. It is regarded as of late Middle Keweenawan age.



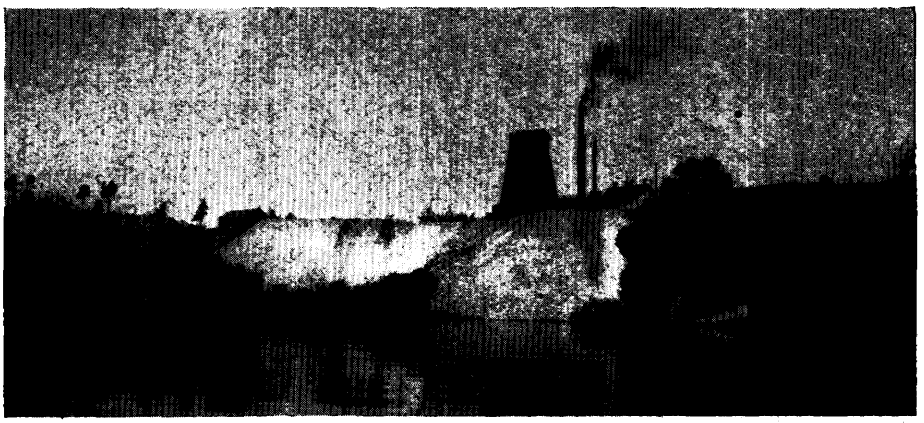
McMillan mine camp.

McMillan Mine

The McMillan mine is situated on the north shore of Moyle (House) lake near its west end, 1.7 miles west of Majestic siding on the Algoma Eastern railway. A wagon road runs to the mine from Majestic siding past the old Majestic mine. The Hawkins Lumber Company, which operates a mill at West River, uses a small tug on Moyle lake for hauling booms of logs. The mine is thus readily accessible from the railroad and is not far from the auto road between Little Current and Espanola. Dr. John H. Banks, of New York, is president of McMillan Gold Mines, Limited, and E. J. McMillan, of Sudbury, is superintendent of the mine. The writer is greatly indebted to these gentlemen for their hospitality to his party while investigating this property and for permission to use plans of the underground workings and other data in this report.

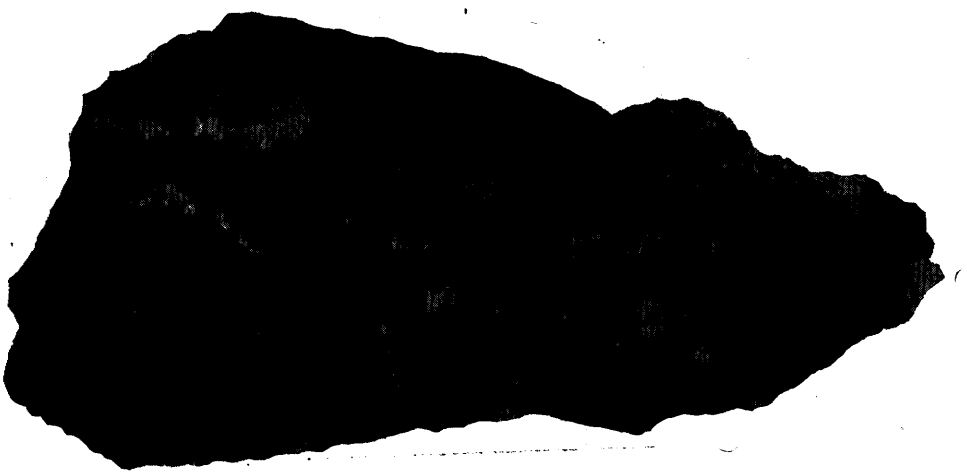
Work was started on the property in March, 1926, and after drilling five holes, the deepest having a vertical depth of 200 feet, shaft-sinking was started in March, 1927. Last summer the shaft was 550 feet deep, and there were two levels at 325 and 525 feet, respectively, with a 25-foot sump at the bottom of the shafts. A large amount of drifting and crosscutting had been done on both levels, as shown on the accompanying plan of the workings. Forty-four men were employed at the camp, of whom 20 were underground. A compressor capable of operating two drills had been installed.

Geology.—The mine is located on the Gowganda formation, which in this area consists of quartzite and schistose argillite. There are many irregularities in the distribution of the two rocks, and the veins run from one to the other, but they tend to follow the steeply dipping argillite bands and the contact between



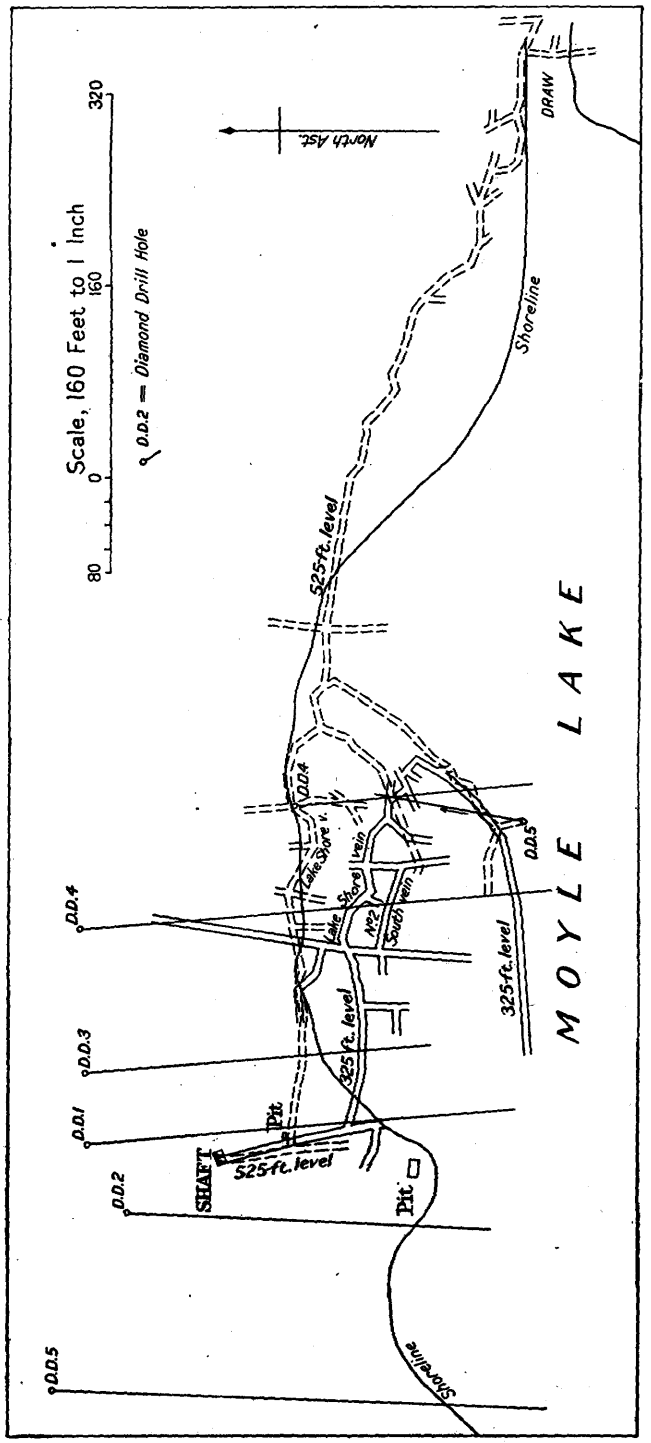
McMillan mine shaft on Moyle lake.

the two rocks. The Gowganda formation has been intruded by a number of diabase dikes and sills, and the dikes affect the underground workings in deflecting the veins. A large olivine diabase dike crosses the property east of the mine but does not materially affect the ore deposits.



Polished specimen of ore from McMillan mine. Argillite and chlorite (black) with quartz (white), pyrrhotite (dark-grey), and arsenopyrite (light-grey).

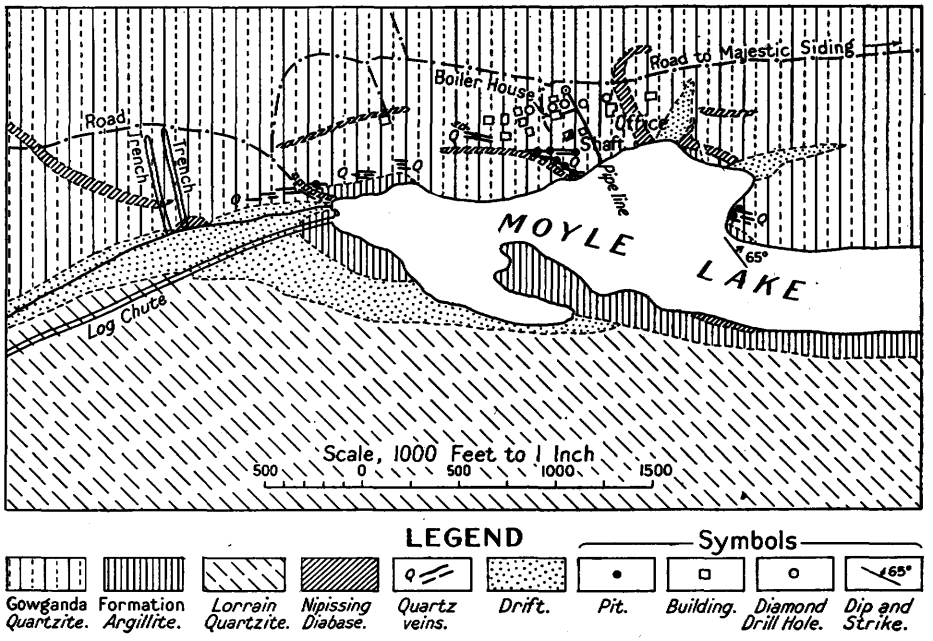
The ore minerals are arsenopyrite, which is abundant, pyrrhotite, chalcopyrite, and pyrite. These occur in a quartz and chlorite gangue. The order of formation of the minerals in the vein has been chlorite, quartz, arsenopyrite, pyrite, pyrrhotite, and chalcopyrite. There may have been more than one generation of quartz. It has generally been considered that the arsenopyrite is the sulphide that carries the gold.



PLAN OF WORKINGS AT THE 325- AND 525-FOOT LEVELS, MCMILLAN MINE, LOT 11, CONCESSION III, MONGOWIN TOWNSHIP.

From a series of assays made for the writer by D. R. Derry at the University of Toronto, it was shown that arsenopyrite carried most gold but that the other sulphides carried lesser quantities. Gold was found in all the sulphides, but the coarsely crystallized pyrite found in vugs in the mine was barren. The gold values per ton of sulphide obtained by Mr. Derry were as follows: arsenopyrite, $32.00 to $39.00; pyrrhotite, $23.25; chalcopyrite, $27.40.

It was difficult to get a complete separation of the chalcopyrite from all the other sulphides, but the sample assayed was practically free from them. Native gold is associated with arsenopyrite and was observed by the writer in



Geology of McMillan mine, lot 11, concession III, Mongowin township.

several spots on the 500-foot level. On this level east of the shaft there is one lens 35 feet wide which carries commercial ore across 24 feet. East of this lens the vein becomes very narrow and then widens out again. No attempt was made by the writer to sample the whole mine, but a sample taken across 4 feet at the end of the drift, where it swings south on the 3rd level, assayed $12.80 to the ton in gold. The ore on the whole is heavily mineralized with sulphides.

The veins were traced as far as possible on the surface. Beginning at the west end of Moyle lake stringers of quartz are found for about 450 feet along the edge of the hill west of the lake, and just north of the west end of the lake there is a pit showing a vein 4 feet wide in quartzite. This quartz vein is well mineralized with arsenopyrite, chalcopyrite, and pyrite. From this pit eastward there are stringers of quartz in quartzite for 460 feet, and then no further sign of the vein is seen for some distance. It would appear that a fault runs up the little ravine past the powder magazine and shifts the vein northward on the east side. Greywacké or argillite lies opposite quartzite on the side of the ravine, but this rock would have to move in the opposite direction from the apparent displacement of the vein. Further, the diabase dike crossing the ravine at the magazine is not displaced, so if a fault exists it must be earlier than the diabase

and quartz vein. It is probable that the vein west of the shaft has been deflected northward by the diabase dike that rises from the lake just southwest of the shaft and runs northwest a short distance before bending to the west.

South and southwest of the shaft there are several pits exposing two well-mineralized veins, which are found in the underground workings. Very little underground work has been done west of the shaft. East of the shaft there are few exposures on the surface, but the veins have been followed in the drifts dipping steeply southward and pitching a little eastward. They make a sudden bend southward and even curve around to the west, apparently because of the diabase dike which is seen on the lake shore about 260 feet east of the shaft. This intrusion has quite a different shape underground from that on the surface. There is a question as to whether it runs beneath the lake to connect with the diabase exposed on the south shore. It seems more probable that the mass on the south shore is a continuation of that seen at the west end of the lake, and it is possible that the two dikes exposed on the opposite sides of the shaft are connected beneath the lake; this would explain the curving of the vein around to the west under the lake. From information lately received, the company has apparently driven eastward through the dike and picked up the ore on the east side of it beneath a small ravine, in which a branch of the diabase disappears.

The only sign of a vein on the surface to the east of the shaft is found on the east side of the bay, and from the strike of the formation there it seems probable that the vein will follow the argillite band eastward beneath the lake. There is a little evidence of mineralization at the east end of Moyle lake. A pit has also been made on well-mineralized quartz on the north shore about halfway down the lake, but the vein here runs northwestward and there does not seem to be any chance of it continuing toward the shaft. If the main vein runs under the lake this may be a branch running along the north side of a diabase dike which appears to underlie the lake in this section and emerges at the pit.

Majestic Mine

The Majestic mine lies east of the McMillan property and close to the Algoma Eastern railroad. It is owned by Majestic Gold Mines, Limited, and has been idle for a number of years, but several reports have been circulated that it is to be reopened. The shaft, which is said to be 200 feet deep, is full of water, and most of the buildings are in a decaying condition. There is a spectacular quartz vein on this property, much larger but less mineralized than the vein at the McMillan mine, and is not, as has been believed by some persons, the same vein. Commencing at the west end as stringers, it widens rapidly into a solid quartz vein about 30 feet wide cutting quartzite. In one place there is 18 feet of solid quartz with 32 feet of stringers running into the quartzite walls. It runs southeast for a short distance and then bends around so that at the shaft it strikes nearly east. It can be traced to the eastern border of the property where it gradually dies out. This large vein may connect with the small vein exposed to the west near the centre of the eastern half of lot 9, concession III. The quartz is not heavily mineralized and some of it has a barren, vitreous appearance. The sulphides found are chalcopyrite, pyrite, and arsenopyrite. The vein is of sufficient size to be of considerable economic importance if it carried higher values, but apparently these do not increase greatly at depth.

Magnetite Vein

There is an ususual type of magnetite deposit in lot 11, concession VI, Mongowin township. This vein, which is from 3 to 4 inches wide, is in a mass

of peridotite, and the magnetite is remarkable in that it forms concretionary masses of radiating crystals. It is also mammillary and botryoidal in structure, resembling hematite or göthite much more than magnetite. Associated with the magnetite is a yellowish-white, porcelainous mineral, which resembles the dense form of magnesite. A chemical analysis, however, showed that this mineral is a variety of serpentine.

A specimen from the vein has somewhat the appearance of slag, and at first sight it resembles a furnace product more than a natural mineral. Tests were made for nickel, chromium, titanium, and manganese, but none of these substances was found. An analysis of the magnetite showed that it contained 69.9

Quartz vein at the Majestic mine.

per cent. iron, so it is nearly pure magnetite. The residue consists of silicate, probably a little serpentine, mixed with the iron oxide. As no record can be found of a similar occurrence of magnetite, the writer is at a loss to explain its origin. The only explanation that occurs to him is that this iron oxide vein in the peridotite was originally in the form of hematite or göthite and an intrusion of granite that cuts the peridotite on its southwest side not far from the vein has metamorphosed the iron oxide to magnetite. The mineral is not lodestone but it possesses polarity, as shown by the fact that it attracts and repels a compass needle. The vein was only exposed in a pit about 4 feet deep, the remainder being covered.

It is reported that since the writer's trip to the property the pit has been deepened, disclosing the fact that this unusual type of magnetite grades into veinlets of the normal mineral.

McKINNON TOWNSHIP

Several properties have been under development in McKinnon township, near Evangeline (Moose or Big) lake. The Big Lake Mining Company, with headquarters in Toronto, have 20 claims in this township adjoining the McMillan property on the west side and have been prospecting, test-pitting, and shaft-sinking. J. J. Bradley was superintendent of operations, and the writer is

indebted to him for his hospitality during a visit to the property. An attempt was being made to find the continuation of the McMillan vein in this area. Several trenches and pits had been dug, and a shaft was down 22 feet on showings of chalcopyrite and pyrite in quartz cutting quartzite and conglomerate near some diabase intrusions. In the shaft a clay seam extended down 16 feet along a wall grooved and polished by the glacier.

Shaft of Big Lake Mining Company on a clay seam along a wall grooved and polished by the glacier to a depth of 16 feet, McKinnon township.

On the north shore of the lake there are a number of pits on the Tough property. In these pits a vein about 4 feet wide and mineralized in places with pyrite runs through quartzite not far from a large olivine diabase dike.

FOSTER TOWNSHIP

There are a number of properties staked or patented in the southern halves of Merritt and Foster townships. A short distance north of the east end of Stratton lake there is an old shaft on a large quartz lode about 60 feet in width. It is reported by C. Bosquet, who kindly acted as guide over the property, that a few dollars in gold to the ton were found in this vein. Several other veins, which cut quartzite, greywacké, and limestone near a large diabase intrusion that forms a hill on the north side of the shaft, are mineralized to some extent with pyrite, chalcopyrite, and arsenopyrite, but the largest vein does not contain much sulphide.

On the south side of a small valley below the shaft another vein system composed of quartz stringers lies in conglomerate and is exposed across the strike for 25 feet. Some streaks on this vein are well mineralized with arsenopyrite. Some 250 feet to the south there is another small vein well mineralized with pyrite. Still another vein runs eastward from the east end of Stratton lake, and in a small pit on the hillside back from the lake a specimen was obtained showing a little cobalt bloom. This was not in place, but it has apparently been blasted out of the pit.

On the south shore, just west of the narrows in Stratton lake, there are trenches and pits and a shaft 12 feet deep on a 150-foot stretch of vein. The vein is 2 feet wide at the surface and widens out at the bottom of the shaft to 4½ feet. It is well mineralized with veinlets of pyrite, which also extend into the quartzite walls. About 30 feet east of the shaft the vein contains much pyrrhotite as well as pyrite.

A sample was taken across 4½ feet near the bottom of the shaft and assayed by the Provincial Assayer. It contained no gold, which was surprising in view of reports that this vein carried considerable values in this metal.

About a quarter of a mile farther west along the lake shore there is an area of gossan, 60 feet wide at the water's edge, under which are several small reticulated veins of highly mineralized quartz. The most abundant sulphides are pyrite and pyrrhotite. There is also a little chalcopyrite. Mr. Bosquet claimed that gold has been panned from the gossan. Peculiar concretions of pyrite were found in the gossan.

Stringers of quartz may be seen along the south shore of Loon lake and on a small island about three-quarters of the distance down the lake from its east end. These are in line with a zone of veinlets which crosses the road and enters the lake at its west end; they are probably a continuation of the vein that runs along the south side of Loon lake.

TOWNSHIP 11

Howrey Creek Mine

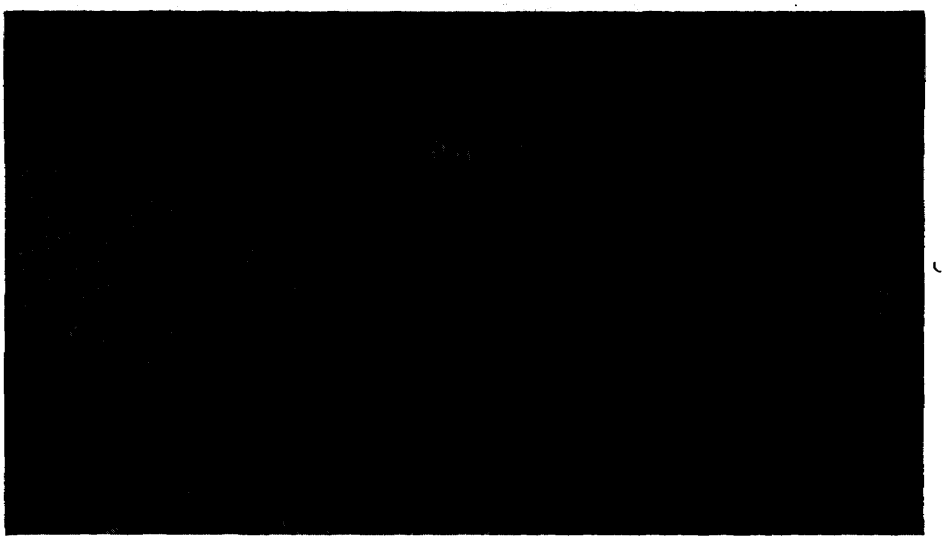
Although no work has been done on the Howrey Creek and adjacent Bosquet properties for a number of years, a short visit was paid to them because of the similarity of the ore to that on the McMillan property, which lies some distance away but in line with them almost directly west. The shaft at the Howrey Creek mine is said to be 70 feet deep and at the bottom to contain a vein 4 feet wide. At the surface the width of the vein is 2½ feet. A tunnel has been driven for 528 feet into the quartzite hill on which the shaft stands, without reaching the ore. Why such a costly tunnel should have been dug into the hill when it would not tap the vein below the shaft is impossible to understand. Some of the ore in the dump at the shaft head is solid arsenopyrite, and a specimen of it assayed $10.80 per ton in gold.

The vein is exposed in pits and trenches for a considerable distance west of the shaft, but it is very irregular in character. In one pit 23 feet of vein matter is exposed but here the vein lies nearly flat and this does not represent the true width of the vein. A sample was collected from a rusty quartz vein 4 inches wide at a point half a mile west of the shaft and analysed for gold and platinum, because it was claimed that high values in platinum had been found in it. The Provincial Assayer reported that it contained no platinum and only $1.88 per ton in gold.

On the Bosquet property, lying west of the Howrey Creek mine, there is a shaft 24 feet deep. The vein at the shaft is about a foot wide, but on the west

side it is 3½ feet wide and in places contains veinlets of solid arsenopyrite. A specimen of the arsenopyrite assayed $8.80 per ton in gold. The vein is exposed for 160 feet east and 180 feet west of the shaft. A large quartz diabase dike forms the north wall and argillite and quartzite the south wall. There are many other small prospects in this region.

In proximity to the veins on the Howrey Creek and adjacent properties are a number of dikes which are much altered, and it is difficult to determine the original character of the rock composing them. Some of these dikes seem to have been quartz diabases and others are more like diorite. It would appear that the dikes have been responsible for forming the veins but, as previously pointed



Shaft at Howrey Creek mine.

out, the presence of auriferous arsenopyrite in practically all the veins in this section of the North Shore area and its general absence in the other sections suggests that the veins originated from the Killarney granite lying east of Lake Panache and probably underlying a considerable area west of the lake. The diabase probably formed some veins carrying copper, pyrite, and pyrrhotite. There is a little pyrite in practically all the Nipissing diabase in the North Shore area.

TOWNSHIP 90

Clarence Property

What is generally known as the Clarence property is situated in Township 90 around Leech lake and less than a quarter of a mile from La Plonge lake. It is easily reached from Fox Lake station on the Algoma Eastern railroad by boat up Long lake and a short stretch of river and across La Plonge lake. Close to the camp there is a pit showing an irregular vein in quartzite near diabase. It contains considerable arsenopyrite, but an assay of the mineral made by the Provincial Assayer did not yield any gold.

There are two other veins south of Leech lake, which lies immediately south of the camp, and a large vein, from 2 to 10 feet wide, running under Harwood

lake at a point 500 feet south of Leech lake and disappearing under drift at the northwestern end. It strikes N. 25° W. and dips 50° to 60° S. 65° W. The vein consists of quartz, which in some sections carries considerable arsenopyrite; in one section there is 6 feet of solid quartz. A shaft 14 feet deep has been sunk on the vein, and it has been stripped for 300 feet. It is claimed that it carries gold values, but no assays were made by the writer. This area has been mapped by Collins and assistants, and the reader is referred to the Lake Panache sheet[1] of the Geological Survey for a map showing the general geology of the region.

SUMMARY

From the description of the various deposits given above it will be seen that ore deposits are very widely distributed over the North Shore area, although most of them are small and of little economic importance. The metals have unfortunately been dissipated in a very large number of veins. Had they been concentrated into about one-tenth of the number of deposits there would undoubtedly have been a number of large mines in the area. Some of the deposits carry good values, and there is still hope that larger concentrations of ore may be found, because there are considerable sections of the area in which little detailed work has been done. The most promising sections for gold deposits lie in the southeastern part. Copper is more abundant farther north. Nickel occurs in a number of deposits southwest of the Sudbury nickel area, but it is doubtful whether large deposits of nickel will be found far from the Sudbury nickel intrusive. Most of the veins are found in and adjacent to diabase intrusions, the parent magma of which has been responsible for their formation. The copper and nickel have come from the same magma as the diabase and possibly the auriferous gold deposits are of similar origin, but it is probable that they have been derived from the granite magma and they should be looked for in the sections of the area not far removed from the granite batholiths but not in these intrusions themselves. The old Bruce Mines copper deposits and the Long lake gold deposits represent the two different types, the former in the diabase and the latter near the granite. Since the granite and diabase appear to have originated from the same magma reservoirs, the two types had a related origin and probably they both formed in Keweenawan time.

[1]Map No. 1971, Geol. Surv. Can., Mem. 143, 1925.

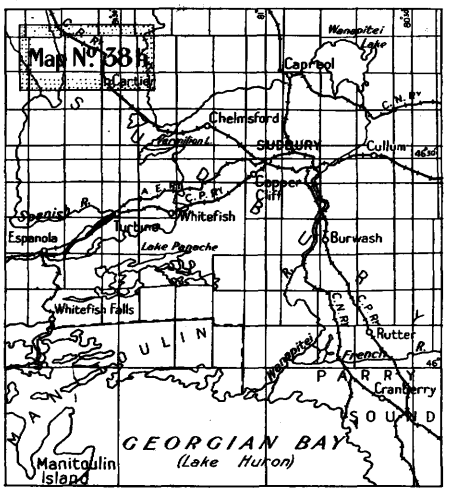
The Cartier-Stralak Area, District of Sudbury

By F. F. Osborne

Introduction

The Cartier-Stralak area includes the country lying along the main line of the Canadian Pacific railway between Cartier and Stralak stations. It comprises the townships of Hess, Moncrieff, and Craig, and the parts of the adjacent townships of Stralak, Ulster, Munster, Leinster, Harty, Cartier, Hart, and 108 that lie between latitudes 46° 41′ and 46° 51′ and longitudes 81° 22′ and 81° 50′.

The main line of the Canadian Pacific railway runs north from Cartier, the divisional point, along the western side of Hess township to the fourth concession



Key map showing the Cartier-Stralak area.
Scale, 32 miles to the inch.

line where it turns northwest and crosses the township of Moncrieff. It leaves Moncrieff near the northwest corner and runs north through Stralak township. Trails and roads from Geneva, Benny (Pulp Siding), and Stralak make a large part of the area accessible. A good road runs from Benny to the dam on Onaping lake. Many of the numerous trails and abandoned logging roads, especially those occupying north-south valleys or running near the large lakes, have been rendered almost impassable by the storm of July 7, 1928.

The Spanish river flows south through the eastern parts of the townships of Stralak, Craig, and 108. It is easily navigable for canoes throughout its whole length in Craig township, but in Stralak township and Township 108, rapids are numerous and canoe travel is difficult. The Onaping river flows south through Harty township. The larger part of the area thus lies in the drainage basins of these two rivers, and most of the streams in the area are short. Onaping creek, which is formed by the diversion of water by a dam from Onaping lake and the drainage of Bailey and Halfway lakes, is the largest stream in this part of the area. It has numerous rapids and falls throughout its length, which render it practically useless as a canoe route. With control of the water level by dams it

is possible that considerable power might be developed on this stream. At present it is used for driving logs, and the flow is irregular.

Geneva lake is the largest in the area, and it gives a ready means of access to the larger part of Hess and to the eastern part of Moncrieff townships. It empties into the Spanish river, but the outflow by way of Geneva creek is small, and it is useless as a canoe route. The southern part of Stralak township may be reached by going up Kennedy creek, which enters the Spanish river from the west, through Bluewater lake, into Kennedy lake. This is a good canoe route during high water, but even then four portages are necessary between the mouth of the creek and Bluewater lake. An alternative route is from Wye (Munro Siding, mileage 22½) to Pogamasing lake and thence by a portage of seven-tenths of a mile to the head of Kennedy lake.

Timber

Much of the area has been burned over by forest fires and is now covered with a dense growth of small poplar, which, combined with the burned remnants of the old timber, makes progress on foot difficult in parts of the area. Some good timber is left. Deciduous trees, principally birch and poplar, make up about half, the rest being pine, spruce, and a few tamarac. Lumbering is being carried on to the north of the area and some of the logs are floated down Onaping creek to the saw-mill at Benny.

Game and Trapping

Aside from lumbering and prospecting, trapping is the only important industry. Fox are fairly numerous in the area, but other fur-bearers, except bear, which are found in the northern part, are scarce. Deer and moose are encountered occasionally, but they are not numerous. Trout may be caught in the larger and deeper lakes, such as Geneva, Bluewater, and Kennedy.

Field Work

Previous geological work in the area is practically confined to the mapping of Hess and part of Moncrieff townships by T. T. Quirke[1] for the Geological Survey of Canada.

The Onaping map area to the north was mapped by Collins.[2] The writer spent the field season of 1928 in the Cartier-Stralak area. In mapping, the township maps were used as a base. These were supplemented by pace and compass traverses, and some information was taken from the maps of the Abitibi Power and Paper Company.

Acknowledgments

The writer wishes to acknowledge his indebtedness to residents of the district for the many courtesies extended to him in the course of the work. W. B. Mather, A. H. Lacey, and A. H. Stewart acted as assistants during the field season.

Physiography

The elevation of the railroad in the area ranges from 1,270 to 1,380 feet, and some points in the area are 200 to 300 feet higher. The plateau surface slopes

[1]T. T. Quirke, Geneva Map-Area, Sudbury District, Ontario, Geol. Surv. Can., Sum. Rept., 1920, pp. 7-17D.

[2]W. H. Collins, Onaping Map-Area, Geol. Surv. Can., Mem. 95, 1917.

southward toward Lake Huron at about 15 feet per mile. The hills of Lorrain quartzite rising above the surrounding country are the most conspicuous features of the area. The hills composed of the less resistant granitic rocks are not so high and those formed of basic intrusives are still lower. The altered sediments, other than quartzite, and the pre-Huronian gneisses form the parts of least relief. Many departures from these generalizations are found, so they are not safe guides for areal mapping. The ridges are commonly parallel to the regional strike of the rocks and are broken by transverse valleys, which commonly lie along faults. Many valleys trend at an acute angle to the regional strike of the rocks. These directions are undoubtedly due to the underlying fracture or joint system. For example, the valley of the Spanish river is parallel to that occupied by Kennedy and Bluewater lakes, and valleys in other parts of the area have the same direction. The lower part of Onaping creek has the same direction as Spanish river below Spanish lake. The rectangular bends in the Onaping river suggest a control by structure. In some places a fault can be proved. For instance, the Onaping river, from the sharp bend at the boundary line between Hess and Harty townships, takes a course that is directly in line with a fault that runs from this point to the southeast arm of Geneva lake, cuts the quartzite on the west side of the lake, and continues along the valley of Bannerman lake. Evidences of stream capture and late modifications of the drainage pattern are numerous. The faulting and the heavy cover in many places make the determination of geological boundaries difficult and their mapping uncertain.

A large part of the area is mantled by glacial material. Till is found in only a few places, but outwash plains of sand and gravel cover much of the lower ground. The outwash deposits are characterized by terraces and eskers. The eskers are particularly numerous in the northern part of the area, and many of the roads and trails follow their summits for considerable distances. The coarse boulders and cobbles flooring some stream valleys suggest a different drainage pattern in late glacial or post-glacial time. For example, the valley extending from the southeast arm of Geneva lake to the Onaping river is broad, the bottom is covered with large boulders, and the divide between the stream flowing into Onaping river and Geneva lake is low and close to the lake, suggesting that at some period Geneva lake drained into Onaping river.

There are recent fluvial deposits along many of the streams, and those along the larger streams have well-marked terraces. The Spanish river, in particular, has many such terraces, and some are found along Bluewater lake. In many places the banks of the Spanish river show natural levees, and it is usual to find swampy areas and small lakes parallel to the river.

Structural Geology

The general structure of the region is relatively simple, but in detail it is complex. A series of northeastward-trending synclines of Huronian rocks are faulted into pre-Huronian granites, which in turn intrude an irregular band of gneisses and schists. The gneisses and schists have an easterly strike and a steep southerly dip. They extend along the northern boundary of Moncrieff and Craig townships to the northeast corner of Hess township, where they pass beneath the Huronian syncline. Locally, there is a considerable departure from the general easterly strike. For example, in the vicinity of Benny the strike is N. 60° E. A notable feature of the contact between the granitic and the pre-Huronian rocks is the occurrence of foliation in the granitic rocks which parallels that of the gneisses and extends for a considerable distance into the igneous rocks

away from the contact. The writer could not work out any original structures within the pre-Huronian gneisses and schists, owing to the intense alteration and feldspathization of the material as well as the lack of suitable key beds.

The Huronian sediments occupy synclines which are in fault contact with the pre-Huronian granites to the west and unconformable to the east. The dip of the sediments averages about 50 degrees, although flatter and steeper dips are encountered. In general, the folding within the synclines is relatively simple, but in the formations underlying the thick Lorrain quartzite, it is more complex. This is probably due to the fact that the quartzite acted as a competent bed and the lower formations were crumpled beneath it. Such crumpling may account for the apparent increase in thickness of the Gowganda and Serpent formations where the trend of the Lorrain quartzite changes. The Huronian rocks are cut by many faults; although most of these are small, they render the outcrop pattern irregular. One fault near the outlet of Geneva lake shows the beds overturned. As far as could be determined most of the faults are of the normal type.

The basic intrusive bodies, mostly diabasic in character, have followed the planes of weakness in the rocks. In the lower Huronian rocks the intrusions are commonly of sill form, and in the pre-Huronian they lie along faults or minor displacements. In some localities, where granites have been intruded by the diabase, a peculiar type of breccia results. Angular and rounded granite fragments of boulder and cobble size are held in a matrix of chilled diabase. The same type of structure is found in other rocks, and on account of the variety of fragments it has been erroneously called a "basal conglomerate."

General Geology

PRE-HURONIAN

Gneisses and Schists

The Pre-Huronian gneisses and schists form a band from 1 to 3 miles wide extending from the northeast corner of Hess township along the northern boundaries of Moncrieff and Craig townships into Township 115. The rock composing this band has been intensely metamorphosed, and it is almost impossible to distinguish its original character. The narrowness of the bands intruded by the granite has allowed penetration by solutions, which produced feldspathization, making much of the rock a gneiss. Most of the material is basic; dark-green hornblende gneisses and schists are common, and a few chloritic schists are found. The foliation strikes east and dips steeply south, although in a few places steep northerly dips are found. The direction of foliation is parallel to the contact with the granitic rocks to the north and south. The age of the rocks is a matter of doubt. They are older than a granite that is older than the lower Huronian. Any original flow or pillow structure in the rocks has been obliterated. The marked basic character and the intense metamorphism which the rocks have undergone suggest that they are of Keewatin age.

Within the band of pre-Huronian rocks are some which do not share the prevailing easterly strike and are of markedly different lithological character. These rocks occupy an elliptical area whose short axis extends from a point east of Benny to another about a mile west; the long axis is northeast and southwest. They are much less altered than the typical pre-Huronian rocks and much more altered than the Huronian formations. They are lithologically unlike any Huronian section, but consist of conglomeratic-appearing rocks with a dark matrix and coarse cobbles; sandstone members; and some phyllites, which show the development of porphyritic texture. Several beds are quartzitic in appear-

ance, and the microscope shows that they are either sheared acidic lavas or arkosic quartzite. The relationships of these rocks to the definitely pre-Huronian ones is obscured by the heavy outwash mantle along Onaping creek. They appear, however, to grade into one another west of Benny. Stratigraphically these rocks seem to be above the more metamorphosed gneisses. Several possibilities may be considered: (1) the rocks are metamorphosed Bruce series, (2) they are a pre-Huronian series (Timiskaming) younger than the gneisses, or (3) they are a less intensely metamorphosed part of the pre-Huronian gneisses. No definite Timiskaming rocks have been recognized in this area, and the writer considers it probable that these rocks are a part of the pre-Huronian gneisses

View looking west across Bannerman lake. The topography in the foreground is developed on the pre-Huronian gneisses and schists. The higher hills in the distance are of granite.

which have been protected from metamorphism. Possibility No. 2 is eliminated because of the number of pegmatite dikes cutting these rocks and the lithological dissimilarity to the Bruce series. It may be noted that close to the place where these rocks are found there is a marked change in the direction of the gneiss band, and it is possible that this circumstance protected them from the metamorphism accompanying the granitic intrusion.

Granite

The appearance of the granitic rocks is not uniform but varies from place to place. Examination shows that the variation in appearance is not due to a diversity of minerals but to differences in quantities of the minerals present. The most common rock is generally pink, and the pink and white feldspars may be distinguished together with colourless or "smoky" quartz. The pink feldspar usually predominates, and in many places it appears as phenocrysts, which range from sporadic to dense in distribution. The mafic minerals are commonly present in small amounts, and much of the rock may be called an alaskite.

The microscope shows that all the varieties are surprisingly similar in the kind of minerals present and their relationships to one another. The feldspars include twinned and untwinned potassic varieties and plagioclase ranging from albite to nearly andesine in composition. The potassic feldspars are clear, but the soda-lime feldspars are commonly so clouded as to be almost indeterminable.

The alteration is of the saussuritic type and is practically uniform over the entire area. The content of mafic minerals is very low. Hornblende is found but biotite, commonly altered to chlorite, is much more important. The rock shows a well-marked cataclastic structure. The deformation produced a straining and breaking of many of the quartz grains and may have been responsible for the development of much of the microcline.

Near their contacts with the pre-Huronian schists, the granitic rocks show a pronounced change due to assimilation. They are markedly gneissic. The foliation is parallel, even in detail, to the foliation of the rocks which they intrude. A slight change in direction of foliation of the country rock is reflected in a corresponding change in direction of the granite contact and the foliation of the granite. The microscope shows that the amount of quartz is low; much of the rock is, therefore, a syenite. Hornblende and biotite are present in large amounts. The accessory constituents, magnetite, apatite, titanite, and pyrite, are more plentiful than in the granitic rocks and are visible to the naked eye. The rocks of this type grade on the one side into the normal granite and on the other into the pre-Huronian gneisses. The transition zones range in width from a few hundred yards to several miles. This fact makes the mapping of the granite-gneiss contact difficult, and in many places arbitrary. In the opinion of the writer the foliation of the transition zone is not due to the primary fluidal arrangement of the minerals of the marginal facies in the magma, nor to orientation during crystallization under stress, but is formed by a granitization of the old rocks by a process similar to metasomatism. With this interpretation the foliation is a relic structure left by the old rocks. There is little evidence for the bodily injection of pegmatitic material, although in a few places *lit par lit* injections are found.

In every locality where the age relationships of the granite are clear, it is unconformable beneath the lower Huronian rocks. The alaskitic character has been described in many Killarnean[1] intrusive bodies and suggests such an age for some of these rocks. However the alaskitic character is found in the granite immediately below the unconformity along the railroad in Hess township. The evidence seems to indicate that practically all the granitic rocks in the area are of pre-Huronian age, and since many of the granites in this part of Ontario are of Algoman age it seems probable that these are the same.

HURONIAN

Bruce Series

The lower Huronian Bruce series[2] is much thinner in this area than in the type area on the north shore of Lake Huron;[3] nevertheless, lithological similarity, stratigraphic position, and degree of metamorphism all support this correlation.

Mississagi Formation.—In the Cartier-Stralak area the basal member of the Bruce series, correlated with the Mississagi quartzite of the North Shore section, is thin. It is occasionally wanting, but in places is over 600 feet thick. It overlies granitic rocks unconformably in several places. Along the Canadian Pacific railway, south of Geneva station, it overlies an alaskitic granite, and at a place half a mile southwest of the east end of Bannerman lake it overlies a syenite

[1]W. H. Collins, North Shore of Lake Huron, Geol. Surv. Can., Mem. 143, 1925, p. 86.
Carl Tolman, Geology of the Big Eddy Lake Map-Area; Dissertation presented to the Department of Geology, Yale University, 1927.
[2]T. T. Quirke, op. cit., pp. 9-11.
[3]W. H. Collins, op. cit.

porphyry. The basal portion of the Mississagi is a conglomerate or arkose. This may grade into a dark cherty quartzite or white quartzite, and this in turn into a greywacké.

Espanola Formation.—The greywacké grades, in a short distance, into a thin-bedded impure limestone, which ranges from a few feet to 125 feet in thickness. The impurities may be either distributed through the rock or as bands about half an inch apart. Specimens tested showed only a trace of magnesium. Examination of the residue left after acid treatment showed a number of angular quartz grains. Quirke correlates this formation with the Espanola limestone of the North Shore section on the relationship to the overlying Serpent formation and the occurrence of clastic dikes. In this area the Espanola is found resting on the granitic rocks in a number of places.

Serpent Formation.—The Serpent formation overlies the Espanola formation conformably. Its thickness may exceed 1,000 feet. Commonly it has a conglomeratic facies near the base, although in some sections this is wanting. In one section this conglomerate has cobbles and boulders in a well-sorted matrix and was found to be 500 feet thick. Overlying this is 200 to 300 feet of cross-bedded white quartzite. The marked cross-bedding and well-sorted character of this material suggest an aeolian origin. Above the conglomerate is a group of argillites, which show well-defined ripple and rill marks and some impact marks, possibly rain prints. These are succeeded by fine sandstones and thinly bedded argillites. The history that may be worked out from this section is: first, terrestrial deposition, followed by wind deposition, and then by a period of deposition in shallow water, which was in turn followed by deposition in deeper water.

A notable feature of the Bruce series in this section is the variation of every formation both in thickness and lithology from place to place. The Espanola formation is the most nearly uniform in the area, but it ranges from a few feet to 125 feet in thickness in different localiteis.

Cobalt Series

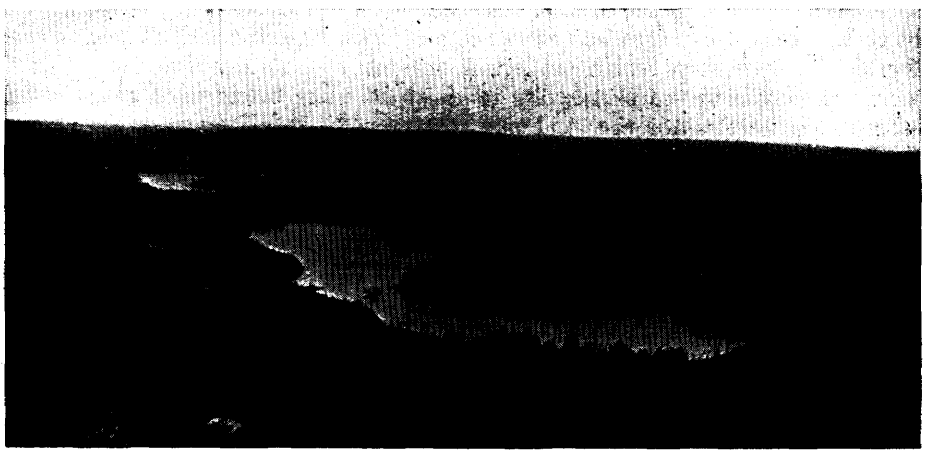
The upper Huronian Cobalt series is divided into two formations, the Gowganda and Lorrain. A marked unconformity separates the Bruce and Cobalt series in other localities, but in this area it is difficult to recognize because of the lithological similarity of some facies of the Serpent and Gowganda formations. The rather abrupt thickening of the Gowganda formation in some sections may be due to the filling of valleys cut in the underlying Bruce series, although folding and thickening of incompetent beds beneath thick Lorrain quartzite may be responsible for some of it.

Gowganda Formation.—The Gowganda formation is distinguished from the Serpent formation by the bands of conglomerate containing large angular and subangular boulders in a matrix of unsorted material. The rest of the formation is made up of quartzite, greywacké, and some thinly bedded rocks showing contemporaneous deformation and resembling varved sediments. Under the microscope these show an alternation of argillaceous and less argillaceous beds. The coarser bands contain angular quartz fragments, and both the bands contain material that may be tuffaceous in character. The differentiation of the Gowganda from the Serpent formation is almost impossible unless the distinctive boulder conglomerate may be found. In a number of places it is possible that some of the Serpent formation has been folded into the Gowganda, thus increasing the apparent thickness. Such seems to be the case just south of Geneva lake.

Lorrain Formation.—The Gowganda grades upward into an arkosic quartzite that forms the base of the Lorrain. The Lorrain is the most conspicuous formation in the area because of the greenish-white colour of the outcrop and its resistant character. It ranges from a pure quartzite to a conglomeratic and arkosic quartzite. The maximum thickness of the formation is about 1,700 feet. A notable feature is the large number of quartz and jasper pebbles and the absence of pebbles of the underlying formations.

BASIC INTRUSIVES

Intrusive diabase bodies are exceedingly common in the area. The outlines of some of these bodies are shown on the map, but in places the country rock is



View looking northeast on Geneva lake. The hills are Lorrain quartzite.

literally riddled with diabase dikes. Within the Huronian rocks the diabase shows a tendency to form sills, whereas in the older gneisses and schists it forms dikes. The diabase is frequently found along lines of weakness, such as the boundaries between formations, or along lines of dislocation. In a few places it forms a peculiar type of intrusive breccia, in which rounded and partially rounded fragments of varying composition and considerable range in size are found in a matrix of diabase, which shows chilled margins against them. This material resembles some types of basal conglomerate and has been so called, but the intrusive character and igneous matrix is apparent in most places. There is little evidence to show the assimilation of rock by the diabase magma after emplacement. Only a few rounded fragments are found in contact with coarse-grained diabase and in these cases reaction zones are wanting. However, a variation due to another cause is apparent, especially on some of the weathered surfaces. It shows as a poorly defined banding due to alternating coarse and fine zones. The coarser zones show a concentration of the minerals believed to be due to the influence of volatile constituents, which suggests that the variation in granularity is due to an uneven distribution of the volatile constituents in the original magma. Such a concentration of the volatile constituents need not have taken place until near the end of the period of crystallization.

The principal mineral of the diabase is, of course, the plagioclase, which is commonly andesine or labradorite of tabular habit parallel to the side pinacoid. It shows considerable zoning, including the oscillatory type. The next most abundant constituent is amphibole, including hornblende and actinolite and a possible alkalic variety. The alkalic variety is found along the margins of grains where they are in contact with a more acidic mineral. A small amount of residual augite is found, but it is not certain that all the hornblende is of uralitic character. Biotite is common, possible as a reaction product. Epidote and sericite are found in some of the plagioclase. Quartz occurs in micrographic intergrowth along the margins of plagioclase grains and as an interstitial mineral. It seems to be a mineral of late crystallization and dependent on the volatile constituents. Iron ore appears to have crystallized after the plagioclase, and apatite is found as rods within the biotite and quartz. Sections which contain quartz also commonly show some titanite.

At a few places in the area olivine diabase dikes are found. In most places this rock is easily distinguished from the quartz diabase by the tendency toward spheroidal weathering, which renders it difficult to obtain a specimen. In the specimens examined the plagioclase tends to be more calcic than in the quartz diabase and there is not the tendency toward zoning. The augite is a slightly titaniferous variety, as shown by the slight pleochroism and the strong dispersion. It is interstitial to the plagioclase, giving a well-marked ophitic texture. The olivine belongs to an early crystallization period and is fresh. A chilled facies of the rock shows the development of the olivine to almost full size with the plagioclase as microlites. In this rock the iron ores appear to have crystallized early.

Most of the quartz diabase bodies are younger than the Huronian, but some may be older. The olivine diabase cuts all the formations, including the quartz diabase. The larger part of the diabase of the area is believed to be of Keweenawan age.

KEWEENAWAN

Quirke[1] mapped several bodies of syenite in the area as Keweenawan. The writer was not able to determine the age relationships of all the bodies so mapped but can see no reason for not regarding some, at least, of the syenite porphyry as pre-Huronian. At one locality southwest of Bannerman lake Quirke mapped as granite a rock which is lithologically similar to and traceable into a mass of his "Keweenawan syenite porphyry." This rock is unconformable beneath the Mississagi formation, and must be pre-Huronian. In a number of places there is an apparent gradation from the alaskitic granite with sporadic phenocrysts into the syenite porphyry. In no place did the writer observe undoubted syenite porphyry in intrusive contact with undoubted Huronian rocks. Most of the contacts are faults. The syenite porphyry is cut by the olivine diabase dikes. The only evidence for a post-Huronian age of the syenite porphyry encountered by the writer is in the southwest corner of Leinster township, where blocks of quartzite resembling the Lorrain are found in an intrusive breccia of the syenite porphyry. On account of doubts about the age the writer mapped all the acidic plutonic rocks under one colour.

Economic Geology

At the time of the excitement over the discoveries at Sudbury a number of claims were laid out along the main line of the Canadian Pacific railway in the

[1]T. T. Quirke, op. cit., *see* map accompanying report.

area mapped. Most of these deposits contained pyrrhotite or pyrite with a small amount of sphalerite. A few claims are also staked for gold and lead. These are the old mining locations found on the township maps. On many of them no work has been done for a number of years. After Quirke's examination of the area in 1920 there was some staking. In October, 1922, A. H. Crichton staked several claims in lots 2 and 3, concession VI, Hess township. A company was organized and some diamond-drilling done on an olivine diabase dike cutting syenite porphyry. Very little other staking was done at this time. In the latter part of 1924, there was some further activity; and in 1925, J. Collins staked some of the claims which are at present included in the property of the Lake

Cook and bunk house at the Lake Geneva mine.

Geneva Mining Company. Since the discovery of lead and zinc ores on these claims there has been more or less continual staking. A number of the old mining locations were found to be open and have been restaked. At the time of writing most of the ground that is at all favourable for the occurrence of ore minerals has been staked.

There are only two outstanding properties in the area. The surface work and diamond-drilling on the property of the Lake Geneva Mining Company has shown sufficient ore to justify further development. The Sudbury Concentrating and Mining Company has not developed as large a body of ore, but they have done no diamond-drilling. Owing to the occurrence of the ore in shoots a considerable amount of underground work or diamond-drilling will be necessary before an estimate of the ore reserves may be obtained. The Sudbury Concentrating and Mining Company has an advantage in the great length of mineralized zone shown on the surface.

LEAD-ZINC

Lake Geneva Mining Company, Limited

The property of the Lake Geneva Mining Company has been developed to a greater extent than any other property in the area. The nucleus of the group was staked by John Collins and it was the discovery of lead-zinc ore as well as the phenomenal values in gold obtained from one pit that led to much of the present staking. Later the Babson interests took over part of the property, and

then the control passed to the Towagmac Exploration Company. The writer is indebted to their superintendent, W. E. Bawden, for many courtesies in the field and much information. Since the end of field work in 1928 the Lake Geneva Mining Company, Limited, has been organized to operate the property.

Most of the work has been done on lot 7, concession VI, Hess township. A trail a little over a mile long to the head of Geneva lake and a wagon road to connect with the old tote road to Onaping river have been built. A dam across the outlet of Geneva lake has raised the level, making it navigable for power-boats. Substantial bunk and cook houses have been built, and a compressor and an oil engine were moved into the property over the snow during the winter of 1927-28. At the time of writing, these had not been installed. The vein has been stripped and open-cut over a length exceeding 100 feet, and more than 4,000 feet of diamond-drilling has shown that there is a sufficiently large body of ore above the 150-foot level to justify the erection of the compressor and to develop the property by a shaft.

The country rock of the deposit is a part of the pre-Huronian gneiss and schist series. The rocks are well foliated but show a considerable local variation in trend, which is natural when the narrowness of the band and the bounding igneous rocks are taken into consideration. Quirke[1] mapped these rocks as part of the Serpent formation. The writer believes that they are not Serpent but pre-Huronian because they are unlike the typical Serpent formation in composition, even taking into consideration the changes due to metamorphism, and because they are intruded by granitic rocks with a wide transition zone to the northwest of the property. They are lithologically similar to and apparently continuous with the pre-Huronian rocks to the west. They are separated from the Gowganda formation by a fault but strike at an angle to it. The rocks consist of hornblende gneisses, metamorphosed quartzitic sediments, and some chlorite schists. Feldspathization has produced much gneiss. All the rocks are cut by numerous pegmatitic and granitic intrusions and diabase dikes.

Where the vein has been stripped, it strikes N 45° W. and dips 45° to 50° S.W. The strike conforms closely to the strike of the enclosing rock. The vein is of the composite type in which a part of the mineralization is due to replacement and a part to fissure filling. The replacement is shown by the unreplaced remnants of country rock in the ore and in the euhedral grains of pyrite disseminated through the country rock near much of the ore. The quartz and calcite, with the minor amounts of sphalerite and galena that are found in a few places, are possibly the result of fissure filling. The vein ranges from 6 inches to 5 feet in width, and the values show a comparable range.

The results of diamond-drilling and the logs of the 20 holes were placed at the disposal of the writer. A transit survey of the surface was made by Mr. Bawden, and the collars of the holes were located and their elevations fixed. The holes themselves were not surveyed, but the direction and dip at the collar were taken and used to plot the elevation and position of the mineralized sections of the core. Structure contours were drawn on the vein. These show that there are two parallel zones over a part of the distance. The second should outcrop about 150 feet northeast of the present line of cuts. It is, of course, possible that it does not reach the surface because of faulting or igneous intrusion. South of the zone with the two veins, the holes cut only one, and this is broken either by faults or intrusions. In any case, the segments are fairly long and should be quite easy to mine. Besides the ore zones mentioned, small mineralized zones, not of commercial ore, parallel the structure of the gneisses.

[1]T. T. Quirke, op. cit., *see* map.

The hornblende gneisses and quartzitic rocks show the effects of pneumatolysis. Orthoclase and microcline are fresh. The sodic plagioclase is also fresh, but the more calcic varieties are clouded with alteration products. Quartz is exceedingly variable in quantity; some is original, and a part was introduced during alteration. The large amount of the accessory minerals, apatite, magnetite, and titanite, is a notable feature of the rock. They are commonly contained in the mafic minerals, hornblende and biotite. The alteration that these rocks have undergone makes the correlation between diamond-drill holes difficult, if not impossible. It is difficult to distinguish these highly altered rocks from somewhat similar granite sills or dikes.

As previously stated the mineralization is largely of the replacement type. For the most part it follows the foliation of the gneisses, but in a few places it cuts across the foliation. The minerals present are sphalerite, galena, pyrite, quartz, magnetite, calcite, and arsenopyrite. The granular texture of the ore is exceedingly variable. Most of it is a rather fine grained mixture of sphalerite and pyrite with a small amount of galena. The coarse galena is associated with quartz. Arsenopyrite is found in a few places as euhedral grains up to 3 millimeters in diameter. Magnetite is especially plentiful where pyrite is the only sulphide, although it is found in some of the lead-zinc ore. Chalcopyrite is found in small quantities in the polished surfaces of the ore.

The values are rather spotty, as shown by the assays of the diamond-drill core. One of the highest, made on 4½ feet of core from No. 11 hole, gave the following: lead, 5.48 per cent.; zinc, 16.35 per cent.; silver, 1.06 ounces; gold, 40 cents. In some assays the gold values reach $1 per ton. The above assay is about the highest for lead. The gold and silver tenor seems to follow the lead. One pit had phenomenal values in native gold, but at the time of the writer's visit this pit was filled; the gold values in other places were rather low.

In the opinion of the writer the diamond-drilling has exposed sufficient ore to justify the work on the property and the programme of development laid out. The attempts to find the extension of the vein on the surface are rather disappointing. The fine-grained character of the sphalerite-galena-pyrite aggregate as shown on the polished surface of the ore may make fine crushing necessary. Complex mineral intergrowths, however, are absent.

Sudbury Concentrating and Mining Company, Limited

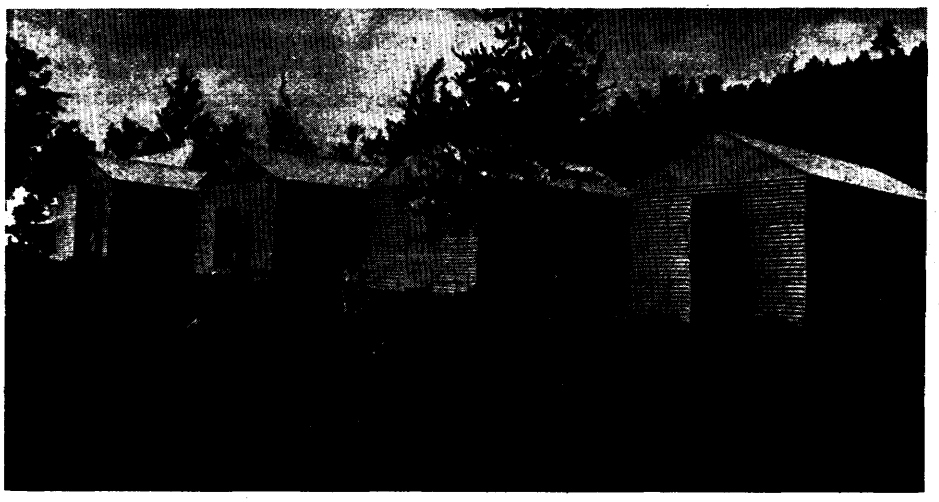
The Sudbury Concentrating and Mining Company controls a block of claims in the northeast corner of Craig township, including mining location I-S. They also have claims along the Spanish river. The property is being developed by John Dawson and H. N. Kilpatrick, to whom the writer wishes to express his indebtedness for courtesies in the field. A camp was erected and a wagon road built from Stralak, and a number of men have been employed in the development of the property. Besides the original work on the old mining location, numerous trenches and open cuts have been made across the strike of the ore zone and several shallow pits or shafts have been sunk.

The vein is located in the pre-Huronian rocks a short distance south of the contact with the granitic rocks. The ore zone has a general east-west trend parallel to the foliation of the gneiss and the general direction of the contact between granite and gneiss. A number of quartz diabase bodies cut the gneiss and apparently also the mineralized zone; however, a mass of highly altered basic rock that outcrops at the west end of the ore zone may be older. The gneisses and schists show the same type of feldspathization as those at the Lake

Geneva mine. The gneisses in the vicinity of the deposit may be divided into a more basic and less basic variety, depending on the extent of feldspathization.

The ore zone may be traced for more than 6,000 feet, but the ore outcrops are not continuous. In some places the gossan from disseminated iron sulphides is the only evidence of mineralization; in a number of places along the zone, however, good values in zinc have been found. Gold, copper, and lead raise the value of the ore. Good values have been found only in relatively short sections; but there are a number of these which are worth investigating.

Examination of polished surfaces of the ore from various cuts shows much pyrite as euhedral grains and in most of the ore some pyrrhotite. Sphalerite is



Buildings of the Sudbury Concentrating and Mining Company at Stralak.

the most common ore mineral. Galena occupies fractures in other minerals but is present only in small amounts. Chalcopyrite is also disseminated through the country rock away from the more massive sulphides. Quartz dikes have intruded the ore zone and produced reaction rims of mica against hornblende. H. C. Rickaby visited the property in 1927 and sampled the ore zone over 5½ feet near the east end. His assay gave no gold, silver, or lead; copper, 3.10 per cent.; and zinc, 9.90 per cent.

The writer sampled a pit to the west, which showed what appeared to be the best ore. The sample was taken across 7 feet, including 5 feet of massive sulphide. An Assay by the Ontario Department of Mines gave: gold, 20 cents; silver, 3.40 ounces; copper, 3.40 per cent.; lead, none; zinc, 6.70 per cent.

The source of the ore is a matter of doubt. The country rock in the vicinity is cut by a number of basic dikes, which appear to cut all the sulphide streaks in the gneiss and are probably younger than the ore. The relationship of the ore to the numerous pegmatite dikes cutting the gneiss is uncertain. Some are definitely older; others may be younger. The most probable source of the ore-forming solutions is in the magma which consolidated as granite a short distance north. An opening parallel to the foliation of the rock was probably the main channel for ore-bearing emanations. The feldspathization tends to follow the foliation, and it is difficult to trace any particular bed. In one place, a quartz sericite schist, which is a good horizon marker, and the ore were found to converge. The most

likely places for ore deposition may, therefore, be at the intersection of a zone parallel to the foliation with beds of favourable composition. The convergence would account for the occurrence of the ore in shoots. Definite evidence for such a control is difficult to find in the field, and this is offered merely as a working hypothesis in the hope that it may be of use when more information, such as may be derived from diamond-drilling, is at hand.

Turja Property

The eastern end of the zone on which the property of the Sudbury Concentrating and Mining Company is situated is covered by sands and gravel, but it has a possible extension on the north side of Straight lake. This property was controlled by Mrs. Ida Turja but was being developed in 1928 by Peter Chistman for Paxton and Mulholland of Toronto. The country rock is similar to that on the south side of the lake. A shaft has been sunk on a replacement zone about 5 feet wide showing pyrrhotite, with pyrite, chalcopyrite, and sphalerite. An assay of material taken from the shaft dump by Mr. Rickaby gave no gold, silver, or lead; copper, 0.44 per cent.; zinc, 3.55 per cent.

An examination of the ore under the microscope shows small stringers of galena replacing sphalerite and pyrite. In a few specimens galena is megascopically visible.

Claims near Stralak

A number of other claims in the vicinity of Stralak show outcrops of sulphide. In general these bodies are parallel to the foliation of the gneisses and schists. On the surface there are rusted zones, which are locally known as "burns." At several places shafts have been sunk on these gossans disclosing bodies of pyrrhotite and pyrite. One shaft just north of Marion lake shows a very small amount of low-grade chalcopyrite replacing pyrite. Other polished surfaces show some sphalerite, but this is also usually of low grade.

Mining Locations E and F, Craig Township

The old mining locations E and F in Craig township have been restaked, and two of three shafts on the property were unwatered at the time of the writer's visit. One shaft is about two-fifths of mile east of the mouth of Kennedy creek on the valley wall. It is about 15 feet deep in silicified pre-Huronian rocks, which show some sulphide mineralization along a shear zone running N. 80° E. Another shaft to the south is about 30 feet deep and cuts a zone mineralized with pyrite, pyrrhotite, and minor quantities of sphalerite. Small banded veins, rarely exceeding an inch in thickness, carry galena, pyrite, and calcite; their exposed length is only equal to the width of the sulphide zone. It is, however, possible to handpick specimens of good grade. The third shaft is on an apparently barren quartz vein. Development work has been practically confined to the shafts.

The Iron Mask Cobalt Silver Mines Company

One of the most interesting deposits[1] from a scientific point of view is found in lots 7 and 8, concession V, Hart township. The group is under the control of P. J. Finlan, of Cartier, who guided the writer to the exposures. The country rock in the vicinity consists of the upper part of the Mississagi formation, the Espanola formation, and the lower part of the Serpent formation. A thick sill

[1]F. F. Osborne, A Diabase Contact Metamorphic Mineral Deposit in Ontario, Jour. Econ. Geol., Nov., 1929.

of diabase cuts the series below the base of the Espanola formation. The granular texture of the sill varies considerably, a condition which the writer would ascribe to changing concentration of the volatile constituents rather than to marginal chilling of the magma.

A body of magnetite, which can be traced for 400 feet in one locality and outcrops sporadically for 1,000 feet, is found within the limestone next the diabase. The material has been regarded as an iron ore, but it is too impure with sulphides and silicates and of too low a grade to be a source of iron. The similarity of the mineralization to that at Cornwall, Penn.,[1] is notable, and it seems probable that in this instance also the mineralization is of contact metamorphic origin due to the intrusion of the diabase. At a little greater distance from the diabase, the country rock is replaced by disseminated pyrite and chalcopyrite with quartz, and at one place by a network of quartz crystals stained with erythrite. An assay of a specimen by Mr. Rickaby gave: gold, 80 cents; silver, none.

A mineralographic examination of the primary cobalt mineralization shows it to consist almost entirely of a ferriferous and nickeliferous cobaltite. An analysis of a polished surface of the mineral made by J. G. Fairchild in the chemical laboratory of the United States Geological Survey gave the following results:—

	Percentage	Ratio
Co	20.08	340
Ni	6.35	108
Fe	5.82	104
As	36.20	483
S	15.47	483
CaO	4.65	.....
MgO	2.35	.....
CO_2	6.23	.....
Insoluble	3.84	.....
Total	100.99	.....

Part of the iron is from rouge used in polishing

Lead-zinc ore is found in bands replacing the metamorphosed Huronian rocks, especially the Espanola limestone. During the recrystallization the silty beds were preserved as bands of garnet and diopside within crystalline limestone. The lenses are small and distributed over a considerable distance in the limestone. They are of low grade owing to the presence of much silicate mineral. Mr. Rickaby gives the following assay of a grab sample of the better grade of ore: gold, $1.20; silver, none; lead, 5.80 per cent.; zinc, 4.80 per cent.

The occurrence of the mineralization along the sill and the presence of cobalt suggest the diabase as the most probable source of ore of all types.

OTHER MINERALS

Copper-Nickel

Some work has been done in lots 1 and 2, concession IV, Hess township, by H. Muir for S. E. Sterling, of Toronto. The exposures are of interest because of the similarity of the type of mineralization to that found at Sudbury. At this locality a silicified granite was intruded by diabase. Just to the north of the

[1]A. C. Spencer, Magnetite Deposits of the Cornwall Type in Pennsylvania, U.S. Geol. Surv., Bull. No. 359, 1908, pp. 74-76.

exposures the diabase covers a large part of the country. A zone, 6 to 8 feet in width, mineralized with chalcopyrite and pyrrhotite occurs along one wall of a diabase dike about 35 feet wide. Except for the unusual amount of sulphide, the diabase is of normal character.

Under the microscope the diabase was found to contain hornblende, probably uralitic, remnants of augite, and plagioclase. Quartz is found in micrographic intergrowths along the margins of some of the plagioclase anhedra. The ore minerals are interstitial to the silicate minerals and surrounded by biotite reaction rims. The sulphides visible in the polished section are pyrrhotite and chalcopyrite, and there is a small amount of ilmenite. A specimen containing pyrrhotite but not much chalcopyrite gave a trace of copper and 0.28 per cent. nickel. Much of the material would yield more copper.

The ore deposit appears to be of the Sudbury type, commonly referred to as the magmatic segregation type. A notable feature of the deposit is the small size of the diabase mass with which the sulphides are associated, since in many instances the size of the sulphide body is proportional to that of the parent mass. It is possible that in some place a greater concentration of the ore minerals may be found, although the smallness of the diabase body is rather against the probability of a commercial ore deposit.

Magnetite and Specularite

At a number of localities in Hess township, for example near the end of the southeast arm of Geneva lake, small specularite or magnetite bodies are found in the Huronian rocks. In a few places these deposits contain a small amount of sphalerite or other sulphide, but in no instance has a commercial ore body been found. The mineralization is magnetite if it is in the Espanola limestone or near it; but if the country rock is non-calcareous, specularite is more likely to be found. The specularite is likely to have with it glassy quartz. The diabase magma seems to be the most probable source for the emanations giving rise to these deposits.

Molybdenum

Molybdenite is found in quartz in small granite bodies intruding the pre-Huronian rocks in the northern part of Hess township. No workable bodies have been uncovered.

Tin

The announcement that assays for tin were obtained from exposures on some claims controlled by M. D. Eames of Detroit occasioned some interest in the area. Three claims are in lot 5, concession VI, Hess township, and three more are west of Lake Geneva mine. On the eastern group the discovery is on claim No. 6,762. The pre-Huronian gneisses are intricately intruded by a syenite porphyry facies of the granitic rock with the resultant feldspathization and assimilation. A part of this mixed rock is mineralized and is cut by an olivine diabase dike. The olivine diabase is later than the ore, since it shows chilled contacts against it and in one place appeared to include a mineralized fragment. The principal minerals are pyrite, pyrrhotite, magnetite, and chalcopyrite. Mr. Eames reported an assay of about 17 pounds of tin per ton. The writer selected specimens from the spot reported to contain tin and submitted them for assay to the Ontario Department of Mines. The results are: copper, 4.1 per cent.; tin, none.

It should be borne in mind that this is not an assay of a sample but of several high-grade specimens selected to show the presence or absence of tin. On the property to the west of the Lake Geneva mine there is a small milky quartz vein that is apparently barren. It was not sampled on account of its small size.

ECONOMIC POSSIBILITIES OF THE AREA

The properties of promise discovered to date are in the pre-Huronian gneisses and schists. These rocks have been extensively metamorphosed and have been invaded by batholithic intrusions and impregnated by the accompanying emanations. These emanations have produced the feldspathization, the pegmatite intrusions, and the quartz veins and dikes. It seems probable that there would be other emanations bearing metallic elements, which would tend to be deposited in the intruded rock. These emanations would probably not affect the more intensely feldspathized rocks but would seek the less metamorphosed rocks, such as the chloritic and hornblendic schists. This seems to have taken place, because the important ore deposits are found at a distance from the granite contact. It is worthy of note that the Lake Geneva mine and the property of the Sudbury Concentrating and Mining Company are both about the same distance from the contact.

The deposits in granite are unimportant. The most characteristic mineral is molybdenite. The mineralization in the Huronian rocks is sparse and is not comparable to that in the pre-Huronian rocks. The magnetite-specularite deposits and the contact metamorphic deposits in Hart township are examples of the type of mineralization in Huronian rocks. The basic intrusives in the area have probably not been sufficiently mineralized to yield important ore bodies. Besides the segregation type of mineralization, there are small veins of calcite and chalcopyrite cutting the diabase.

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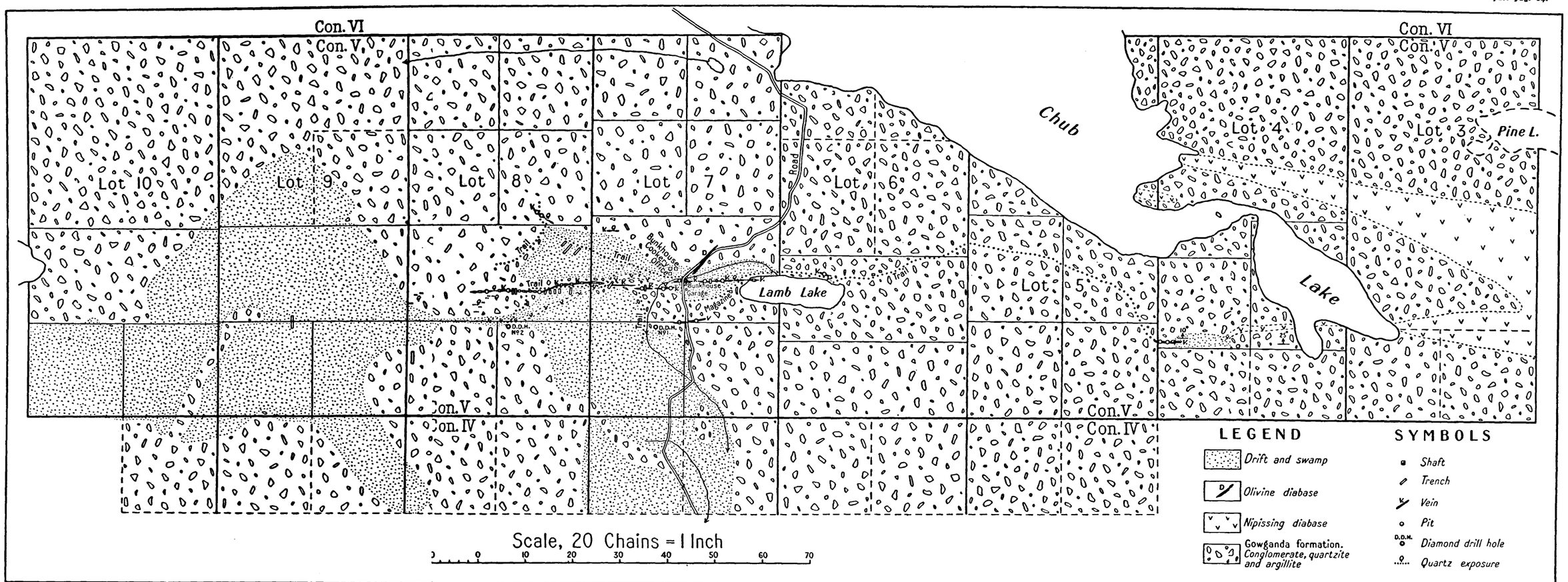

GEOLOGY AND SURFACE PLAN OF THE CHENEY MINE (SUDBURY BASIN MINES, LIMITED) AND VICINITY, GOULD TOWNSHIP.

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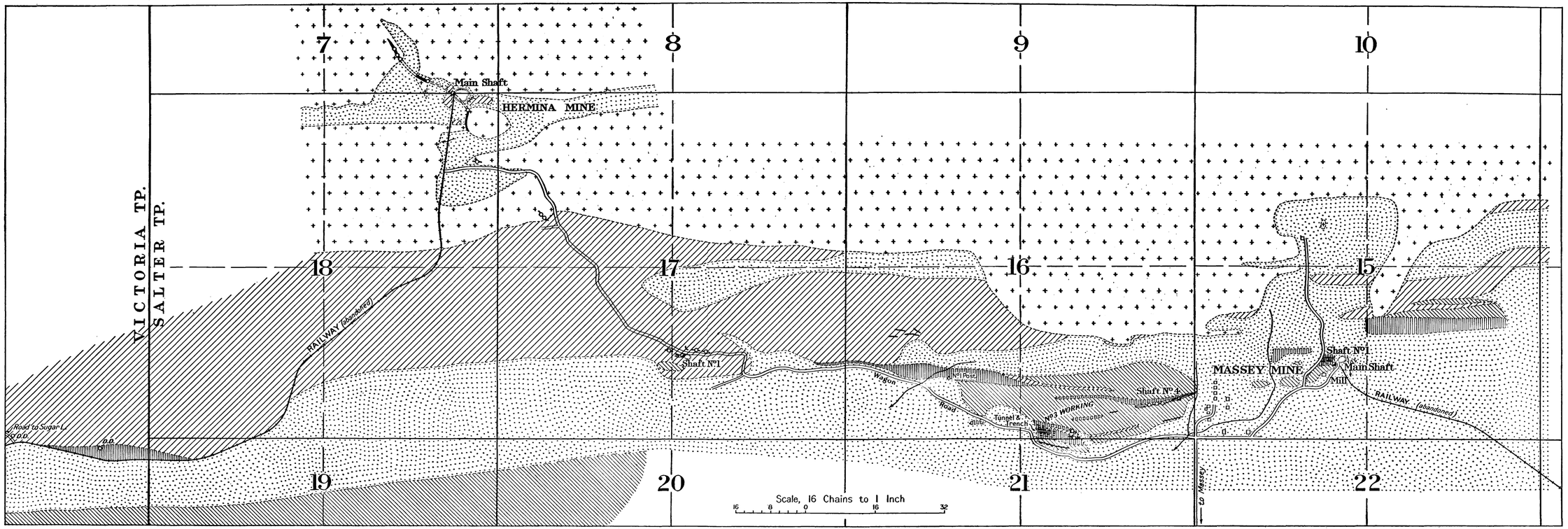

GEOLOGY IN THE VICINITY OF THE HERMINA AND MASSEY MINES, SALTER TOWNSHIP.