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LETTER OF TRANSMISSION

To The Honourable Herbert Alexander Bruce,
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 Forty-second 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, 1933.

INTRODUCTORY LETTER

To The Honourable Chas. McCrea,
Minister of Mines.

Sir,—The undersigned has the honour to submit the Forty-second Annual Report of the Department of Mines, issued in six parts, as follows:—

Part I

Statistical Review of Ontario's Mineral Industry in 1932, by W. R. Rogers and A. C. Young.
Mines of Ontario in 1932, by D. G. Sinclair, R. H. Cleland, E. C. Keeley, D. F. Cooper, and A. R. Webster.
Mining Accidents in 1932, by D. G. Sinclair, R. H. Cleland, E. C. Keeley, D. F. Cooper, and A. R. Webster.
Classes for Prospectors, 1932-33, by E. M. Burwash.

Part II

Erosion and Sedimentation at Point Pelee, with Map No. 42*a*, by E. M. Kindle.

Part III

A Technical and Economic Investigation of Northern Ontario Lignite, by the Ontario Research Foundation.
Lignite and Refractory Clay Deposits of the Onakawana Lignite Field, by W. S. Dyer and A. R. Crozier.
Appendix: Laboratory Classification of Refractory Clays, by R. J. Montgomery.
Refractory Clay Deposits on the Missinaibi River, by A. R. Crozier.

Part IV

Kakagi Lake Area, with Map No. 42*b*, by E. M. Burwash.
Manitou-Stormy Lakes Area, with Map No. 42*c*, by Jas. E. Thomson.

Part V

Natural Gas in 1932, by R. B. Harkness.
Petroleum in 1932, by R. B. Harkness.

Part VI

Shabumeni-Birch Lakes Area, with Map No. 42*d*, by Geo. D. Furse.
Paskokogan-Misehkow Area, with Map No. 42*e*, by W. S. Dyer.

Only Part I is bound with the Sessional Papers of the Legislature. All parts, together with accompanying geological maps as indicated above by number and letter, are available on application to the Department.

Respectfully submitted,

Thos. W. Gibson,
Deputy Minister of Mines.

Department of Mines,
Toronto, 1933.

PROVINCE OF ONTARIO

DEPARTMENT OF MINES

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

FORTY-SECOND ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XLII, PART I, 1933

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1933

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NIGHT VIEW OF THE MCINTYRE MILL, PORCUPINE GOLD AREA

The gold mines of the Province are worked both day and night.

STATISTICAL REVIEW OF ONTARIO'S MINERAL INDUSTRY IN 1932

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

General Remarks

A close relation between commodity prices and gold mining has been noted by many economists. The rise and fall of these prices has synchronized in many cases with gold output throughout the past hundred years. A century ago the world was attempting a recovery from the Napoleonic wars, and it has been observed that the general trend of commodity prices from the end of that war until about 1850 was largely downward. From 1830 to 1850 the decline was about 25 per cent. History records that the tide then turned and with the discoveries of gold in California in 1848, and Australia in 1851 and later, commodity prices, with brief interruptions, rose until 1873, and at that period were 45 per cent. above the quotations of 1850. Prices again fell, to recover once more in the nineties as a result of the South Africa (Rand) discoveries coupled with the new metallurgical treatment by cyanide which made large quantities of new gold available. From the nineties until 1914 or the beginning of the Great War commodity prices on the whole were higher than formerly. The war period witnessed higher levels, culminating in October, 1920, in another slump in prices which by 1922 had decreased by one-third. The recovery was rapid, and remained remarkably stable until the financial crash in 1929, followed by a steady fall in prices which was accentuated by Great Britain going off the gold standard in September, 1931.

If history is to repeat itself, the discovery of a large field from which gold could be rapidly recovered, would again turn the tide of commodity prices. It has always been noted that when commodity prices are low, gold becomes relatively more valuable and every effort is strained to find new mines, push production in old mines, and operate other deposits which in normal times could not be worked at a profit. This must be one of the reasons back of the struggle for gold and as this search intensifies, gold mining in the northern portions of Ontario will continue to thrive while the number of men engaged in the search for gold will increase. Capital in looking for safety and reward cannot fail to be attracted to those countries with lands open to prospect where formations are favourable to gold occurrences. In consequence the immense pre-Cambrian shield of Ontario will undoubtedly experience an increasingly intensive search.

An examination of tables Nos. I and II, which follow, shows that during 1932 the total mineral output declined by $15,297,871 or 16.0 per cent., divided among the main groups as follows: metallics, $8,455,527 or 11.7 per cent.; non-metallics, $280,411 or 3.6 per cent.; structural materials, $4,699,639 or 39.2 per cent., and clay products, $1,862,294 or 52.4 per cent.

The total value of the mineral industry of the Province from all sources to the end of 1932 (Table III) closely approached two billions of dollars.

TABLE I.—SUMMARY OF MINERAL STATISTICS OF ONTARIO FOR 1932

Product (tons of 2,000 lb.)	Quantity	Value	Employees	Wages
METALLIC:		$		$
Gold (standard basis) oz.	2,287,394	47,284,621	8,480	13,522,121
Silver oz.	6,216,490	1,910,937	260	398,311
Copper in matte exported (*a*) lb.	17,650,186	617,756		
Copper metallic and in concentrates, exported "	59,405,227	4,407,928		
Nickel in matte, in speiss, and in ore exported; metallic nickel, also nickel content of oxides and salts "	30,327,968	7,179,862	(*b*)2,579	3,722,676
Platinum metals oz.	64,897	1,998,911		
Bismuth "	16,798	7,289		
Cobalt in metal, oxides, salts, residues and ores "	490,631	587,957	(*c*) 153	146,819
Lead in concentrates exported "	86,477	1,756		
Total		63,997,017	11,472	17,789,927
NON-METALLIC:				
Arsenic, white lb.	2,424,342	98,914	(*d*)	
Diatomite tons	10	309	20	5,000
Feldspar, crude and ground "	3,657	42,920	16	7,903
Fluorspar "	32	464	.....	.....
Graphite, crude and refined "	346	18,483	16	6,042
Gypsum "	35,655	186,176	98	85,036
Iron pyrites and sulphur (*e*) "	3,332	33,320	.....	.....
Mica "	269	2,752	5	520
Mineral water Imp. gals.	61,208	2,473	11	1,850
Natural gas M. cu. ft.	7,386,154	4,719,297	893	1,059,643
Peat tons	4,886	10,107	.....	.....
Petroleum, crude bbls.	130,343	247,468	173	95,138
Quartzite and quartz tons	66,135	93,574	34	14,302
Silica brick M.	93	4,303	.....	.....
Salt tons	231,138	1,789,752	215	253,579
Talc and soapstone "	12,064	111,585	38	30,587
Total		7,361,897	1,519	1,559,600
STRUCTURAL MATERIALS:				
Cement, Portland bbls.	1,599,342	2,288,975	476	437,787
Hydrated lime tons	23,518	255,223	203	154,361
Quicklime "	143,185	1,018,007		
Sand and gravel "	6,590,808	2,000,298	162	114,975
Sand-lime brick (*f*) M.	6,823	78,398	47	32,067
Stone: limestone, trap, granite, etc. tons	1,905,138	1,655,016	894	453,336
Total		7,295,917	1,782	1,192,526
CLAY PRODUCTS:				
Brick, face no.	25,594,293	532,728		
" common "	17,255,677	286,928		
" fancy and ornamental "	36,134	1,790		
" sewer "	666,294	18,638	769	437,595
Tile, drain "	6,364,338	144,579		
" structural, roofing and floor	.....	169,824		
Sewer pipe, copings, flue-linings, etc	.....	451,786		
Pottery	.....	67,866		
Haydite	.....	16,366		
Total		1,690,505	769	437,595
GRAND TOTAL	.....	80,345,336	15,542	20,979,648
Exchange adjustments on gold marketed	.....	6,165,189		
Total value in Canadian Funds	.....	86,510,525		

(*a*) Copper in matte valued at 3½ cents per pound, and nickel at 18 cents.
(*b*) Employees and wages for nickel-copper mines, smelters and refineries include statistics of the Ontario Refining Company.
(*c*) Employees and wages for silver-cobalt smelters and refineries.
(*d*) Employees and wages included with (*c*).
(*e*) Tonnage given is sulphur content of sulphuric acid, no iron pyrites sold in 1932.
(*f*) No deduction made for lime consumed in manufacturing.

TABLE II.—COMPARATIVE VALUE OF MINERAL PRODUCTION, 1928-1932

Product	1928	1929	1930	1931	1932
METALLIC:	$	$	$	$	$
Gold	32,629,111	33,535,226	35,886,558	43,117,615	47,284,621
Silver	4,156,431	4,630,820	3,998,112	1,880,860	1,910,937
Platinum metals	1,309,923	1,646,381	2,436,683	2,812,834	1,998,911
Cobalt (*a*)	1,671,900	1,801,915	1,144,007	651,179	587,957
Nickel (*b*)	22,318,907	27,115,461	24,455,134	15,005,080	7,179,862
Copper, metallic and in matte	8,770,149	14,622,609	15,186,467	8,178,863	5,025,684
Selenium	.....	.....	.....	32,108	.....
Iron ore (*c*) and pig iron (*d*)	.....	.....	.....	.....	.....
Lead (pig) and in ore	402,289	294,431	116,034	41,987	1,756
Zinc in ore and concentrates	3,226	297,190	127,004	.....	.....
Bismuth	5,067	23,413	6,366	3,532	7,289
Molybdenite	.....	.....	.....	280	.....
Total	71,267,003	83,967,446	83,356,365	72,452,544	63,997,017
NON-METALLIC:					
Actinolite	875	375	437	456	.....
Arsenic, white	178,149	154,887	109,932	135,170	98,914
Beryl	.....	114	.....	.....	.....
Diatomite	.....	.....	140	840	309
Feldspar, crude and ground	180,153	206,979	104,670	103,008	42,920
Fluorspar	.....	1,120	1,240	620	464
Graphite, crude and refined	52,373	90,522	86,543	32,149	18,483
Gypsum	553,271	832,689	776,069	374,469	186,176
Iron pyrites and sulphur (*e*)	54,100	54,056	73,855	65,080	33,320
Mica	32,945	45,919	34,275	23,465	2,752
Mineral waters	27,890	13,651	20,754	8,578	2,473
Natural gas	4,535,312	4,968,137	5,061,588	4,635,497	4,719,297
Peat fuel	5,845	4,500	1,602	1,096	10,107
Petroleum, crude	249,981	253,678	235,746	219,993	247,468
Quartzite and quartz	308,608	316,050	274,674	148,642	93,574
Silica brick	(*f*) 86,323	80,374	19,120	13,702	4,303
Salt	1,377,629	1,420,424	1,558,405	1,760,388	1,789,752
Talc and soapstone	179,187	180,492	133,213	122,044	111,585
Total	7,822,641	8,621,427	8,492,263	7,642,308	7,361,897
STRUCTURAL MATERIALS:					
Cement, Portland	5,520,897	6,608,246	5,779,404	5,006,826	2,288,975
Lime, hydrated and quicklime	2,467,843	3,364,412	2,177,587	1,221,190	1,273,230
Sand and gravel	2,056,366	3,156,254	3,559,487	2,317,015	2,000,298
Sand-lime brick (*g*)	745,719	641,159	424,178	253,228	78,398
Stone: limestone, trap, granite, etc.	4,024,989	4,771,616	4,630,970	3,197,297	1,655,016
Total	14,815,814	18,541,687	16,571,626	11,995,556	7,295,917
CLAY PRODUCTS:					
Brick, face	2,267,268	2,467,539	1,811,569	1,278,954	532,728
" common	1,154,763	1,188,688	779,744	622,777	286,928
" fancy and ornamental	25,714	9,012	23,858	16,829	1,790
" sewer	49,547	92,316	12,490	33,321	18,638
Tile, drain	572,577	629,322	593,980	244,368	144,579
" structural, roofing and floor	1,035,119	1,047,807	848,556	378,193	169,824
Sewer pipe, copings, flue-linings, etc	974,157	1,167,463	834,361	696,964	451,786
Pottery	98,519	96,394	89,384	73,860	67,866
Haydite	.....	131,621	227,275	167,533	16,366
Total	6,177,664	6,830,162	5,221,214	3,552,799	1,690,505
GRAND TOTAL	**100,083,122**	**117,960,722**	**113,641,468**	**95,643,207**	**80,345,336**

(*a*) Cobalt in 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 value of sulphuric acid produced.
(*f*) Not included in the total of non-metallics or grand total.
(*g*) No deduction made for lime consumed in manufacturing.

Table III shows the aggregate value of metals from the time production began in Ontario and of other minerals since the year 1891. 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. The table follows:—

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.....	88,715		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		4,480,452		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
1929.....	83,967,446	8,621,427	18,541,687	6,830,162	117,960,722
1930.....	83,356,365	8,492,263	16,571,626	5,221,214	113,641,468
1931.....	72,452,544	7,642,308	11,995,556	3,552,799	95,643,207
1932.....	63,997,017	7,361,897	7,295,917	1,690,505	80,345,336
Total.....	1,319,942,523		602,252,584		1,922,195,107

(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.

AVERAGE METAL PRICES—CANADA AND UNITED STATES

Metal	Unit	Canada—price and market		United States—price and market	
		1931	1932	1931	1932
		$	$	$	$
Cobalt	lb.	.....	.....	2.50	2.50
Bismuth	lb.	0.482 crude at works	0.434	1.00 to 1.50	.....
Copper in matte	lb.	0.055 estimated at works	0.035	.....	.....
Copper in converter	lb.	0.08398 producers' price at works	0.638	.....	.....
Copper, electrolytic	lb.	0.08370 estimated works 0.10005 at Montreal	0.0638 0.07516	0.08116 New York	0.05555
Nickel in matte	lb.	0.18 estimated at works	0.18	.....	.....
Nickel, electrolytic	lb.	0.27144 at works	.....	0.35 New York	0.35
Gold	oz.	20.671834	20.671834	20.671834	20.671834
Silver	oz.	0.2987 estimated	31.672	0.287 New York	27.892
Platinum	oz.	.....	.....	35.665 New York	36.455
Palladium	oz.	.....	.....	20.00 New York	17.00–18.00
Rhodium	oz.	.....	.....	53.00 New York	48.00–50.00
Ruthenium	oz.	.....	.....	53.00 New York	40.00–45.00
Iridium	oz.	.....	.....	105.00 New York	55.00
Lead	lb.	0.04168 Montreal	0.03511	0.4243 New York 0.04049 St. Louis	0.03043 0.03042
Zinc	lb.	0.03961 Montreal	0.03723	0.0364 St. Louis	0.02876
Selenium	lb.	1.90 at works	.....	.....	.....

In 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, 1931	Production, 1932	Production to December 31, 1932
	$	$	$
Gold	394,238,336	47,284,621	441,522,957
Nickel, including nickel oxide and salts	332,073,273	7,179,862	339,253,135
Silver	253,862,752	1,910,937	255,773,689
Copper (*a*)	130,081,341	5,025,684	135,107,025
Pig iron from domestic ore	84,775,556	.....	84,775,556
Cobalt (*b*)	24,743,560	587,957	25,331,517
Platinum metals	21,306,048	1,998,911	23,304,959
Iron ore (*c*)	9,463,516	.....	9,463,516
Lead	4,482,866	1,756	4,484,622
Zinc, in ore and concentrates	535,696	.....	535,696
Molybdenite	210,015	.....	210,015
Bismuth	140,439	7,289	147,728
Selenium	32,108	.....	32,108
Grand total	1,255,945,506	63,997,017	1,319,942,523

(*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.

TOTAL DIVIDENDS PAID BY METAL MINES

Industry	Total to end of 1931	During 1932	Total to end of 1932
	$	$	$
Nickel-Copper*	145,043,210	1,933,909	146,977,119
Gold	119,089,284	16,019,519	135,108,803
Silver-Cobalt	97,576,281	10,000	97,586,281
Grand total	361,708,775	17,963,428	379,672,203

*The amount for 1932 was paid on preferred stock of the International Nickel Company of Canada, Limited.

Gold

Gold mining, the world over, has received of late increasing attention in every gold-producing country, and gold output figures for 1932 are the greatest on record. Outstanding among these developments has been the rising tide of gold production in Canada and more particularly Ontario, which now contributes 75 per cent. of the total Canadian output.

The popularity of gold and the increasing activity to produce the metal arises from the fact that it is the only international medium of exchange. Since nations must meet their foreign obligations in gold, it becomes necessary for them either to buy the metal in foreign markets or to produce it within their own boundaries. Canada is therefore in the favourable position of being able to pay the market price of gold to domestic producers and the exchange compensation paid or the difference in value as between the Canadian and United States dollar in a large measure remains within the country. The gold producer always has a ready market for his product, and profits are greater in times of depression owing to lower production costs.

During 1932, production came from 29 properties operated in Ontario, 10 in the Porcupine belt, eight in the Kirkland Lake belt, seven in the north-western section of the Province, and four under the Miscellaneous heading. The gains in gold output over 1931 by fields were: Porcupine 7.7 per cent. or $1,532,889, Kirkland Lake 9.4 per cent. or $2,046,318, and Northwestern Ontario 60.6 per cent or $613,729.

Apart from the steadily increasing output by the well-established mines of Porcupine and Kirkland Lake, the outstanding features of the year have been the development of smaller mines in other parts of the Province, and prospecting activity. The poor market conditions for base metals such as copper, lead and zinc has tended to turn the prospector's attention almost entirely to gold, with the result that several deposits have been uncovered, and prospectors have spread their activities into new fields where favourable rock formations occur.

During the past year the Ashley mine in Bannockburn was brought into production, the Croesus mine in Munro township was reopened and efforts made to pick up the extension of that fabulously rich vein. Operations in the Swayze area were actively carried on, and good surface showings opened up on the Kenty, Derraugh, and other properties. Farther to the west in the Michipicoten area the Parkhill and Minto produced throughout the year, while the New Goudreau made a small shipment of gold bullion. Mill enlargement to 100 tons has been made at the Parkhill. Diamond-drilling was carried on at Little Long Lac in Thunder Bay district with encouraging results by the Sudbury Diamond Drilling Company. At the turn of the year freighting was being done by airplane to the Central Patricia mine, which lies some 20 miles north of Lake St. Joseph in the Crow River area. A small mill is being erected on this property.

Much investigational work was carried on at several former gold producers in Kenora district, including Caribou, Mikado, and at Cedar Island on Lake of the Woods. This phase of the search for gold was perhaps unique in 1932 inasmuch as the interest in properties worked some years ago was more pronounced than formerly.

Events of interest in the producing gold camps are summarized as follows:—

PORCUPINE BELT:—The *Hollinger* operated at a daily milling rate of 4,834 tons with an average recovery of $5.83 per ton, as against a recovery of $6.15 per ton in 1931. The physical condition of the mine remained unchanged.

A. F. Brigham, retired as General Manager, to become Consulting Engineer. He was succeeded by John Knox. Dr. L. C. Graton completed the underground geological survey. *McIntyre:* The average milling rate was 1,976 tons for the year and $7.50 per ton was recovered. The new mill is now operating smoothly. Preparations are under way to sink a winze from the 3,750-foot level on the Platt Vet section of the mine with an objective of 6,750 feet. Daily capacity of *Dome* mill is 1,466 tons, and recovery $7.47 per ton. The installation of the blanket equipment in the mill has improved the extraction. *Coniaurum* and *Vipond* operated for the whole period. The *March* mine closed July 19. The *Buffalo Ankerite* resumed operations in May, and has now increased the mill capacity to 325 tons daily. The *Hayden* mine operated its test mill in May and June. Some rich ore was recovered from the *John Spence* property at Triple Lake about 20 miles south of the Porcupine camp. The *Munro-Croesus* was also operated and a small recovery of gold was made in September, October and November from the mine ore dumps.

KIRKLAND LAKE BELT:—The daily rate of milling at *Lake Shore* was 2,243 tons with an average of $15.45 per ton recovered. The company is preparing to treat tailings deposited in Kirkland lake independently of the Wright-Hargreaves Mines, Ltd. To this end the Consolidated Tailings, Ltd., was incorporated in April, 1932. The average mill rate at *Teck-Hughes* was 1,300 tons per day showing a recovery of $12.31 per ton. The annual report of Nov. 22, 1932, stated that a block of ten levels below the thirtieth was opened up, and that the total ore length amounted to 3,388 feet having an estimated average grade of $9.32 per ton. Mill capacity at the *Wright-Hargreaves* is 807 tons per day and average grade $13.48. The No. 4 shaft was completed to 4,000 feet in depth early in 1933, and it is planned to deepen No. 3 shaft to the same depth. The present mill capacity is to be increased to 1,000 tons using the flotation process developed by the company's engineers. Other mines in the camp, *Sylvanite* and *Kirkland Lake Gold*, operated throughout the year with daily mill tonnages of 265 and 155 tons, averaging $8.46 and $9.28 per ton, respectively. The *Tough-Oakes* mine, renamed the *Toburn*, resumed operations in August after an idleness of 3½ years. The rate of milling was 105 tons per day with ore averaging $13.87 per ton. Development on the *Macassa* to the west and on the *King Kirkland* to the east of the producers was continued during the period, and at the former ore is being opened up on the 2,200- and 2,325-foot levels. The *Barry-Hollinger*, about six miles south of the Kirkland Lake area, operated at 96 tons daily capacity with an average recovery of $4.59 per ton. The *Ashley* gold mine, operated by Mining Corporation of Canada, Ltd., in Bannockburn about 40 miles west of the main area, commenced milling August 25, 1932, and the average milling rate per day for the period was 75 tons, with a recovery of $9.00 per ton. Considerable absorption took place in the new mill which has recently been stepped up to 115 tons daily.

NORTHWESTERN ONTARIO:—This portion of Ontario may be regarded as extending from the Algoma Central railway to the western boundary of the Province, and while the gold mines of this area with the exception of the *Howey* are not large, yet the developments recently have been important. In the extreme northwest at Red lake in the Patricia portion of Kenora district the *Howey* is operating profitably on an ore averaging $3.94 per ton. The average rate of milling was 780 tons in 1932, and costs of $2.47 per ton before depreciation are the lowest of any gold mine in the Province. This mine which is 100 miles from the railway affords a striking example of what may be accomplished to-day

in developing gold deposits remote from railway transportation. The *Moss* mine near Kashabowie was operated in 1932 at an average rate of 82 tons per day and $6.85 per ton recovery. The *Minto* and *Parkhill* in Michipicoten, while smaller in mill equipment, each treated ores of $8.72 grade. At Schreiber, several properties were being worked including the *McKellar-Longworth* by Schreiber Gold Mines, Limited, and the *Harkness-Hays*. From the former, gold ore was shipped by R. N. Palmer to the International Nickel Company at Copper Cliff and to the Noranda smelter.

TABLE IV.—TOTAL GOLD PRODUCTION IN ONTARIO

Year	Total production $	Porcupine belt		Kirkland Lake belt	
		$	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	86,316	1.9
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	9,941,803	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
1929	33,535,226	19,281,286	57.6	14,046,596	41.8
1930	35,886,558	17,758,842	49.6	17,172,770	47.9
1931	43,117,615	19,891,521	46.2	21,734,729	50.4
1932	47,284,621	21,422,117	45.2	23,782,313	50.3
Total to end of 1932	441,522,957	306,464,833	69.4	125,065,328	28.3

(*a*) Estimated. (*b*) Maximum yearly output was $424,568 in 1899.

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

AVERAGE YEARLY WAGE, ONTARIO GOLD MINING, 1931 AND 1932

Locality	1931			1932		
	No. of wage earners	Wages paid	Average wage per annum	No. of wage earners	Wages paid	Average wage per annum
		$	$		$	$
Porcupine	4,534	7,201,681	1,588	4,685	7,297,216	1,557
Kirkland Lake	3,094	5,148,329	1,664	3,406	5,583,824	1,639
N.W. Ontario	263	411,998	1,566	389	641,081	1,648
Operating but non-producing	400	396,605	991	179	122,442	684
Total	8,291	13,158,613	1,588	8,659	13,644,563	1,575

TABLE V.—ONTARIO'S GOLD PRODUCTION, 1932

Source	Ore milled, tons	Bullion shipped				Total value of bullion[1]
		Gold content		Silver content		
		Fine ounces	Value	Fine ounces	Value	
PORCUPINE BELT						
Buffalo Ankerite	55,267	10,602.45	219,172	1,173	310	219,482
Coniaurum	144,654	41,581.50	859,566	5,315	1,465	861,031
Dome	536,450	195,110 71	4,033,296	28,580	7,022	4,040,318
Hollinger	1,754,863	499,647 85	10,328,637	103,549	28,209	10,356,846
McIntyre	723,285	261,725.11	5,410,338	60,837	14,390	5,424,728
March	26,812	3,808.66	78,732	365	103	78,835
Munro-Croesus (dump)	.....	276.43	5,715	26	7	5,722
Triple Lake (J. Spence)	155	121.48	2,511	16	4	2,515
Vipond	107,197	21,939.46	453,529	3,492	883	454,412
Miscellaneous[2]	2,580	1,481.34	30,621	272	82	30,703
Total	3,351,263	1,036,294 99	21,422,117	203,625	52,475	21,474,592
KIRKLAND LAKE BELT						
Ashley	6,805	2,960.12	61,191	388	99	61,290
Barry-Hollinger	34 977	7,760.48	160,423	1,029	274	160,697
Kirkland Lake Gold	56,492	25,322 73	523,467	3,169	862	524,329
Lake Shore	818,698	610,462.59	12,619,380	101,436	27,748	12,647,128
Sylvanite	96,891	39,919.31	825,205	11,499	2,990	828,195
Teck-Hughes	475,700	282,882 21	5,847,693	28,800	7,877	5,855,570
Telluride (Smelters Corporation)	24	22.41	463	19	5	468
Toburn	14,689	9,840.51	203,421	842	221	203,642
Wright-Hargreaves	295,525	171,299.25	3,541,070	25,948	7,091	3,548,161
Total	1,799,801	1,150,469 61	23,782,313	173,130	47,167	23,829,480
NORTHWESTERN ONTARIO						
Harkness-Hays	32	71.28	1,474	.....	.....	1,474
Howey	284,664	53,947.68	1,115,198	20,132	5,473	1,120,671
Kenora Prospectors	48	187.38	3,874	49	14	3,888
McKellar-Longworth	179	748.08	15,464	47	16	15,480
Minto	18,765	7,906.58	163,443	257	70	163,513
Moss	25,363	7,802 54	161,293	48,065	12,610	173,903
New Goudreau	117	19.91	412	3	1	413
Parkhill	16,822	7,095 32	146,673	455	125	146,798
Total	345,990	77,778.77	1,607,831	69,008	18,309	1,626,140
Total for gold mines	5,497,054	2,264,543.37	46,812,261	445,763	117,951	46,930,212
MISCELLANEOUS						
Nickel-copper refining	.....	22,674.72	468,727	.....	.....	.....
Other sources[3]	22	175.74	3,633	.....	.....	.....
Total	.....	22,850 46	472,360	.....	.....	.....
Total gold output, 1932	5,497,076	2,287,393.83	47,284,621	.....	.....	.....
CALENDAR YEAR 1931						
Porcupine	3,091,946	962,252.44	19,891,521	176,666	50,182	19,941,703
Kirkland Lake	1,703,630	1,051,417.51	21,734,729	171,394	48,433	21,783,162
Northwestern Ontario	230,149	48,750.19	1,007,756	16,341	4,655	1,012,411
Miscellaneous	.....	23,394.60	483,609	.....	.....	.....
Total (1931)	5,025,725	2,085,814.74	43,117,615	364,401	103,270	42,737,276

[1]In addition to the values given, exchange compensation amounted to $2,815,381.21 at Porcupine; $3,137,847.59 at Kirkland Lake, and $211,630.04 in Northwestern Ontario. In addition $329.66 was paid as premium on material shipped to the Ontario Refining Company, or a grand total of $6,165,188.50.

[2]Includes Hayden, and recoveries from scrap machinery, etc.

[3]Includes C. T. Young (Three Duck Lakes), O'Brien Mine (Cobalt), R. Downey (Long Lake mine, located in T. B. 69).

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

Year	Hollinger	Dome	McIntyre	Vipond	Coniaurum	Porcupine Crown and Northcrown	West Dome Lake	Buffalo Ankerite (c)	March	Night Hawk Peninsular	Schumacher (a)	Paymaster	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	.....	Porcupine Crown 685,135	.....	.....	.....	.....	.....	.....	Rea 125,255
1915....	4,206,015	1,530,287	750,812	246,053	.....	Porcupine Crown 602,436	102,880	.....	.....	.....	48,236	.....	.....
1916....	5,073,401	2,153,820	1,218,073	176,686	.....	Porcupine Crown 578,322	16,814	.....	.....	.....	225,301	.....	.....
1917....	4,261,938	1,480,174	1,710,204	209,738	.....	Porcupine Crown 377,904	44,434	.....	.....	.....	198,605	.....	New-ray 1,447
1918....	5,752,371	82,127	1,578,444	82,868	.....	Porcupine Crown 124,474	103,745	.....	.....	.....	92,842	.....	New-ray 1,516
1919....	6,722,266	1,290,301	1,978,014	.....	.....	Porcupine Crown	23,910	.....	.....	.....	.....	.....	.....
1920....	6,219,665	2,020,568	2,223,083	.....	.....	Porcupine Crown 71,529	47,169	.....	.....	.....	.....	.....	.....
						N'crown 97,301							
1921....	9,051,276	2,290,264	1,827,761	.....	.....	N'crown 7,943	.....	.....	.....	.....	.....	.....	.....
1922....	12,274,114	4,178,936	2,021 811	.....	.....	N'crown	.....	.....	.....	.....	.....	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	.....	.....	268,518	.....	.....	.....
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	11,055	111,154	.....	63,551	.....
1927....	14,539,538	4,031,575	3,965,210	667,724	.....	.....	(b)35,252	359,005	19,839	166	.....	135,025	.....
1928....	10,706,235	3,915,051	4,201,808	694,426	220,534	.....	.....	289,960	133,879	.....	.....	183,271	.....
1929....	9,455,290	3,590,537	4,295,491	820,667	635,485	.....	155,797	71,684	256,303	.....	.....	.....	.....
1930....	10,260,950	774,943	4,696,578	909,414	738,941	.....	15,662	878	306,262	.....	.....	.....	.....
1931....	10,097,975	3,512,066	4,756,880	564,291	751,352	.....	.....	.....	217,586	.....	.....	.....	.....
1932....	10,356,846	4,040,318	5,424,728	454,412	861,031	.....	.....	219,482	78,835	.....	.....	.....	.....
Total...	179,589,871	54,926,705	55,250,595	6,739,020	3,207,343	2,871,847	1,114,821	1,081,597	1,023,759	566,885	564,984	384,647	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. (c) Formerly Ankerite, and renamed Buffalo-Ankerite in 1932.

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

Year	Porcupine United	David-son	Preston and Clifton	Scottish-Ontario	Porcupine Pet	Porphyry Hill	Gold Reef	Tommy Burns	De Santis	Hughes	Miscel-laneous	Total value (*d*)
	$	$	$	$	$	$	$	$	$	$	$	$
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								(*e*) 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							(*f*) 217,350	23,976,577
1928				6,795							(*g*) 140	20,352,099
1929	44,285										47,701	19,373,240
1930	56,913										61,940	17,822,481
1931	5,439										(*h*) 36,114	19,941,703
1932											(*j*) 38,940	21,474,592
Total	106,637	53,914	30,477	12,688	10,551	6,236	2,135	289	146	30	404,941	308,097,194

(*d*) A record of exchange compensation received, additional 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; 1929, $87,173; 1930, $20,912; and 1931, $830,799. (*e*) Huddlestone and Cline. (*f*) Includes "high-grade" recovered from W. P. Wilson. (*g*) Blue Quartz. (*h*) Munro-Croesus, $3,955; and miscellaneous, $32,159; (*j*) Hayden, $1,497; Munro-Croesus, $5,722; J. Spence, $2,515; and miscellaneous, $29,206.

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

Year	Lake Shore	Teck-Hughes	Wright-Hargreaves	Sylvanite	Kirkland Lake	Tough-Oakes-Burnside	Barry-Hollinger	Argonaut (a)	Ashley	Canadian Assoc'd. Goldfields	Lucky Cross	Ontario-Kirkland	Swastika and Trout Creek	Total value (b)
	$	$	$	$	$	$	$	$	$	$	$	$	$	$
1913	.....	.....	1,127	.....	.....	66,632	.....	.....	.....	.....	14,006	.....	(c) 7,172	88,937
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	(d) 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	.....	224,396	107,481	.....	.....	.....	.....	.....	10,082	.....	2,172,548
1923	547,600	1,117,963	754,979	.....	223,102	12,174	.....	72,512	.....	.....	.....	.....	.....	2,728,331
1924	1,098,572	1,023,025	1,088,725	.....	46,512	47,547	.....	152,072	.....	.....	.....	.....	.....	3,456,453
1925	1,958,720	996,943	1,913,401	.....	.....	263,064	56,978	214,183	.....	.....	Gold	.....	.....	5,403,289
1926	2,775,000	1,601,209	2,150,844	.....	126,999	309,709	86,263	143,387	.....	.....	Hill	.....	.....	7,193,411
1927	3,375,053	2,781,962	2,151,916	429,424	473,673	153,215	175,692	127,448	.....	34,595	(e) 865	.....	.....	9,703,843
1928	4,073,965	4,948,896	1,838,510	738,146	414,596	82,316	111,767	32,430	.....	17,700	12,784	.....	.....	12,271,110
1929	6,090,189	5,048,420	1,734,728	689,465	352,789	.....	151,758	9,959	.....	.....	.....	.....	.....	(f) 14,089,233
1930	7,836,779	5,398,271	2,432,888	794,459	533,851	.....	217,835	1,891	.....	.....	.....	.....	.....	17,215,974
1931	11,065,618	6,093,199	2,909,837	901,168	586,250	Toburn	224,633	.....	.....	.....	.....	.....	(g) 1,622	(h) 21,783,162
1932	12,647,128	5,855,570	3,548,161	828,195	524,329	203,642	160,697	.....	61,290	.....	.....	.....	.....	(h) 23,829,480
Total	53,618,744	36,349,511	21,756,620	4,380,857	4,092,078	3,113,102	1,195,737	789,093	61,290	52,295	27,655	10,082	8,794	125,469,086

(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; 1926, $595 discount; 1928, $2,810.55; 1929, $70,283; 1930, $15,791; 1931, $893,518. (c) Swastika. (d) Patricia mine, afterwards called Barry-Hollinger. (e) Samples shipped in 1923 and 1926 by the Gold Hill not heretofore reported. (f) Contains $11,925 miscellaneous. (g) Trout Creek. (h) Includes Telluride in Skead tp., $835 in 1931 and $468 in 1932.

TABLE VIII.—DIVIDENDS AND BONUSES PAID BY GOLD MINING COMPANIES TO DECEMBER 31, 1932

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 1931, $	Dividends and bonuses paid during 1932, $	Rate per cent., or per share, 1932	Total of dividends and bonuses paid to Dec. 31, 1932 $	Date when last dividend or bonus was paid
Coniaurum Mines, Ltd.	July 4, 1929	6,000,000	2,697,447	No par	.....	80,923.41	3 cents	80,923.41	Aug. 15, 1932
Dome Mines, Ltd. (*a*)	Sept. 30, 1923	1,000,000	1,000,000	No par	15,265,842.75	1,239,334.20	$1.30	16,505,176.95	Oct. 20, 1932
Hollinger Cons. Gold Mines, Ltd. (*b*)	May 25, 1916	25,000,000	24,600,000	5.00	58,230,400.00	3,690,000.00	15%	61,920,400.00	Dec. 31, 1932
Lake Shore Gold Mines, Ltd	Feb. 25, 1914	2,000,000	2,000,000	1.00	16,020,000.00	6,000,000.00	300%	22,020,000 00	Dec. 15, 1932
McIntyre-Porcupine Mines, Ltd.	Mar. 16, 1911	4,000,000	3,990,000	5.00	9,995,408.00	997,499.86	5–7½%	10,992,907.86	Dec. 1, 1932
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	.....	.....	.....	.....	.....
Sylvanite Gold Mines, Ltd	June 13, 1913	3,300,000	3,299,500	1.00	197,970.00	164,975 00	5%	362,945 00	Dec. 31, 1932
Teck-Hughes Gold Mines, Ltd., The	Mar. 2, 1923	5,000,000	4,807,144	1.00	12,905,288.80	2,884,286.40	60%	15,789,575 20	Nov. 1, 1932
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	April 5, 1927
Wright-Hargreaves Mines, Ltd. (*d*)	June 16, 1916	5,500,000	5,500,000	No par	5,156,250.00	962,500 00	17½c.	6,118,750 00	Oct. 1, 1932
Total	.....	.....	.....	.....	119,089,284.55	16,019,518.87	.....	135,108,803 42	.....

(*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 (repayment of capital not included in above table) distributed to shareholders in addition to dividends paid to September 30, 1923, when the new company, Dome Mines, Limited, issued 1,000,000 N.P.V. shares at $7.00 per share. Of these 46,666 shares are transferred to a Trustee and held in trust for the company.

(*b*) Hollinger Consolidated Gold Mines, Limited, is an amalgamation 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 5,500,000 shares of "no par" value.

TABLE IX.—YEARLY DIVIDENDS AND BONUSES PAID BY ONTARIO GOLD MINING COMPANIES, 1912-1932

Year	Porcupine						Kirkland Lake					Total
	*Hollinger Consolidated	Porcupine Crown	Dome Mines†	McIntyre	Vipond	Rea‡ and Coniaurum	Tough-Oakes	Lake Shore	Teck-Hughes	Wright-Hargreaves	Sylvanite	
	$	$	$	$	$	$	$	$	$	$	$	$
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..	1,560,000	240,000	400,000.00				132,875					2,344,875.00
1916..	3,286,000	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		715,000.00	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	474,714.40	893,750		10,878,732.40
1927..	6,396,000		1,191,667.50	798,000.00	67,500			1,400,000	713,571.60	1,237,500		11,804,239.10
1928..	5,412,000		953,334.00	798,000.00				2,000,000	2,860,286.40	825,000		12,848,620.40
1929..	3,198,000		953,334.00	798,000.00				2,200,000	2,866,286.40			10,015,620.40
1930..	3,444,000		953,334.00	798,000.00				3,000,000	2,872,286.40		65,990	11,133,610.40
1931..	3,444,000		953,334.00	798,000.00				4,800,000	3,118,143.60	825,000	131,980	14,070,457.60
1932..	3,690,000		1,239,334.20	997,499.86		80,923.41		6,000,000	2,884,286.40	962,500	164,975	16,019,518.87
Total.	61,920,400	840,000	16,505,176.95	10,992,907.86	67,500	92,923.41	398,625	22,020,000	15,789,575.20	6,118,750	362,945	135,108,803.42

*Includes $160,000 paid by the Acme in 1915, before amalgamation with the Hollinger. †Does not include repayment of capital of $476,667 in 1922.
‡Includes $12,000 paid by Rea in 1915.

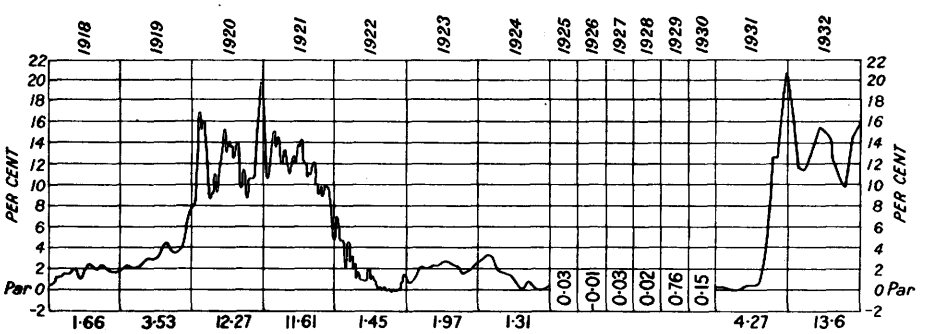
Gold from all sources in Ontario in 1932 totalled 2,287,394 fine ounces or an increase of 9.7 per cent. over the 1931 production. Of this total 2,264,543 ounces were recovered by the gold mines, 22,675 ounces from the refining of nickel-copper mattes, and 175.74 ounces were contained in miscellaneous ores and concentrates.

RECEIPTS OF CRUDE GOLD BULLION FROM ONTARIO MINES AT THE ROYAL CANADIAN MINT, OTTAWA, 1928–1932

Year	Crude ounces	Precious metals			Buying rate in Canada for New York funds*	Exchange compensation†
		Gold, fine oz.	Silver, fine oz.	Total value		
				$		$
1928.....	1,537,295	1,217,622	199,470	25,285,865	100.0817	2,811
1929.....	412,058	328,556	54,068	6,821,876	100.747	157,456
1930.....	908,209	713,527	86,419	4,760,111	100.147	36,702
1931.....	1,762,481	1,441,602	171,408	29,850,774	104.272	1,786,175
1932.....	2,865,271	2,248,106	300,927	46,554,898	113.580	6,164,271

*The average rate of premium on New York funds is based on the day to day record of current quotations.

†The Federal Department of Finance pays for gold in Canadian funds and reimburses producers by an amount equivalent to the exchange premium on New York funds. Export of gold is prohibited except under license.



Graph showing fluctuations of the buying rate in Canada for New York funds from 1918 to 1932, inclusive. The average yearly premium or discount rate is noted in percentage figures at the base of the chart. During 1932 exchange compensation paid to Ontario gold producers amounted to $6,164,271. Further details will be found in the footnotes of the historical production tables for Porcupine and Kirkland Lake, and also in the table showing crude bullion receipts at the Ottawa mint.

World Output.—The following statement of output by the leading gold-producing countries, for 1915 (year of maximum U.S. production), also for 1923 and subsequent years, has been abstracted chiefly from reports of the Director of the United States Mint and the American Bureau of Metal Statistics. Russian figures since 1927 are from Soviet Press Agency sources. Canada attained second place among the gold-producing countries of the world in 1930, having overtaken the United States (exclusive of the Philippine Islands). The Province of Ontario, as deduced from the table, produced 75 per cent. of Canada's gold in 1932. For the first time output exceeded that of the United States.

OUTPUT BY LEADING GOLD-PRODUCING COUNTRIES AND STATES

(Millions of dollars—standard basis of $20.671834 per fine ounce)

Source	1915	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932*
World	470.0	367.8	393.4	393.3	400.0	401.7	408.4	403.0	430.7	459.1	496.4
Transvaal	188.0	189.1	197.9	198.4	205.8	209.3	214.0	215.2	221.5	224.9	238.8
Canada	19.0	25.5	31.5	35.9	36.3	38.3	39.1	39.9	43.6	55.7	63.1
United States†	101.0	50.2	50.6	48.0	46.3	43.8	44.3	42.5	43.4	45.8	47.1
Ontario	**8.5**	**20.1**	**25.7**	**30.2**	**30.9**	**33.7**	**32.6**	**33.5**	**35.9**	**43.1**	**47.3**
Russia(U.S.S.R.)	26.3	5.2	19.8	21.9	20.5	21.9	24.8	29.3	29.6	35.1	39.3
Mexico	6.6	16.2	16.5	16.3	16.0	15.0	14.5	13.5	13.9	12.9	12.1
Oceania‡	49.0	18.1	16.5	14.0	13.5	14.2	13.1	12.1	12.9	17.2	20.7
Australia	40.3	14.9	14.2	11.7	10.9	11.6	10.6	8.3	9.6	12.2	14.5
West Australia	25.0	10.4	10.0	9.1	9.0	8.4	8.1	7.8	8.6	10.6	12.5
S. Rhodesia	18.9	13.4	13.0	12.0	12.3	12.0	11.9	11.6	11.3	11.0	12.0
California	21.4	13.4	13.2	13.1	11.9	11.7	10.6	8.5	9.1	10.6	11.7
S. Dakota	.....	6.3	6.1	6.0	5.9	6.7	6.6	6.5	8.4	8.9	10.2
India	11.5	7.9	8.2	8.1	7.9	7.9	7.8	7.5	6.8	6.8	6.8

*Figures, compiled from various sources, subject to revision. †Excluding Philippine Islands. ‡Includes Australia, Tasmania, New Zealand and New Guinea.

Maximum United States production.....101.0 million dollars in 1915.
Maximum Transvaal production.....238.8 " " " 1932.
Maximum World production.....496.4 " " " 1932.

Silver-Cobalt

The extremely low price of silver and a depressed market for cobalt has lowered Ontario's sales of silver to 6,216,490 fine ounces, and until the price of the metal improves, and a more active consumption of cobalt materializes, the production of silver in Ontario cannot be expected to increase. However, with better conditions obtaining, there are a number of properties in the Cobalt camp which could be brought into production again, and considerable silver and cobalt recovered. On December 29, spot silver on the New York market was quoted at 24¼ cents per fine ounce, the lowest level in history.

Operations are now practically reduced to the O'Brien mines at Cobalt and Cross Lake and the Miller Lake O'Brien at Gowganda. These properties feed the Deloro smelter operated by the same ownership. The Mining Corporation has practically worked out its mines at Cobalt and during the past year removed the remaining backs of stopes underlying the dry bed of Cobalt lake. The Nipissing mine output was just a fraction of its former large production. Activities in this old camp were maintained in part by a number of lessees who operated some of the mines. The difficulty in marketing cobalt ore, however, has retarded operations very considerably.

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 4, or with those found in Table XI. Silver shown as shipped in Table X has been compiled for each mining area and is mainly the silver contents of ore or concentrates shipped to the reduction works at Cobalt or to 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 over a period of years, these figures will agree closely with those for silver bullion sold, as given in Table I on page 4.

Since the discovery of silver at Cobalt in 1903 silver shipments from this and outlying silver camps, as reported by the operators, have been as follows:—

TABLE X.—SILVER SHIPMENTS BY CAMPS, 1904-1932

Year	Average price, cents per ounce (New York)	Silver content in troy ounces					
		Total from silver camps	Cobalt	Casey township	South Lorrain	Gowganda	Montreal R. and Maple Mountain, etc.
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	.....
1929	52.993	7,781,429	4,823,529	.....	876,006	2,081,894	.....
1930	38.154	9,225,610	5,329,335	.....	1,754,989	2,141,234	(c) 52
1931	28.700	5,998,482	3,706,880	.....	594,360	1,697,242	.....
1932	27.892	4,659,304	3,262,380	.....	22,144	1,374,780	.....
Total	.....	417,937,757	371,944,124	2,799,740	22,773,993	20,371,342	48,558

(a) Includes 885 ounces from Silver Islet, Lake Superior.
(b) Silver Islet, Lake Superior.
(c) Nickel Hill Syndicate in the Sudbury area shipped silver-cobalt ore.

According to the records of the Temiskaming and Northern Ontario Railway, total shipments of ore and concentrates during the calendar year were 3,539.84 tons, of which 2,461.03 tons were consigned to the Deloro Smelting and Refining Company; 616.31 tons to Europe; 461.33 tons to Trail, B.C.; and 1.17 tons to the United States. Total shipments were 2,839.03 tons of silver ore and concentrate, and 700.81 tons in which cobalt was the chief constituent.

The statement as given in Molatta & Goldsmid's Annual Circular, London, England, dated Jan. 20, 1933, outlines the statistical position of silver in the world as follows:—

The outlook for the future is particularly obscure at this juncture. The price of silver and other commodities is closely allied to the course of exchanges, which in turn are acutely influenced by the changing International political conditions, of which the question of War Debts is the key note. On its own merits there appears to be little to raise the price of silver; stocks are plentiful in all markets, the offtake is extremely small and production, although estimated at about 160 million ounces, compared with about 192 million ounces last year, is still more than can be absorbed. At the same time a solution of the various problems which beset the world at the present time might easily bring about a rise in world prices, including that of silver.

It may be pointed out that figures of output are based as far as possible on actual sales of bullion and silver contained in concentrate 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 XII but average up over a period of years:—

SILVER PRODUCTION, 1931 AND 1932

Source	1931		1932	
	Fine ounces	Value	Fine ounces	Value
		$		$
Sales of bullion by the reduction companies, smelters and mines	4,901,860	1,391,949	4,662,059	1,455,822
Contained in silver-cobalt concentrates and residues exported	513,795	154,939	162,708	50,126
Estimated as recovered from concentrates treated outside of Ontario	.....	.....	282,121	86,945
In crude gold bullion	364,401	103,270	445,763	117,951
Recovered by nickel-copper refineries	822,971	230,702	663,839	200,093
Total	6,603,027	1,880,860	6,216,490	1,910,937

Shipments of silver mines by camps during 1931 and 1932 were as follows:—

Camp	1931			1932		
	Silver	Cobalt*		Silver	Cobalt*	
	fine oz.	lb.	$	fine oz.	lb.	$
Cobalt	3,706,880	1,106,285	511,941	3,262,380	191,067	48,217
Gowganda	1,697,242	104,223	11,356	1,374,780	72,081	10,469
South Lorrain	594,360	764,989	426,077	22,144	6,517	2,737
Total	5,998,482	1,975,497	949,374	4,659,304	*291,923	71,447

*Figures represent the quantities paid for by the smelters, and values received by the mines.

With regard to the gradual cessation of mining at Cobalt it is of interest to quote from the last annual report of the Nipissing Mining Company, Ltd., one of the most important silver producers at Cobalt. This company to the end of 1931 has paid $29,940,000 in dividends.

Active stoping operations at the Cobalt property ended in March (1932) by which time all the high-grade ore had been extracted from the lower levels and the workings at the various shafts were allowed to fill. The mills and refinery completed the clean-up by the end of April.

The property at Cobalt, so far as immediate profitable operations are concerned, can be considered as finished. There remains some tonnage of unmined cobalt ore and unimportant occurrences of silver. It is highly probable that the last silver vein is still to be discovered, but until there is a material increase in the price of silver, there is no incentive or justification for undertaking further detailed exploration to discover new veins or to eliminate the few remaining possibilities.

Another famous producer was the Mining Corporation of Canada, Ltd., a consolidation of the Cobalt Lake Mining Co., Ltd., the Cobalt Townsite, and City of Cobalt properties. It also closed down mining operations in 1932, and the Annual Report states:

Since the termination of the cobalt ore contract in 1931 mining operations in 1932 were confined to the extraction of silver ore at Cobalt. Low silver prices prohibited any exploration work, though normal prices may eventually justify such work in certain sections of the Cobalt Lake property.

At the beginning of the year, the bulk of the remaining silver ore was contained in old stope backs in proximity to the bottom of Cobalt lake, such ore being overlain with accumulated mill tailings. To make this ore available for extraction, an opening was blasted through from the underground workings and 400,000 tons of the overlying tailings flowed by gravity into the worked-out sections of the mine. This operation permitted the safe and easy extraction of the ore at an unusually low cost per ounce of silver. All available tonnage was completely removed by the end of the year and the long productive record of the Corporation at Cobalt came to an end.

TABLE XI.—TOTAL SHIPMENTS FROM SILVER MINES, SMELTERS AND REFINERIES, 1904–1932

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
1929	13	23,413	13	3,098	3	267	115	63,167	464	1,801,915	1,871	154,887	7,970,540	4,239,980	6,286,727
1930	6	6,366	23	5,070	22	1,748	53	27,455	347	1,143,631	1,375	109,928	9,109,885	3,460,247	4,754,445
1931	4	3,532	29	5,438	40	2,529	47	31,650	261	651,179	1,788	135,170	5,415,655	1,546,888	2,376,386
1932	8	7,289	18	2,152	43	1,756	33	17,772	245	587,957	1,212	98,914	5,106,888	1,592,893	2,308,733
Total	64	135,906	845	271,239	290	27,867	5,722	1,207,658	14,793	25,155,510	67,974	5,571,061	415,931,042	251,530,473	283,899,714

(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 cobalt contained in ores and speiss residues exported. In 1932, it includes 22,258 lb. worth $10,024 from Northwestern Ontario. (d) Prior to 1914 an estimate based on assays was made of the nickel, cobalt and arsenic in the ores. Since that date 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.

TABLE XII.—DIVIDENDS AND BONUSES PAID BY SILVER MINING COMPANIES TO DECEMBER 31, 1932

Name of company	Date of incorporation	Authorized capital	Capital stock issued	Par value per share	Dividends and bonuses paid to end of 1931	Dividends and bonuses paid during 1932	Total dividends and bonuses paid to 31st Dec., 1932	Date when last dividend was paid
		$	$	$	$	$	$	
Aladdin Cobalt Company, Limited	Aug. 23, 1912	500,000	500,000	5.00	75,000.00	.....	75,000.00	Apr. 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. (*d*)	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	2,240,000.00	.....	2,240,000.00	Mar. 15, 1928
Kerr Lake Mining Company, Ltd. (*e*)	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 Canda, Ltd.	Nov. 23, 1916	8,300,250	8,300,250	5.00	7,573,937.47	.....	7,573,937.47	Dec. 19, 1929

City of Cobalt Mining Co., Ltd. (*f*)	Jan. 7, 1909	1,500,000	1,500,000	1.00	145,000.00	.....	145,000.00	April 15 1920
Cobalt Lake Mining Co., Ltd. (*f*)	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. (*f*)	May 8, 1906	100,000	45,011	1.00	1,042,259.61	.....	1,042,259.61	Nov. 11, 1914
Nipissing Mining Co., Ltd. (*g*)	Dec. 16, 1904	250,000	250,000	100.00	31,153,297.25	10,000.00	31,163,297.25	Dec. 31, 1932
Penn-Canadian Mines, Ltd. (*h*)	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 (*i*)	.....	.....	.....	.....	97,576,281.16	10,000.00	97,586,281.16	.....

(*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, but 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*) Name of company changed from Temiskaming and Hudson Bay in 1909.

(*e*) In addition a return of capital amounting to $600,000 was made on July 3, 1919, to stockholders of the Kerr Lake Mines, Ltd.

(*f*) Mining Corporation of Canada, Limited, now owns and operates the City of Cobalt, Cobalt Lake and Cobalt Townsite mines.

(*g*) Includes $16,288,297.25 paid in dividends by the Nipissing Mines Co. (the holding company) to the end of 1916.

(*h*) Paid out of capital $40,491.15 on September 10, 1917, and an equal amount on April 24, 1918.

(*i*) Does not include dividends by private companies such as M. J. O'Brien, Ltd.

Nickel, Copper and Platinum Metals

Statistics of production from the nickel-copper industry are indicative of the general decline in business activity. Throughout the American continent the consumption of nickel, now dependent on industrial manufacturing rather than for armament purposes, will in the future act as a measure of business conditions. The gradual recovery of business coupled with the replacements of machinery which become ever more pressing will be reflected by an increased consumption of nickel.

Robt. C. Stanley, President of the International Nickel Company of Canada Limited, reviewed the nickel industry in *Metal and Mineral Markets*, issue of Dec. 29, 1932, as follows:—

> The nickel business has become one of the basic industries of the world, which rise and fall with the tide of general business. This is demonstrated by the low point that nickel consumption reached last spring, and by the slow but persistent recovery which it has experienced in the last few months. Whether it will continue this advance in 1933 thus depends on what fate has in store for world business as a whole. . . . World consumption of nickel for the first nine months of 1932 slightly exceeded 40,000,000 pounds, compared with slightly more than 56,000,000 pounds for the same period in the previous year. Despite this decrease, four alloys increased in use over 1931.

During 1932 the quantity of ore smelted was only 46 per cent. of that treated in 1931, the figures being 793,552 tons as against 1,689,874 tons. The decrease was due to the slowing down of International Nickel operations. Falconbridge, the other producer which supplies the European trade from its refinery in Norway and is very much smaller in capacity, was able to increase its smelting unit to meet the requirements of that market, and while this trade improved greatly in 1932, the increase was relatively so small as to have little effect on the total decline. At present Falconbridge has a 250-ton concentrator under construction, planned for operation in April, 1933. The 325-ton smelter completed in February, 1930, was lengthened in December, 1932, increasing the capacity to 450 tons daily.

Copper Refining.—The Ontario Refining Company, Ltd., the only electrolytic refining plant in the province, operated steadily throughout the year. Commencing in July 1930, the capacity maintained during its first year of operation was around 5,000 tons per month. For the calendar year 1931 the total output of electrolytically refined copper was 120,078,611 pounds, of which more than 80 per cent. originated in Ontario. The production included wire bars, ingot bars, small ingots, vertical cast cakes, cathodes, slabs, and billets. Blister copper received for treatment totalled 99,045,950 pounds from Ontario, 12,609,298 pounds from Manitoba, and 9,222,112 pounds from British Columbia.

In 1932 blister received for treatment totalled 83,078,293 pounds of which 70,685,237 was of Ontario origin and 12,393,056 from Manitoba. The total treated was 83,480,193 pounds from which 75,157,299 pounds of electrolytic copper in the usual forms was recovered. Until June 24 Canadian electrolytic copper entered the United States free of duty. A tariff of 4 cents a pound which was then imposed, made it imperative for Canadian producers to find other buyers and the European market was then entered. During the period England, France, Germany, Belgium, Holland, Sweden, Italy, and Denmark bought Ontario copper, in the order named.

Precious Metals.—The most important precious metals recovered in the electrolytic refining operations of the nickel-copper industry are platinum, palladium, osmium, iridium and ruthenium. Silver is recovered in much greater quantity than the platinum metals, but the value is much lower. Gold is recovered in appreciable amounts.

In 1932, the total platinum metals was 64,897 fine ounces valued at $1,998,911, gold 22,675 fine ounces worth $468,727 and silver 663,795 ounces valued at $200,080, or a total of $2,667,718 for all precious metals. As compared with 1931, platinum metals are seen to have decreased by about 30 per cent. while silver and gold fell off by much smaller percentages. Falconbridge Mines, Limited, reported a recovery of platinum metals for the first time, residues having accumulated since the opening of the refinery at Kristiansand South, Norway, in April, 1930.

In a quarterly letter to International stockholders, R. C. Stanley, President of the company, described the platinum metals industry as follows:—

The so-called "platinum group" comprises six metals—platinum, palladium, iridium, rhodium, ruthenium and osmium. All these metals with the exception of osmium, are refined to high purity (99 per cent.) by your company. In the process of extracting nickel from our ores the platinum metals are recovered as a by-product. To separate and refine the platinum metals the company has developed at Acton, England, the world's largest and most modern platinum metals refinery, having a capacity of 300,000 ounces a year.

PRECIOUS METALS RECOVERED, 1928–1932

	1928	1929	1930*	1931	1932	
	Ounces	Ounces	Ounces	Ounces	Ounces	Value
Platinum metals:						$
Platinum	10,452	12,474	34,000	44,725	64,897	1,998,911
Palladium	11,389	12,231	29,907	39,313		
Rhodium, Ruthenium, Osmium and Iridium	1,689	4,910	4,133	7,605		
Total.....ounces	23,539	29,615	68,040	91,643	64,897	.....
Value.....$	1,309,923	1,646,381	2,436,683	2,812,834	.....	1,998,911
Gold	3,850	7,802	22,867	23,381	22,674.72	468,727
Silver	222,924	429,541	1,067,154	822,971	663,795	200,080

*In 1930, 5 oz. gold, 62 silver, 4 platinum, and 14 palladium were included in ore exported from Strathy township.

TABLE XIII.—NICKEL-COPPER MINING AND SMELTING, 1928–1932

Schedule	1928	1929	1930	1931	1932
Ore shipped.....tons	1,457,910	1,991,910	2,115,139	1,690,192	790,614
Ore smelted..... "	1,476,704	2,033,457	2,357,154	1,689,874	793,552
Bessemer matte produced..... "	91,313	132,030	166,703	100,273	41,660
Nickel content..... "	43,393	58,095	61,112	40,643	16,936
Copper content..... "	29,704	46,315	70,800	38,811	16,176
Matte exported*..... "	39,310	28,402	34,550	30,294	21,778
Nickel content..... "	18,856	14,068	20,978	16,847	8,068
Copper content..... "	13,221	8,449	5,855	6,620	8,825
Matte refined in Canada†..... "	67,866	109,818	139,635	69,215	6,651
Men employed.....No.	3,845	4,546	5,246	3,530	2,269
Wages paid.....$	6,005,697	7,069,995	7,992,294	5,087,215	3,363,692

*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.

†In 1932, after the reorganization of the metallurgical practice, the Orford process, i.e. the separation of the matte into copper tops and nickel bottoms, was carried out at Copper Cliff. The figure for 1932 does not include the matte so treated.

TABLE XIV.—STATISTICAL SYNOPSIS OF THE NICKEL-COPPER INDUSTRY IN ONTARIO DURING 1930, 1931, AND 1932

Year	Number of producing companies	Number of plants in Ontario	Capital invested (*b*)	Dividends paid (*c*)	Salaried employees		Wage-earners		Selling value of products (*d*)	
					No.	Salaries	No.	Wages	Kind	Value
			$	$		$		$		$
1930	2	5 mines	94,354,807	16,083,010.00	43	178,211	3,428	5,210,574	Matte (exported)	25,598,443
		3 smelters			75	296,268	1,818	2,781,720	Metallic nickel	
		2 refineries (*a*)			130	374,983	1,435	2,142,193	Nickel oxide	
									Converter copper	12,748,178
									Gold	472,599
									Silver	407,138
		Construction	.....	.....	.....	.....	1,245	1,781,655	Platinum metals	2,436,683
		Total	94,354,807	16,083,010.00	248	849,462	7,926	11,916,142	.....	41,663,041
1931	2	5 mines	20,932,914	.....	39	167,035	2,116	2,975,821	Matte (exported)	15,701,636
		3 smelters	36,479,787	8,494,405.77	71	298,170	1,414	2,111,394	Metallic nickel	
		2 refineries	31,874,415	.....	126	367,390	972	1,752,020	Nickel oxide	
									Converter copper	8,172,327
									Gold	483,328
		Construction	.....	.....	.....	.....	528	683,989	Silver	230,702
									Platinum metals	2,812,834
		Total	89,287,116	8,494,405.77	236	832,595	5,030	7,523,224	.....	27,400,827
1932	2	5 mines	90,815,075	1,933,909.26	41	150,509	1,173	1,621,364	Matte (exported)	7,779,846
		3 smelters			77	288,609	966	1,365,220	Metallic nickel	
		2 refineries			106	262,381	440	736,093	Nickel oxide	
									Converter copper	3,787,581
									Gold	468,727
									Silver	200,080
									Platinum metals	1,998,911
		Total	90,815,075	1,933,909.26	224	701,499	2,579	3,722,677	.....	14,235,145

(*a*) Port Colborne plant, and Ontario Refining Company plant at Copper Cliff.
(*b*) The capital invested is exclusive of value of mineral lands. In the Report for 1929, Vol. XXXIX, Part 1, the capital shown includes the book value for mineral lands, or a total of $74,077,808 for the lands.
(*c*) On preferred shares only in 1932. (*d*) Figures do not include the output of the Ontario Refining Company.

Dividends.—Total dividends paid to the end of 1931 and payments in 1932 are given in the table which follows. For convenience of comparison Mond figures have been converted to dollars on the basis of £1 = $4.8665.

TABLE XV.—TOTAL DIVIDENDS PAID BY NICKEL COMPANIES

Company	Period (inclusive)	Total to end of 1931	Paid in 1932
Canadian Copper Company	1894–1901	$1,975,000	.....
*International Nickel Company—Preferred	1906–1928	12,299,273	.....
*International Nickel Company—Common	1909–1928	65,811,694	.....
†International Nickel Company of Canada, Limited—Preferred	1929–1932	5,581,003.52	$1,933,909.26
†International Nickel Company of Canada, Limited—Common	1929–1931	33,085,113.56	.....
Total	.....	$118,752,084.08	$1,933,909.26
‡Mond Nickel Company.—Deferred	1906–1914	£264,043	.....
‡Mond Nickel Company.—Preferred	1904–1929	2,556,359	.....
‡Mond Nickel Company.—Ordinary	1905–1929	2,581,984	.....
Total	.....	£5,402,386 or $26,291,126	.....
Grand Total	.....	$145,043,210.08	$1,933,909.26

*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.

†Dividends paid by the International Nickel Company of Canada, Limited, on the common stock in 1929 were 90c. per share, and $1.00 per share in 1930. Common stock was increased to 15,000,000 shares of no par value on July 25, 1930; and as a result shares issued were increased from 13,758,208 to 14,584,025. Seven per cent. preferred stock (cumulative) now stands at $27,627,825. Dividends on common stock aggregated 45 cents a share in 1931.

‡Upon completion of the exchange of stock under the amalgamation of the Mond and International companies, effective, December 31, 1928, stock issued or issuable was as follows: $27,627,825 of 7 per cent. cumulative preferred, and 13,758,208 common shares without par value. Dividends paid on February 16, 1929, by the Mond company cover the 8 months' period ending December 31, 1928.

Iron Ore, Pig Iron, Steel, Ferro-Alloys, and Coke

Not for many years has the production of pig iron in Ontario fallen so low. The year opened with one 550-ton furnace in blast at Hamilton, which operated steadily until October. During the months of March, April, May and June one furnace also operated at Sault Ste. Marie, while in November no production of pig iron from any company was reported. The year closed with one active furnace at Sault Ste. Marie. Thus of seven blast furnaces available with a total capacity of 2,775 long tons, only two having a capacity of 990 tons were in blast. The Canadian Furnace Company at Port Colborne was idle throughout the entire year.

As shown in the following table, foreign iron ore charged amounted to 198,063 long tons, the average price of which was $4.65 at lower lake ports. From this ore 113,665 long tons of pig iron were produced, including 74,593 of basic, 25,246 foundry, and 13,826 of malleable. The average selling prices of these grades were $18.00 per long ton for basic, and $23.80 for foundry and malleable. Steel billets were quoted at $34.00. Figures for five years follow:—

TABLE XVI.—IRON AND STEEL STATISTICS, 1928–1932

Unit	1928	1929	1930	1931	1932
Ontario ore smelted.....long tons	.....	.....	.....	.....	.....
Foreign ore smelted..... " "	1,242,937	1,331,498	935,005	568,886	198,063
Limestone for flux.....short tons	324,550	342,776	234,309	149,454	56,880
Coke..... " "	736,746	767,420	542,094	320,133	119,064
Pig iron produced.....long tons	734,779	769,359	534,542	318,645	113,665
Value.....$	11,544,668	17,408,514	11,465,435	6,363,101	2,558,799
Steel made.....long tons	790,548	899,807	639,128	444,107	244,693
Value.....$	22,370,425	32,393,052	22,369,480	15,099,638	8,319,562

IRON BLAST FURNACES IN OPERATION, 1932

Name of company	Stacks operating	Furnaces		Location
		Total number of stacks	Daily capacity, long tons	
Algoma Steel Corporation, Ltd....	1	4	1,600	Sault Ste. Marie
Steel Company of Canada, Ltd....	1	2	825	Hamilton
Canadian Furnace Company, Ltd..	.....	1	350	Port Colborne

PIG IRON, STEEL, AND FERRO-ALLOY PRODUCERS, 1932

Company	Location
Abrasive Company of Canada, Ltd. (*c*)	Hamilton
Algoma Steel Corporation, Ltd. (*a*), (*b*)	Sault Ste. Marie
Canadian Carborundum Co., Ltd	Niagara Falls
Electro-Metallurgical Co. of Canada, Ltd. (*c*)	Welland
Lionite Abrasives, Ltd. (*c*)	Stamford
Steel Company of Canada, Ltd., (*a*), (*b*)	Hamilton
Superior Alloys, Ltd. (*c*)	Sault Ste. Marie

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

Ferro-Alloys.—Of the fourteen plants listed in the 1931 Report only four reported production which with an additional plant, namely, the Canadian Carborundum Company, Ltd. not listed in 1931, produced a total of 15,595 long tons of various kinds of ferro-alloys as against 46,440 tons in the previous year. The production of these materials during the past five years in Ontario was as follows:—

STATISTICS OF FERRO-ALLOYS PRODUCTION IN ONTARIO, 1928–1932

Year	No. of producing companies	No. of long tons	Kind of material
1928	3	44,842	Ferro-silicon, ferro-manganese, silicon speigel, spiegeleisen, calcium manganese silicon, zirconium manganese silicon.
1929	4	81,137	
1930	5	60,545	
1931	8	46,440	
1932	5	15,595	

Coke.—The coking industry in Ontario is carried on by the large iron and steel metallurgical works, and by chartered companies operating in the cities supplying artificial gas to the householders and to industries. The statistics shown in the following table are combined and show the raw materials used in manufacturing with products made. The table is more complete than those published in these reports hitherto inasmuch as the consumption of coke and gas in the plants of the reporting companies is shown as well as the quantities marketed or sold to consumers. Statistics are given in Table XVII which follows:—

TABLE XVII.—THE COKING INDUSTRY IN ONTARIO, 1932

		Quantity	Cost at works
MATERIALS USED:			
Coal	tons	1,436,069	$6,337,605
Coke	"	56,924	387,090
Oil	Imp. gal.	9,309,607	553,649
Absorbing and wash oil	"	135,816	14,294
Caustic soda	lb.	201,981	6,499
Soda ash		.....	30
Lime	tons	463	4,538
Water		.....	5,837
Oxide for purification	"	2,520	22,119
Sulphuric acid 66° Be. purchased	lb.	16,685,119	111,748
All other materials		.....	38,144
Total		.....	$7,481,553
GAS MADE AND SOLD:			
Retort coal gas	M. cu. ft.	4,544,701	.....
Coke oven gas	" "	10,010,350	.....
Straight water gas	" "	124,359	.....
Carburetted water gas	" "	3,172,548	.....
Mixed coal and water gas	" "	72,419	.....
Oil gas	" "	11,836	.....
Total	" "	8,774,476	$8,045,961
Used in producing plants	" "	4,557,333	1,217,606
Used in associated metallurgical works	" "	3,938,972	653,384
Otherwise accounted for	" "	154,324	50,229
Not accounted for	" "	511,108	521,831
Total		17,936,213	$10,489,011
COKE AND BY-PRODUCTS MADE:			
Coke, including breeze	tons	1,087,122	7,876,941
Tar	Imp. gal.	13,850,265	774,678
Ammonia liquor	lb. NH_3	1,452,074	14,521
Ammonium sulphate	lb.	18,794,133	180,402
Benzol	Imp. gal.	2,331,036	475,280
All other products		.....	.....
Total		.....	$9,321,822
COKE SOLD AND USED, AND STOCKS:		Coke	Breeze
Used by reporting companies	tons	257,572	77,253
Sold for domestic use		579,598	42,952
Other uses		33,287	.....
On hand, December 31, 1932		143,340	16,698

Lead and Zinc

The production of refined pig lead in Ontario dates from 1917 when a smelter having a capacity of 18 tons a day was built near Galetta in Carleton

county by the Estate of James Robertson of Montreal. This company later became the Kingdon Mining, Smelting and Manufacturing Company, and over a period of 15 years a high grade pig lead was produced and consumed mainly in the manufacture of lead pipe and other plumbing supplies by the Robertson firm. The mine closed down on May 8, 1931. In 1932 the Galetta smelter did not produce any pig lead and the Ontario production came entirely from the silver-cobalt ores.

For some years a small quantity of lead has been recovered in the concentrating and smelting of silver-cobalt ores, and more recently the Treadwell Yukon mine at Bradley, Sudbury area, recovered lead concentrates from a lead-zinc-copper ore. The depressed markets for base metals, however, has not permitted production from this property which was idle during the period.

Uraninite

There was no production of radium-bearing ore from the Ontario deposits in 1932, but two companies operated in the township of Cardiff, Haliburton county. International Radium and Resources, Limited, employed a force of men sinking and drifting on its property near Wilberforce. Small test runs were put through the mill in March, April and May. The Canada Radium Mines, Limited, near Cheddar, sank a shaft to the 125-foot level, crosscutting from that point 200 feet to the vein and drifting about 200 feet along it. The shaft was being sunk to 250 feet, commencing March, 1933. About 22 men were employed.

The Eldorado Gold Mines, Limited, commenced operating its radium extraction plant at Port Hope on January 10, 1933, and was getting into production at the time of writing. A few months will be necessary to test the strength of the various compounds of radium to be produced. The capacity of the Port Hope plant, which is expected to be in full production in the autumn of 1933, is not known at present. In the meantime production of radium compounds on a small scale will be continuous. The grade of ore from the Great Bear Lake property which was tested at the Mines Branch Laboratory, Ottawa, was 45 per cent. U_3O_8.

NON-METALLIC MINERALS

During 1932 the value of the output of non-metallic minerals totalled $7,361,897 as against $7,642,308 in 1931, or a decrease of 3.6 per cent. The principal items with values, in order of importance, were as follows: Natural gas, $4,719,297; salt, $1,789,752; petroleum, $247,468; gypsum, $186,176; and talc, $111,585. Beryl, feldspar, fluorspar, graphite, iron pyrites, quartz and quartzite, sulphuric acid (i.e. sulphur content), mica, mineral water, peat, and silica brick were represented, but were each under $100,000 in value, as may be seen in Tables I and II in the list of non-metallics.

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 in ground form mixed with mica, where it is used as an ingredient in the manufacture of roofing material. In 1931, the output was 35 tons valued at $456 as against 34 tons worth $437 in 1930, and in 1932 the plant did not produce.

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 with 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 1932 was 2,424,342 pounds valued at $98,914 as against 3,575,936 pounds worth $135,170 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, owned by 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. During the last half of 1932 a force of 15 men was employed in remodelling the milling equipment of the above-mentioned company and preparing to produce a marketable product.

Beryl

This mineral occurs in fine green crystals on lot 23, concession XV, Lyndoch township, in the county of Renfrew. No production apart from hand specimens was reported from this property for a number of years, but in 1927 some 4,456 pounds of beryl were shipped to Germany, the c.i.f. value of which at Hamburg was $175. This production was not reported until the year 1929. Exploratory work on this and other deposits in Lyndoch was under way during 1931 by the Madawaska Syndicate. A company known as Madawaska Minerals, Ltd., was incorporated in Ontario, February 17, 1932, to supersede the syndicate.

Calcite

No pure calcite has been produced recently in Ontario, although important deposits are available. Lack of markets has discouraged any development work. The position of this mineral is described in Volume XLI, Part 1, Report of Ontario Department of Mines.

Diatomite

Diatomite is a hydrous type of silica in the form of countless microscopic siliceous remains of aquatic plants called algae, and may be of either fresh water or marine origin. In addition to its use as an insulator, diatomite is employed as a filtering material, as a filler, as a fine abrasive polish, and for many other uses. Ontario deposits are all of fresh water origin. Two companies were preparing to enter the Canadian market in 1932, namely, Diatomite Products, Limited, at Martin's Siding south of Huntsville, and Dominion Diatomite, Limited, four miles west of Novar. The latter reported sales of small lots totalling 11 tons valued at $309 in 1932.

Feldspar

This industry which reaches its highest production when the foreign market is open, had a poor year in 1932 owing to the extraordinary business slump in the United States with the consequent lessened demand. The only domestic grinding plant in the Province, that of Frontenac Floor and Wall Tile Co. at

Kingston, continued to supply the home demand. The grade of spar mined in Ontario compares favourably with that of any other country, being particularly rich in potash and alumina so desirable in glazing pottery and enamel-ware, and in the porcelain insulator trade. During the period the total shipments were 3,657 tons worth $42,920 as against 7,962 tons valued at $100,119 in 1931. The main producer was T. H. Craig of Perth. The Bathurst Feldspar Mines which formerly shipped large quantities to the United States did no quarrying in 1932 but sold a few carloads from stock.

Fluorspar

The output of fluorspar from Ontario deposits has been practically negligible during the past decade. A few tons, however, have been recovered from the old ore dumps on lot 3, concession I, Madoc township. During 1930 and 1931 the production was 80 tons worth $1,240 and 40 tons valued at $620 respectively. Output in 1932 was 32 tons worth $464. This property was operated under lease from W. N. Ponton, Belleville, Ont.

Graphite

In 1932 the only producer in this mineral in Ontario was the Black Donald Graphite Company, Limited, of Calabogie from its property on lots 16, 17 and 18, concession III of Brougham township, Renfrew county. During the year 1931 sales totalled 548 tons valued at $32,149 as against 1,338 tons worth $86,543 in 1930. Crude ore mined in 1932 was 1,002 tons and ore milled totalled 1,424 tons. Shipments were 346 tons valued at $18,483.

Gypsum

Despite the entrance of another producer into the gypsum products business in Ontario, the Ontario production of this mineral again showed a decline owing to the greatly restricted demand in the building trades. Gypsum, Lime and Alabastine Canada, Ltd. at Caledonia and Lythmore, and the Canadian Gypsum Company at Hagersville which commenced operating in October, 1931, together produced 35,655 tons in 1932 as against 53,358 tons in 1931. The Lythmore plant of Gypsum, Lime and Alabastine Canada, Ltd., closed down in November and will not be reopened.

As will be noted in the table which follows, sales in 1932 were much below those of the past four years:—

GYPSUM SALES, 1928–1932

Grade	1928	1929	1930	1931	1932
Crushed.....tons	20,675	23,533	25,130	10,263	5,656
Fine ground..... "	1,134	497	1,190	451	364
Calcined sold..... "	4,133	5,269	3,515	1,606	217
Calcined used in products..... "	59,869	71,048	65,111	41,038	29,418
Total sold or used.....tons	85,811	100,347	94,946	53,358	35,655
Total value.....$	553,271	832,689	776,069	374,469	186,176
Number of workers.....	248	257	*92	155	*98
Wages paid.....$	289,292	311,609	92,918	87,263	85,036

*Exclusive of wage earners employed in the manufacturing division of the Caledonia plant.

In 1928 and 1929 considerable research work was carried on in Nova Scotia on anhydrite plasters and cements. This was fully described in a paper by A. E. Flynn given before the Mining Society of Nova Scotia in June, 1930, and published in The Bulletin of the Canadian Institute of Mining and Metallurgy, June, 1930. While gypsum, a hydrous sulphate of calcium ($CaSO_4$. $2H_2O$), has always been used for the manufacture of wall plasters, the associated mineral anhydrite CaO. SO_3) which lacks water of crystallization, does not lend itself to this use. The results of the research indicated that by artificial hydration this heretofore useless anhydrite could also be utilized along with lime finishing plaster or gypsum hardwall plaster. Recently a process for utilizing anhydrite as a plaster was patented in England by Major Victor Lefebure under the trade name "Pioneer Plaster". This process has been investigated by the Mines Branch, Ottawa.

Iron Pyrites and Sulphuric Acid

No pyrite ore was shipped, while the estimated content of the sulphuric acid manufactured at Copper Cliff by Canadian Industries Ltd. from sulphur fumes derived from nickel-copper smelting was 3,332 tons worth $33,320.

Mica

This industry which is principally in the hands of small producers is dependent almost entirely on the electrical manufacturing business. The decline in consumption was particularly marked in 1932 and there were fewer producers than during the past two decades. By grades the shipments in 1930, 1931 and 1932 were as follows:—

Grade	1930		1931		1932	
	Quantity	Value	Quantity	Value	Quantity	Value
	lb.	$	lb.	$	lb.	$
Rough cobbed	2,130	85	.....	.....	.....	.....
Thumb-trimmed	1,375	1,168	5,593	1,876	232	224
Splitting	60,180	24,788	30,015	10,505	.....	.....
Scrap	1,417,662	8,234	2,062,300	10,902	536,980	2,528
	1,481,347	34,275	2,097,908	23,283	537,212	2,752

The prices for the various sizes and grades as reported by the producers, covered the following:—

Size	Cents, per lb.	Size	Cents, per lb.
Scrap	.0045 to .0057	2- by 3 inches	30
*Splittings	.35	2- by 4 "	53
*1- by 1 inch	5 to 10	3- by 5 "	1.00
*1- by 2 inches	10 to 14	4- by 6 "	1.75
*1- by 3 "	30	*5- by 8 "	2.50 to 3.00

*None produced in 1932—prices shown are 1931 quotations.

Mineral Waters

The production in Ontario while not extensive is sufficient to supply all domestic consumption. The output from five or six springs during the past decade has ranged from 61,000 to 309,000 Imperial gallons. During 1931 six wells, all in eastern Ontario, produced 197,540 Imperial gallons worth $8,578 at the shipping point, and in 1932 four wells produced 61,208 gallons. The record for the past ten years follows:—

Sales	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932
Imp. gals..	227,030	201,670	183,012	208,400	293,200	253,630	309,700	214,200	197,540	61,208
Value, ...$	14,047	13,133	25,452	27,277	12,811	27,890	13,651	20,754	8,578	2,473

In addition to the above there are springs near Wilberforce in Haliburton county close to the uraninite deposits which are radio-active and which possibly may have therapeutic value. Another mineral water is calcium chloride which has been found in saline waters near Concord in York county, Burlington in Halton county, and elsewhere. These waters have had some use for medicinal purposes. It has also been tried as a dust allayer on the highways, but the ratio of calcium chloride to water was found to be too low and it could not compete with the calcium chloride in crystal form as now used. Sanatoria at St. Catharines and Preston have long been using the mineral waters at those points both for baths and drinking purposes. This consumption has not been included with the figures of output.

Natural Gas and Petroleum

The Natural Gas Commissioner of Ontario, R. B. Harkness, has supplied the following notes:—

Production of natural gas in 1932 was 7,386,154 M. cu. ft. valued at $4,719,297 which is about the same as for the years 1924, 1925, 1927 and 1931. However, the number of consumers has increased each year and hence the consumption per consumer shows a corresponding decrease. The year 1932 is, therefore, below normal production. The quantity of gas used by industries has shown an increase. Exploration activities have been at a minimum; the normal drilling continued within the known gas fields.

The production of petroleum has shown an increase over 1931 of 7,979 barrels. The major portion of this increase is from Dawn township, where the Union Gas Company drilled three very good oil wells. A small increase is noted in the Petrolia, Oil Springs and Bothwell fields. A test is being made in the old Petrolia field of cleaning out wells by washing them with acid. Early reports are that production is increased, but sufficient time has not yet elapsed to determine to what extend or how long the effect will last. Following are details of output for the past five years, given in barrels of 35 Imperial gallons:—

CRUDE PETROLEUM PRODUCTION,* 1928–1932

Field	1928	1929	1930	1931	1932
	Barrels	Barrels	Barrels	Barrels	Barrels
Petrolia and Enniskillen township...	60,547	56,284	55,130	57,515	58,871
Oil Springs	35,653	30,789	29,160	30,792	31,438
Moore township	2,148	1,230	1,576	3,739	3,272
Sarnia township	1,221	749	1,149	1,466	1,227
Plympton township	371	315	296	296	274
Bothwell	24,255	23,236	21,176	18,084	19,460
Dover township	773	715	457	891	453
Dawn township	.....	.....	.....	.....	5,061
Onondaga township	87	243	231	34	543
Mosa township	7,268	6,850	7,166	8,517	8,429
Thamesville	1,006	427	447	462	534
Dunwich township (Dutton and Iona)	.....	148	365	628	781
Tilbury East township	736	139	149	.....	.....
Total quantity.....bbls.	134,065	121,125	117,302	122,364	130,343
Value	$249,981	$293,724	$235,746	$219,993	$247,468
Average price per barrel	$1.86	$2.42	$2.00	$1.80	$1.89

*Information furnished by the Imperial Oil Refiners, Limited, of Sarnia, and others.

Peat

Shipments in 1932 from the Albert bog, in Prescott county east of Ottawa, totalled 86 tons valued at $387, f.o.b. plant. This material was bought by the Ontario Department of Public Works for consumption in the Normal Schools at North Bay, Peterborough, and Ottawa. Other shipments from bogs in Dundas county were reported as 2,400 tons worth $3,920, which with other miscellaneous lots made a total 4,886 tons having a value of $10,107.

Quartz, Quartzite, and Silica Brick

The production of quartz showed a considerable decrease in 1931. The volume decreased from 167,487 tons in 1930 to 97,888 tons in the following year. In 1932, the production fell to 66,135 tons valued at $93,574, or a decline of 32.4 per cent. The total output of silica brick in 1931 was 459,000, of which 279,053 worth $13,702 were sold or used. In 1932, only 93,050 brick valued at $4,303 were consumed. Production figures for the past five years follow:—

QUARTZ, QUARTZITE, AND SILICA BRICK, 1928–1932

Schedule	1928	1929	1930	1931	1932
Rock sold or used.....tons	194,503	187,973	167,487	97,888	66,135
Value.....$	308,608	316,050	274,674	148,642	93,574
Silica brick sold or used.....M.	1,597	1,566	378	279	93
Value.....$	86,323	80,374	19,120	13,702	4,303
Total, Value.....$	394,931	396,424	293,794	162,344	97,877

Salt

During 1932 six companies produced salt, or brine, which is used in the manufacture of chemicals by Canadian Industries, Ltd., and Brunner Mond Canada, Ltd. This industry which is located in the southwestern part of the Province is well organized and the fluctuations shown in the figures of production reflect fairly closely the general progress of industry in the Province. Production figures covering a 5-year period follow:—

SALT STATISTICS, 1928–1932

Schedule	1928	1929	1930	1931	1932
Land.....tons	3,621	1,919	245	513	557
Coarse..... "	26,730	22,632	21,160	17,678	15,683
Fine..... "	51,055	49,869	55,373	115,180	59,036
Table and dairy..... "	56,214	54,138	49,467		59,620
Pressed blocks..... "	7,083	5,560	7,655		
Brine (salt equivalent)..... "	135,138	168,327	114,737	97,928	96,242
Total sold or used..... "	279,841	302,445	248,637	231,329	231,138
Value of products old or used.....$	1,377,629	1,420,424	1,558,405	1,760,388	1,789,752
Employees*.....No.	299	263	263	233	215
Wages.....$	337,214	303,618	288,237	259,646	253,579

*Employees of Sandwich salt and chemical works are included.

Talc

This industry ran a uniform course during the five years up to and including 1929. Production from the two operating companies near Madoc, namely, the Geo. H. Gillespie Co. and Canada Talc, Ltd., ranged from $174,000 to $180,000 per annum. In 1930 and 1931 the value was lower and amounted to $133,213 for 11,664 tons and $122,044 for 11,806 tons, respectively, and in 1932 the value declined although the quantity sold showed an improvement. The product in the ground state ranges in price from $9.00 to $18.00 per ton, depending on grade, and is marketed in Canada and the United States. No soapstone has been mined since 1927 from the Eagle Lake deposit in Kenora district, or elsewhere.

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

TALC AND SOAPSTONE STATISTICS, 1928–1932

Schedul :	1928	1929	1930	1931	1932
Ground talc shipped.....tons	14,925	15,463	11,664	11,806	12,064
Total value of shipments.....$	179,187	180,492	133,213	122,044	111,585
Employees, mine and mill.....No.	45	42	36	36	38
Wages paid.....$	44,858	40,055	32,718	29,419	30,587

STRUCTURAL MATERIALS

Building Permits—In 61 Canadian cities building permits in 1932 were valued at $42,319,397. Of this total thirty Ontario cities accounted for $16,887,761, as noted in the following table abstracted from *Annual Review of Building Permits in Canada in 1932*, issued by the Dominion Bureau of Statistics, Department of Trade and Commerce, Ottawa.

BUILDING PERMITS IN ONTARIO, 1920–1932

Year	30 Ontario cities, value	Wholesale prices index number (*a*)	Toronto metropolitan area, value (*b*)	Wages index number (*c*)
	$		$	
1920	58,636,365	144.0 (*d*)	30,049,413	180.9
1921	59,315,845	122.8	31,979,346	170.5
1922	81,396,259	108.7	36,405,625	162.5
1923	74,673,080	111.9	39,530,877	166.4
1924	57,330,141	106.6	29,636,428	169.1
1925	59,888,867	102.9	32,408,636	170.4
1926	65,373,757	100.0	31,588,124	172.1
1927	79,883,344	96.1	37,316,511	179.3
1928	104,777,566	98.1	59,817,568	185.6
1929	95,055,827	99.0	57,522,927	197.5
1930	69,042,946	90.9	38,371,587	203.2
1931	44,371,578	82.6	27,950,136	195.7
1932	16,887,761	77.5	9,461,050	178.2

(*a*) Applies to average index numbers for Canadian wholesale prices of building materials on the basis of 1926 = 100, as compiled by the Dominion Bureau of Statistics. In 1913 the index was 67.0, dropping to a low of 60.5 in 1915.

(*b*) Includes York and East York municipalities.

(*c*) Average index numbers of wages in Canadian building trades as compiled by the Federal Department of Labour on the basis of 1913 = 100. (*d*) Peak year.

Construction Contracts.—The value of Canadian construction contracts awarded for 1932, reported by *McLean Building Review*, was $132,872,400 as compared with $315,482,000 in 1931. Ontario contracts in 1932 amounted to $49,291,800 or 37.1 per cent. of the total. Prices of materials were considerably below the peak of 1920, and decided drops were recorded in 1930 and 1931, and in 1932. Figures by class follow for a five-year period:—

VALUE OF ONTARIO CONSTRUCTION CONTRACTS, 1928–1932

Classification	1928	1929	1930	1931	1932
	$	$	$	$	$
Residential	64,628,600	59,211,000	44,427,000	39,274,300	14,143,200
Business	58,700,200	82,949,000	52,636,400	28,819,400	16,925,600
Industrial	25,109,800	28,247,200	12,787,400	6,836,300	1,871,000
Engineering	39,913,100	45,365,900	65,608,800	50,522,300	16,352,000
Total	188,351,700	215,773,100	175,459,600	125,452,300	49,291,800

Cement

During 1932 the plants in operation were those of the Canada Cement Company, Limited, located at Belleville, Port Colborne, and Lakefield; and that of the St. Marys Cement Company, Limited, at St. Marys. Stocks on hand December 31, 1931 and 1932, were 814,418 and 1,099,530 barrels, respectively. Production during the past decade is given in the following table:—

PORTLAND CEMENT STATISTICS, 1923–1932

Year	No. of operating plants	Sales		
		Barrels (350 lbs.)	Total value	Average price per bbl.
			$	$
1923	4	3,296,428	5,855,590	1.77
1924	4	3,564,499	5,668,671	1.59
1925	4	3,462,358	5,253,911	1.52
1926	3	3,398,860	4,792,857	1.41
1927	4	3,751,786	5,144,326	1.34
1928	4	3,911,795	5,520,897	1.41
1929	4	4,624,712	6,608,246	1.43
1930	4	3,942,690	5,779,404	1.47
1931	4	3,470,056	5,006,826	1.44
1932	4	1,599,342	2,288,975	1.44

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, as the raw materials entering into the manufacture of these products have all been accounted for. Cement products being so closely allied to the building industry, statistics are included so that complete information covering all structural materials is available under one cover. Monolithic construction is not included. The following tables give the record of materials used and products made during the past two years, also general statistics for a five-year period:—

CEMENT PRODUCTS MANUFACTURE IN ONTARIO,* 1931–1932

		1931		1932	
		Quantity	Cost at works	Quantity	Cost at works
Materials Used					
Portland cement	bbls.	142,707	$316,294	54,477	$123,965
Quicklime	bush.	122	45	168	97
Sand	cu. yd.	39,339	55,040	14,079	16,335
Gravel	"	34,746	48,913	11,069	13,173
Crushed stone	"	10,470	17,686	2,523	5,369
Cinders	"	.....	24,705	7,047	8,291
Boxes, crates, lumber, etc		.....	17,601	.....	17,465
Reinforcing		.....	71,269	.....	5,591
Haydite	cu. yds.	.....	7,739	5,668	19,840
Keen's cement	bbls.	87	732	.....	.....
Medussa cement	"	.....	617	.....	.....
Hydrated lime	tons	50	627	.....	.....
Colour pigments		.....	476	.....	.....
Dolomite	tons	.....	.....	268	2,312
Brass		.....	.....	.....	22,077
Other materials		.....	67,361	.....	43,525
Total		.....	629,105	.....	278,040
		Quantity	Selling value	Quantity	Selling value
Products Made					
Cinder bricks	M	229	$4,588	.....	.....
Artificial stone		.....	179,354	.....	$58,245
Cinder blocks	M	1,473	226,552	494	73,069
Cement bricks	"	1,093	12,891	1,243	39,664
Cement hollow building blocks		.....	385,247	.....	138,177
Cement drain pipe		.....	61,368	.....	5,531
Cement laundry tubs	No.	6,837	50,385	4,221	30,982
Cement posts, poles, etc		.....	1,000	.....	790
Cement sewer pipe and culvert pipe		.....	596,681	.....	180,731
Cement stucco		.....	23,160	.....	8,039
Burial vaults		.....	11,451	440	16,646
Concrete blocks		.....	35,263	.....	.....
Drain tile		.....	662	.....	.....
Railway-crossing ties and slabs		.....	3,301	.....	.....
Roofing tile		.....	1,388	.....	.....
Garden furniture		.....	.....	.....	3,311
Haydite blocks	tons	.....	.....	3,054	25,961
Haydite roof slabs		.....	.....	349	9,893
Septic tanks		.....	1,665	.....	.....
Other products		.....	187,444	.....	146,307
Total		.....	1,782,400	.....	737,326

*Supplied by Dominion Bureau of Statistics, Ottawa.

PRINCIPAL STATISTICS OF CEMENT PRODUCTS INDUSTRY,* 1928–1932

	1928	1929	1930	1931	1932
Plants No.	105	106	88	92	69
Wage-earners (average) "	590	767	533	562	352
Salaries and wages $	617,503	897,481	658,381	599,640	308,898
Cost of fuel and electricity $	39,669	49,974	44,697	43,429	27,692
Capital invested $	2,501,018	3,031,747	3,148,950	2,955,610	2,286,460
Value products at works $	2,441,717	2,664,372	1,921,018	1,782,400	737,326

*Supplied by Dominion Bureau of Statistics, Ottawa.

Lime

During 1932 twenty-two lime establishments were active, but at greatly reduced capacity. Six of these plants are equipped for the production of hydrated lime. Of the 22 active plants 3 were operated by Gypsum, Lime and Alabastine, Canada, Ltd. Figures of production for the past five years are given in the table which follows:—

LIME STATISTICS, 1928–1932

Year	Lime marketed or used						Fuel costs	Employees	Wages
	Hydrated			Quicklime					
	Tons	Value		Tons	Value				
		Total	Per ton		Total	Per ton			
		$	$		$	$	$		$
1928..	49,085	597,367	12.17	228,101	1,870,476	8.20	388,152	414	390,611
1929..	55,916	740,127	13.24	314,246	2,624,285	8.35	513,741	577	398,266
1930..	42,726	504,178	11.80	209,340	1,673,409	7.99	343,237	330	352,768
1931..	34,284	379,996	11.08	113,267	841,194	7.43	177,310	287	216,337
1932..	23,518	255,223	10.85	143,185	1,018,007	7.11	204,546	203	154,361

Distribution of the quicklime and hydrated lime sold in 1932, as reported by the producing companies, was as follows:—

Industrial consumption	Quicklime		Hydrated lime	
	Tons	Value	Tons	Value
		$		$
Building trades: finishing and masons	10,064	72,824	21,676	235,868
Sand-lime brick	1,826	13,901	9	113
Agriculture	715	6,005	625	6,138
Chemical and metallurgical Industries: Smelters	259	1,716	30	315
Iron and steel	7,844	52,972	3	32
Gold milling	18,490	126,045	.....	.....
Pulp and paper	534	3,672	56	588
Glass	5,483	40,747	.....	.....
Sugar	8,909	75,875	.....	.....
Tanneries	1,736	12,065	42	441
*Other chemicals	87,324	612,184	1,077	11,728
Total	143,185	1,018,007	23,518	255,223

*Uses for lime under this heading include the manufacture of alkali, acetate of lime, and calcium carbide, the last mentioned being used largely for making cyanamide.

Sand-Lime Brick

In sympathy with other building and construction materials the output of sand-lime brick fell off again in 1931. The average price per thousand declined from $11.50 in 1929 to $9.25 in 1931, and rose to $11.49 in 1932. As the industry is mainly centered in and around Toronto and is dependent on the building activity, the figures of output strikingly reflect the depression in the building industry during 1932.

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

SAND-LIME BRICK STATISTICS, 1928–1932

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	
			$		$	$	$	$
1928.....	7	183	205,497	61,506	745,719	12.12	624,228	15.83
1929.....	6	190	228,576	55,750	641,159	11.50	540,299	15.84
1930.....	6	129	147,827	41,576	424,178	10.20	318,037	15.08
1931.....	5	93	72,762	27,378	253,228	9.25	197,470	15.00
1932.....	3	47	32,067	6,823	78,398	11.49	58,586	16.63

Sand and Gravel

The sand and gravel industry suffered severely in Ontario during 1931 and 1932. A decreased building and construction programme and smaller mileage of new highway construction accounts for the drop in production. While the production figures for 1932 were again lower, the decline in output seems to have spent itself, and this section is now probably at its lowest ebb. As indicated in the table below the total output from all sources, exclusive of the material produced by the railways and used by them for ballast, was 6,590,808 tons worth $2,000,298 in 1932 as against 6,663,972 tons worth $2,317,015 in the previous year.

The railways in Ontario produced 413,919 tons valued at $45,498, which was all consumed as ballast on their own railway systems. As this material does not enter into active competition with other producers it has been omitted from the totals shown, in agreement with the statistical practice of other years.

The table which follows shows the quantity and value of output from each source. All sources reported decreases except that of Northern Development and in this case the unemployment relief measures of the Ontario and Federal Governments accounted for the improvement.

OUTPUT OF SAND AND GRAVEL, 1931–1932

Source	1931		1932	
	Tons	Value	Tons	Value
		$		$
Private pit operators	1,880,750	902,377	1,737,065	615,452
Dredged from Great Lakes and rivers	866,315	481,286	425,340	212,670
Department of Northern Development	2,365,619	157,708	2,497,500	301,625
Department of Highways	527,000	263,500	270,000	40,000
Miscellaneous counties and townships	1,024,288	512,144	1,660,903	830,551
Total	6,663,972	2,317,015	6,590,808	2,000,298

Stone

Stone statistics for 1932 by varieties and uses, also employment figures, are given in the following table:—

STONE STATISTICS BY VARIETIES AND USES, 1932

Uses	Limestone (a)		Granite		Trap		Sandstone		Total	
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value
		$		$		$		$		$
Building and ornamental	12,889	125,307	2,969	69,026			3,678	8,757	19,536	203,090
Flagstone, Curbstone	35	35	128	32			65	473	228	540
Paving blocks			260	1,940					260	1,940
Lining open-hearth furnaces										
Chemical—										
Cement plants		(b)								
Flux in iron and steel plants	49,660	36,172							49,660	36,172
Flux in smelters	13,164	9,345							13,164	9,345
Glass factories										
Manufacture of lime		(c)								
Pulp and paper mills	30,365	25,289							30,365	25,289
Sugar refineries	19,503	11,552							19,503	11,552
Other chemical uses	7,625	2,265							7,625	2,265
Whiting										
Asphalt filler	5,832	15,709							5,832	15,709
Dusting coal mines										
Agricultural purposes	4,440	6,077							4,440	6,077
Poultry grit	2,531	7,397							2,531	7,397
Stucco dash and terrazzo flooring	819	3,790							819	3,790
Rubble and riprap	13,444	10,743					265	205	13,709	10,948
Crushed stone: Concrete aggregate	407,359	285,958							407,359	285,958
Crushed stone: Road metal	1,212,086	859,771	33,000	62,700	36,915	52,659			1,282,001	975,130
Crushed stone: Railroad ballast	48,106	59,814							48,106	59,814
Total	1,827,858	1,459,224	36,357	133,698	36,915	52,659	4,008	9,435	1,905,138	1,655,016
Producers, No.	53		9		2		5		69	
Wage-earners, "	840		16		38				894	
Wages paid, $	431,455		3,441		18,440				453,336	

(a) The figures for marble production are included with those for limestone.
(b) Value included with cement.
(c) Stone used for making lime accounted for in statistics for lime.

The production value of stone decreased from $3,197,297 in 1931 to $1,655,016 in the year under review, due entirely to a greatly depressed building industry and a reduced road-building programme. In the table showing values for the past five-year period, the output of granite indicates an improvement in 1932, but such is not the case, as the excess includes large shipments of building granite produced in 1931 and not reported until 1932.

The limestone statistics include the figures for marble which recently has shown signs of activity. In 1932 three operators produced 2,065 tons valued at $40,175 which included 501 tons of rough monumental stone worth $32,560; 745 tons of poultry grit at $3,825 and 819 tons of stucco and terrazzo material valued at $3,790.

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

VALUE OF STONE PRODUCTION, 1928-1932

Year	Limestone	Sandstone	Trap	Granite	Total
	$	$	$	$	$
1928	3,440,858	53,903	456,351	73,877	4,024,989
1929	3,759,357	69,898	367,590	574,771	4,771,616
1930	3,722,196	32,664	184,191	691,919	4,630,970
1931	2,929,885	26,186	128,258	112,968	3,197,297
1932	1,459,224	9,435	52,659	133,698	1,655,016

Clay Products

Comparing the 1932 statistics with those of the former year, the total value of all clay products has dropped by more than 50 per cent., and as compared with 1929, the maximum year, the decline in value was almost 76 per cent. As the average prices of brick do not show very wide fluctuation, it would appear that the percentage decreases in quantity production would be very much the same. These decreases bear a close relation to the declines in total value of building permits and construction contracts in Ontario as shown elsewhere.

In 1932 the total number of paid workers was 769 who received $437,595 in wages as against 1,404 workers in 1931 who were paid $1,159,701.

The clay products group has suffered more than others of the mineral industry during the depression. With a view to promoting the use of brick in all kinds of construction work some fourteen of the more important brick manufacturers of the Toronto and Hamilton areas, in March, 1932, formed the Brick Manufacturers Association with headquarters at 44 Victoria Street, Toronto. Officers are: Secretary, H. A. Badden, and Engineer, W. R. McCaffrey.

The price trends for brick and tile for the past three years are noted below:—

AVERAGE PRICES OF BRICK, 1930, 1931 AND 1932

Process and kind			1930	1931	1932
			$	$	$
Soft-mud	face	M	20.60	21.20	18.09
	common	"	15.20	15.09	15.14
Stiff-mud	face	"	20.67	21.33	21.79
	common	"	15.18	14.70	17.81
Dry-press	face	"	19.78	21.50	20.97
	common	"	12.80	14.65	15.80
Drain tile	(average of all sizes)	"	26.07	23.93	22.69

As the above items have been marketed in large quantities the averages given will therefore be representative. These averages, it will be seen, have moved both up and down but on the whole have not varied greatly.

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

HEAVY CLAY PRODUCTS MARKETED, 1932

Kind	Number or quantity	Value
		$
Brick—Soft-mud process {face	5,715,520	103,391
Brick—Soft-mud process {common	6,520,070	98,747
Stiff-mud (wire cut) process {face	15,211,838	331,441
Stiff-mud (wire cut) process {common	9,210,135	164,081
Dry-press {face	4,666,935	97,896
Dry-press {common	1,525,472	24,100
Fancy or ornamental brick (including special shapes, embossed and enamelled brick)	36,134	1,790
Sewer	666,294	18,638
Tile, structural: Hollow blocks (including fireproofing and load-bearing tile)...tons	21,787	144,422
Roofing tile...no.	48,939	3,900
Floor tile (quarries)...sq. feet	94,316	21,502
Tile, drain...no.	6,364,338	144,579
Sewer pipe (including copings, flue linings, etc.)	.....	451,786
Pottery (flower pots) from domestic clay...no.	4,500,000	67,866
Haydite	.....	16,366
Total value...$	.....	1,690,505

Values of clay products marketed for the last pre-war year (1913), for the year of maximum value (1922), and for the past five years, are given below:—

VALUE OF CLAY PRODUCTS SOLD OR USED, 1913, 1922, AND 1928–1932

Year	Brick		Pottery	Drain tile	Sewer pipe	Haydite	Total
	Common	Pressed, fancy, building tile, etc.					
	$	$	$	$	$	$	$
1913	3,283,894	1,162,860	52,875	292,767	600,297	.....	5,392,693
1922	2,614,120	2,899,205	88,889	368,180	973,824	.....	6,944,218
1928	1,154,763	3,377,648	*98,519	572,577	974,157	.....	6,177,664
1929	1,281,004	3,524,358	96,394	629,322	1,167,463	131,621	6,830,162
1930	792,234	2,683,983	89,381	593,980	834,361	227,275	5,221,214
1931	662,777	1,707,297	73,860	244,368	696,964	167,533	3,552,799
1932	305,566	704,342	67,866	144,579	451,786	16,366	1,690,505

*Includes $400 worth of other products.

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, 1913-1932

Year	Incorporated				Extra-provincial and mortmain companies licensed	
	No.	Nominal capital	"No par" companies		No.	Capital for use in Ontario
			No.	Shares		
		$				$
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	7,302,000
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	1,030,500
1922....	91	181,040,000	.....	.....	6	830,000
1923....	88	179,295,500	.....	.....	6	1,775,000
1924....	85	156,485,000	.....	.....	2	200,000
1925....	70	107,400,000	4	9,010,000	3	162,510
1926....	145	165,655,750	28	22,386,500	6	4,850,000
1927....	199	344,145,000	30	40,034,000	10	3,260,000
1928....	211	495,575,000	28	30,778,400	17	7,208,500
1929....	97	142,390,000	27	32,557,200	13	1,540,000
1930....	37	23,234,600	20	16,808,909	6	5,525,000
1931....	44	60,670,000	15	5,909,000	1	400,000
1932....	43	58,766,000	12	5,844,000	0	.....

Of the 43 companies incorporated in 1932, 31 had specified capital only, 10 were companies having shares without nominal or par value exclusively, while 2 companies had shares of both kinds.

MINING COMPANIES INCORPORATED IN ONTARIO IN 1932 HAVING SHARES WITHOUT NOMINAL OR PAR VALUE

Name of company	Head office	Date of incorporation	No. of shares
Amador Mines, Limited	London	Jan. 15	300,000
Consolidated Tailings, Limited (Private)	Kirkland Lake	April 7	300,000
Delta Metals, Limited	Sault Ste. Marie	Dec. 19	1,500,000
Denyes Exploration Syndicate, Ltd	Toronto	Nov. 23	100,000
Dyment Mining & Investments, Ltd	Toronto	Mar. 31	100,000
*Howard Sand & Gravel Co., Ltd	Aldershot	Feb. 6	5,000
*National Whiting Corp'n., Ltd	Toronto	Aug. 25	15,000
Nerlip Mines, Limited	Toronto	Feb. 16	500,000
Swayze Gold Belt Exploration Co., Ltd	Oakville	April 16	4,000
Vermillion Lake Gold Mines, Ltd	Toronto	June 6	15,000
West McWatters Syndicate, Ltd	Toronto	Nov. 21	5,000
Young-Shannon Gold Mines, Ltd	Toronto	Jan. 13	3,000,000
Total (12 companies)			5,844,000

*Also see list with specified capital. Two companies having both specified capital and "no par" shares are included in both lists.

ONTARIO COMPANIES WITH SPECIFIED CAPITAL INCORPORATED IN 1932

Name of company	Head office	Date of incorporation	Capital
Alcona Gold Mines, Ltd	Toronto	Nov. 14	$2,000,000
Bear Exploration and Radium, Ltd	Toronto	June 6	4,000,000
Beaver-Bethnal Gold Mines, Ltd	North Bay	Nov. 2	500,000
Buffalo Ankerite Gold Mines, Ltd	Toronto	Oct. 5	1,000,000
Burvan Gold Mines, Ltd	Toronto	Dec. 15	3,000,000
Canadian Asbestos Ontario, Ltd (Private)	Toronto	Mar. 10	40,000
Canadian Reserve Mines, Ltd	Toronto	Dec. 10	5,000,000
Canusa Gold Mines, Ltd	Toronto	July 4	1,500,000
Central Matachewan Mining Corp'n, Ltd	Toronto	Jan. 8	2,000,000
Central Tyrrell Gold Mines, Ltd	Toronto	Nov. 7	3,000,000
Chester Gold Mines, Ltd	Toronto	April 25	1,000,000
Circle Minerals, Ltd	Toronto	Jan. 21	3,000,000
Chromium Alloy Co., Ltd	Hamilton	Dec. 2	3,000,000
Dominion Bannockburn Co., Ltd	Toronto	Nov. 25	40,000
Erie Canadian Mines, Ltd. (Private)	Kirkland Lake	Mar. 21	40,000
Great Bear Development Co., Ltd	Toronto	Feb. 1	3,000,000
Halcrow-Swayze Mines, Ltd	Toronto	Nov. 4	2,500,000
Hincks-Montrose Co., Ltd	Toronto	Nov. 25	40,000
*Howard Sand & Gravel Co., Ltd	Aldershot	Feb. 6	95,000
J-M Consolidated Gold Mines, Ltd	Toronto	Feb. 18	2,500,000
Kam-Kotia Porcupine Mines, Ltd. (Private)	Toronto	Aug. 8	40,000
Kenty Gold Mines, Ltd	Toronto	Sept. 21	3,000,000
MacDonald Gold Mines, Ltd	Elmira	Aug. 5	256,000
Madawaska Minerals, Ltd	Toronto	Feb. 17	5,000,000
Mid-Continent Goldfields, Ltd	Toronto	June 17	5,000,000
Mills-Mining-Machinery Co., Ltd	Toronto	Dec. 5	2,000,000
Muskoka Diatomite, Ltd	Toronto	Oct. 7	200,000
*National Whiting Corporation, Ltd	Toronto	Aug. 25	75,000
Northern Empire Mines Co., Ltd	Beardmore Siding	July 28	100,000
Radium Group Syndicate, Ltd (Private)	Toronto	Aug. 30	90,000
Silica Supplies, Ltd	Toronto	June 2	250,000
Sun Bear Mines, Ltd	Toronto	June 6	2,500,000
Tashota Goldfields, Ltd	Tashota	Nov. 15	3,000,000
Total (33 companies)			$58,766,000

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

Mining Revenue and Expenditures

The following is a comparative statement of Mining Licenses and Renewals issued, and Mining Claims recorded in Ontario, also Profit Tax and total Mining Revenue, during the past ten years, 1923–1932 inclusive:—

PROSPECTING ACTIVITY, PROFIT TAX, AND TOTAL REVENUE, 1923-1932

Year	New mining licenses issued	Mining licenses renewed	Total licenses and renewals	Mining claims recorded	Profit tax	Total mining revenue
					$	$
1923	2,844	3,704	6,548	6,092	253,126.18	562,872.25
1924	2,676	4,466	7,142	5,222	191,982.36	593,215.14
1925	2,391	4,439	6,830	4,751	287,186.88	613,411.96
1926	6,631	5,521	12,152	13,486	410,974.17	838,415.81
1927	6,923	7,221	14,144	15,564	340,890.08	839,793.43
1928	6,059	8,688	14,747	15,046	356,033.83	968,243.84
1929	3,271	8,049	11,320	8,207	397,004.41	882,026.05
1930	1,554	5,885	7,439	3,886	502,525.38	1,017,030.67
1931	2,174	4,808	6,982	5,779	480,300.69	799,240.06
1932	2,035	3,670	5,705	4,945	515,153.59	793,759.20

The revenue of the Department of Mines for the fiscal year ending October 31, 1932, was $793,759.20 as compared with $799,240.06 in the previous year. Expenditures were $339,233.92. Details of revenue follow:—

ORDINARY:			
Sand and Gravel—			
Royalties	$ $51,060.06		
Licenses	2,475.00		
		$ 53,535.06	
Casual fees		663.76	
Boring permits		100.00	
Sale of record books—Unwrought Metal Sales Act		71.00	
Gas leases		4,100.00	
			$ 58,469.82
Inspection—cable testing fees			3,640.00
Assessment—			
Acreage tax	$ 20,618.07		
Profit tax	515,153.59		
Gas tax	67,831.61		
			603,603.27
Chemical and assay—fees			976.23
Mine rentals—			
Mining leases	$ 3,493.98		
Licenses of occupation	1,858.23		
Miners—Licenses	35,617.01		
Fees—Recording	47,115.44		
Miscellaneous	2,112.01		
Maps—Sales	1,170.98		
			91,367.65
Natural Gas Commissioner—permits			1,580.67
Temiskaming Testing Laboratories—fees			15,106.77
Sulphur Fumes Arbitrator—damages collected			1,096.84
			$ 775,841.25
CAPITAL:			
Mining Recorders—Mining Land Sales			17,917.95
Total Revenue			$ 793,759.20

The figures of moneys derived from sales and leases, divided according to district, do not agree with corresponding items of the preceding revenue statement which records collections of moneys actually received during the fiscal year. Details are given in the following table:—

MINING LANDS SOLD AND LEASED FOR FISCAL YEAR ENDING OCT. 31, 1932

District	Sales			Leases			Total sales and leases		
	No.	Acres	Amount	No.	Acres	Amount	No.	Acres	Amount
			$			$			$
Thunder Bay	2	47.00	122.50	4	266.30	223.55	6	313.30	346.05
Sudbury	54	2,046.72	5,910.22	7	210.35	21.08	61	2,257.07	5,931.30
Timiskaming	60	2,507.06	5,671.35	92	3,439.15	789.63	152	5,946.21	6,460.98
Nipissing	....	.....	.....	7	313.45	31.36	7	313.45	31.36
Cochrane	43	1,718.50	4,775.39	....	.....	.....	43	1,718.50	4,775.39
Patricia	25	568.40	1,442.25	....	.....	.....	25	568.40	1,442.25
Kenora	16	459.49	1,733.00	....	.....	.....	16	459.49	1,733.00
Algoma	11	610.62	776.56	....	.....	.....	11	610.62	776.56
Rainy River	1	42.50	112.50	....	.....	.....	1	42.50	112.50
Elsewhere	10	619.00	162.50	....	.....	.....	10	619.00	162.50
Total	222	8,619.29	20,706.27	110	4,229.25	1,065.62	332	12,848.54	21,771.89

SUMMARY OF BUSINESS TRANSACTED IN THE SEVERAL MINING DIVISIONS DURING THE CALENDAR YEAR, 1932

Schedule item	Fort Frances	Sudbury	Porcupine	Larder Lake	Sault Ste. Marie	Port Arthur	Kowkash	Timiskaming and Coleman	Gowganda	Montreal River	Kenora	Red Lake	Total
1. Letters received	633	4,341	2,924	3,601	892	2,251	730	1,416	716	856	864	2,210	21,434
2. Letters written	556	3,587	2,366	3,576	574	1,943	666	972	656	981	774	2,059	18,710
3. Miner's Licenses issued	25	611	156	273	63	136	42	93	.....	76	99	72	1,646
4. Miner's Licenses renewed	80	585	380	503	103	382	66	401	64	199	77	178	3,018
5. Mining claims recorded*	98	1,986	387	790	92	475	40	63	114	156	203	185	4,589
6. Mining claims cancelled	104	5,044	3,056	1,133	461	1,329	1,201	1,508	327	457	194	611	15,425
7. Agreements, Transfers, etc., recorded	31	860	105	259	115	341	82	17	30	149	91	230	2,310
8. Receipts for Miners' Licenses, Permits, Recording Fees, etc.....$	1,700.75	24,878.48	5,936.75	11,680.00	2,389.00	7,721.75	1,026.25	3,186.25	1,547.25	3,197.00	2,766.35	5,975.25	72,005.08
9. Receipts as Purchase Money or Rental.....$	.....	6,565.27	2,238.40	4,850.83	904.05	475.68	.....	1,343.96	104.50	361.36	1,982.85	2,504.32	21,331.22
10. Total remitted to Department.....$	1,700.75	31,443.75	8,175.15	16,530.83	3,293.05	8,197.43	1,026.25	4,530.21	1,651.75	3,558.36	4,749.20	8,479.57	93,336.30
11. Claims of which surveyors' plans were filed	5	50	27	24	.....	5	.....	15	3	29	16	61	235
12. Disputes entered	1	8	.....	8	.....	1	.....	1	.....	.....	.....	.....	19
13. Disputed cases decided by Recorders	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
14. Appeals to Mining Court	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
15. Extensions of time granted	105	643	184	564	70	302	76	37	77	145	52	860	3,115
16. Certificates of Record granted	.....	93	25	76	9	9	.....	14	3	4	27	49	309
17. Certificates of Performance of Work granted	.....	59	11	49	10	9	.....	16	3	7	32	60	256
18. Claims for which papers were forwarded to the Department for issue of title	.....	55	19	60	9	9	.....	12	3	7	21	58	253
19. Forest Reserve Permits issued	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20. Substitute Miners' Licenses issued	1	9	2	6	1	1	.....	2	1	1	2	2	28
21. Abstracts issued	203	1,790	202	676	163	249	43	37	231	396	166	919	5,075
22. Blue prints sold	47	844	410	930	183	151	35	72	246	64	64	114	3,160

*There were 356 claims recorded at the Department of Mines, Toronto, making a total of 4,945 for the entire Province as compared with 5,779 in 1931.

STATEMENT OF MONIES REMITTED BY MINING RECORDERS FOR THE FISCAL YEAR ENDING OCTOBER 31sr, 1932.

Mining Division	Name of Recorder	Address	Purchase price	Miners' licenses	Recording fees	Maps	Miscellaneous fees	Total
			$	$	$	$	$	$
Fort Frances	Alexander, J. A	Fort Frances	128.40	543.00	810.00	30.00	400.00	1,911.40
Montreal River	Coghill, J. M	Elk Lake	414.66	1,281.00	1,711.00	22.25	112.10	3,541.01
Gowganda	do	do	104.50	332.00	1,396.00	55.00	56.53	1,944.03
Porcupine	Dixon, R	South Porcupine	1,745.55	2,650.00	3,739.00	118.50	101.50	8,354.55
Larder Lake	Ginn, H. G	Swastika	4,393.12	3,631.00	6,834.00	215.75	266.00	15,339.87
Red Lake	Holland, H. E	Sioux Lookout*	1,279.53	1,226.00	4,070.25	53.50	236.75	6,866.03
Sudbury	McArthur, T. A	Sudbury	6,272.64	5,410.00	17,666.70	199.00	627.33	30,175.67
Timiskaming	McAulay, N. J	Haileybury	1,334.50	2,484.00	1,721.00	26.75	34.25	5,051.50
Port Arthur	McGregor, C. F	Port Arthur	348.50	2,517.00	4,575.00	38.00	81.25	7,559.75
Sault Ste. Marie	Miller, W. N	Sault Ste. Marie	829.50	1,299.00	1,264.00	47.25	61.75	3,501.50
Kowkash	O'Rourke, M. F	Tashota		554.00	819.00	9.50	18.50	1,401.00
Kenora	Smith, J. D. C	Kenora	7,144.13	889.00	1,825.00	40.50	116.05	4,614.68
Total			18,595.03	22,816.00	45,881.95	856.00	2,112.01	90,260.99

*Office moved June 1, 1932, from Goldpines.

MINING CLAIMS RECORDED IN THE SEVERAL MINING DIVISIONS, 1907, AND 1913–1932

Mining division	1907	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932
Timiskaming	7,860	1,326	215	222	156	269	184	244	329	159	328	971	735	634	438	875	499	346	202	78	63
Coleman†	291																				
Sudbury	456	483	237	233	464	262	168	673	267	319	701	436	559	546	1,367	3,351	6,424	2,164	807	1,597	1,986
Sault Ste. Marie	291	127	23	92	44	135	199	90	90	216	541	498	284	451	395	735	702	487	318	276	92
Port Arthur	317	182	353	641	172	180	66	171	108	120	296	222	300	494	1,278	982	1,269	691	338	609	475
Kenora			25	23	45	32	48	31	25	53	168	150	77	229	935	140	520	348	194	109	203
Parry Sound‡	102		2		10	25	12	39	33												
Larder Lake	3,813	1,575	718	915	783	160	423	1,015	712	918	2,344	1,736	1,219	890	1,532	3,141	1,781	891	424	628	790
Montreal River	866	63	28	2	56	294	293	134	81	143	174	400	471	471	290	126	156	48	661	1,127	156
Gowganda		68	23	14	51	113	52	145	215	101	55	33	444	220	96	24	40	34	244	377	114
Porcupine		496	240	262	401	236	48	136	192	273	760	1,424	556	620	1,297	3,127	611	650	135	307	387
Kowkash					160	135	2	9	31	3	148	206	438	150	28	250	368	319	12	56	40
Red Lake															5,827	2,018	1,100	973	305	298	185
Fort Frances																		70	75	175	98
At Toronto			49	92	128	95	39	231	87	145	171	116	139	226	203	795	1,576	1,186	171	142	356
Total	13,996	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	8,207	3,886	5,779	4,945

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

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. on profits up to $1,000,000. On profits over $1,000,000 and up to $5,000,000 the tax is 5 per cent., and on profits in excess of the latter amount the rate is 6 per cent. A portion of this money is returned to organized municipalities for municipal government purposes.

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, 1932:—

DETAILS OF PROFIT TAX

GOLD:—		
Dome Mines, Limited	$ 35,219.78	
Hollinger Consolidated Gold Mines, Ltd.	70,037.95	
Kirkland Lake Gold Mining Co., Ltd	1,757 74	
Lake Shore Mines, Ltd.	222,166.03	
McIntyre Porcupine Mines, Ltd.	24,091.29	
Sylvanite Gold Mines, Ltd.	1,507.96	
Teck-Hughes Gold Mines, Ltd.	102,786.44	
Wright-Hargreaves Mines, Ltd.	13,835.66	
		$471,402.85
SILVER:—		
Keeley Silver Mines, Ltd.	$ 1,100.36	
Mining Corporation of Canada, Ltd. (Cobalt Lake, $564.49, South Lorrain $1,246.58)	1,811 07	
O'Brien, M. J., Ltd. (O'Brien mine)	1,990.27	
" " " (Miller Lake O'Brien mine)	2,658.23	
		7,559.93
NICKEL-COPPER:—		
International Nickel Company of Canada, Ltd.	$ 35,909.03	
Falconbridge Nickel Mines, Ltd.	281.78	
		36,190.81
Total		$ 515,153.59

Temiskaming Testing Laboratories

This plant, located at Cobalt and 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 1932, inclusive:—

COMPARATIVE FINANCIAL STATEMENT OF THE TEMISKAMING TESTING LABORATORIES, 1922–1932

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
1929	19,604.70	21,690.60	18,088.41	3,602.19	.....
1930	25,070.27	24,316.82	24,153.03	163.79	.....
1931	18,522.88	20,770.06	23,553.61	.....	2,783.55
1932	13,323.28	11,150.42	15,219.64	.....	4,069.22
Gross operating profit and loss				6,765.64	12,703.24

Following is a brief summary of operations for the year 1932:—

Assaying.—Gold, 1,528 samples; silver, 1,343; copper, 12; silver bullion, 227; cobalt, 113; nickel, 74; zinc, 7; silica, 3; arsenic, 26; iron, 19; lead, 7; sulphur, 8; barium, 4; moisture, 13; specific gravity, 4; one each of lime, mercury, platinum, volatile, and amalgamation test.

Silver Ore Milled and Sampled.—Weight, 307.14 tons; silver content, 416,775 ounces.

Cobalt Ore Milled and Sampled.—133.35 tons.

Base Bullion Melted.—69 bars containing 65,400 gross ounces of silver.

Gold Ore Purchased and Sampled.—Two lots, for one of which $52.19 was paid.

Copper Melted and Sampled.—One lot of 21 bars or 896 pounds.

Coal Milled.—Three lots or 7.10 tons.

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, Queen's Park. The Provincial Assayer, W. K. McNeill, reports as follows for 1932:—

The Assay Office has been in operation during the entire year and the usual variety of work carried on with the assistance of T. E. Rothwell and W. F. Green, Chemists and Assayers, also Robert Stewart and William Ley, Laboratory Assistants.

The schedule of charges, effective Jan. 1, 1930, for the Provincial Assay Office and Chemical Laboratory, may be obtained on application. Minerals and rocks not requiring chemical analysis are identified free of charge. Tests for radio-activity are free.

Total free assays, under the provisions of *The Mining Act* of Ontario, numbered 1,316 in 1928, 649 in 1929, 427 in 1930, and 953 in 1931. Out of a total of 1,415 free assays in 1932 there were 1,270 for gold.

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, 1932

Assay and No. of samples		Assay and No. of samples	
Gold	631	Limestone	1
Silver	40	Clay	2
Copper	28	Radium	42
Lead	5	Antimony	1
Zinc	1	Barite	1
Nickel	19	Magnesia	1
Iron	6	Phosphorus	1
Platinum	5	Chlorine	1
Manganese	2	Soda	1
Sulphur	3	Potash	1
Molybdenite	1	Oil	2
Cobalt	5	Insoluble	2
Arsenic	2	Water	3
Uranium	13		
Identification—samples received by mail and reports issued. A large number were brought directly to the Laboratory; of these no record was kept			185
Rocks—samples submitted by geologists of the Department for complete analysis			20
Total			1,028

Directions and Terms

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 whence they were taken.

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.

Crushed samples representing large quantities, or samples less than one pound weight, may be sent by mail as third-class matter. Write your name and address plainly on each parcel. Send instructions, with money in payment of fees, 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, Queen's Park,
TORONTO, ONT.

Draughting Office, North Bay

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 for northern Ontario residents is saved through the mails compared with former practice when blue-prints were prepared at Toronto. The office was established in February, 1920. It is now in charge of A. D. Williams.

During the calendar year 1932, there were 984 blue-prints distributed from the North Bay office. Total receipts from this source were $261.75, and in addition $16.05 was received for outside blueprinting work. In addition maps were supplied by this office to Mining Recorders, who sold 3,160 blue-prints during the calendar year 1932.

LIST OF MINES, METALLURGICAL WORKS, AND QUARRIES

METALLICS

GOLD

Operator	Mine	Manager	Address
Ashley Gold Mining Corp'n., Ltd., operated by Mining Corp'n. of Canada, Ltd.	Ashley	W. H. Emens	Elk Lake.
Barry-Hollinger Gold Mines, Ltd.	Barry-Hollinger	Jas. A. Houston	Boston Creek.
Bathurst Mines, Ltd.	Bathurst		Narrow Lake.
Bey Mines, Ltd.	Ore Chimney	Colin Campbell	Northbrook.
Buffalo Ankerite Gold Mines, Ltd.	Buffalo Ankerite	Martin O. Knutson	South Porcupine.
Casey Summit Gold Mines, Ltd.	Casey Summit (Birch Lake)		411 McCallum-Hill Bldg., Regina, Sask.
Cole, J. Y., Jr.	J. Y. Cole	J. Y. Cole, Jr.	Red Lake.
Coniaurum Mines, Ltd. (Ventures subsidiary)	Coniaurum	John Redington	Schumacher.
Dome Mines, Ltd.	Dome	H. P. De Pencier	South Porcupine.
Grenfell Kirkland Gold Mines, Ltd.	Grenfell Kirkland		4 Excelsior Life Bldg., Toronto.
Hayden Gold Mines Co., Ltd.	Hayden		611 Federal Bldg., Toronto.
Hollinger Consolidated Gold Mines, Ltd.	Hollinger	John Knox	Timmins.
Horseshoe Mines, Ltd.	Regina	Geo. Miller	Box 811, Kenora.
Howey Gold Mines, Ltd.	Howey	Edward Futterer	Red Lake.
Kenora Prospectors and Miners, Ltd.	Cedar Island	F. L. Smith	Kenora.
	Mikado	R. C. Brehaut	Kenora.
Kirkland Consolidated Gold Mines, Ltd.	Kirkland Consolidated	E. B. Wood	1717 Metropolitan Bldg., Toronto.
Kirkland Gold Belt Mines, Ltd.	Kirkland Gold Belt		Kirkland Lake.
Kirkland Lake Gold Mining Co., Ltd.	Kirkland Lake Gold	Wm. M. Sixt	Kirkland Lake.
La Roche Mines, Ltd.	La Roche	R. R. Brown	116 Federal Bldg., Toronto.
Lake Shore Mines, Ltd.	Lake Shore	E. W. Todd	Kirkland Lake.
Lakeland Gold Mines, Ltd.	Lakeland	Oscar Knutson	Bourkes.
Macassa Mines, Ltd.	Macassa	G. A. Howes	Kirkland Lake.
McIntyre-Porcupine Mines, Ltd.	McIntyre	R. J. Ennis	Schumacher.
March Gold, Ltd.	March	Martin O. Knutson	South Porcupine.
Metals Development, Ltd.	Metals Development		811 Sterling Tower Bldg., Toronto.
Minto Gold Mines, Ltd. (under option)	Minto	John Knox, Jr.	Wawa, via Hawk Junction.
Moffatt-Hall Mines, Ltd.	Moffatt-Hall		Haileybury.
Moss Gold Mines, Ltd.	Moss	J. D. Tolman	Kashabowie.
Munro-Croesus Mines, Ltd.	Munro-Croesus	Jas. E. Grant	Haileybury.

Northern Empire Mines Company, Ltd	Beardmore	R. J. Hendricks	Gold Mine camp, via Jellicoe.
Palmer, R. N. (under contract with Schreiber Gold Mines, Ltd.)	McKellar-Longworth	R. N. Palmer	Schreiber.
Parkhill Gold Mines, Ltd	Parkhill	E. S. Turner	Wawa.
Porcupine United Gold Mines, Ltd.	Rochester	J. D. Tolman	Timmins.
Rich Rock Gold Mines, Ltd. (under option)	Golden Fleece	C. N. Thompson	806 Central Bldg., 45 Richmond St. W., Toronto.
Sylvanite Gold Mines, Ltd.	Sylvanite	C. E. Rodgers	Kirkland Lake.
Tashota Gold Mines, Ltd	Tashota	P. W. Ogden	Room 804, 1111 Beaver Hall Hill, Montreal, P.Q.
Teck-Hughes Gold Mines, Ltd	Teck-Hughes	R. J. Henry	Kirkland Lake.
Toburn Gold Mines, Ltd.	Tough-Oakes Burnside	M. W. Hotchkin	Kirkland Lake.
Triple Lake Mines, Ltd	Triple Lake	E. W. Ahr	South Porcupine.
Trout Creek Gold Mining Co., Ltd.	Trout Creek	J. Price, Sec.-Treas.	Bank of Commerce Bldg., St. Catharines.
Vipond Consolidated Mines, Ltd.	Vipond	Robert E. Dye	Timmins.
Wright-Hargreaves Mines, Ltd.	Wright-Hargreaves	M. W. Summerhayes	Kirkland Lake.
Young-Davidson Mines, Ltd. (subsidiary of Hollinger)	Young-Davidson	A. F. Brigham	Elk Lake.

NICKEL AND COPPER

Falconbridge Nickel Mines, Ltd	Falconbridge	Ernest Craig	Garson.
International Nickel Co. of Canada, Ltd	Creighton	S. J. Kidder	Creighton.
	Frood	H. J. Mutz	Frood.
	Garson	W. J. Mumford	Garson.

RADIUM

Canada Radium Mines, Ltd	Canada Radium (Cardiff tp.)		9 Adelaide St. E., Toronto.
International Radium and Resources, Ltd.	Richardson (Cardiff tp.)		Wilberforce.

SILVER-COBALT

Operator	Mine	Manager	Address
Brocklebank, Arthur (under lease)	Kerr Lake	Arthur Brocklebank	Cobalt.
Cain, C. E. and Taylor, W. D.	Beaver	C. E. Cain	Cobalt
Hudson Bay Mines, Ltd. (under lease)	Hudson Bay		Cobalt.
Jemmett, D. L., Ltd.	Agaunico		Cobalt.
Kenora Prospectors and Miners, Ltd	Werner Lake (cobalt ore)		Kenora.
Laurentian Mines, Ltd. (under lease)	Right of Way		50 Albert St., Ottawa.
McKinley Mines Securities Co., Ltd. (under lease)	McKinley-Darragh-Savage		Cobalt.
Mining Corporation of Canada, Ltd.	Cobalt Lake and Townsite	Arnold Smith	Cobalt.
Morrison Mines, Ltd.	Morrison	H. F. Strong	Haileybury.
Nipissing Mining Co., Ltd.	Nipissing	Hugh Park	Cobalt.
O'Brien, M. J., Ltd.	O'Brien and Cross Lake	W. A. O'Flynn	Cobalt.
	Miller Lake O'Brien	H. G. Kennedy	O'Brien.
Perry, R. E. (under lease)	Aladdin Cobalt	R. E. Perry	Cobalt.
Price, C. W. (under lease)	Foster	C. W. Price	Cobalt.
Sandoe, Richard, and Moyle, H. (under lease)	Temiskaming	Richard Sandoe	Cobalt.

METALLURGICAL WORKS

Algoma Steel Corporation, Ltd.	Iron blast furnace	Jas. H. Bell	Sault Ste. Marie.
Canadian Furnace Co., Ltd.	Iron blast furnace (idle)	Richard C. Yates	Port Colborne.
Canadian Industries, Ltd.	Acid and chemical plant	G. G. Vincent	Copper Cliff.
Deloro Smelting and Refining Co., Ltd.	Silver-cobalt refinery	S. B. Wright	Deloro.
Falconbridge Nickel Mines, Ltd.	Nickel-copper smelter	J. R. Gill	Falconbridge.
International Nickel Co. of Canada, Ltd.	Nickel-copper smelter	Peter Macdonald	Copper Cliff.
	Nickel-copper smelter	Peter Macdonald	Coniston.
	Nickel refinery	H. W. Walter	Port Colborne.
Ontario Refining Co., Ltd.	Electrolytic copper refinery	F. Benard	Copper Cliff.
Steel Company of Canada, Ltd.	Iron blast furnace	R. A. Gillies	Hamilton.

NON-METALLICS

ACTINOLITE

Building Services, Ltd	Actinolite, Elzevir tp	George Seller	1111 Beaver Hall Hill, Montreal, Que.

ARSENIC

Deloro Smelting and Refining Co., Ltd.	Silver-cobalt refinery	S. B. Wright	Deloro.

BARITE

Canada Night Hawk Mines, Ltd.	Canada Night Hawk		305 Sterling Tower Bldg., Toronto.

DIATOMITE

Dominion Diatomite, Ltd.	Lot 3, con. I, Perry tp., Parry Sound	E. C. Wainwright	Huntsville.
Diatomite Products, Ltd.	Martin's Siding, Muskoka	C. Lindley Wood	409 Metropolitan Bldg., Toronto.

FELDSPAR

Anderson & Son, James G.	Britt, lots 3-5, con. I, Henvey tp.	Jas. G. Anderson	Lucknow.
Bathurst Feldspar Mines, Ltd.	Bathurst, Bathurst tp.	B. S. Hyde	230 King St. E., Toronto.
Craig, T. H.	W. ½ lot 12, con. IX, Bathurst tp.	T. H. Craig	Perth, Box 302.
Genesee Feldspar Co., Inc.*	Dwyer, near Hybla	P. McDonald	Boxart St., Rochester, N.Y.
Minerals Development, Ltd.	Lot 21, con. VI, Monteagle tp.	Jas. Campbell, Hybla	36 King E., Toronto.
Verona Quarries, Ltd.	Verona		Verona.
Frontenac Floor and Wall Tile Co., Ltd.	Grinding plant, Kingston	Everett Townsend	Box 178, Kingston.

*Operated by P. McDonald.

FLUORSPAR

Stoklosar, Chas. A.	W. ½ lot 3, con. I, Madoc tp.	Chas. A. Stoklosar	Madoc.

GRAPHITE

Black Donald Graphite Co., Ltd.	Black Donald, Brougham tp.	R. F. Bunting	Calabogie.

GYPSUM

Operator	Mine or Plant	Manager	Address
Canadian Gypsum Co., Ltd	Hagersville	W. E. Allen	Hagersville.
Gypsum, Lime and Alabastine, Canada, Ltd.	Caledonia	L. V. Robinson	Caledonia.
	Lythmore*	L. V. Robinson	Caledonia.

*Mine closed permanently in 1933.

IRON PYRITES AND SULPHURIC ACID

Canadian Pyrites, Ltd.†	Caldwell mine, Flower station	O. M. Hook, Sec	1400 Guardian Bldg., Cleveland, Ohio.
Canadian Industries, Ltd	Acid plants, Coniston and Copper Cliff	G. G. Vincent	Copper Cliff.

†Idle in 1932.

MICA

Austin, Louis		Louis Austin	Perth Road.
Kent Bros.	Buyers	W. C. Kent	114 Gore St., Kingston.
Lee, W. W.	Buck Lake mine	W. W. Lee	Bedford Mills.
Loughborough Mining Co., Ltd.	Lacey mine, Loughborough tp.		General Electric Co., Schenectady, N.Y.
Martin, A. G.	Lot 3, con. III, S. Burgess tp	A. G. Martin	236 Besserer St., Ottawa.
Tory Hill Marble & Mica Co., Ltd	Tory Hill, Haliburton county		Tory Hill.

MINERAL WATERS

Canada Dry Ginger Ale, Ltd	Caledonia Springs and Bourget	J. C. Haggarty	6380 St. Urbain St., Montreal, Que.
Carlsbad, Ltd	Carlsbad Springs	Barclay Boyd	Carlsbad Springs.
Deneault, F	Bourget Springs	F. Deneault	Bourget.
Gurd, Chas., and Co., Ltd	Caledonia tp., Prescott county		1016 Bleury St., Montreal, Que.

QUARTZ, QUARTZITE AND SILICA BRICK

Algoma Steel Corporation, Ltd.	Silica brick (quartz from Deroche tp. quarry)	.....	Sault Ste. Marie.
Dominion Mines & Quarries, Ltd.	Killarney, North shore of Lake Huron, East Neebish island (idle)	.....	40 University Avenue, Toronto.
Falconbridge Nickel Mines, Ltd.	Quarry on property	Ernest Craig	Falconbridge.

SALT

Brunner Mond, Canada, Ltd.	Amherstburg (Brine for chemical use)	F. Nill	Amherstburg.
Canadian Industries, Ltd.	Sandwich (Chemicals and salt)	.....	P. O. Box 1260, Montreal, Que.
Dominion Salt Co., Ltd., The	Sarnia	W. H. Spence, Sec.-Tr.	1610 Bank of Commerce Bldg., Toronto.
Goderich Salt Co., Ltd.	Goderich	A. C. Dunlop, Asst.Sec.	Goderich.
Kincardine Salt, Ltd.	Kincardine (Operated by Canadian Industries, Ltd.)	.....	P.O. Box 1260, Montreal, Que.
Western Canada Flour Mills Co., Ltd.	Goderich	.....	287 MacPherson Ave., Toronto.

TALC

Canada Talc Co., Ltd.	Connolly—Mill at mine	Roy Taylor	Madoc.
Geo. H. Gillespie Co., Ltd.	Henderson mine—Mill at Madoc	Geo. H. Gillespie	Madoc.
Henderson Mines, Ltd.	Henderson (Huntingdon tp.)	Ed. Phillips	Madoc.

STRUCTURAL MATERIALS

CEMENT

Canada Cement Co., Ltd.	Belleville, Plant No. 5 Lakefield, Plant No. 7 Port Colborne, Plant No. 8	.....	Box 290, Station B, Montreal, Que.
St. Marys Cement Co., Ltd.	St. Marys	.....	357 Bay St., Toronto.

LIME

Operator	Pit or Quarry and Location	Manager	Address
American Cyanamid Company	Quarry at Beachville, kilns at Niagara Falls	A. J. Kennedy	535 Fifth Ave., New York.
Bell, Harry	N. ½ lot 23, con. XII, Sullivan tp.	Harry Bell	R.R. 4, Chesley.
Biederman, Albert G	Wilberforce tp., Renfrew county	Albert G. Biederman	Golden Lake, R.R. 1.
Brown's Lime Works	Owen Sound	Wm. Brown	491 9th Ave. E., Owen Sound.
Brunner, Mond Canada, Ltd	Lots 6, 7, 8, con. I; lots 2, 3, con. II, Anderdon tp.	F. Nill	Amherstburg.
Cameron, W. M	Ramsay tp.	W. M. Cameron	Carleton Place.
Canada Lime Co., Ltd	Coboconk	Chas. R. Christie	50 King St. E., Toronto.
Chalmers Lime Works	Owen Sound	Miss M. Chalmers	689-7th Street W., Owen Sound.
Dominion Sugar Co., Ltd	Wallaceburg	R. A. Lauper	Wallaceburg.
	Chatham	C. Moulthrop	Chatham.
Gallagher Lime & Stone Co., Ltd., The	*Hamilton	Raymond Gallagher	R.R. 4, Hamilton.
Gow, James	Rockwood	Jas. Gow	Rockwood.
Gypsum, Lime and Alabastine, Canada, Ltd.	*Beachville	T. F. Robinson	Beachville.
	*Elora	J. H. Robinson	Elora.
	*Hespeler	M. M. Miller	Hespeler.
	*Milton	Robt. F. Adams	Milton.
	Limehouse	Wm. Gowdy	Limehouse.
Innerkip Lime and Stone Co., Ltd	Beachville	C. E. Downing	Beachville.
Jamieson Lime Co	Renfrew	J. A. Jamieson	Renfrew.
Morris, Stanley	Delta	S. Morris	Delta.
Shane Lime Co	Eganville	Geo. R. Shane	Eganville.
Toronto Brick Co., Ltd	Coboconk	F. Conway James	897 Bay St., Toronto.
Weppler, Henry	Lot 7, con. II, Glenelg tp.	H. Weppler	R.R. 2, Priceville.

*Hydrated lime plants.

SAND-LIME BRICK

Harbour Brick Co., Ltd	Fleet St. at Bathurst	K. M. Goodings	Fleet St., Toronto.
Hinde Bros.	134 Northland Ave., Toronto	Jas. H. Hinde	Mount Dennis.
Toronto Brick Co., Ltd.	Off Victoria Park Ave., Toronto		897 Bay St., Toronto.

SAND AND GRAVEL (Licensed Dredging Operations)

Grace, Chas. W. S.	Lake Huron		291 S. Christie St., Sarnia
Lapish, F. C.	Lake Superior and St. Mary river		433 Cedar St., Sault Ste. Marie, Mich.
McLean, A. B., & Sons	Lake Superior		Brock St., Sault Ste. Marie.
Montreal Trust Co., Ltd. (Trustee for Sin-Mac Lines, Ltd.)	Lake Superior		635 Common St., Montreal.
National Sand & Material Co., Ltd.	Lake Erie		402 Harbour Bldg., Toronto.
Pyke Salvage Co	St. Lawrence river		506 Princess St., Kingston.
Ray, George	Thames river		22 Pegley St., Chatham.
Scott, T. J.	Lake Superior		66 Marsh St., Sault Ste. Marie.
Tees, Capt. T. A.	St. Clair r., Lakes Erie and Ontario, Niagara bar		123 Bold St., Hamilton.
Wallaceburg Sand & Gravel Co., Ltd.	St. Clair river		Wallaceburg.

SAND AND GRAVEL* (Pit Operations)

Barnes, Wm. R., Co., Ltd	Spring Vale, Waterdown, Brantford		243 Cumberland Ave., Hamilton.
Bast, Aaron	Bridgeport, Waterloo tp.		112 Lydia St., Kitchener.
Canadian Aggregates, Ltd.	Burford tp., Brant county		Burford.
Carroll Bros.	Sherkston, Humberstone tp.		490 Ellicott Sq., Buffalo, N.Y.
Conlin, Herbert L.	Highland Creek		Highland Creek P.O., Ont.
Consolidated Sand and Gravel, Ltd.	Paris		402 Harbour Bldg., Toronto.
Durham Stone & Sand Co., Ltd.	Durham.		
Fuller Gravel, Ltd.	Fuller.		
Waterford Sand & Gravel Co., Ltd.	Waterford.		
Empire Limestone Co.	Sherkston, Humberstone tp.		19 Hudson St., Buffalo, N.Y.
Foster, R. R.	Nepean and Gloucester tps., Carleton county		86 Spadina Ave., Ottawa.
Greenburn Sand & Gravel Co., Ltd.	Lot 8, con. V, Pickering tp.		331 Bay St., Toronto.
Hinde Bros.	Northlands Ave., York tp.		134 Northlands Ave., Toronto.
Howard, N. H.	Lot 7, con. I, E. Flamborough tp.		Aldershot.
A. E. Jupp Construction Co., Ltd.	Emily tp.		170 Berkeley St., Toronto.
Kingston Sand & Gravel Co.	Lots 33, 34, con. V, Kingston tp.		183 William St., Kingston.
Maple Sand, Gravel & Brick Co.	Maple, Vaughan tp.		801 Dominion Bank Bldg., Toronto.
Smythe, C., Ltd.	Lambton Rd., Etobicoke tp.		Maple Leaf Gardens, Toronto.
Windsor Sand & Gravel Co., Ltd.	Gosfield S. tp., Essex county		201 Guaranty Trust Bldg., Windsor.
Woollatt Fuel & Supply Co., Ltd.	Shipped for Windsor S. & G. in liquidation		201 Guaranty Trust Bldg., Windsor.

*Only operators producing 5,000 tons or over are listed.

STONE (LIMESTONE AND MARBLE)

OPERATOR	QUARRY AND LOCATION	MANAGER	ADDRESS
American Cyanamid Co.	Beachville	A. J. Kennedy	Ingersoll.
Bolender Bros	Haliburton	Chas. Bolender	Haliburton.
Bonter, J. W	Marmora tp	J. W. Bonter	Box 61, Marmora.
Bourgie, J. B	Gregnon, con. VIII, Russell tp	J. B. Bourgie	Box 50, Embrun.
Brule, E. D., & Sons, Ltd	Billings Bridge	A. A. Brule	Box 116, Billings Bridge.
Brunner, Mond Canada, Ltd	Lots 6, 7, 8, con. I; lots 2, 3, con. II, Anderdon tp	F. Nill	Amherstburg.
Canada Cement Co., Ltd	Thurlow tp., Hastings County	J. H. Legate	Belleville.
Canada Crushed Stone Corp., Ltd	Dundas, Town of	J. Stephens	35 Cline Cres., Hamilton.
Hagersville Contracting Co., Ltd	Walpole tp., Haldimand county	Gordon Gilbertson	Hagersville.
Puslinch Quarry, Ltd	Puslinch tp., Wellington county	H. Hill	Puslinch.
Queenston Quarries, Ltd	Niagara tp	A. Michie	Box 110, Niagara Falls.
Coldwater Crushed Stone, Ltd	Lots 19, 20, con. XIII, Medonte tp	Thos. Langton	Coldwater.
Decewsville Crushed Stone, Ltd	Decewsville		52 Elgin St., Hamilton.
Dibblee Construction Co., Ltd	Lot 14, con. 11, Beckwith tp., Lanark county	T. Moffatt	246 Albert St., Ottawa.
Dufferin Paving and Crushed Stone Co., Ltd.		H. H. Salmon	Fleet and Bathurst Streets, Toronto.
Hagersville Quarries, Ltd	Walpole tp., Haldimand county	J. S. Beck	Hagersville.
Innerkip Quarries, Ltd. (dismantled)	East Zorra tp., Oxford county	H. M. McQuoid	Innerkip.
Kirkfield Crushed Stone, Ltd	Eldon tp., Victoria county	John Welch	Kirkfield.
St. Mary's Crushed Stone, Ltd. (idle)	St. Marys.		
Edgar Irvine Co., Ltd., The	Near Centreville	Geo. Miller	Bath.
Foster, R. R	Merivale Road, Nepean tp	R. R. Foster	86 Spadina Ave., Ottawa.
Georgian Bay Quarries, Ltd. (idle)	Lot 8, con. XXIV, Amabel tp., Bruce county		1165 Greene Ave., Westmount, Que.
Gordon Crushed Stone Co., Ltd., The	Hagersville	C. F. Anderson	Hagersville.
Grenville Crushed Rock Co., Ltd	Oxford tp., Grenville county	W. H. Roberts	Oxford Mills.
Gypsum, Lime and Alabastine, Canada, Ltd	Lot 3, con. VI, Nassagaweya tp., Halton county	R. S. Adams	Milton.
	Lot 18, con. III, N. Oxford tp	T. F. Robinson	Beachville.
Hagersville Contracting Co., Ltd	*See* Canada Crushed Stone Corporation		
Hagersville Quarries, Ltd	*See* Dufferin Paving and Crushed Stone Co.		
Halliday, Fred	Lot 23, Gloucester tp	H. Halliday	Cummings Bridge.
Henniger, M. G	Kitley tp., Leeds county	M. G. Henniger	Smiths Falls.
Highways, Department of	Various quarries	R. M. Smith	Parliament Bldgs., Toronto.
Huffman Construction Co., Ltd., The R. C.	Clappison cut, Wentworth county	Darius Stringer	Waterdown.
Innerkip Quarries, Ltd	*See* Dufferin Paving and Crushed Stone Co.		
Kingston Penitentiary	Portsmouth	Samuel Donaldson	34 Pembroke St., Kingston.

Kirkfield Crushed Stone, Ltd	*See* Dufferin Paving and Crushed Stone Co.		
Law Construction Co., Ltd	Collingwood Municipal Quarry	B. J. Williams	225 Sterling Rd., Toronto.
Limestone Products, Ltd	Con. V, Orillia tp	Geo. F. Morse	R.R. 4, Orillia.
Longford Crushed Stone Co., Ltd	Lots 20 to 24, Front con., Rama tp	R. M. Craig	Longford Mills.
MacDonald, A. N	Bronte (Lake Ontario)	A. N. MacDonald	Box 67, Bronte.
Maple Leaf Marble Quarries, Ltd	Faraday & Dungannon tps	P. J. Wright	Bancroft.
McGinnis & O'Connor	Ernestown tp	T. A. McGinnis	Kingston.
Merritt, Sidney W	Saltfleet tp., Wentworth county	S. W. Merritt	Vinemount.
Noranda Mines, Ltd	Farr quarry, Haileybury		804 Royal Bank Bldg., Toronto.
Ontario Reformatory	Guelph tp., Wellington county	J. Hunter	Guelph.
Owen Sound, City of	City quarry, 8th Street West	Robt. Crannie	6th Street East, Owen Sound.
Pembroke, Corporation of	Markus quarry	J. P. Howe	Pembroke.
Pirson, John	Hydro dump, Stamford tp.	John Pirson	Stevensville.
Puslinch Quarry, Ltd	*See* Canada Crushed Stone Corp.		
Queenston Quarries, Ltd	*See* Canada Crushed Stone Corp.		
Quinton, W. Y	Kitley tp., Leeds county	W. Y. Quinton	Jasper.
Rayner Construction, Ltd	Forfar, Merrickville, Campbellford, Ivanhoe		159 Bay St., Toronto.
Robillard, H., & Son	Gloucester tp., Carleton county	B. E. Robillard	195 Nicholas St., Ottawa.
Routly, H. T	Rawdon tp., Hastings county	H. T. Routly	21 Dundas Square, Toronto.
Russell, Samuel	N. Dumfries tp., Waterloo county	S. Russell	St. George.
Silvertone Black Marble Quarries	St. Albert	Carl Bird	339 Queen St., Ottawa.
Standard Quarries, Limited	Lot 18, con. X, Grantham tp	Geo. Lahey	Box 188, St. Catharines.
St. Catharines Stone Quarry	Grantham tp	M. Burson	198 Queen St., St. Catharines.
T. Sidney Kirby Co., Ltd., The	Gloucester tp		215 Sussex St., Ottawa.
Walker Bros., Ltd	Stamford tp., Welland county	J. G. Walker	49 Carleton St., Thorold.
Webber, John	Dunn tp	J. Webber	R.R. 9, Dunnville.
Wehman, John	Lot 24, con. II, Kingston tp., Frontenac county	John Wehman	251 Division St., Kingston.
Welland Ship Canal	Rock excavation	A. J. Grant	St. Catharines.
Wilford & Co., Ltd., R. F	Victoria county	C. Lindsay	Lindsay.
Windmill Point Crushed Stone Co., Ltd.*	Ridgeway	R. E. Law	Ridgeway.

*Subsidiary of Law Construction Company, Ltd.

STONE (GRANITE)

Beresford, John	Gananoque	John Beresford	Gananoque.
Billie, Chas. V	Maberley and Sharbot Lake	T. R. Billie	P.O. 1185, Smith Falls.
Bradley, Wm	Leeds county	W. Bradley	81 Garden St., Gananoque.
Cold Spring Granite Co., Ltd	Peninsula		Cold Spring, Minn.
Grenville Crushed Rock Co., Ltd	Hawk Lake, 25 miles east of Kenora	J. P. Bains	Hawk Lake
Horne, Wm	Butler	Wm. Horne	Butler, via Ignace, Ont.

STONE (GRANITE)—*Continued*

OPERATOR	MINE, QUARRY, OR WORKS	MANAGER	ADDRESS
Morrison & Henderson	2 miles N. of Gananoque	S. Tregunna	R.R. 1, Gananoque.
Newell, Thos	Ascot, Leeds county	T. Newell	R.R. 2, Mallorytown.
Reece-Hall, R.	Mill Lake quarry, lots 24, 25, con. III, McDougall tp., Parry Sound district	R. Reece-Hall	Box 115, Parry Sound.

STONE (SANDSTONE)

Campbell Sandstone Quarries	Nepean tp., Carleton county	M. N. Cummings	143 Main St., Westboro.
McAlpine Bros.	Esquesing tp	K. McAlpine	Limehouse.
Norrie and McHarg	Halton county		R.R. 4, Acton.
Terra Cotta Quarries	Halton county	J. L. Craine	Terra Cotta.

STONE (TRAP)

Fort William, City of	Rifle Range, City Quarry	City Engineer	City Hall, Fort William.
Ontario Rock Co., Ltd.	Belmont and Methuen tps.	H. L. Scott	Havelock, R.R. 3.

CLAY PRODUCTS

See The Ceramic Industry of Ontario, by R. J. Montgomery, Vol. XXXIX, Part 4, 1929.

MINES OF ONTARIO IN 1932

By

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

BARITE

Canada Night Hawk Mines, Limited

This property consists of 34 claims in one group lying along the centre of the south boundary of Langmuir township, district of Timiskaming. In summer the property is easily reached by water starting at Connaught, a distance of about 30 miles through Night Hawk lake and river.

Operations on the barite vein first started fifteen years or more ago, at which time a small plant for mining and milling was in operation, although the operations were not successful.

Canada Night Hawk Mines, Limited, opened up the property in July and employed about 20 men in building and renovating as well as on surface and underground work. The previous operators had driven a tunnel some 150 feet in length on a 5-foot vein of barite, and this company took up the floor of this as a sample of the ore and sent it out for testing. Some surface work was still in progress early in 1933 under the direction of H. S. Bowler.

The following are the officers of the company: A. D. F. McIntosh, Rochester, N.Y., president; G. W. Forrest, Toronto, secretary-treasurer. Thomas Bland, Toronto; G. J. Chantler, London, Ont., and T. C. Forrester, Rochester, N.Y., are directors. The head office is at 305 Sterling Tower, Toronto.

COBALT

Kenora Prospectors and Miners, Limited

The company's cobalt property consists of 10 claims situated at the northwest end of Werner lake, which is located about 10 miles east of the Ontario-Manitoba border and 40 miles north of Minaki, in the district of Kenora.

A contact replacement zone was uncovered, which contained small lenses of cobaltite in a chloritic matrix. An open cut was made by hand along this zone for about a 100 feet, and a small tonnage of high-grade cobalt ore obtained by sorting and cobbing. A total of 69 tons, averaging, it is understood, from 18 to 20 per cent. cobalt, was transported to Minaki by airplane, thence by rail to Norwood, Ohio.

An average of 5 men was employed for eight months of the year under the direction of Hugh Smith.

Details of the capitalization and directorate of the company will be found on page 75, where a report on its gold properties is given.

GOLD

Ashley Gold Mining Corporation, Limited

The report on this company's property in Bannockburn township, district of Timiskaming, will be found on pages 107 and 108 of this report. The Mining Corporation is the operating company.

Barry-Hollinger Gold Mines, Limited

The Barry-Hollinger mine is located in the township of Pacaud, district of Timiskaming. It was operated throughout the year with a force of 60 men. The capitalization of the company is $4,000,000, in shares of $1 par value. The officers and directors are: Dr. E. H. Greene, president; E. M. Tice, secretary; M. J. Conkey, vice-president; P. A. Barry and Robert Fennell, directors. Jas. A. Houston, Boston Creek, is mine manager.

The following is taken from the mine manager's report for 1932:—

Development

Owing to lack of development funds during the year, sinking of the main 3-compartment winze was postponed. The ore shoot in No. 7 vein on the 2,000-foot level was opened up during the early part of the year. This work disclosed an ore length of 125 feet.

The crosscut to No. 9 vein, on the 1,875-foot level, was completed and the vein drifted on for a distance of nearly 600 feet. No values of any consequence were secured from the sampling of this drift (No. 1,809 east drift) and, in order to curtail expenses, exploration work on this vein was suspended during the latter part of August. At the first opportunity we plan on continuing this drift to the east for another 200 feet, as there is a good possibility of opening up an ore shoot in this area. At a point in this drift a diamond-drill station is at present being cut. It is proposed to diamond-drill No. 7 vein from this diamond-drill station, and holes will be put down to cut this vein at the 2,125-, 2,250-, and 2,375-foot levels.

Summary of Underground Operations.—During the year ending December 31, 1932, the following development work was completed:—

	Feet
Crosscutting and drifting	1,404.8
Raising	517.5

Some 35,000 tons of ore were hoisted, of which 34,730 tons were taken from the stopes, the balance being taken from development drifts.

Mill

During the year under review the mill has been operating continuously, except for minor delays, on an average daily tonnage of 96 tons. The average mill recovery for the year was 93.6 per cent.

The following is a summary of mill returns based on government quarterly returns for the year:—

	Production (Mint returns)	Premium on exchange	Dry tons milled	Recovery per ton milled
January, February, March	$40,165.24	$5,260.50	8,817	$4.55
April, May, June	36,859.90	4,891.51	8,811	4.18
July, August, September	38,865.99	4,846.75	8,870	4.38
October, November, December	44,637.51	6,057.12	8,479	5.26

Production

Bullion produced for the year amounted to $160,528.64 from 34,977 dry tons milled, making an average recovery of $4.59 per ton. To this was added $21,055.88, premium on exchange, making a total production for the year of $181,584.52, or a total value of $5.19 per ton milled. This shows a drop in total production from the previous year of $52,751.36. The lowering of mill grade was due to encountering a lean section of ore between the 1,750- and 1,875-foot levels and also to mining lower-grade sections of ore which were left from previous work. This was necessary in order to secure ore for the mill. Hanging-wall dilution was also a big factor in lowering the grade of ore going to the mill.

During the early part of October, coarse sorting of the ore at the crusher bin was tried out with success. This sorting was mainly responsible for raising the mill grade, during the last quarter, approximately 20 per cent. With better sorting arrangements, grade could be raised considerably higher.

Costs

The costs per ton milled for the year 1932 are as follows:—

Mining	$2.774
Development	.976
Milling and refining	1.337
Marketing bullion	.032
Head office and administration	.285
Insurance and taxes	.088
Workmen's compensation	.167
Operating cost	$5.659

The recovery per ton milled was $4.59, and the premium on exchange was 60 cents, making the total value per ton milled $5.19—a loss of $0.469 per ton milled.

Future Development

Funds are now available for exploration work, and a number of the lower levels will be opened up for a considerable distance both to the east and west of the ore zone with the hope of locating other ore bodies. A diamond-drilling campaign is also being planned to explore other sections of the property.

It is expected that the sinking of the main 3-compartment winze will be undertaken in the near future. Forty per cent. of all the ore handled during the year came from below the 1,875-foot level, which necessitated triple hoisting of this ore. This added materially to the mining costs during the year. With the deepening of the main winze this extra handling charge will be eliminated.

Broken and unbroken ore above the 2,000-foot level at the end of the year will approximate 10,000 tons.

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; Dr. F. P. Quinn, secretary; M. Pollex, acting treasurer. T. H. Rea, R. H. New, and E. P. Gleeson 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 has been installed: 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 11- by 8-inch Canadian Ingersoll-Rand hoist. The blacksmith shop is equipped with a Rand sharpener and furnace.

The shaft is 225 feet deep with one level at the 200-foot horizon, on which 1,741 feet of drifting and 1,291 feet of crosscutting had been done.

About $2,500 had been recovered from a small mill, 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.

The property was closed down late in 1929 and only reopened again in the fall of 1932, when a Jack Nutt mill was flown to the property and put in operation. A production of $1,500 was recorded before the end of the year.

Buffalo Ankerite Gold Mines, Limited

This company was formerly known as the Ankerite Gold Mines Syndicate, and before that as Ankerite Gold Mines, Limited. The officers and directors are as follows: Geo. R. Feine, president, Buffalo, N.Y.; Gustave R. Loesch, vice-president, Buffalo; Edward G. Kinkel, managing director and secretary, Buffalo; Henry Kobler, treasurer, Buffalo; Henry J. Tiedt and Jacob Betz, Buffalo, and Alphonse J. Baldeck, Mumford, N.Y., directors. The head office of the company is at 902 Lumsden Building, Toronto, and an office is also maintained at 1005 Stock Exchange Building, Buffalo. The mine office is at South Porcupine. Martin O. Knutson is mine manager.

The company is capitalized at 1,000,000 shares of $1 par value, of which 500,000 are issued.

The mine, which is in Deloro township, district of Cochrane, has been developed on four levels through two shafts; the main shaft has 4 compartments and is about 660 feet in depth, and the No. 1 shaft is about 385 feet in depth. Over 14,000 feet of lateral work has been done, as well as considerable raising and diamond-drilling.

Since operations first started, under the syndicate, the following work has been accomplished: crosscutting, 122 feet; drifting, 1,132 feet; and diamond-drilling, 2,421 feet. Some 55,267 tons have been milled. The production value from May 1, 1932, to December 31, 1932, has been $219,482, with $28,053 in premium added. An average of 135 men has been employed on the property.

Casey Summit Gold Mines, Limited

This company operates a property at Summit lake, district of Kenora, Patricia portion, about a hundred miles due north of Sioux Lookout on the main line of the C.N.R. The property can best be reached by airplane from Sioux Lookout. The water route by way of Lac Seul, Woman lake, and Birch lake is about 200 miles long and has many portages.

The company was formed from a parent company known as the Casey Mountain Operating Syndicate, Limited, to operate some 800 acres of a 2,000-acre group at Summit lake. The directorate is as follows: R. J. Williamson, president and general manager; Andrew Cunningham, Dr. H. C. Hall, Dr. E. M. Carefoot, J. F. Brown, Wm. C. Vancise, George Speers, and Robt. S. Banberry, directors.

The company was organized under a Dominion charter and has an authorized capital of 5,000,000 shares of no par value. The head office is at 411 McCallum-Hill Building, Regina, Sask.

The mine closed down in the fall of 1931, at which time the shaft had been sunk 85 feet and about 140 feet of lateral work had been done on the 75-foot level.

Early in 1932 the property was again operated for a time under the direction of H. F. Fancy.

J. Y. Cole, Jr.

In the Pipestone bay section of Red Lake, some 30 miles west of the Howey gold mine, in the district of Kenora (Patricia portion), a private venture has been conducting work on claims Nos. 1,628 to 1,636, township of Ball. The shaft, put down 30 feet by hand during the year, is located on claim No. 1,629.

A small steam plant, put in operation in January, 1933, consists of the following equipment: 70 h.p. boiler, 8- by 10-inch hoist, and a 12- by 12-inch NF-1 compressor. This equipment is housed in a log structure, approximately 70 by 30 by 35 feet.

J. Y. Cole, Jr., is in charge of operations, and during the summer from 6 to 10 men were regularly employed.

Coniaurum Mines, Limited

This company has an authorized capitalization of 6,000,000 shares of no par value. The mine is in the township of Tisdale, district of Cochrane, and adjoins the property of the McIntyre-Porcupine Mines on its east boundary.

The officers and directors of the new company organized under Ventures, Limited, are as follows: Thayer Lindsley, president; A. L. Bishop, vice-president; H. Whittingham, secretary; J. Gordon Hardy, D. M. Hogarth, Alex. Longwell; and T. H. Rea, directors. The head office is at 100 Adelaide Street West, Toronto.

The following statement is taken from the report of the general manager, John Redington, for the year 1932:—

Development

The greater part of the development work has been confined to virgin ground with the expectation of locating new ore bodies. A main drive has been driven from No. 5 vein on the 400-foot level westward far enough to explore No. 12 system. That which is thought to be No. 12 vein has been drifted on for over 400 feet. The values encountered in this vein are below mill grade.

It will be seen from the above that this work has not responded to development as kindly as was anticipated and, as a whole, has been somewhat disappointing. Some of the other work has met with more encouraging results.

SUMMARY OF DEVELOPMENT

	Feet
Drifting	3,391
Crosscutting	2,403
Raising	1,452
Diamond-drilling	7,096

Footage driven in ore is 1,120 feet, with an average value of $5.69 over a stoping width of 4.7 feet. Veins Nos. 5, 9, and 15 were drifted on. Development of these three veins was confined mostly to levels above the 1,000-foot. A very limited amount of work was done below the 2,000-foot level.

Milling

During the year the mill treated 144,654 tons of ore with an average recovery of $5.818 and extraction of 95.70 per cent. of the gold content, operating 363.85 days, or 99.68 per cent. of the possible running time.

Ore Reserves

The broken ore reserves have been increased during the year. Stoping added 176,879 tons of broken ore, and development a further 9,503 tons. Milling drew 144,654 tons of ore, leaving a carry-forward of 160,927 tons of broken ore available at the end of the year. The grade of this broken ore is $5.01, which is considerably lower than the previous year.

New Equipment

During the year the mining plant has been increased by the installation of a new 2,354-cubic-foot Ingersoll-Rand air compressor to better the pressure to existing drilling equipment and provide for additional drills when required. With this increased power the mine can be operated at much larger capacity as soon as developments warrant such. The hoisting plant has also been enlarged and strengthened to increase the hoisting depth to 3,000 feet. The transformer capacity has been increased sufficiently to operate the new equipment at full load. All the above equipment has been installed without loss in milling time and is operating satisfactorily.

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 officers of the company are: Jules S. Bache, president and treasurer; H. P. De Pencier, first vice-president; 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 directors are: Jules S. Bache, Morton F. Stern, New York; G. C. Miller, Buffalo; Dwight B. Lee, Detroit; G. H. Harris, Innis P. Allen, Rochester; Alex. Fasken, Frank E. Maulson, Frederick Burnett (who fills the vacancy caused by the death of R. F. Segsworth), Toronto.

H. P. De Pencier is the general manager of the company, and J. H. Stovel is general superintendent.

The office of the executive and financial department is at 42 Broadway, New York. The Toronto office is at 36 Toronto Street.

The following statements are taken from the report of the directors to the shareholders on January 20, 1933:—

The net profit or income for the year was $2,196,267.15. Your directors are pleased to report that the net excess of current assets (bonds and shares at cost) over current liabilities (including dividends payable January 20, 1933, $333,666.90) is the sum of $6,349,999.87, which includes the sum of $3,080,822.01, set apart as a dividend assurance fund. Dividends, however, were paid for the year out of the general fund and not out of the dividend assurance fund.

East Geduld Mines, Limited, declared an initial dividend of one shilling per share in June and in December a further dividend for the year of one shilling and nine pence per share, payable to shareholders of record December 31, 1932. The operation and developments throughout the year have fully met our expectations and are very satisfactory.

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

During the year 576,850 tons was hoisted; of this 536,450 tons was ore which was sent to the mill and treated and 40,400 tons was waste which was dumped on the surface. In addition 13,700 tons of waste was disposed of in old stopes. The 536,450 tons milled yielded bullion worth $4,040,317.50; the yield per ton being $7.532.

The following statement gives particulars of revenue and expenditures for the year under review:—

EARNINGS STATEMENT

for the year ended December 31, 1932

EARNINGS:		
Bullion production		$4,040,317.50
Non-operating revenue		527,232.00
		$4,567,549.50
OPERATING AND MAINTENANCE EXPENDITURE:		
Development and exploration	$444,268.25	
Mining, including hoisting	709,004.48	
Crushing and conveying	96,186.53	
Milling	608,445.97	
Bullion expense	21,890.01	
Fire protection	7,146.57	
Warehouse expense	9,782.52	
Auditors' expense	2,643.01	
Administrative expense:		
Mine office	111,484.84	
Executive offices	21,435.72	
Municipal taxes	33,929.58	
Insurance	16,094.61	
	$2,082,312.09	
Reserve for provincial and income taxes	288,970.26	
		2,371,282.35
PROFIT FOR THE YEAR		$2,196,267.15

Development

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

SUMMARY OF DEVELOPMENT WORK FOR YEAR 1932

Level	Drifts	Cross-cuts	Drifts and crosscut slash	Raises	Winzes	Box-holes	Raises, winzes, and box-hole slash	Total	Diamond-drilling
	feet	feet	feet	feet	feet	feet	feet	feet	feet
1st	.....	.....	7	.....	.....	.....	.....	7	.....
3rd	.....	.....	.....	249	.....	123	123	495	312
6th	198	.....	9	12	.....	45	.....	264	544
7th	105	61	14	.....	6	229	.....	415	946
8th	.....	192	24	71	.....	106	35	428	696
9th	351	315	89	46	49	86	2	938	1,534.5
10th	345	98	32	311	.....	361	45	1,192	1,392
11th	776	488	146	106	82	265	86	1,949	1,796
12th	673	407	133	340	49	643	81	2,326	1,687
13th	1,411	275	256	288	90	504	47	2,871	1,635
14th	478	119	36	271	.....	252	5	1,161	1,848.5
15th	478	83	58	59	.....	223	18	919	1,121.5
16th	228	13	74	145	132	55	5	652	1,975.5
17th	414	13	8	179	.....	104	6	724	1,369
18th	75	.....	157	.....	93	36	6	367	4,543
19th	608	28	24	86	.....	97	4	847	584
23rd	1,133	331	97	10	.....	.....	3	1,574	4,965.5
Total	7,273	2,423	1,164	2,173	501	3,129	466	17,129	26,949.5

Most of the development was done in the greenstone areas. Some development was done in the sediments lying to the east of the upper greenstone ore zones and also in the sediments on the 23rd level. Approximately 15,500 feet of drifting, crosscutting, raising, winzing, and box-holing has been done in the course of searching for and opening up the various ore shoots. Above the 11th level, practically all the work done was in connection with known ore bodies.

It must be borne in mind that to mine any ore on the 23rd level, or below it, will entail heavy capital expenditure, and sufficient evidence is not yet disclosed to warrant any definite plans regarding this discovery. Much development work and diamond-drilling will be necessitated before we will be able to decide whether it will add materially to our ore reserves or not.

During the year, 26,949.5 feet of diamond-drilling was done. Apart from the work done on the 23rd level, the major part of the drilling was done in the vicinity of known ore bodies, and much information of immediate value was obtained.

Of the tonnage milled, the stopes yielded 483,550 tons, averaging $8.2618 per ton, and development work yielded 52,900 tons, averaging $4.8113, a total of 536,450 tons, averaging $7.9215 per ton.

The ore drawn from the Dome Extension ground during the year was 110,812 tons, containing $691,695.41, or $6.2421 per ton.

Ore from stopes wholly in the sedimentary area yielded 165,973 tons, containing $1,631,644.98, an average of $9.8307 per ton. Ore from stopes wholly in the greenstones and partially in greenstones yielded 317,577 tons, containing $2,363,337.39, an average of $7.4418 per ton.

The expenditure on mining was $709,004.48, or $1.322 per ton.

The expenditure on development and exploration work charged to operation was $444,268.25, or $0.828 per ton milled. This includes $37,749.63 for outside exploration work carried on during the year.

Ore Reserves

The ore reserves are estimated at 2,000,000 tons. This includes 723,960 tons of broken ore. Ore in the sediments is estimated at 285,000 tons and ore in the greenstones at 1,715,000 tons.

Exploration

Your engineers have been active in considering and examining properties and in the case of one property in Quebec, considerable trenching and diamond-drilling were done. The results, however, did not justify our proceeding further with the option. At the close of the year we are working on a group of claims held under option in the Swayze district of Ontario. The work, however, has not yet disclosed anything of economic interest.

Prospecting rights on certain areas in South Africa were obtained, but the results of our examination were unsatisfactory and we abandoned operations.

Mill

The following are the results of the mill operations during the year:—

	Total value	Value per ton	Extraction per cent.
Heads	.....	$7.9215	.....
Bullion	$4,040,317.50	7.5316	95.08

The blanket plant, put into operation late in December, 1931, gave very satisfactory results, the over-all extraction being increased from 92.5806 to 95.08 per cent.

General

Operating costs for the year were $3.882 per ton milled, as against $3.482 in the year 1931; the increase is due to charges for silicosis, expenditures on tailings dams, increased tonnage broken in stopes, and increased expenditure on exploration.

Golden Summit Mines, Limited

Golden Summit Mines, Limited, have a capital of 2,500,000 shares of $1 par value, of which 1,100,000 are issued. The officers and directors of the company are: Thos. A. Wilson, president; W. J. Simpson, secretary-treasurer. The directors are John A. Gunn, Henry A. Marsh, Benjamin Kerr, J. M. Calder, and Charles Ling. The head office of the company is at 594 Bloor Street West, Toronto. In 1932 an average of 6 men was employed. The company owns 460 acres in Grenfell and Maisonville townships, district of Timiskaming. The shaft and plant are about 2 miles southeast of Sesekinika station.

Up to July, 1933, two shafts had been sunk on the property, one 42 feet and the other 140 feet, and a total of 480 feet of crosscutting had been done on the 125-foot level.

Grenfell Kirkland Gold Mines, Limited

Grenfell Kirkland Gold Mines, Limited, has a capital of 2,500,000 shares of $1 par value, of which 1,397,547 are issued. The property consists of 200 acres in Grenfell township, district of Timiskaming. The officers and directors are Alex. McNiven, president; Fred A. Day, secretary-treasurer; David Hill and James A. Dunn, directors. David Hill is mine manager. The head office is at 4 Excelsior Life Building, Toronto.

The mine operated for three months, closing in October, 1932, with an average force of 9 men. During that time a shaft was sunk 70 feet, and 50 feet of drifting was done on the 70-foot level.

Hayden Gold Mines Company, Limited

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

The following are the officers of the company: Jas. S. Pierce, Rochester, president and managing director; A. E. Davis, Rochester, vice-president; O. W. Summer, Rochester, secretary-treasurer; B. J. Fryatt, East Rochester; J. Montgomery, Toronto. T. W. Heberle and R. N. Clark, Rochester, are directors. The executive offices are at 421 Temple Building, Rochester, N.Y., and 611 Federal Building, Toronto.

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.

Early in 1932 a small mill, using flotation and amalgamation methods, was put in operation.

The mine and mill operated from April 23 to June 30, and about 30 tons per day were treated. In the late fall a cyanide unit was added to the mill. The capacity is now 40 tons per day and this new mill started up along with the mine about the first of the new year. Operations were carried on for about two months, when the mill was stopped. Underground operations were curtailed, and in April there were two machines working. About 100 feet of raising was done during the year, and 2,580 tons of ore were milled. During the year an average of about 18 men was employed.

Hollinger Consolidated Gold Mines, Limited

The authorized capital of this company is $25,000,000, in 5,000,000 shares of $5 par value; 4,920,000 shares were outstanding on December 31, 1929. The head office is at Timmins, Ont.

The officers of the company are: Noah A. Timmins, president; Jules R. Timmins, vice-president; John B. Holden, secretary-treasurer; A. F. Brigham, consulting engineer; John Knox, general manager. The directors are: Noah A. Timmins, John B. Holden, Jules R. Timmins, Wilson Bell, Senator W. L. McDougald, Leo H. Timmins, and Allen A. McMartin.

The following information is taken from the twenty-first annual report of the directors for the year ending December 31, 1931:—

Net profit from operations amounted to $3,962,885.34 (about $450,000.00 in excess of the previous year), out of which the usual thirteen regular dividends and two extra dividends were paid, leaving the sum of $272,885.34 to be added to surplus.

In the latter part of the year, Mr. A. F. Brigham, who filled the position of general manager so acceptably over a period of about fifteen years, retired to become consulting engineer; and Mr. John Knox, formerly assistant general manager, became general manager in Mr. Brigham's place.

Your company has taken an option on the Young-Davidson property in the Matachewan district, as well as an option on the Woods claims in Tiblemont township, Quebec.

At the close of the year 1932, the net assets of your subsidiary, International Bond and Share Corporation, had a market value of $2,687,279.14, compared with a market value of $3,104,440.43 as of December 31, 1931. A large proportion of the decrease in the net asset value of your company shown at the end of 1932 is due to the fact that the premium on American funds on December 31, 1932, was 13 1/16 per cent., while it was 18½ per cent. on December 31, 1931.

Your company's portfolio, as in the past, consists chiefly of listed securities, which are readily marketable.

The following is taken from the report of the general manager for the year 1932:—

PROFIT AND LOSS STATEMENT

SOURCES OF 1932 INCOME:		
Gold and silver produced		$11,723,074.28
Interest on investments and other income		145,418.84
		$11,868,493.12
DISPOSAL OF 1932 INCOME:		
General charges	$436,993.28	
Mining charges	5,316,503.53	
Milling charges	1,074,239.57	
		6,827,736.38
Operating profit		$5,040,756.74

DEDUCT:			
Taxes—			
Province of Ontario	$90,986.71		
Royalty to Town of Timmins	35,748.32		
Municipal to Town of Timmins	93,117.05		
Royalty to Township of Tisdale	2,304.86		
Municipal to Township of Tisdale	3,015.24		
Dominion of Canada re 1931	25,960.20		
Dominion of Canada and Province of Ontario, reserve for	275,000.00		
		$526,132.38	
Workmen's compensation and silicosis assessment		491,786.72	
			$1,017,919.10
Net profit from operations before depreciation			$4,022,837.64
Depreciation—			
Plant		$11,110.19	
Investments in other companies and properties written down		3,003.78	
Expenditures on properties abandoned		45,838.33	
			59,952.30
NET PROFIT FROM OPERATIONS			$3,962,885.34
PAID OUT IN DIVIDENDS			3,690,000.00
ADDED TO SURPLUS			$272,885.34

BULLION STATEMENT

INVENTORY, JANUARY 1, 1932:			
Solutions			$98,117.40
Slags, litharge, and miscellaneous			880.00
Precipitates held over			4,290.00
Total			$103,287.40
VALUES PRODUCED IN 1932:			
Ore milled		$10,808,817.89	
Tailings loss		414,409.00	
			10,394,408.89
			$10,497,696.29
INVENTORY, DECEMBER 31, 1932:			
Solutions			$131,931.40
Slags, litharge, and miscellaneous			880.00
Precipitates held over			8,141.00
			$140,952.40
BULLION SHIPPED DURING 1932			10,356,743.89
			$10,497,696.29

YEARLY AVERAGE COSTS

Account	Sundries	Labour	Stores	Total	Per ton ore milled
General miscellaneous charges and administration		$273,632.88	$52,615.14	$326,248.02	$0.1859
Surface services		41,894.92	25,874.65	67,769.57	.0386
Insurance	$13,414.59			13,414.59	.0076
Marketing bullion	29,561.10			29,561.10	.0169
Workmen's compensation[1]		491,786.72		491,786.72	.2802
Milling charges		427,802.03	646,437.54	1,074,239.57	.6122
Mining charges		3,733,331.71	1,583,171.82	5,316,503.53	3.0296
Total charges	$42,975.69	$4,968,448.26	$2,308,099.15	$7,319,523.10	$4.1710

[1]Includes silicosis assessment of $330,876.06.

Employees

The average number of men employed during the year has been 2,485, distributed as follows:—

Miners:		Mechanics:		General:	
Exploration	36	Operation	109	Mill and refinery	189
Development	382	Maintenance	169	Engineering staff	71
Production	1,372			Clerical staff	40
				Miscellaneous	117
Total	1,790	Total	278	Total	417

The Mill

Milling results were as follows:—

Tons ore milled	tons	1,754,863
Average value per ton		$6.16
Gross value		$10,808,817.89
Deduct loss in tailings		414,409.00
Net value recovered		$10,394,408.89
Average tons per day		4,834
Per cent. of possible time run		93.3
Tons per 100 per cent. running time		5,181
Solution precipitated per ton ore	tons	1.04
Value per ton in tailings		$0.24
Cyanide consumed per ton of ore	lbs.	0.461
Zinc consumed per ton of ore	lbs.	.044
Zinc consumed per ton of solution	lbs.	.043
Lime consumed per ton of ore	lbs.	1.964
Lead acetate per ton of ore	lbs.	.010
Average value of pregnant solution		$5.67

Ore Reserves

Our ore reserves on the 31st of December, 1932, consisted of 6,049,548 tons of a total value of $45,492,076.00, having an average value of $7.52 per ton. These figures compare with 6,236,887 tons, of a total value of $46,241,688.00, having an average value of $7.41 per ton at the 31st of December, 1931.

The Mill

While investigations looking to improved metallurgy and reduced operating costs have been vigorously prosecuted throughout the past year, no alternative process would seem to indicate better results on Hollinger ore.

Present practice gives a $0.24 residue at a milling cost of $0.6122, a combined cost of $0.8522. While operating charges could be reduced at the expense of extraction, or extraction improved by ignoring increased operating charges, no alternative process so far investigated gives promise of improving upon the only significant figure—that of cost plus tails.

The Mine

During the year operations have been carried on on all levels from surface to the 3,950-foot level. However, no stoping is being carried on below the 2,750-foot level. We are gradually reducing the number of shrinkage stopes in the mine, and recovering ore from shrinkage stopes which have been standing for some time.

The completion of the backfilling at certain points has given us the opportunity to explore areas adjacent to existing stopes. The results of these explorations have been most gratifying, as a considerable tonnage of ore is being developed. This exploration of necessity delays the recovery of sill floors, but to date has been most profitable. Forty-two per cent. of the ore milled came from above the 800-foot level; 975,000 tons of backfill was placed during the year.

Development.—Development has been conducted on all levels during the year, a considerable portion of it being in the area above the 900-foot level. As noted above, the operations in the block from the 2,750-foot to the 3,950-foot level are confined to development only, and results for the year have been satisfactory. Ore put in sight below the 2,750-foot level amounts to over $3,200,000, the grade being approximately $9.00.

Ore conditions on the lower levels are most interesting. The apparent extension of the ore zone to the west continues, and while still too early to speak definitely, it opens up possibilities in an area which has heretofore been considered unfavourable at depth.

While it is the intention to sink below the 3,950-foot level, the new developments have reopened the question of the shaft location, and the work is delayed pending further information.

Costs.—There was no material change in costs for the year.

The following is taken from the report of the consulting engineer:—

YOUNG-DAVIDSON MINES, LIMITED

During December, 1932, a proposal was discussed at a special meeting to consider the matter of the company's investigation of the possibilities of the Young-Davidson. It was agreed to do this, subject to a satisfactory agreement and the right to rigidly sample the ore body.

The ore body covers an area of about 2¾ acres, mainly on claim No. 5,372 with a small portion on claim No. 5,374 in the Matachewan gold area. The agreement was signed on or about the 9th of February, 1933, and work was started at once on the property. This type of ore occurrence is rare in Northern Ontario because, owing to the average low grade, it will have to be mined by quarry methods.

Former work was done on this mine by the Porcupine Gold Fields Development and Finance Company, Limited. This consisted of an extensive diamond-drilling campaign and about 2,000 feet of underground tunnelling. The mine was abandoned as the work proved that the grade of the ore was too low for profitable exploitation by underground methods.

The Hollinger problem is to reveal the actual minimum value of the ore body and aside from the cost of sampling have no other financial commitments. From an investigation of the records of the Porcupine Gold Fields and from careful sampling of the dump rock, which is the average of the rock encountered during the underground work, the value appears to be around $2.50. This data is being supplemented by an elaborate series of cross-trenches, which will be sampled thoroughly by channel and bulk samples, and then the whole problem reviewed for a decision. It is thought that the grade can be materially improved by sorting out as much as possible of the poor rock before milling as may be recognized by inspection and where possible. The tests in the ore so far show good extraction both by cyanidation and flotation. Work now in progress will decide this matter.

Horseshoe Mines, Limited

This company was incorporated in 1929 with a capitalization of 4,500,000 shares of $1 par value. The officers are: W. A. Lamport, president; Lt.-Col. Kelly Evans, vice-president; C. M. Chandler, secretary-treasurer; J. H. Lumbers, director. The head office is at 301 Royal Bank Building, Toronto.

The properties held by this company include 310 acres on the south shore of Regina bay, Lake of the Woods, about 40 miles by water southeast of Kenora. This covers the old Regina mine, which began production in 1895, and was operated continuously until October, 1899, and again for short periods in 1902 and 1905. The total production is estimated to have been about $500,000. The mine was involved in litigation from 1908 to 1923 and remained dormant. It was dewatered and examined in 1924, 1929, and 1931.

The underground workings consist of a 560-foot two-compartment shaft, with 9 levels opened up at intervals of 40 to 60 feet. A total of 3,560 feet of drifting has been done on these levels. The main ore body has been practically all stoped out between the 8th level and surface.

Between June and December, 1932, the mine was again dewatered in anticipation of active development, which did not materialize. However, repairs were made to the surface plant, and an air compressor was installed to replace obsolete equipment.

The mining plant consists of two 100 h.p. return tubular boilers, a 12- by 16-inch Jenckes steam hoist, and the compressor referred to above. The last mill used on the property is equipped with 30 gravity stamps, 6 amalgam plates, 5 Wilfley tables, and an obsolete 4-vat cyanide leaching plant.

An average of 5 men was employed under the direction of George Miller.

Howey Gold Mines, Limited

The company is capitalized at 5,000,000 shares of $1 par value. They are all issued. The head and mine offices of the company are at Red Lake. The executive office is at 802 Federal Building, Toronto. The following are the executive officers and directors: R. T. Birks, president; W. S. Cherry, vice-president;

H. C. McCloskey, secretary-treasurer; J. E. Hammell and John A. Northway, directors. Fraser D. Reid is general manager.

The company's holdings lie at the southeastern corner of the lower part of Red lake and include the following claims situated in Dome and Heyson townships, 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.

The following is an extract from the president's report to the shareholders for the year 1932:—

During the year you will note that the recovery of gold amounted to $1,268,780.07, from which an operating profit (before depreciation, pre-production charges, and taxation) of $470,411.96 was realized. The cost per ton of ore treated during 1932 was $2.471, as compared with a corresponding cost of $3.126 during the preceding year. While it is true that the average recovery is the lowest of any mine operating profitably in Ontario, it will be observed that the cost per ton is proportionately low.

Since the end of the calendar year the general manager has recommended, and the directors have approved, a plant extension which will increase the capacity of the mill to approximately 1,300 tons per day. This will not only insure a larger profit on the ore reserves indicated in the general manager's report, but will also open up, as a commercial possibility, a large block of ore above the 1,000-foot level lying west of the shaft.

The following is the general manager's report for the year 1932:—

SUMMARY OF WORK ACCOMPLISHED

	1932	1931
Drifts, crosscuts, raises, etc. ..... feet	3,562.5	3,117
Shafts and winzes ..... feet	430.5	.....
Shaft stations, slashing, etc. ..... cu. yds.	1,550	2,225
Diamond-drilling (underground) ..... feet	1,856.6	2,030.9
Diamond-drilling (outside exploration) ..... feet	701	.....
Box-holes ..... feet	830.5	1,560
Ore broken mining ..... tons	339,675	323,289
Low-grade material discarded by sorting ..... tons	44,585	15,324
Milled after sorting ..... tons	284,664	211,522
Broken reserve in stopes (Jan. 1, 1933) ..... tons	206,150	195,724

EARNINGS STATEMENT

	1932	1931
Total receipts from sale of gold and silver (including exchange)	$1,268,780.07	$914,290.58
Total operating cost (including Toronto office), expenses, and taxes.	813,368.11	709,111.29
Operating profit	$455,411.96	$205,179.29

MISCELLANEOUS OPERATING DATA

	1932	1931	Total from start of operations
Tonnage milled and sorted ..... tons	329,249	226,876	667,355
Tonnage discarded by sorting ..... tons	44,585	15,324	60,701
Tonnage milled ..... tons	284,664	211,552	606,654
Value per ton hoisted	$3.70	$4.20	$3.97
Value per ton material discarded by sorting	$0.42	$0.60	$0.47
Value per ton of ore milled	$4.21	$4.45	$4.33
Loss in tailings per ton milled	$0.27	$0.35	$0.30
Loss per ton of ore hoisted (in milling and sorting) ...	$0.29	$0.37	$0.31
Net percentage recovery per ton of ore hoisted	92.4	91.5	92.3
Total net recovery of gold and silver (including exchange)	$1,268,780.07	$914,290.58	$2,643,499.01

PRODUCTION RECORD, 1932

	Tons waste sorted	Dry tons milled	Value per ton	Total value	Average loss in tailings	Total loss in tailings	Per cent. recovery	Total recovery mint returns including exchange
January	1,077	23,540	$4.55	$107,206.46	$0.29	$6,839.39	93.6	$116,461.18
February	2,780	22,521	4.02	90,546.57	.29	6,611.39	92.6	94,569.72
March	2,845	21,926	4.60	100,778.19	.29	6,447.98	93.6	104,809.41
April	3,842	23,468	4.60	107,988.57	.30	6,978.68	93.5	113,074.68
May	3,575	24,808	5.07	125,884.26	.30	7,428.18	94.1	134,878.67
June	3,542	23,945	4.57	109,358.30	.29	6,952.14	93.6	117,263.88
July	3,754	24,692	4.09	101,015.34	.29	7,065.20	93	107,749.91
August	3,445	24,328	3.91	95,110.76	.26	6,338.72	93.3	100,071.94
September	5,209	23,501	3.34	78,405.65	.23	5,316.46	93.2	80,580.73
October	5,196	24,151	3.99	96,294.03	.26	6,201.07	93.6	99,182.15
November	4,450	23,354	3.79	88,446.91	.22	5,211.31	94.1	96,734.92
December	4,870	24,430	3.96	96,660.52	.23	5,634.25	94.2	103,402.88
Total	44,585	284,664	$4.21	$1,197,695.56	$0.27	$77,024.77	93.6	$1,268,780.07

ANALYSIS OF COSTS

	1932 (329,249 tons)		1931 (226,876 tons)		21 months ending December 31, 1931 (337,314 tons)	
	Total cost	Cost per ton milled and sorted	Total cost	Cost per ton milled and sorted	Total cost	Cost per ton milled and sorted
Mine operation	$425,094.74	$1.292	$371,396.72	$1.637	$633,444.71	$1.878
Outside exploration	2,089.95	.006	1,803.00	.008	1,803.00	.005
Crushing and conveying	38,866.59	.118	38,894.55	.172	59,341.66	.176
Ore sorting	12,820.98	.039	4,616.05	.020	4,616.05	.013
Milling	216,049.24	.656	176,358.66	.777	277,087.62	.822
General expense	59,337.36	.180	44,990.64	.198	80,215.88	.238
Total plant cost	$754,258.86	$2.291	$638,059.62	$2.812	$1,056,508.92	$3.132
Toronto office salaries, general expenses and taxes	45,313.19	.138	34,598.27	.152	61,535.02	.182
Interest charges	13,796.06	.042	36,453.40	.162	58,844.38	.175
Total before depreciation and pre-operating charges	$813,368.11	$2.471	$709,111.29	$3.126	$1,176,888.32	$3.489
Depreciation (on 10 per cent. basis)	115,333.90	.350	108,266.64	.477	181,246.48	.537
Pre-operating charges	197,549.40	.600	126,931.20	.560	193,194.00	.573
Total cost	$1,126,251.41	$3.421	$944,309.13	$4.163	$1,551,328.80	$4.599

CAPITAL EXPENDITURES

Haulage locomotive and generator set	$10,254.11
Granby type ore cars	1,224.65
Miscellaneous mine hoists, blowers, etc.	4,023.04
Low-pressure mill compressor and building	3,820.63
Wilfley tables	4,255.98
Pebble mill and classifier	2,669.74
New waste bins	1,467.78
Shaper for machine shop	368.14
Kelvinator and building	2,251.13
Ford truck	1,007.50
Cletrac tractor	1,400.00
Fire-fighting equipment	257.07
Incinerator	659.85
Mill oil warehouse	138.04
Mill lime shed	655.31
Dock warehouse	334.59
Garage	506.65
Addition to dock	561.59
Skillsaw	325.03
Miscellaneous—motors and equipment	1,530.07
Total	$37,815.89

Ore Reserves

The broken reserve above the 1,000-foot level on the 31st day of December amounted to 206,150 tons. The reserve of unbroken ore of a similar grade above the same level amounted to approximately 500,000 tons. In addition to these reserves, there is a body of ore lying to the west of the shaft and above the 1,000-foot level. This section has not as yet been explored sufficiently to permit including it in the reserves. We do feel, however, that it will give a substantial tonnage of a relatively lower grade ore.

Limited work done below the 1,000-foot level and above the 1,315-foot haulage level disclosed a reserve of approximately 500,000 tons, estimated from diamond-drilling results to have a gold content of $2.45 a ton. This lower grade ore we believe can be mined and milled at a cost of at least $1.85 a ton, including head office expenses, provided the capacity of the plant is increased to approximately 1,300 tons a day.

Exploration

During the past year, the mine was developed to the 1,315-foot level by a winze from the 1,000-foot level. From this winze, the 1,315-foot haulage level was extended westward to the position of the present shaft, and also to a point 373 feet east of the winze; also from the winze the 1,175-foot service drift was driven to the position of the shaft, and the shaft connected by raising from this level. This service drift was also extended to a point 97 feet east of the winze for exploratory purposes. Both the 1,175-foot service level and the 1,315-foot haulage level were thoroughly explored by diamond-drilling as far as development extended, with the result as previously stated.

A longitudinal section of the mine is attached showing the location of the ore reserves with respect to the shaft. It will be seen from a study of this that there is still a large section to be explored, both above and below the 1,000-foot level, before the possibilities of the mine are fully determined.

An average of 193 men was employed throughout the year. Edward Futterer is superintendent.

Kenora Prospectors and Miners, Limited

This company has an authorized capital of 500,000 shares of $1 par value. The officers and directors are: Thayer Lindsley, president; Mrs. Ida A. Lindsley, vice-president; Geo. H. Ince, secretary-treasurer; Mrs. Ida Machin and G. H. Marsh, directors. The head office is at 100 Adelaide Street West, Toronto.

Cedar Island

This property is located on Cedar island, in Bag bay, Shoal lake, in the Lake of the Woods area, district of Kenora. It is about 45 miles by water from Kenora.

During 1932 a small two-compartment inclined shaft was sunk to a depth of 165 feet, and a level established at 150 feet. A total of 385 feet of drifting and 163 feet of crosscutting was accomplished at this horizon. A shipment of 44 tons of high-grade ore was made to the Ontario refinery at Copper Cliff.

The plant used consisted of a 25 h.p. vertical boiler, 6- by 8-inch Jenckes hoist, and a 310-cubic-foot gasoline air compressor.

An average of 8 men was employed under the direction of F. L. Smith from February until work was suspended in October, 1932.

Mikado

The old Mikado gold mine, also situated in Bag bay, Shoal lake, was acquired, and work commenced in November, 1932.

After the mine was dewatered, the old No. 1 shaft, a vertical two-compartment shaft to the 4th level, was cleaned out and retimbered. A new headframe was erected, and a small single-drum steam hoist and bucket installed.

At the 4th level, 240 feet vertically, an old 87-foot inclined winze located near No. 1 shaft was cleaned out and prepared for sinking. The hoist used at Cedar island was transferred and installed underground. Sinking was started in the winze in January, 1933, with the 9th or bottom level horizon 522 feet vertically from surface, as an objective.

The old Mikado plant consisting of two 150 h.p. boilers and a 500-cubic-foot steam-driven compressor were used.

About 25 men were employed. R. C. Brehaut is in charge.

Kirkland Consolidated Gold Mines, Limited

The officers and directors of the company are: James M. Ryan, president; J. W. Rudhard, vice-president; Andrew James, secretary-treasurer; R. W. Langford, Kelvin Killeen, N. R. Davis, directors; and E. B. Wood, director and mine manager. The capitalization is 7,000,000 shares at $1 par value; 3,500,000 shares are issued. The head office of the company is at 1717 Metropolitan Building, Toronto.

The company owns 4 claims in McVittie township, 12 claims in Grenfell township, and 14 claims in Gauthier township, all in the district of Timiskaming. A shaft was sunk in 1932 on the claims in Grenfell township about 3 miles southeast of Sesekinika. The shaft is down 60 feet, and 50 feet of drifting was done. A narrow high-grade vein was opened up for a short distance. Three camps, a blacksmith shop, and a cookery were constructed early in 1933.

Kirkland Gold Belt Mines, Limited

The Kirkland Gold Belt Mines, Limited, own 293 acres in the township of Teck, district of Timiskaming, east of Kirkland Lake. The officers and directors of the company are: John R. Bookser, president; Jas. E. Day, vice-president; G. W. Morris, treasurer. Dr. W. H. Bennett, M. C. Smith, J. J. Byrne, F. W. Alderman are directors. Roy Weldon is secretary. The head office is at 504 Kent Building, Toronto. The capitalization is 3,000 000 shares of no par value.

During the year the following work was done: on the 125-foot level, 202 feet of drifting and 80 feet of crosscutting; and on the 250-foot level, 90 feet of drifting and 180 feet of crosscutting. On the 125-foot level, approximately 200 feet of $10 ore, 5 feet wide, was opened up; and on the 250-foot level, 100 feet of $8 ore. Up to the end of May, 1933, the shaft had been sunk to the 500-foot level,

and stations had been cut at the 375- and the 500-foot levels. A new steam hoist and electric compressor are being installed. During the year 20 men were employed.

Kirkland Lake Gold Mining Company, Limited

The officers and directors of this company are: J. B. Tyrrell, president and managing director; R. Graham, secretary; R. G. O. Thomson, vice-president; Wm. M. Sixt, mine manager; A. C. Matthews, J. A. Dalton, A. M. McQueen, W. S. Walton, and J. C. Haight, directors. The company owns 465 acres in the township of Teck, district of Timiskaming, and is capitalized at 5,500,000 shares of $1 par value.

Production for 1932 amounted to $592,451.17, plus exchange of $14,509.79, making a total of $606,960.96.

On an average, 147 men were employed at the mine.

The following is taken from the mine manager's report for 1932:—

During the year we had a very heavy shaft-sinking and equipment cost. After paying for this we were able to show a very favourable profit.

Shaft-sinking from the 4,750- to the 4,900-foot level was started at the beginning of the year. At the 4,900-foot a main haulage level was driven 1,000 feet south to No. 2 winze. The No. 2 winze was sunk 543 feet. This provides four new levels that will be worked during the coming year. A new hoist and all necessary equipment was installed at No. 2 winze. This work had to be done before development could be started on new levels at No. 2 winze. For this reason the development of new ore was small as compared with the previous year.

The main development of new ore was on the 4,900-foot level. To the east a wide zone was opened up. While this did not produce ore, the formation and structure were very good. This section below the 4,900-foot level will be developed during the coming year.

To the west we developed a fair length of good grade ore, and at the end of the year the face was still assaying high-grade ore. The ore zone on the 4,900-foot west drift was considerably longer than on the 4,750-foot level. If this condition continues down below the 4,900-foot, with this formation and structure, we should find ore below 4,900 feet during the coming year. During the coming year we will be carrying on development of ore, as shaft-sinking is completed for a period.

A fairly large expenditure was made on the plant and addition of new equipment to keep up the working standard generally. During the next year this expenditure will be considerably less.

During the year the major work was done on the following levels: 500-, 700-, 2,725-, 2,850-, 3,875-, 4,000-, 4,150-, 4,300-, 4,750-, and 4,900-foot levels and No. 2 winze. The ventilation raise has been constructed so that at the end of the year it is connected from the 4,900-foot level to surface, which provides taking down air from surface to improve working conditions on lower levels.

Due to the unemployment situation, we have shortened the hours of some of our men so as to keep as many men at work as possible.

La Roche Mines, Limited

The capitalization of La Roche Mines, Limited, is $3,000,000, in shares of $1 par value. The officers and directors of the company are: James E. McMahon, Timmins, president; J. C. Roche, Buffalo, N.Y., secretary-treasurer; John J. Stack and John Hanover, Buffalo, N.Y., directors. R. R. Brown is general manager. The head office is at 116 Federal Building, Toronto.

The property, consisting of two claims about 2 miles southeast of Timmins, in the township of Tisdale, district of Cochrane, was operated during the latter part of 1931 and the early part of 1932. During this period a small plant was erected and a shaft was sunk to a depth of 140 feet. A level was cut at the 125-foot horizon, and about 500 feet of drifting and crosscutting was done.

George Gray was in charge of operations, and about 20 men were employed.

Lake Shore Mines, Limited

Lake Shore Mines, Limited, has a capital of 2,000,000 shares of $1 par value. The officers of the company are: Harry Oakes, president and managing director;

W. H. Wright, vice-president; Dr. W. P. St. Charles, treasurer; Kirkland Lake Securities, Limited, secretary. The directors are: Harry Oakes, Albert Wende, Louis Oakes, Wm. H. Wright and Ernest Martin. E. W. Todd is mine superintendent. The mine and works are at Kirkland Lake, township of Teck, district of Timiskaming. During the year an average of 1,420 men was employed.

The following information is taken from the seventeenth annual report of the company for the year ending June 30, 1932:—

During the year 834,434 tons of ore were treated, yielding bullion to the amount of $12,356,759. This shows an increase of 135,810 tons of ore milled over last year, with a corresponding increase in bullion of $3,203,823.92.

Mill Production by Months

Month	Tonnage	Bullion production	Recovery per ton
1931			
July	69,120	$930,000.00	$13.45
August	72,865	890,000.00	12.24
September	70,933	960,759.00	13.54
October	72,640	1,100,000.00	15.14
November	71,000	1,080,000.00	15.21
December	69,010	1,050,000.00	15.21
1932			
January	68,118	1,025,000.00	15.05
February	66,032	1,000,000.00	15.14
March	70,719	1,002,000.00	14.17
April	67,677	1,025,000.00	15.14
May	67,555	1,125,000.00	16.65
June	68,765	1,169,000.00	17.00

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
July 1, 1929, to June 30, 1930	12	467,648	6,576,780.45	2,600,000
July 1, 1930, to June 30, 1931	12	698,624	9,152,935.08	3,600,000
July 1, 1931, to June 30, 1932	12	834,434	12,356,759.00	6,000,000
Total	.....	.....	$47,393,367.46	$19,020,000

Mining and Development

The total tonnage milled during the year was made up of 83,668 tons of ore from development and 750,766 tons from mining. The broken ore reserves now amount to 258,914 tons, valued at $4,490,000. The mine is now practically all changed over to cut-and-fill stoping or various applications of this method, and, as pointed out last year, the broken ore reserves are being gradually reduced.

Work accomplished on the new upper levels between the 2,000- and 2,950-foot horizons has given very satisfactory results as regards lengths, widths, and grade of ore developed.

SUMMARY OF ORE DEVELOPMENT ON NO. 2 VEIN

Level	Lengths	Average width	Average grade
	feet	inches	
2,200-foot	2,519	71	$20.70
2,325-foot	2,378	65	17.80
2,450-foot	2,285	77	20.80
2,575-foot	1,738	78	18.10
2,700-foot	1,620	70	19.60
2,825-foot	2,129	65	16.83
2,950-foot	1,363	69	18.40

The above summary includes only the widths of ore found in the drifts down to the 2,950-foot level. The vein has been intersected by crosscuts on five levels below the 2,950-foot with satisfactory results.

Three new levels on No. 1 vein show the following results to date:—

Level	Lengths	Average width	Average grade
	feet	inches	
2,575-foot	209	79	$16.90
2,700-foot	920	60	16.50
2,825-foot	629	73	11.40

During the year No. 1 shaft was carried to a depth of 3,725 feet, and at the same time raising on No. 3 shaft from the 3,075-foot and 3,200-foot levels was in progress. The main crosscuts connecting the two shafts were completed to the 3,200-foot level and ore and waste passes completed.

DEVELOPMENT FOOTAGE FOR YEAR

Level	Drifting	Cross-cutting	Raising	Shaft-sinking	Shaft-raising	Winze	Sub-drifting	Ore passes	Total footage	Diamond-drilling	Station-cutting
	feet	feet	feet	feet	feet	feet	feet	feet		feet	cu. ft.
200-foot	.....	95.5	302	.....	.....	.....	102.4	.....	499.9	.....	.....
400-foot	52.4	508.7	259.8	.....	.....	.....	24	.....	844.9	526	.....
600-foot	277.6	493.4	150.4	.....	.....	.....	279.3	.....	1,200.7	370.5	.....
800-foot	314.5	60.5	607.5	.....	.....	.....	104.1	.....	1,086.6	634	.....
1,000-foot	.....	253.9	796.3	.....	.....	.....	489.2	.....	1,539.4	90.5	.....
1,200-foot	591.9	.....	707.4	.....	.....	.....	192.8	.....	1,492.1	537	.....
1,400-foot	27.1	90.2	882.5	.....	.....	.....	654.1	.....	1,653.9	299.5	.....
1,600-foot	49.7	.....	347	.....	.....	.....	177.9	.....	574.6	628.5	3,168
1,800-foot	700.3	4.4	794.8	.....	.....	.....	123.8	.....	1,623.3	828	.....
2,000-foot	10.5	478.9	912.9	.....	.....	99.4	35.9	86	1,623.6	1,064.7	26,676
2,200-foot	763.9	45.5	1,572.5	.....	.....	.....	23.5	35	2,440.4	907	.....
2,325-foot	3,332.2	437.3	922.7	.....	.....	.....	61	.....	4,753.2	1,426.5	.....
2,450-foot	3,034.9	479.3	895.1	.....	.....	.....	124	.....	4,533.3	566.5	.....
2,575-foot	3,915	470.2	764.8	.....	.....	.....	18.2	.....	5,168.2	1,291	.....
2,700-foot	4,914.6	1,262.7	847.1	74	.....	.....	.....	.....	7,098.4	2,689.5	2,580
2,825-foot	4,092.9	664.4	87	125	38.5	.....	.....	247	5,254.8	2,551	5,472
2,950-foot	1,989.6	364	.....	125	.....	.....	.....	255.3	2,733.9	435.5	11,724
3,075-foot	86.9	413.2	.....	125	69.3	.....	.....	164.4	858.8	.....	16,320
3,200-foot	11.4	404.6	.....	125	110.7	.....	.....	277.3	929	.....	16,416
3,325-foot	.....	82.2	.....	125	.....	.....	.....	12.5	219.7	.....	22,800
3,450-foot	.....	231.1	.....	125	.....	.....	.....	.....	356.1	.....	1,980
3,575-foot	.....	96	.....	125	.....	.....	.....	.....	221	.....	8,580
3,700-foot	.....	.....	.....	20	.....	.....	.....	.....	20	.....	.....
Total....	24,165.4	6,936	10,849.8	969	218.5	99.4	2,410.2	1,077.5	46,725.8	14,845.7	115,716

SUMMARY OF ORE AND WASTE HOISTED FOR THE YEAR

Level	Ore from development	Ore from mining	Waste
	tons	tons	tons
200-foot	522	3,577	.....
400-foot	112	21,533	.....
600-foot	896	1,560	.....
800-foot	1,333	9,624	.....
1,000-foot	1,183	12,026	.....
1,200-foot	847	61,535	.....
1,400-foot	527	33,398	.....
1,600-foot	427	82,040	.....
1,800-foot	390	168,528	6
2,000-foot	2,732	101,247	2,954
2,200-foot	7,901	98,087	2,822
2,325-foot	13,779	60,430	9,763
2,450-foot	11,952	48,186	6,445
2,575-foot	11,849	25,305	13,414
2,700-foot	15,133	19,180	15,764
2,825-foot	9,100	4,510	14,899
2,950-foot	4,608	.....	9,633
3,075-foot	332	.....	7,918
3,200-foot	.....	.....	8,038
3,325-foot	.....	.....	5,504
3,450-foot	.....	.....	3,798
3,575-foot	45	.....	5,943
3,700-foot	.....	.....	67
Total	83,668	750,766	106,698

TOTAL FOOTAGE OF DEVELOPMENT AND EXPLORATION WORK SINCE BEGINNING OF OPERATIONS

	Feet
Drifting	81,107
Crosscutting	20,727
Raising	57,391
Sinking	7,133
Shaft-raising	523
Winze	1,151
Ore passes	6,973
Sub-drifting	2,410
Diamond-drilling	54,780
	cu. ft.
Box-holing	258,826
Station-cutting	572,781
Sumps	46,184

Milling

The new equipment, which was installed at the conclusion of the experiment work on our new method of tailings treatment carried out so successfully last year, is at present working very satisfactorily, effecting an increase in extraction of approximately 5 per cent. over previous practice.

COSTS

	Cost per ton milled
Development	$1.198
Mining	2.529
Milling and refining	1.188
Marketing bullion	.078
General and administrative expense	.248
Operating cost	$5.241
Depreciation	.884
	$6.125
Provision for provincial and Dominion taxes	1.192
Total cost	$7.317

Lakeland Gold Mines, Limited

This company operated its property, about 4 miles southeast of Bourkes station in the township of Maisonville, district of Timiskaming, from April to the end of the year with a force of 28 men. The property consists of 800 acres.

The officers and directors are: F. A. Pollard, president; Robert Johnston, vice-president; A. W. Morris, secretary-treasurer; Gideon Grant, Luther Davison, Wm. Brittain, and R. A. Tresidder, directors. Oscar Knutson is mine superintendent. The head office is at 19 Sun Life Building, Hamilton, Ont. The company is capitalized at 4,000,000 shares of $1 par value, of which 2,300,000 shares are issued.

The following work was done in 1932: shaft-sinking, 277 feet to the 500-foot level; crosscutting, 353 feet; drifting, 832 feet; diamond-drilling, 5,354 feet.

Macassa Mines, Limited

The Macassa Mines, Limited, has a capitalization of 5,000,000 shares of $1 par value. The officers and directors are: Robert A. Bryce, president; L. Soliague, secretary-treasurer; Arthur G. Slaght, James Cowan, Joseph Caldwell, and Thomas Riggs, directors. The head office is at 85 Richmond Street West, Toronto. G. A. Howes is superintendent at the mine. An average of 31 men were employed in 1932.

A start has been made on the construction of a 200-ton mill, together with an assay office, refinery, machine shop, and other essential buildings for the operation of a complete 200-ton mill. The work is well under way, and it is expected that both the mine and mill will reach production by October, 1933.

The following is an extract from the report of the president to the shareholders on June 5, 1933:—

When the previous annual report was issued in April, 1932, the major development operation, upon which the company had commenced work in the early part of 1931, was still in progress. The new central shaft, sunk to a depth of 2,500 feet, was connected in August last with the 2,475-foot drift, which had been driven from the workings on that level of the Kirkland Lake Gold Mining Company, Limited.

The completing of the initial programme of work and the subsequent exploration and development covered by this report have involved an expenditure of $10,100.89, in addition to plant and equipment, and $191,685.73 in exploration, development, and general expenditure.

The amount of development completed at the end of June, 1933, was as follows: 5,350 feet of drifting, and 1,500 feet of raising.

The following is taken from the annual report of the superintendent for the year ending April 30, 1933:—

Following the completion of the central shaft and its connection with the 2,475-foot level drift, a development programme was inaugurated, designed to open up the sections of ore encountered in this drift. This work has comprised the putting up of three raises from this drift and the establishing of three new levels at 2,325, 2,175, and 2,000 feet; and in addition thereto, a drift is being driven westward on the 750-foot level to explore the western section of the property. These operations have entailed the following work: raising, 615 feet; drifting, 3,170.5 feet; crosscutting, 717.5 feet; diamond-drilling, 941 feet.

In the report of September last it was stated that sections of ore had been encountered on the 2,475-foot level having a combined length of 310 feet, assaying $11.20 over a width of 4.6 feet. During the progress of the above work these sections have been further developed, and at April 30 the results were as given below. I believe that when these ore sections have been fully developed their true widths will be must greater.

Level	Length	Width	Value
	feet	feet	
2,475-foot	500	4.6	$11.00
2,325-foot	536	4.8	15.05
2,175-foot	50	4	9.07
No. 3 raise	190	6	16.60

On the 2,475-foot level, where raises Nos. 1 and 2 were started, values were low, but some ore was encountered during their progress. The main object of these two raises was to reach the new levels, 2,325- and 2,175-foot, as quickly as possible and develop them. No. 3 raise, however, was started on ore at the 2,475-foot level, was driven at an angle of 45 degrees and continued in ore up to the 2,325-foot level. While it showed an average width of 6 feet there still remains some ore in part of the south wall, so that the ore on each side of it may stope wider than 6 feet.

Horizontal diamond-drilling from these levels indicates that considerable crosscutting must be done with the strong possibility of finding parallel ore or the extensions of some of the known ore bodies. Two diamond-drill holes drilled below the 2,475-foot level intersected the main break at 90 and 200 feet below this horizon, proving its continuity to greater depths than now explored.

Several additions have been made to the mining plant and equipment both above and below ground in order to facilitate the carrying on of the more extended programme which has been in progress since September, 1932.

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; E. D. Fox, secretary; Balmer Neilly, treasurer. The directors are: J. P. Bickell, W. J. Sheppard, J. B. Tudhope, D. H. McDougall, Strachan Johnston. R. J. Ennis is general manager.

The mines and plant are at Schumacher, in the township of Tisdale, district of Cochrane. The head office of the company is at Schumacher, and the executive offices are at 15 King Street West, Toronto.

The following information is taken from the twentieth annual report of the general manager for the year ending March 31, 1933:—

PRODUCTION

(from 736,300 tons treated)

Value per ton	$7.70
Gross value	5,669,510.00
Bullion recovered, valued at $20.67 per ounce	5,427,211.15
Bullion recovered per ton	7.37
Bullion contained (gold, 261,784.62 fine ounces; silver, 60,787.84 fine ounces)	5,981,967.06
Bullion marketing costs	24,751.37
Net value of bullion recovered	$5,957,215.69

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
Apr. 1, '29, to Mar. 31, '30	12	550,495	8.46	4,657,188.00	8.05	4,433,626.45
Apr. 1, '30, to Mar. 31, '31	12	558,115	8.84	4,934,122.00	8.30	4,633,140.73
Apr. 1, '31, to Mar. 31, '32	12	655,030	8.00	5,239,822.90	7.63	4,997,461.80
Apr. 1, '32, to Mar. 31, '33	12	736,300	7.70	5,669,510.00	7.37	5,427,211.15
Total		6,752,018	$8.83	$59,627,351.17	$8.37	$56,513,762.59

Mining

	Tons
Ore broken in stopes	684,453
Ore from development	62,212
Ore hoisted	744,623

Cut-and-fill methods of mining were used for 59 per cent. of the ore stoped.

Development

Development work amounted to 27,480 feet. This work included 14,851 feet of drifts, of which 1,463 feet was on line and 13,388 feet in vein material; of this, 5,827 feet was in ore of $7.60 grade over drift width.

ORE RESERVES, 1932–1933, BY CLAIMS

Claims	Tons	Fine ounces gold	Value calculated at $20.67 per ounce	
			Assay per ton	Value
McIntyre	548,663	203,654	$7.65	$4,209,534
McIntyre Extension	128,851	54,049	8.65	1,117,206
Jupiter	1,267,323	488,023	7.95	10,087,440
Plenaurum	403,602	136,310	7.00	2,817,465
Platt Veteran	58,327	18,561	6.60	383,669
Total	2,406,766	900,597	$7.75	$18,615,314
Broken ore	198,300	67,812	7.05	1,401,686
Total	2,605,066	968,409	$7.70	$20,017,000

SUMMARY OF DEVELOPMENT AND EXPLORATION, 1932–1933

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.		cu. ft.	feet
1	1,894	683	232	.....	.....	.....	.....	.....	2,809	.....	3,202
2	1,509	838	267	.....	.....	.....	.....	.....	2,614	.....	3,048
3	1,459	838	40	.....	.....	.....	.....	.....	2,337	.....	2,909
4	1,349	726	39	.....	.....	.....	.....	.....	2,114	.....	2,537
5	1,200	850	36	.....	.....	.....	.....	.....	2,086	.....	2,750
6	1,047	660	187	.....	.....	5,400	.....	.....	1,894	5,400	3,074
7	938	1,267	188	.....	.....	22,250	.....	.....	2,393	22,250	3,057
8	908	1,627	500	.....	74	37,769	.....	.....	3,109	37,769	2,944
9	899	796	180.5	.....	150	12,070	.....	.....	2,025	12,070	2,830
10	1,193	736	152	.....	15	2,880	.....	.....	2,096	2,880	3,185
11	935	649	206	.....	.....	7,550	.....	.....	1,790	7,550	3,327
12	1,520	549	143	.....	.....	25,694	.....	.....	2,212	25,694	3,380
Total	14,851	10,219	2,170.5	.....	239	113,613	.....	.....	27,479	113,613	36,243
Previous to date	184,265.3	86,818.8	19,112.4	612.7	12,619.9	702,591	55,039	139,699	303,429	897,329	317,471
Total to date	199,116.3	97,037.8	21,282.9	612.7	12,858.9	816,204	55,039	139,699	330,908	1,010,942	353,714

OPERATING COSTS

	Total cost	Cost per ton ore milled
MINING:		
Exploration	$70,901.91	$0.0963
Development	328,751.78	.4465
Breaking and stoping	1,922,310.34	2.6108
	$2,321,964.03	$3.1536
Milling	585,317.20	.7949
Heating and maintenance—buildings and camps	66,448.13	.0902
Administration and general expense	90,854.19	.1234
Total	$3,064,583.55	$4.1621

ANALYSIS OF MINING COSTS PER TON MILLED

	Stoping	Drifting	Cross-cutting	Raising	Shafts and winzes	Stations and sumps	Total cost	Cost per ton
Labour	$875,025.24	$102,495.15	$55,795.42	$4,609.59	$12,243.53	$15,031.30	$1,065,200.23	$1.4467
Explosives	128,347.58	45,870.32	22,680.94	1,598.00	2,198.23	2,856.92	203,551.99	.2765
Supplies	86,858.56	8,168.93	5,187.37	389.10	8,254.81	1,448.17	110,306.94	.1498
Power	55,183.16	7,880.59	4,181.58	875.48	1,067.46	1,671.41	70,859.68	.0962
Timbering	202,811.98	.....	.....	613.85	32,532.09	3,812.39	239,770.31	.3256
Shaft repairs	3,304.14	.....	.....	.....	.....	.....	3,304.14	.0045
Back-filling	133,911.79	.....	.....	.....	.....	.....	133,911.79	.1819
Steel-sharpening	35,218.01	10,828.05	5,602.86	572.12	436.98	930.15	53,588.17	.0728
Drill repairs	24,890.79	3,602.54	1,755.99	339.70	441.83	622.94	31,653.79	.0430
Surveying and engineering	30,525.28	4,227.27	2,258.18	526.22	712.40	777.66	39,027.01	.0530
Sampling and assaying	43,725.32	2,859.24	1,537.88	336.33	.....	41.07	48,499.84	.0659
Pumping	11,502.55	1,807.52	947.35	253.96	156.93	275.44	14,943.75	.0203
Ventilating	19,284.05	936.32	504.88	101.96	4,509.61	198.01	25,534.83	.0347
Fire protection	98.00	16.01	7.24	7.20	.....	.....	128.45	.0002
Underground lighting	2,800.59	.....	.....	.....	.....	.....	2,800.59	.0038
Tramming	77,682.43	10,880.98	5,798.73	1,108.50	1,346.20	2,031.39	98,848.23	.1342
Underground crushing	8,302.51	487.60	9.90	.....	.....	.....	8,800.01	.0120
Hoisting	182,838.36	10,559.97	530.96	.....	1,670.01	1,020.08	196,619.38	.2670
Total	$1,922,310.34	$210,620.49	$106,799.28	$11,332.01	$65,570.08	$30,716.93	$2,347,349.13	$3.1881
Less undistributed development	.....	.....	.....	.....	.....	.....	96,287.01	.1308
							$2,251,062.12	$3.0573
Exploration	.....	.....	.....	.....	.....	.....	70,901.91	.0963
Total	.....	.....	.....	.....	.....	.....	$2,321,964.03	$3.1536
Unit cost per ton	$2.6108	$0.2861	$0.1450	$0.0154	$0.0891	$0.0417	.....	.....

Milling

The mill operated 98.16 per cent. of the possible running time with satisfactory costs and metallurgical results.

SUMMARY OF MILLING COSTS

	Labour	Supplies	Shop repairs and maintenance	Power	Total	Cost per ton
Crushing and conveying	$32,920.32	$28,288.88	$4,875.31	$20,457.90	$86,542.41	$0.1175
Flotation	45,838.12	127,325.30	12,427.12	71,594.69	257,185.23	.3493
Cyanidation	40,810.98	133,188.07	5,263.13	26,568.07	205,830.25	.2795
Refining	6,595.01	8,163.02	495.60	867.88	16,121.51	.0219
Assaying	6,291.41	3,288.81	1,067.23	996.46	11,643.91	.0158
Mill alterations	2,187.09	3,829.70	1,977.10	.....	7,993.89	.0109
Total costs	$134,642.93	$304,083.78	$26,105.49	$120,485.00	$585,317.20	$0.7949

Additions to Plant Buildings and Equipment

Compressor building and equipment	$28,563.90
Warehouses	19,155.20
Dust filter-mill equipment	8,364.65
Miscellaneous	6,607.97
Underground equipment	45,651.67
Total	$108,343.39

General

Veins Nos. 16, 19, and 20, located in the quartz porphyry on the 3,750- and 3,875-foot levels, will pass into the underlying basic schist at a depth of approximately 4,700 feet. From the interpretation of geological data accumulated over a period of years, we believe that these veins will become important producers below this horizon. To develop this area, an internal vertical shaft was started from the 3,875-foot level. It is located 1,500 feet south and 1,000 feet east of No. 11 shaft. The permanent hoisting equipment will be placed on the 3,750-foot level, with dumping and storage facilities above the 3,875-foot level. The plant is laid out to afford necessary ventilation, and provide a hoisting capacity of 1,500 tons in 16 hours from a depth of 3,500 feet below the 3,875-foot level. Sinking operations are well under way, and the second station is just being completed.

Development work in the north contact zone, from the west to the east end of the property, and to a depth of approximately 1,000 feet, is proving up a large number of short lenses of ore that are of good width and grade and give promise of very considerable tonnage.

March Gold, Limited

This company owns and operates five claims in Deloro township, district of Cochrane. The officers and directors of the company are as follows: Henry Kobler, Buffalo, president; B. C. Conderman, Hornell, vice-president; Edward G. Kinkel, Buffalo, secretary; F. J. C. Bull, Buffalo, treasurer; Geo. R. Feine, Chas. J. Schmidt, Henry Tiedt, Gustave Loesch, Jacob Schwingel, all of Buffalo, directors. Martin O. Knutson, South Porcupine, is mine manager.

The mine operated during the early part of the year at a reduced tonnage and finally ceased operations. The pumps and all equipment were taken to surface and the mine allowed to fill with water.

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: Dr. M. H. Lebel, Montreal, president; W. R. Salter, vice-president; M. F. Blue, secretary-treasurer; C. H. Ackerman, Peterborough; W. J. Scarrow, Sarnia; J. L. Tetreault, P. E. Lalaune, P. E. Lavallée, and B. M. Maase, Montreal, 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 25 claims and has shown up several long breaks and many different geological conditions. 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.

During the winter of 1931-32 the complete mining plant of the nearby Dunkin mine was placed on the property, and on April 6, 1932, a 12- by 7-foot

two-compartment shaft was started and sunk 239 feet. A station was cut at 211 feet, but no lateral work was done at this time. This work was completed in June and was under the direction of J. C. Nelson.

Minto Gold Mines, Limited

The officers and directors of this company are: John Knox, Jr., president; M. E. Knox, secretary-treasurer; John Knox, Sr., and M. K. Knox, directors. The authorized capital is 8,000 shares of no par value.

This company holds a working option on the Minto, Jubilee, and Cooper properties, situated near Wawa in the Michipicoten area, district of Algoma.

Production from the Minto property was continued without interruption throughout 1932. During the first four months mining operations were confined to stoping on the 1st level, during which period 6,229 tons were mined and treated in the 75-ton cyanide mill. For the balance of the year operations were confined to stoping on the 2nd level, during which period 12,537 tons of ore were mined and milled. Thus a total of 18,766 tons of ore was mined and milled during 1932.

All stoping was done by open-stope methods. No development work was done, as these levels had been opened up by previous operators.

The only addition to the plant was a Link-Belt vibrating screen, which was installed to by-pass fines around the crusher.

The company employed an average of 42 men, of whom 18 were underground. All work was in charge of John Knox, Jr., with William Hocking as mill superintendent, and Frank McLennan as mine captain.

Moss Gold Mines, Limited

The property of this company is situated in Moss township, district of Thunder Bay. It is connected by an 18½-mile road to Tip Top siding on the Fort Frances branch of the Canadian National railway, about 82 miles west of Port Arthur.

The officers and directors during 1932 were: N. R. Fisher, president and managing director; Alistair Fraser, vice-president; James Cooper, secretary-treasurer; R. Blackburn, S. C. Gzowski, J. D. Paterson, C. G. Greenshields, and R. W. Steele, directors. The authorized capital is 4,000,000 shares of $1 par value. The executive offices are at 132 St. James Street Montreal.

Underground development work accomplished during 1932 consisted of 2,047 feet of drifting, 125 feet of crosscutting, and 647 feet of raising. The drifting was distributed as follows:—

Level	Feet
500-foot	785
625-foot	632
750-foot	630
Total	2,047

Twenty-one stopes in all six levels of the mine were operated during the year. They were first worked by shrinkage methods, but there was heavy dilution because of the weak nature of the walls. This led to the adoption of cut-and-fill and stulled-shrinkage methods. A total of 28,477 tons of ore was hoisted in 1932.

Production was started upon completion of the 200-ton cyanide mill in February, 1932, and a total of 25,363 tons of ore was milled in 1932. The mill is operated by electricity generated by four Diesel engines, three of which are rated

at 250 b.h.p., and one at 125 b.h.p. Electricity is also used to operate a 325-cubic-foot compressor and the mine pumps.

Steam is used to operate four compressors, having a total rated capacity of about 1,400 cubic feet, and the 10- by 12-inch double-drum hoist. The steam plant was enlarged during the year to five boilers having a total rating of about 435 h.p.

An average of 115 men was employed during the year, of whom 19 were employed on construction and 51 underground. N. J. Everard, D. J. Russell, H. J. Darling, and J. D. Tolman, successively, were in general charge of operations. Robert Miller was mill superintendent until December, when he was succeeded by J. E. Sullivan. Alec Hattie was succeeded as mine captain by G. R. MacLaren.

Northern Empire Mines Company, Limited

This company was incorporated in 1932 with a capital of 10,000 shares of $10 par value. It is a subsidiary of the Empire Star Mines Company of California, which in turn is controlled by Newmont Mining Corporation of New York.

The officers are: Fred Searls, Jr., president; Geo. B. Agnew and David E. Thomas, vice-presidents; H. E. Dodge, secretary-treasurer; and Carroll Searls, assistant secretary-treasurer. The directors are Fred Searls, Jr., H. E. Dodge, Geo. B. Agnew, Carroll Searls, and Walter Douglas. The executive address is 14 Wall Street, New York.

This company took over the holdings of Beardmore Gold Mines, Limited, situated near Beardmore station on the Port Arthur–Long Lac branch of the Canadian National railway. To these they added several adjoining groups of claims.

Work was commenced on the property in June, 1932, and consisted of surface trenching and plant renovation until October, when underground work was started on the 150-foot level. Drifting was undertaken in both directions on this level on a three-shift schedule, and by the end of the year a total footage of 1,200 feet had been accomplished.

The renovated plant consists of two small vertical boilers, with a total rating of 35 h.p., an 8- by 10-inch Jenckes single-drum steam hoist, and two 260-cubic-foot gasoline compressors. A warehouse, gasoline supply building, powder magazine, and a bunk-house were erected to augment the old Beardmore buildings.

During the last three months of 1932 an average of 47 men was employed, of whom 30 were underground. Robert J. Hendricks is in charge of the work.

R. N. Palmer

In March, 1932, R. N. Palmer and associates obtained an operating contract with Schreiber Gold Mines, Limited, and commenced work on the property, which is located about 3½ miles south of Schreiber. It consists of mining locations B.J. 122 and 123 and was formerly known as the McKellar-Longworth property.

An old 180-foot adit was cleaned out and driven 50 feet farther, and stoping commenced on a narrow high-grade vein. The high-grade ore was picked out and bagged in the stopes, then transported to Schreiber for shipment.

During 1932 five shipments of high-grade ore were made, totalling 180 tons. Of this amount 150 tons was shipped to the Ontario Refining Company at Copper Cliff, and the balance to the Noranda smelter in Quebec.

The mining plant used consisted of a 310-cubic-foot gasoline compressor and a Rand steel sharpener. A power-house, dry-house, bunk-house, and cook camp were erected.

Ten men were employed under the direction of R. N. Palmer, of whom six worked underground.

Parkhill Gold Mines, Limited

The officers and directors of this company are: Sir Thomas Tait, president; C. F. Elderkin, vice-president; G. S. Andrews, secretary-treasurer; Geo. M. McKee, Lt.-Col. Chas. Adams, and Geo. Glendenning, directors. The authorized capital is 3,000,000 shares of $1 par value.

The property is located near Wawa in the Michipicoten area, district of Algoma.

During 1932, the two-compartment, 40-degree shaft was sunk an additional 200 feet, and levels were established at 480 feet and 600 feet on the incline.

Development footages and tonnages of ore removed by open stoping on the various levels were as follows:—

Level	Drifting	Crosscutting	Stoping
	feet	feet	tons
120-foot	nil	nil	516
240-foot	23	50	4,766
360-foot	256	nil	6,943
480-foot	1,313	15	9,826
600-foot	310	70	886
Total	1,902	135	22,937

The 60-ton cyanide mill operated throughout the year and treated a total of 16,822 tons of picked ore. A single-drum electric hoist was installed to replace the small air hoist formerly used.

The company employed an average of 68 men during 1932, of whom 44 were underground. A. R. Lawrence, J. A. S. Roussac, and Wm. T. May were successively in charge of operations under the general direction of E. S. Turner.

Rich Rock Gold Mines, Limited

This company has a capitalization of $4,000,000. The officers and directors are: Noah Dyment, Beamsville, president; Charles G. Henderson, Toronto, vice-president; D. H. Fletcher, Toronto, secretary-treasurer; George Millen, Stoney Creek, S. G. Hodgson, Frank Austin, and N. E. Odell, all of Toronto, directors. The company maintains an office at 806 Central Building, 45 Richmond Street West, Toronto.

In June, 1932, an option on the old Golden Fleece mine near Flinton, in Frontenac county, was granted to C. N. Thompson, of Toronto, by which a controlling interest might be obtained on a working basis. Under the auspices of Goodrich Gold Syndicate, sampling operations were conducted over a period of four months during the year. The mill was operated in a small way with steam power and about 150 tons of ore were hoisted and sampled in the mill, giving an average of $6.00 per ton. From one section assays as high as $17.30 average were procured from run of mine ore. No attempt was made to operate the cyanide section, which has a capacity of 250 tons per day. It was the purpose of the

syndicate to demonstrate the commercial possibilities of the property, and having done so, to incorporate a three-million-share company, acquire the controlling interest, and resume operations. It is hoped that this will be accomplished during 1933.

An average of 20 men was employed during the 4-month period of operation. C. N. Thompson was in charge of the work.

Sylvanite Gold Mines, Limited

Sylvanite Gold Mines, Limited, has an authorized capital of 3,300,000 shares of $1 par value. The officers and directors 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; Alfred H. Sharpe and Harry Yates, directors. The head office is at Kirkland Lake, and the Buffalo office is at 300 Erie Building. An average of 228 men were employed during the year.

The general manager's report for the fiscal year ending March 31, 1933, is as follows:—

Production

Some 96,140 tons were milled, or an average of 263.4 tons per day. This resulted in an increase of 1,864 tons over the previous year. The mill operated 97.2 per cent. of possible time and produced bullion amounting to $912,377.15, including exchange premium, but before deduction of $12,830.08 premium paid in purchasing U.S. funds for dividend purposes.

A slight decrease occurred, for a short period, in mill tonnage and operating time. This was caused through some difficulty being experienced at first with settlement of ore from the newly encountered sedimentary formation as compared with porphyry.

The following table shows production and tons milled for a 5-year period:—

TONS MILLED AND YEARLY PRODUCTION FOR FISCAL YEARS ENDING MARCH 31

Year	Tons	Production	Average recovery
1929	70,833	$737,573.12	$10.41
1930	75,408	690,400.14	9.16
1931	83,034	837,013.97	10.08
1932	94,276	948,926.13	10.07
1933	96,140	912,377.15	9.49

Mining

Some 66,130 tons were broken in stopes, with a further 37,467 coming from development; the total being 103,597 tons. Waste broken totalled 27,121 tons, of which 21,774 were hoisted to surface and 5,347 used for backfill. The combined total of ore and waste broken for the year was 130,718 tons.

Ore Reserves.—Broken ore was estimated March 31, 1933, at a total of 95,529 tons. This was an increase of 7,457 tons over the figure for 1932, and consisted of 89,001 tons in stopes and 6,528 tons on the ore dump at surface.

Following the practice of past yearly reports, no estimate of unbroken ore has been shown. This is due to the extreme difficulty of making such an estimate with any degree of accuracy, where ore occurrences are of the nature found to date in your mine.

Development and Exploration

A 3-year comparative statement, including total from beginning of operations, follows:—

Class of work	Year ending March 31, 1933	Year ending March 31, 1932	Year ending March 31, 1931	Total from beginning of operations to March 31, 1933
	feet	feet	feet	feet
Drifting	6,681	4,225.5	5,911.5	35,006
Crosscutting	4,201	1,638	2,506.5	19,790.5
Raising	3,029	1,128	1,232.5	9,368.5
Sublevel drifting	1,436	712.5	325.5	4,623
Box-hole raising	1,179	1,163	702.5	5,863.5
Box-hole pillar drifting	(1)	192	591.5	1,925.5
Shaft-sinking	.....	695.5	586	5,042
Total	16,526	9,744.5	11,856	81,619
Per cent. of crosscutting to total of crosscutting and drifting	38.7	27.8	29.8	36.1
	cu. ft.	cu. ft.	cu. ft.	cu. ft.
Shaft stations and sump excavations	5,610	37,359	22,768	185,878
	feet	feet	feet	feet
Diamond-drilling	11,945	4,674	5,910	54,361

[1]Included with sublevel drifting for 1933.

No. 2 Shaft Section.—Approximately 1,200 linear feet of ore of an estimated grade slightly below mill average was developed in several sections by drifting. The location was from 200 feet to and on the 3,000-foot horizon. About 71.8 per cent. of this ore was either in the sediments or on the contact with porphyry intrusions encountered north of the shaft. Ore at this point was first indicated by diamond-drilling. Later, crosscuts were driven on certain levels, followed by drifting and some stoping.

Work already completed has shown a fair tonnage, on and above the lowest level, of what is considered as a new source of ore, and it is reasonable to expect that extensions of these ore bodies will be found by further prospecting of this favourable area.

South of No. 2 shaft, on the main south vein, drifting and stoping at 2,250 and 2,500 feet proved a substantial amount of ore. An important volume, averaging about $6.00, was also indicated by diamond-drilling and developed by drifting on four levels between 400 and 1,500 feet. In addition, and within the same vertical limits, ore of $9.00 grade and about 300 feet in total length was broken during the period.

Exploration at 3,000 feet disclosed the vein as being low in grade but having continuity, favourable structure, and persistence of mineralization. More, a study of ore occurrences along this south vein system, over the extent thus far explored at Sylvanite and elsewhere in the camp, leads to the assumption that good ore possibilities exist in this part of your property below present workings.

No. 4 Shaft.—A number of branch and parallel veins were found during the year, and in several instances fairly large sections of high grade were developed. As a whole, mining operations were fully up to expectations. Broken reserves here were decreased only 16 per cent. yet 54 per cent. of the tonnage milled came from this part of the mine. Certain sections of the area still remain to be explored, and it is felt that conditions are encouraging for adding materially to known ore reserves.

Comparison of Work at No. 2 and No. 4 Shafts in Relation to Total for the Year

Shaft	Drifting	Crosscutting	Raising
	feet	feet	feet
No. 2	5,938	4,055	1,574
No. 4	743	146	1,455
Total	6,681	4,201	3,029

The extent over which mining operations were carried on was from 200 to 3,000 feet, and 86.2 per cent. of the ore treated for the year came from above 1,750 feet. At No. 2 shaft, mining was done on and between the 400- and 3,000-foot levels; and from 200 to 1,700 feet at shaft No. 4.

No sinking was done in 1932. It is now planned, however, to extend No. 2 shaft to about 3,500 feet. This will make available for intensive exploration a further and favourable block of ground about 500 feet in vertical extent.

Diamond-Drilling.—Work of this nature, amounting to 11,945 feet, greatly assisted in development and exploration carried on during the period under review.

Operating Costs

Below is shown data covering the past four years:—

	Total cost	Cost per ton		
		Ore milled	Ore broken	Total ore and waste
1930:				
Development and exploration	$206,426.48	$2.738	$2.412	$1.789
Mining	236,501.18	3.136	2.763	2.049
Milling	100,570.17	1.334	1.175	.872
General charges	50,176.06	.665	.586	.435
Administrative charges	19,756.45	.262	.231	.171
Total	$613,430.34	$8.135	$7.167	$5.316
1931:				
Development and exploration	$212,792.08	$2.563	$2.293	$1.793
Mining	267,376.14	3.220	2.882	2.253
Milling	106,575.54	1.283	1.149	.898
General charges	34,187.94	.412	.368	.288
Administrative charges	21,213.75	.255	.229	.179
Total	$642,145.45	$7.733	$6.921	$5.411
1932:				
Development and exploration	$184,936.28	$1.962	$1.711	$1.411
Mining	285,365.41	3.026	2.640	2.178
Milling	112,630.68	1.194	1.042	.859
General charges	49,478.61	.525	.458	.378
Administrative charges	24,594.16	.261	.227	.188
Total	$657,005.14	$6.968	$6.078	$5.014
1933:				
Development and exploration	$227,278.95	$2.364	$2.194	$1.735
Mining	249,907.58	2.599	2.412	1.907
Milling	105,168.81	1.094	1.015	.803
General charges	48,907.65	.509	.472	.374
Administrative charges	23,437.97	.244	.226	.189
Total	$654,700.96	$6.810	$6.319	$5.008

New Construction

Orders were placed approximately at the fiscal year-end for a new steel headframe, ore and waste bins of steel, combined skips and cages, and a larger hoist motor and suitable control. This equipment is expected to be placed in operation at No. 2 shaft not later than July, 1933. When installed, it will permit deepening the shaft to below 3,000 feet. It will also provide a substantial increase in hoisting and greater ore and waste bin capacity.

Summary

Mining and milling costs per ton treated were $0.527 below those of last year, while development and exploration expense was $0.402 above 1932. This resulted in total operating costs for the two years being about equal.

The past profitable basis of operation was maintained. Dividend requirements (slightly increased) were met, and a substantial amount was added to surplus. Further, the situation regarding deep-level development in the sediments, hitherto unproductive, was much improved. This tends toward additional confidence in future ore possibilities at your property.

Tashota Gold Mines, Limited

The authorized capital of this company is 4,000,000 shares of $1 par value. The officers of the company are as follows: H. H. Vaughan, president; F. C. Shorey, vice-president; P. W. Ogden, secretary-treasurer. The directors are: Thos. Arnold, R. M. Davy, and J. Bonsall Porter, Montreal; E. R. Read and L. Soliague, Toronto.

The property held by the Tashota Gold Mines, Limited, consists of 8 claims in the Tashota area, district of Thunder Bay, and 21 claims in the Boston Creek area, McElroy township, district of Timiskaming.

The mine in the Tashota area was idle from March, 1930, to September, 1931, when work was again resumed. Some 140 feet of drifting was done up to the end of the year. Work ceased on March 5, 1932. An average of 10 men was employed during the period of operation.

A total of 1,700 feet of lateral work has been done on two levels, and about 5,000 feet of diamond-drilling from surface and underground. W. A. Coughlin was manager.

Teck-Hughes Gold Mines, Limited

Teck-Hughes Gold Mines, Limited, has an authorized capital of 5,000,000 shares of $1 par value, of which 4,467,144 shares are issued. The officers and directors are: Albert W. Johnston, chairman of the board; D. L. H. Forbes, president; George C. Miller, vice-president; Conrad E. Wettlaufer, secretary; K. P. Emmons, treasurer; P. Nugent Tapley, assistant treasurer. The operating officials are D. L. H. Forbes, general manager; R. J. Henry, general superintendent; George Gill, mine superintendent; H. N. Read, mill superintendent, and J. G. McMillan, exploration superintendent. Some 690 men are employed at the mine in the township of Teck, district of Timiskaming.

The report of the general superintendent for the fiscal year ending August 31, 1932, is as follows:—

During this period, 475,700 tons of ore were treated. Bullion amounting to $5,953,687.37, or $12.52 per ton, was recovered. The value of this bullion is the equivalent of 288,009.69 fine ounces of gold. The gross revenue was $6,824,238.98, or $14.35 per ton. Including the sum of $303,658.51 charged for depreciation on buildings and fixed plant, the total operating cost was $2,663,067.05, or $5.60 per ton. After making provision of $437,880.62 for taxes, the surplus was $3,723,291.31. From this surplus was paid extra federal income tax and extra Ontario corporation tax, due to a retroactive increase in rate for 1931, totalling in all $45,296.53, and dividends amounting to $3,122,643.60.

Following is an analysis of operating costs:—

	Total cost	Cost per ton of ore treated	Cost per ounce of gold produced
Development and exploration	$593,952.22	$1.25	$2.062
Mining	1,054,386.01	2.22	3.661
Milling	472,489.89	.99	1.641
General expense	237,310.50	.50	.824
Examination of new properties	1,269.92	.....	.004
Depreciation	303,658.51	.64	1.054
Total	$2,663,067.05	$5.60	$9.246

New construction charged to capital account absorbed $16,726.27. Most of this was spent underground on the completion of the south shaft extension hoist on the 29th level and the drill-steel sharpening shop on the 30th level.

Results from further development on levels from the 25th to the 30th permitted an addition to the ore reserves of an important tonnage of ore of higher grade than was estimated a year ago in this part of the mine. Besides the elaboration of development details above the 30th level, eight new levels below the 30th were started from No. 2 winze.

At the end of the fiscal year, south shaft extension had been sunk to a depth of 4,864 feet, and station-cutting for the 40th level had been commenced, while No. 2 winze had reached a depth of 4,611 feet.

Classified under the usual headings, the year's development work was as follows:—

	Feet
Drifting	10,301.8
Crosscutting	1,902
Raising	3,241
Winzing	1,193.5
Shaft-sinking	1,303.3
Total development	17,941.6

Diamond-drill exploration amounted to 9,371.3 feet. Ore produced from development amounted to 24,774 tons.

Milling costs were 15 cents a ton lower than for 1930–31, due, in part, to the larger tonnage milled and, in part, to an increase in general efficiency and many small improvements.

The technical estimate of "positive ore" reserve at September 1 is as follows:—

	Tons	Gross value	Average grade
Broken ore	335,135	$4,032,254	$12.03
Blocked ore	291,354	3,899,084	13.38
Total	626,489	$7,931,338	$12.66

The estimated average stoping grade of blocked ore, below the 30th level is $9.68.

Toburn Gold Mines, Limited

The Toburn Gold Mines, Limited, which has a capital of 2,000,000 shares of $1 par value, was formed as a subsidiary to the Premier Gold Mining Company, Limited, to acquire the option from the Bunker Hill Extension Mines, Limited, to purchase the Tough-Oakes Burnside mine in the township of Teck, district of Timiskaming, from the bondholders of the bankrupt Tough-Oakes Burnside Mines, Limited. The officers and directors are: H. A. Guess, president; J. C. Emison, vice-president; G. A. Brockington, secretary; R. F. Goodwin, M. P. Van Der Voort and W. J. Boland, directors. M. W. Hotchkin is superintendent of the mine in Kirkland Lake. The office in New York is at 120 Broadway, and in Toronto at 217 Bay Street, in care of W. J. Boland. The property consists of 343 acres adjoining the Sylvanite mine on the east. The average number of men employed in 1932 was 82, and 11 men were employed on construction.

The development work underground consisted of the following:—

	Feet
Raising	716
Drifting	1,176
Crosscutting	939
Diamond-drilling	2,442

The mill started on August 4, 1932, and to the end of the year milled 14,689 tons at an average value of 0.819 ounces. to the ton. The production was $203,641.93, and a premium of $24,314.48 was received.

Triple Lake Mines, Limited

This property consists of four claims, Nos. 11,209, 11,210, 11,742 and 12,112 in McArthur township, district of Timiskaming, about 20 miles due south of South Porcupine. The property has been operated by John Spence and E. W. Ahr, of South Porcupine, during the year. The company has a capitalization of 500 shares of $100 par value. John Spence, E. W. Ahr, and L. E. Ahr are directors.

The property can be reached by winter road from Timmins and in summer by canoe up the east branch of Mountjoy creek. It is best reached by air from South Porcupine, being only about a 15-minute flight.

The vein, upon which a small shaft has been sunk some 10 feet, outcrops on the east shore of Triple lake on claim No. 11,209 and strikes a little north of east. To the south of this along the shore some quartz stringers occur showing some mineralization. The enclosing rocks are greenstones, which are quite schistose. The rocks are little exposed on account of very heavy overburden.

During the winter of 1932 some small milling equipment was placed on the property, and in July operations were commenced, putting through about 100 tons of ore taken from the shaft and pit. A fair recovery was made considering the equipment, and plans are under way to operate on a larger scale.

In the fall, about 500 feet of diamond-drilling was done, and the vein was tapped about 100 feet below surface. It is understood that the values shown were encouraging.

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: R. Home Smith, president; John H. Black, vice-president; J. Ingram, secretary. The directors are: John H. Black, R. Home Smith, A. Dorfman, Toronto; W. H. Stafford, Almonte, Ont.; R. T. Shillington, Haileybury, Ont.; F. H. Hamilton, E. Turk, London, Eng. Robert E. Dye is manager.

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 following summary of company operations is taken from the report of the directors in the tenth annual report for the year ending July 31, 1932:—

The mine and mill were in continuous operation during the year and produced bullion to the value of $478,021.52, representing a recovery of $4.69 per ton from 102,000 tons milled. The cost of production amounted to $593,248.06, or $5.82 per ton milled, as against $5.77 per ton in the previous year.

The operating loss for the year under review (before allowing for depreciation and writing off other charges) amounted to $6,417.97. The net current assets of the company, not including the shares of Huronian Mining and Finance Company, Limited, amounted to $827,084.91, as against $821,404.10 in the previous year.

The following is taken from the report of the manager for the year ending July 31, 1932:—

Results of Development

Development work done during the year was directed mainly to a further search for extensions of the Porcupine Crown vein and associated bodies at and below the 1,000-foot level, and to a

vigorous investigation at the 1,450-foot level of No. 9 vein, especially in those parts below the Central system and below the southeastern nose. In addition to these items, considerable work was done in a search for extensions of the 5-8 system south of former workings from the 500-foot level down to the 733-foot level. Considerable work was done also in the older parts of the mine in making an intensive search for any deposits which might have been overlooked in the course of former work. Each of these items yielded some ore, but on the whole results of development work have been disappointing, both as regards this year's work and as regards the expanded development programme as a whole, which programme was undertaken in the fall of 1930.

While a total of 1,713 feet of drifting has been done in the Crown area at various horizons from the 1,000-foot level down to the 1,450-foot level, less than 20 per cent. of the ground opened up represents minable ore of even marginal grade. The work at the 1,450-foot level on No. 9 vein at the southeastern nose gave negative results. Drifting on the northern part of No. 9 vein in the region below the Central system exposed a section showing average values of $3.97 over a width of 55 inches and for a length of 55 feet. A prospect stope was put through on this showing, which was found to represent a restricted lens of ore of medium grade extending from the 1,450-foot level up to about 100 feet above the 1,000-foot level.

The work done in the southern part of the 5-8 system from the 500-foot level down to the 733-foot level disclosed no lenses comparable with those previously found in the region of the shaft. Work done in the older parts of the mine has resulted in the recovery of some salvage ore and a few fragmentary parts of formerly mined veins, but has not contributed in a big way to current ore resources.

Summary of Underground Operations

During the fiscal year ended July 31, 1932, the following development work was done:—

Operation	Feet	Total cost	Cost per foot
Drifting and crosscutting	8,151.5	$86,351.54	$10.59
Raising	1,172	17,550.14	14.98
Diamond-drilling	25,610	32,618.14	1.27

The Mill

The mill operated continuously during the year, and the following data will indicate the results obtained:—

Tons milled	102,000
Average value per ton	$5.13
Gross value	$523,233.24
Bullion recovered	$478,021.52
Average running time, per cent.	95.42

PRODUCTION

From bullion produced during the year	$478,021.52
From bullion produced during former years	6,094,584.75
Total	$6,572,606.27

The above figures do not include bullion produced by the Porcupine Crown (approximately $2,871,816) before the property was acquired by this company.

COST OF PRODUCTION

	Total cost	Cost per ton
Development	$136,519.82	$1.34
Ore extraction	258,537.06	2.53
Crushing, conveying, milling, and refining	111,989.35	1.10
Shipping and marketing bullion	3,507.30	.04
Administration and general expenses	58,175.93	.57
Taxes, municipal	2,847.36	.03
Insurance, including compensation	21,671.24	.21
Total	$593,248.06	$5.82

Conclusion

Ore resulting from the development work done during the past two years has fallen far short of meeting mill requirements. Formal reserves have been depleted to such an extent that the bulk of the present ore supply is coming from prospect stopes, raises, salvage operations, etc., all of which are becoming increasingly expensive.

Wright-Hargreaves Mines, Limited

The Wright-Hargreaves mine has an authorized capital of 5,500,000 shares of no par value. The officers and directors of the company are: Oliver Cabana, Jr., president; W. H. Wright, vice-president; Gerard F. Miller, treasurer; E. L. Miller, secretary and managing director; James Y. Murdoch and Oliver G. Donaldson, directors.

M. W. Summerhayes is general manager, and 780 men were employed during the year. The report of the general manager for the year is as follows:—

During this period 295,525 tons of ore, having an average grade of $12.85 per ton, were treated in the mill, producing bullion to the value of $3,546,902.85.

ANALYSIS OF OPERATING COSTS

	Total	Cost per ton milled
Development and exploration	$455,880.65	$1.542
Less: Excess of tons developed to tons milled	183,130.12	.619
Development cost	272,750.53	.923
Stoping	612,646.27	2.073
Transporting ore (hoisting, etc.)	250,981.53	.849
Milling charges	321,023.85	1.086
Marketing bullion	18,783.68	.064
New road construction and general surface	29,706.69	.101
Stock transfer and registrar charges	4,828.11	.016
Rents, cottage operation, etc	1,834.60	.006
General and undistributed charges (storehouse, maintain. misc. mine buildings, administration and management, property taxes, insurance, interest and exchange, legal expenses, miscellaneous)	172,427.49	.583
Depreciation plant and equipment	176,303.17	.597
Total	$1,861,285.92	$6.298

SUMMARY OF DEVELOPMENT AND EXPLORATION

December 31, 1932

	Drifting	Shaft-sinking	Cross-cutting	Raising	Total footage	Diamond-drilling	Excavation
	feet	feet	feet	feet		feet	cu. ft.
December 31, 1931	95,313	6,016	29,334	4,992	135,655	60,975	136,877
Fiscal year	16,508	4,175	7,717	1,655	30,055	17,679	73,091
December 31, 1932	111,821	10,191	37,051	6,647	165,710	78,654	209,968

PRODUCTION RECORD, 1921-1932

Year	Tons milled	Value per ton	Gross value	Recovery per ton	Bullion produced	Dividends
1921 (8 months)	36,081	$13.96	$503,302	$13.00	$468,665	.....
1922	66,181	12.49	827,447	11.52	762,752	$412,500
1923	79,242	10.48	830,992	9.52	754,978	206,250
1924	84,487	14.16	1,194,217	12.89	1,088,725	206,250
1925	147,939	14.49	2,148,554	12.93	1,913,401	550,000
1926	153,392	15.66	2,400,795	14.02	2,150,844	893,750
1927	209,164	11.77	2,455,460	10.51	2,151,916	1,237,500
1928	256,331	8.36	2,144,002	7.20	1,845,923	825,000
1929	188,238	10.29	1,938,552	9.25	1,741,872	.....
1930	220,430	12.20	2,687,828	11.03	2,431,896	.....
1931	266,352	11.73	3,124,533	10.93	2,912,308	825,000
1932	295,525	12.85	3,796,295	12.00	3,546,903	1,100,000
Total	2,003,362	$12.01	$24,051,977	$10.87	$21,770,183	$6,256,250

MILLING STATISTICS

January 1 to December 31, 1932

Ore milled	tons	295,525
Average value per ton		$12.85
Gross value		$3,796,294.80
Loss in tailings		249,391.95
Net value recovered		$3,546,902.85

Average tons milled per day		807.45
Per cent. of possible running time		97.87
Tons 100 per cent. running time		825
Solution precipitated	tons	665,318
Solution precipitated per ton of ore	tons	2.25
Value per ton in tailings		$0.84
Per cent. extraction		93.43
Cyanide consumed per ton of ore (K.C.N.)	lbs.	.343
Zinc consumed per ton or ore	ounces	1.088
Zinc consumed per ton of solution	ounces	.483
Lime consumed per ton of ore	lbs.	3.710
Average value of pregnant solution		$5.35
Average h.p. consumed per day		1,434
Average h.p. consumed per ton		1.78
Power cost per h.p. consumed		$68.89

ORE RESERVES ESTIMATE

	Tons	Grade	Value
On hand January 1, 1932	753,510	$11.65	$8,776,551
Developed in 1932	493,954	16.01	7,910,636
	1,247,464	$13.37	$16,687,187
Milled in 1932	295,525	12.86	3,799,145
Ore reserves, December 31, 1932	951,939	$13.54	$12,888,042

ADDITIONS TO PLANT, BUILDINGS, AND EQUIPMENT, 1932

Coarse crushing plant	$10,999.91
Power-house equipment	8,891.93
Substation and equipment	12,415.10
No. 3 hoist-house and equipment	57,171.98
No. 4 hoist-house and equipment	17,320.58
Dry-house equipment	1,559.18
Incinerator	3,090.69
Shops and equipment	10,758.82
General buildings	5,354.84
Mill and equipment	72,210.60
General surface	9,659.88
Underground equipment	29,496.13
Total	$238,929.64

Development

The programme of development work during the period under review has given most satisfactory results; some 493,954 tons of ore were developed, having an average grade of $16.00 per ton. After deducting 295,525 tons milled, there were 198,429 tons added to ore reserves. Due to the higher average grade of ore developed, the average of the total present reserves has been increased to $13.54 per ton, as against $11.65 per ton last year. Some 16,508 feet of drifting was done. Of this, 8,019 feet, or 48.6 per cent., was on ore.

The outstanding feature of this year's developments was the continuous character of the North vein ore body on the two lowest levels, the 2,850-foot and the 3,000-foot. Approximately 1,500 feet of ore on each of these levels has been opened up with ore still to be developed at each end. The grade of ore on these two levels and on this vein is over $20 per ton for the lengths so far opened up. Developments on the 2,400- and 2,550-foot levels were also eminently satisfactory.

As reported in our last annual report, the 2,700-foot level coincided with a roll in the vein, so that not much development has been done at this horizon. It is interesting to note that 523 feet of ore were opened up between the 400- and 1,375-foot levels. Also, 685 feet were developed between the 1,500- and 2,125-foot levels, while on the five lower levels 6,811 feet of ore were opened up; 2,329 feet on the 2,850-foot level and 1,606 feet on the 3,000-foot level.

It may be remarked that there is prospectively good virgin territory on all levels above the 3,000-foot level, which is the present lowest development level. As opportunity offers, these areas are being thoroughly explored.

Shaft-Sinking

No. 4 shaft was deepened to 3,710 feet, or 3,409 feet for the 12 months, at a cost at this date of less than $100 per foot. This shaft will be finished early in February and put into operation this summer. No. 3 shaft was deepened to 3,889 feet, or 766 feet during the year. The sinking programme should be finished by the first week in February.

Milling

During 1932 the full benefits of the changes made in 1930 and 1931 were felt, allowing over 800 tons per day to be milled without seriously affecting the extraction; in fact, a slightly higher extraction was made. As a result of the work done in the pilot mill, it was demonstrated that a change in the flow-sheet would have material benefits. A further increase in extraction is made possible, also a great saving in floor space may be made, allowing an increase of tonnage to be planned within the present mill building. Our plans for increasing the capacity of the mill from 800 tons to 1,000 tons per day are well under way. Construction should start in the spring and will be completed in the fall.

Costs

So as to preserve more accurate and comparative operating cost figures, it has been thought advisable to defer the expenditures for sinking No. 4 shaft, and we expect to write the deferred amount off during the following four years. Inasmuch as the shaft will only be completed and put into operation this year, the first amount to write into operating costs will come at the end of this year. As in past years and for the same reasons, the difference between ore developed and ore milled is written off surplus.

Young-Davidson Mines, Limited

This company is a subsidiary of Hollinger Consolidated Gold Mines, Limited, which has an option on the property in the Matachewan area, district of Timiskaming. An account of the operations will be found on page 72 of this report.

GRAPHITE

Black Donald Graphite Company, Limited

Owing to adverse market conditions this company only operated the mine and mill intermittently during 1932, the total period of operation amounting to nine weeks.

Considerable stocks of the various grades of graphite have been accumulated, and from these 346 tons were shipped to Canadian, English, and American users.

During the period of operation 6 men were employed in the mine and 10 in the mill.

R. F. Bunting, Calabogie, is manager. R. A. Telfer, Calabogie, is secretary of the company.

GYPSUM

Canadian Gypsum Company, Limited

The Canadian Gypsum Company, Limited, has a capitalization of $300,000, in shares of $1 par value. The officers and directors of the company are: S. L. Avery, president; R. G. Bear, secretary-treasurer; O. M. Knode, C. F. Henning, and J. E. MacLeish, all of Chicago, directors. The head office is at 1221 Bay Street, Toronto. The head office officials are: B. S. Barns, agent and comptroller, and F. B. Gibbs, manager. Otis Wack, Windsor, N.S., is director of operations.

The company operates a gypsum mine and plant near Hagersville, in Oneida township, Haldimand county. All commercial gypsum products are produced at the plant, which includes a mill, wall board and block manufacturing buildings. During 1932 an average of 25 men was employed. W. E. Allen, Hagersville, is superintendent.

The company also operates a quarry and lime plant at Guelph, a large gypsum quarry at Windsor, N.S., a gypsum mill at Hillsborough, N.B., a gypsum calcining mill at Iona, Cape Breton, and a winter gypsum storage depot at Deep Brook, N.S.

Associated with the company is the Gypsum Packet Company, Limited, operating four 7,000-ton freight and passenger steamers between Nova Scotia and United States ports.

Gypsum, Lime and Alabastine, Canada, Limited

The Gypsum, Lime and Alabastine, Canada, Limited, operated the mines and mills at Caledonia, Seneca township, and Lythmore, Oneida township, Haldimand county, during the entire year. L. V. Robinson is general superintendent. The head office is at Paris, Ont.

At Caledonia 20,195 tons of rock were hoisted. J. D. Kerr was superintendent, employing an average of 54 men.

At Lythmore the three-entry room-and-pillar system was continued. There were mined 4,208 tons of rock. Joseph Mark was superintendent, employing an average of 28 men. The Lythmore property shut down at the end of the year.

In addition to the Caledonia and Lythmore mines, the company operates gypsum plants at Montreal, Winnipeg, Vancouver, and Calgary.

Lime plants are situated at Beachville, Elora, Hespeler, Milton, Limehouse, and Puslinch, Ont., and at St. Mark and Joliette, Que.

Quarries are operated at Mabou, N.S., Gypsumville, Man., and Salmon River, B.C. The alabastine plant is at Paris, Ont.

NICKEL AND COPPER

Falconbridge Nickel Mines, Limited

The officers and directors of this company are: Thayer Lindsley, president; Halstead Lindsley and J. Gordon Hardy, vice-presidents; N. F. Parkinson, secretary-treasurer; W. S. Morlock, director. The authorized capital is 5,000,000 shares of no par value. The head office is at 100 Adelaide Street West, Toronto.

The following information is extracted from the annual report of the company covering the year ending December 31, 1932:—

Production during the year was affected by several interruptions to operation. The principal of these consisted of delays occasioned through the necessity of having to reline the furnace and settler, and an 11-day period in December when the blast furnace was extended from 10 to 15 feet, along with the necessary changes and added equipment to increase the scale of production approximately 50 per cent. The smelter was operated on the increased basis very successfully for the remaining twenty days in December.

Mine Development

Combined development footages on all levels during the period under review are distributed as follows:—

Drifting and crosscutting, including slashing	feet	2,585
Raising	feet	748
Box-holes		44
Diamond-drilling	feet	603

Of the total of 2,585 feet of drifting and crosscutting recorded, 526 feet was driven west along the ore zone on the 350-foot level. This drive revealed an average ore width of 7 feet for the total distance of average mine run. On the 500-foot horizon a station was cut and a main crosscut driven 140 feet north to the ore body. Drives were then made east and west along the ore zone, the former being opened up for a distance of 134 feet in ore. The west drift was extended 924 feet. Although this drift was in ore for the total distance, the first 624 feet was for the greater part low grade over widths of from 20 to 30 feet, while the last 300 feet of the drift showed an average width of 30 feet of ore better than mine run. This ore continues in the present face. A station was opened up on the 750-foot level and connected by a main drive to the ore body. Not a great deal of work was accomplished on this level during the year; however, the ore appears to be of good grade, with an approximate width of 23 feet. No extensions were made on the 1,000-foot, or bottom, level during the period under review.

Development was preferably kept away from the east end of the mine, owing to a strong fault zone crossing the ore-bearing contact in that direction, and acting as a water-course, which we are not desirous of draining at this time. The western section responded kindly to the work done, and may be said to have replaced all the ore smelted during the year, plus some 200,000 tons more.

A two-compartment shaft was put down vertically from surface, 100 feet north of the main shaft, to connect with a series of raises from the 1,000-foot level. This shaft will be equipped for back-filling as well as a permanent mine exit.

Ore Reserves

Following is a tabulation of ore reserves computed to December 31, 1932:—

	Tons
Ore reserves as at December 31, 1931	2,725,382
Plus new ore added, 1932	314,648
Total	3,040,030
Less: hoisted during 1932	159,573
Balance	2,880,457
Plus disseminated ore on surface dump	40,000
Total ore reserves (averaging 2.25 per cent. nickel, 0.93 per cent. copper), December 31, 1932	2,920,457

Of this tonnage over two million lies above the present bottom of the mine (1,000 feet) and promises, say, eleven years' life at the rate of 200,000 tons per year, which is present maximum expectancy of production. The rest of the reserve tonnage lies beneath the 1,000-foot level, and was intersected by diamond-drilling.

Mining

The following table sets forth the result of mining activities during the year:—

	Tons
Balance broken ore in stopes, December 31, 1931	124,407
Broken during 1932	247,004
Total	371,411
Less: hoisted from stopes during 1932	144,090
Broken ore reserves, December 31, 1932	227,321

From the total ore hoisted, amounting to 159,573 tons (144,090 tons from stopes and 15,483 tons from development), 22.2 per cent, or 35,427 tons, of combined waste and disseminated ore was eliminated during the various stages of crushing. The balance of 124,146 tons was transported by the aerial tram to the smelter bins.

Smelting

The average grade of ore smelted in 1932, 2.50 per cent. nickel and 1.04 per cent. copper, is somewhat above the average of our reserves. This was determined by the exigencies of our one-unit direct-smelting plant, requiring as it does a relatively low-silica ore to function economically, and thereby necessitating hand-sorting of the ore as mined. The smelter was in operation a total of 341 days during the year. Results tabulate as follows:—

Tons of ore smelted: 123,306	Nickel	Copper
Metals recovered.....tons	2,908.17	1,196.63
Metals per ton in ore.....lbs.	50.17	20.91
Metals recovered per ton ore.....lbs.	47.17	19.41
Metallurgical losses.....lbs.	3	1.5

Construction

On September 1, 1932, authorization was granted to commence work on foundations for a 250-ton concentrator, sintering plant, smelter extension, and the necessary additions to the the crushing plant and ore bins that would be required to synchronize with these units to effect increased capacity. Early in October further permission was granted to make preparations for the purchase of machinery and equipment essential to the completion of the plant during the winter months. Satisfactory progress has been made on this work, and barring unforeseen delays, the new plant will be in operation some time during the month of April.

Refinery

The refinery situated at Kristiansand, Norway, operated satisfactorily without any close-down during the year, with a somewhat increased production, which during the last months reached 9 metric tons daily. Several times during the year the production was slightly slowed down on account of lack of matte. Almost the normal amount of custom matte was received during the year.

At the end of the year, construction work was going on for increasing the capacity of the refinery by 1,000 metric tons annually.

Sales

The production of refined nickel in 1932 totalled 5,408,373 pounds. Our sales, on the other hand, aggregated 7,844,648 pounds, thereby permitting us to move the stock carried forward from 1931 and end the year with only a modest surplus. Copper was sold practically as produced, our cathodes having met with acceptance in Scandinavia particularly.

During 1932 an average of 289 men was employed, exclusive of construction work, in Ontario, of whom 96 were employed underground. In addition, an average of 137 men was engaged in construction work during the last four months of the year.

Ernest Craig is superintendent; J. R. Gill, smelter superintendent; and R. Oliver, mine engineer.

International Nickel Company of Canada, Limited

The officers of this company are: Charles Hayden, chairman of the board; Robert C. Stanley, president; John F. Thompson, vice-president; Paul D. Merica and John C. Nicholls, assistants to the president; James L. Ashley, secretary-treasurer.

The directors whose term expires in 1933 are: James L. Ashley, John F. Dulles, Wm. T. Graham, Reg. Halladay, Charles Hayden, J. W. McConnell, Britton Osler, J. A. Richardson, Robert C. Stanley, Andrew V. Stout, John F. Thompson, and the Rt. Hon. Lord Weir.

The directors whose term expires in 1934 are: John P. Bickell, Hon. H. Cockshutt, Wm. E. Cory, Wm. N. Cromwell, D. Owen Evans, Wm. J. Hutchinson, Sir Harry McGowan, Wm. W. Mein, Rt. Hon. Lord Melchett, Sir Robert L. Mond, Thomas Morrison, Seward Prosser, and Grant B. Shipley.

The executive office is at 67 Wall Street, New York City, and the general offices of the mining and smelting division are at Copper Cliff, Ont.

This company and subsidiary companies operate hydro-electric power plants at High Falls, Big Eddy, Wabageshik, and Nairn Falls, Ont.; nickel-copper mines in Sudbury district, Ont.; smelters at Copper Cliff and Coniston, Ont.; refineries at Port Colborne, Ont., Acton, England, and Clydach, Wales; rolling mills at Birmingham, England, Huntington, W.Va., and Glasgow, Scotland; a colliery at Pontardawe, Wales; and a foundry at Bayonne, N.J.

The authorized capital of this company consists of $27,679,900 of preferred shares of $100 and $5 par value, and 15,000,000 shares of common stock of no par value.

The following information is extracted from the annual report of the company covering the year ending December 31, 1932:—

General

This report for 1932 marks the third year of the current world-trade depression. Your company's volume of sales dininished rapidly, and the price of copper fell to the lowest figure of all time. During the second quarter the nickel business was at its lowest rate, after which there was a slight improvement for the remainder of the year.

In order to maintain a strong financial position drastic retrenchment was effected throughout all branches of your company's activities. With the completion of major construction items, capital expenditures during 1932 were very much less than in former years and should be even less in the current year, as there is little probability of any new construction being required for some time to come.

Sales

Sales of nickel in all forms, including nickel in alloys, amounted to 34,406,953 pounds, compared with 55,739,047 pounds in 1931, a decrease of 38 per cent. The world's consumption of nickel in all forms aggregated 57,000,000 pounds compared with 73,000,000 pounds in 1931 and 88,000,000 pounds in 1930.

Copper sales, inclusive of copper sulphate produced in Wales, decreased from 96,919,677 pounds to 57,662,789 pounds, or 41 per cent.

Gold sales were 23,042 ounces, silver sales 652,638 ounces, and sales of platinum metals 19,300 ounces.

Ore Reserves

Proven ore reserves as at December 31, 1932, were 203,909,973 tons. Because of this adequate tonnage of available ore your management deemed it unnecessary to carry on other than a minimum of development work. During this period of retrenchment no exploratory work can be justified since it is known that large additional tonnages may be added to ore reserves whenever it is considered expedient to incur the necessary expense.

Outlook

Deliveries of nickel, both domestic and foreign, recorded a slight improvement beginning in the third quarter of 1932. Your company's sales policy, including technical development and

research, stood the test of depression, and the relatively satisfactory showing made in the past year may be credited to it more than to any other contributing factor.

The futility of attempting to forecast business conditions has become more and more apparent as the years of trade stagnation continue. Business is now marking time at its lowest ebb in generations. However, your company's market is world-wide and well diversified; its mines and plants are highly efficient, and metal inventories are not excessive. World industry has passed through severe storms in the past, and your company, whose financial condition is strong, should be considered well equipped to weather this particular storm.

ONTARIO OPERATIONS

Hydro-Electric and Metallurgical Plants

Hydro-Electric Plants.—Owing to general curtailment, the Wabageshik station and two units at the Big Eddy station were sufficient to supply power requirements. The High Falls station was shut down May 1, and the Nairn Falls station was idle throughout 1932.

Surplus electrical power was used for heating during the winter, and to effect this economy electric steam boilers were installed at Coniston and Garson mines.

Copper Cliff Concentrator.—Mill operations were greatly curtailed during the year, there being only 579,640 tons milled, or about 20 per cent. of capacity. Notwithstanding restricted operations definite metallurgical advances were made, and experimental work continues to be actively prosecuted.

Copper Cliff Smelter.—Three reverberatory furnaces were operated until the end of March, after which two furnaces were used for the remainder of the year. The smelter treated 336,215 tons of dry concentrates and produced 27,033 tons of bessemer matte and 27,770 tons of blister copper.

The Orford process plant was started in March, 1932, and ran intermittently throughout the year. No difficulties were experienced with any of the equipment and results indicate that with increased tonnage the lower operating costs assured in this plant will fully justify its transfer from Port Colborne to Copper Cliff. This plant treated 11,370 tons of bessemer matte and produced 6,651 tons of matte for refining at Port Colborne and 2,249 tons of blister copper.

Coniston Smelter.—This smelter was operated from January to July and has been shut down since that time. During the period of operation 90,606 tons of ore were smelted and 9,679 tons of bessemer matte produced. There was no construction at this plant during the year, but the smelter has been maintained in first-class condition.

Port Colborne Refinery.—There were two electrolytic units in operation from January 1 until August 1, when operations were suspended. The refinery produced 14,125,388 pounds of nickel in the form of electrolytic cathodes and nickel in oxide. An interesting development was the utilization of electric power for heating. Practically all power purchased was required during the winter, 2,000 k.w. being used for heating electrolytic tank solutions.

Ontario Refining Company, Limited (Associated Company).—In consequence of the reduced rate of world consumption of copper, the Ontario Refinery operated throughout the year at a greatly reduced rate, even as compared with that of 1931. Nevertheless, it was possible to hold the cost of copper refining at a level only slightly above that of 1931. Refined copper was shipped from the refinery to practically all copper-consuming countries and the ORC brand of copper is now well established throughout the world.

Your company's present 42 per cent. stock interest may be increased upon termination of the present copper purchase contract.

Mines

During 1932 there was mined a total of 666,468 tons of ore, of which the Frood mine supplied 513,590 tons; Creighton mine, 96,850 tons; and the Garson mine, 56,028 tons. This is a decrease in total tonnage of ore mined of about 58 per cent. from 1931, when 1,580,355 tons were mined.

Frood Mine.—Frood mine development to date, including shafts, drifts, crosscuts, raises, winzes, and box-holes, aggregates 137,515 feet or approximately 26 miles. During 1932, 10,337 feet of this total were accomplished. There are now 68 stopes prepared in this mine to yield 150 tons per day per stope.

No. 1 ventilating shaft was completed to the 3,100-foot, or bottom, level and has made for pronounced improvement in underground air conditions. The

average temperature underground is now 67° F., as compared with 78° F. prior to the installation of the new ventilating system. The relative humidity has also been decreased by 10 per cent. The fact that ore per man mined in stopes has increased about 36 per cent., and that there has been a decrease of approximately 60 per cent. in lost-time accidents is largely due to improved ventilation.

During the year, work was continued on the return air raise system between the 2,000-foot level and surface. The reconditioning and equipping of No. 4 shaft for high-speed hoisting were completed in July, 1932, since when all ore has been hoisted through this shaft.

Stopes were worked, principally by filled square-set methods, on the 2,400-, 2,600-, 2,800-, 2,950-, and 3,100-foot levels.

H. J. Mutz is mine superintendent; F. J. Eager and A. L. Sharp, assistant mine superintendents; and A. F. Brock, operating engineer.

Creighton and Garson Mines.—These mines were operated at minimum capacity from January 1 to August 1 and were closed for the remainder of the year. Conforming to the policy of curtailment, development work in all mines was restricted and exploratory work entirely suspended.

S. J. Kidder is mine superintendent at Creighton, and W. J. Mumford at Garson.

An average of 1,914 men was employed in the Sudbury area during 1932, distributed as follows: Creighton, 131; Frood, 797; Garson, 74; Levack, 12; Copper Cliff, 780; and Coniston, 120. Of these, an average of 702 men was employed underground.

Donald MacAskill is general manager; E. A. Collins, assistant to the general manager; and R. D. Parker, general superintendent of mines.

RADIUM

Canada Radium Mines, Limited

Canada Radium Mines, Limited, has an authorized capital of 2,500,000 shares of no par value, of which 1,381,475 are issued. The property consists of 750 acres in Cardiff township, Haliburton county. The officers and directors are Kenneth W. Wright, Toronto, president; George F. McCandless, vice-president; Frank Austin, director; E. W. Austin and Jacob Kohler, directors; Chas. G. Henderson, Toronto, secretary-treasurer. The head office is at 9 Adelaide Street East, Toronto. In 1932 and to March, 1933, when the property was closed, the following work was done: shaft-sinking, 125 feet; drifting, 200 feet; crosscutting, 50 feet.

An average of 20 men was employed during the time of operation.

SILVER

Arthur Brocklebank

The Kerr Lake mine in Coleman township, district of Timiskaming, was operated under lease by Arthur Brocklebank throughout 1932.

Shipments of ore amounted to 135.73 tons, which yielded $53,132 in silver.

Cain and Taylor

The Beaver mine in Coleman township, district of Timiskaming, was operated throughout 1932 by the owners, C. E. Cain and W. D. Taylor.

Ore having values of $61,430.47 in silver and $275.66 in cobalt was shipped. An average of 13 men was employed.

Hudson Bay Mines, Limited

The Hudson Bay mine in Coleman township, district of Timiskaming, was leased to the Hudson Bay Mines, Limited, during 1932.

From 7.6 tons of ore hoisted and shipped to Deloro, values of $3,580.07 in silver and $47.14 in cobalt were obtained. An average of 3 men was employed.

D. L. Jemmett, Limited

The Agaunico mine in Bucke township, district of Timiskaming, is owned by the Estate of D. L. Jemmett, Limited. No development work was carried on during the year, but several men were employed in hand-picking ore from the dumps.

Values of $7,706.73 in cobalt and nickel were obtained from 64 tons of ore shipped to Havre, France.

Laurentian Mines, Limited

The Right of Way mine, in Coleman township, district of Timiskaming, was leased to the Laurentian Mines, Limited, during the year. This company's address is 50 Albert Street, Ottawa.

Four tons of ore shipped to Deloro yielded $2,035 in silver.

McKinley Mines Securities Company, Limited

This company leased the McKinley-Darragh-Savage mine in Coleman township, district of Timiskaming, during 1932. Ore and bullion valued at $980.33 were shipped to the Deloro smelter.

A clean-up of the tailings dump was made by I. Mosher and yielded a value of $393.00 in silver, which was sold to M. J. O'Brien, Limited.

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 officers and directors of the company are: J. P. Watson, president; E. H. Rose and G. M. Clark, vice-presidents; G. C. Ames, secretary-treasurer; A. B. Stodart, J. G. Watson, and C. E. Trafford, directors. M. F. Fairlie is managing engineer. The head office is at 350 Bay Street, Toronto.

The average number of men employed during the year was 140 at Cobalt and 125 at the Ashley in Bannockburn township.

The following is taken from the president's report to the shareholders for the year ending December 31, 1932:—

Cobalt and South Lorrain

The total production of silver in 1932 amounted to 1,177,791 ounces. Despite the high production, the profit was considerably less than in the preceding year due to the very low average price for silver and the expiry of the contract for the sale of cobalt.

Hudson Bay Mining and Smelting Company, Limited

In spite of the low prices which prevailed for metals this company operated at full capacity throughout the year at a satisfactory net profit before depreciation.

Base Metals Mining Corporation, Limited

The properties owned by this company remained closed during the year, pending an improvement in metal prices.

Quemont Mining Corporation, Limited

This company acquired an additional interest in Ashley Gold Mining Corporation, during the year, and now holds 200,000 shares of that company.

Mincor Exploration and Development Company, Limited

There is nothing new to report in connection with this company, except that certain claims, which in the opinion of your engineers are not likely to give profitable results, were dropped.

Normetal Mining Corporation, Limited

No work has been done on the properties of this company during the year.

Ashley Gold Mining Corporation, Limited

Our objectives in connection with this company, namely (1) vigorous exploration and ore development, (2) gradual increase of tonnage to the mill, (3) maintenance of profitable heads, (4) progressive reduction in costs, are being gradually attained. Full details of the operation of this company are given in the managing engineer's report.

The following is from the report of the managing engineer for the year ended December 31, 1931:—

In spite of silver prices, which averaged for the year the lowest recorded in history, production of silver at Cobalt was maintained throughout the year, and resulted in a satisfactory profit in spite of these abnormal conditions.

The smelter contract for cobalt ore, under which a large tonnage of cobalt metal was profitably marketed in the two previous years, terminated in December, 1931, and it proved impossible to find a satisfactory outlet in 1932. As a result, mining operations at Cobalt were confined to the production of silver ore, and no payment was made, as formerly, for the cobalt metal contained therein.

In the year's operations ore of profitable grade at present prices was exhausted, and mining at Cobalt was discontinued at the end of the year. Fortunately, gold production at the Ashley property of the Corporation coincided with the stoppage of silver mining.

Production figures for silver are given in the accompanying table. An increase in silver over that of the previous year will be noted; the production in 1932 being 1,177,791 ounces, as compared with 1,053,727 for 1931.

PRODUCTION OF SILVER

	Ore and concentrates produced		Silver produced	
	1931	1932	1931	1932
	tons	tons	ounces	ounces
Cobalt properties	3,691	1,161	733,425	1,155,647
South Lorrain properties	2,494	61	320,302	22,144
Total	6,185	1,222	1,053,727	1,177,791

The table below gives the production of silver by years from the mines of the corporation. The aggregate amounted to 50,196,941 ounces at December 31, 1932.

TOTAL PRODUCTION IN OUNCES FINE SILVER TO DECEMBER 31, 1932

	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
" " " 1929	970,954	14,295	985,249
" " " 1930	559,286	404,903	964,189
" " " 1931	733,425	320,302	1,053,727
" " " 1932	1,155,647	22,144	1,177,791
Total	44,043,108	6,153,833	50,196,941

Mining Operations

Cobalt.—As indicated in the last annual report, the cobalt ore contract was terminated. As a result, mining operations during 1932 were confined to the extraction of silver ore at Cobalt. Low silver prices prohibited any exploration work, though normal prices may eventually justify such work in certain sections of the Cobalt Lake property.

At the beginning of the year, the bulk of the remaining silver ore was contained in old stope backs in proximity to the bottom of Cobalt lake, such ore being overlain with accumulated mill tailings. To make this ore available for extraction, an opening was blasted through from the underground workings and 400,000 tons of the overlying tailings flowed by gravity into the worked-out sections of the mine. This operation permitted the safe and easy extraction of the ore at an unusually low cost per ounce of silver. All available tonnage was completely removed by the end of the year, and the long productive record of the corporation at Cobalt came to an end.

South Lorrain.—The properties of the corporation in this camp were idle throughout the year and will remain so until silver and cobalt prices justify their reopening and further exploration.

Ashley Gold Mining Corporation, Limited.—During 1932, development which had been started in the previous year was continued aggressively on this property. The three-compartment inclined shaft was completed to 570 feet early in the year, and ore and waste passes put through between the three bottom levels, located at 250, 375, and 500 feet. So satisfactory were the early results from drifting on all levels that decision was made to install a mill, and the necessary equipment for a cyanide plant of 150 tons daily capacity was hauled in over 45 miles of snow roads, the only method of transportation at that time. Construction of plant began in May and was completed in August, gold production beginning in September.

Electric power was delivered to the property in March, and this permitted speeding up of development and preparation of stopes for production during the period of mill construction. A road suitable for motor traffic was constructed by the Ontario Government during the late summer, and this also has greatly facilitated operations in a hitherto almost inaccessible area.

The Ashley vein, upon which practically all development has been concentrated to date, has proven down to the 500-foot level to be a narrow high-grade vein, the average gold value being approximately $15.00 over a width of 30 inches. Of the four levels so far developed by drifting, the 4th or 500-foot level has shown the most consistent ore conditions. On the latter level, a length of 950 feet, in practically one continuous ore shoot, has been proven.

To the north, an east-west granite porphyry dike intersects the Ashley vein. Drifting has been carried only a short distance beyond this dike, with grade of ore below mill grade, but diamond-drilling has indicated commercial grade ore several hundred feet beyond the present face. To the south an east-west fault displaced the Ashley vein 85 feet to the west. The southern extension has so far shown a narrower vein than average, though of fair grade. A vein parallel to the Ashley and lying 280 feet to the west was proven by diamond-drilling, and at the date of this report has been reached by crosscutting on the 500-foot level. Though in ground much broken by minor faulting, the drift on this vein has recently shown considerably better grade than the Ashley over a 30-inch width.

An inclined winze was sunk from the 400-foot level on the Ashley vein. This winze was located 350 feet south of the shaft and reached a depth of 125 feet. Its purpose was for use in future stoping operations, but incidentally it proved normal vein conditions to continue for the full depth attained. A vertical winze was also sunk 200 feet from the 500-foot level to open up two new levels, at 625 feet and 750 feet on the inclination of the vein. Crosscuts on these two levels have shown much faulted conditions in their vicinity. This condition is considered local, and coincides in a general way with similar limited sections on the levels above.

When production began in September there was developed on the Ashley vein, above the 500-foot level, approximately one year's supply of ore for the mill, at a rate somewhat over 75 tons daily. This reserve had been increased by the end of the year, and if ore equivalent to that shown on the 500-foot level is developed on the two new levels, two years additional ore supply, at the above rate, will be made available above the 750-foot level. The new west vein will also contribute to production as development proceeds.

Actual gold production to December 31 is not indicative of normal conditions, as tonnage was low while the new plant was being tuned up. Also absorption of gold in the mill circuit has been unusually high, corresponding to that of a 150-ton mill, even though tonnage treated is at a 75-ton rate. Such gold is, of course, eventually retrieved. The head assay of ore going to the mill in October was $15.57 per ton, in November $15.72, and in December $18.76.

Owing to the narrow character of the Ashley vein, special stoping methods and hand-sorting of waste are required to avoid dilution from overbreak of low-grade wall rock. Such methods involve high per ton costs which, however, are being materially reduced by raising mill tonnage. At the date of this report tonnage is being maintained at a daily rate of 110 tons, with grade approximately $12.00 per ton. When development results justify, tonnage will be raised to the maximum capacity of the mill. Exploration in search of other veins has been limited by present development and production programme. Surface trenching is impossible owing to heavy overburden. The whole area in the vicinity of the Ashley vein remains unexplored and this will require to be done by underground crosscutting and diamond-drilling.

McGill Gold Mines, Limited.—No further work was done during the year under the option held by the corporation. A stock interest has been retained for the money expended in the previous year.

Quemont Mining Corporation, Limited.—This property, controlled by the corporation, remained idle throughout the year.

Pascalis.—Assessment work in the form of trenching on a previously discovered vein was done. Results were inconclusive, but the claims are being held in good standing.

Base Metals Mining Corporation, Limited.—This property remained idle throughout the year, as prevailing prices of lead, zinc, and silver offered no profit. The mine and mill are in excellent condition for unusually low-cost production of these metals.

Morrison Mines, Limited

No operations were carried on during 1932 at the property in Nicol township, district of Timiskaming. Some 50 pounds of samples sent to the Timiskaming Testing Laboratories yielded 120 fine ounces of silver. Horace F. Strong, Haileybury, is manager for the company.

Nipissing Mining Company, Limited

Nipissing Mines Company, Limited, has a capital of 1,200,000 shares of $5 par value. The directors of the company are: E. P. Earle, president and treasurer; Alexander Fasken, vice-president and secretary; Richard T. Greene, Dr. F. R. Bennetto, C. W. Nichols, Halstead Lindsley, and Hugh Park, directors. The head office is at 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 of the company are: Alexander Fasken, president and secretary; E. P. Earle, vice-president and secretary; Richard T. Greene, C. W. Nichols, Dr. F. R. Bennetto, Halstead Lindsley, and Hugh Park, directors. The operating officials are Hugh Park, general manager; E. V. Neelands, manager; and J. M. Carter, mill manager.

The holding company has in storage 2,750,000 ounces of silver.

An average of 83 men was employed from January to April, and an average of 47 from April to October.

The general manager reports as follows for the year 1932:—

Active stoping operations at the Cobalt property ended in March, by which time all known high-grade ore had been extracted from the lower levels, and the workings at the various shafts were allowed to fill. The mills and the refinery completed the clean-up by the end of April. The production during this period was 177,000 ounces, which was added to the silver held in storage. The value of the year's production shows as a minus amount in the financial report, due to the difference in the prevailing prices at the end of December in each year. The inventory of 1932 was largely a carry-over from 1931, and the effect of a 6-cent decrease is reflected in the theoretical value of the production for 1932. The average official price per ounce of silver during the year was 27.892 cents, a decrease of one cent from 1931, ten cents from 1930 and twenty-five cents from 1929. The highest quotation for the year was 31 cents at the end of February, and the low record of 24¼ cents was established on December 29. The year closed at 24⅜ cents, as compared with 30¼ cents closing in 1931.

The property at Cobalt, so far as immediate profitable operations are concerned, can be considered as finished. There remains some tonnage of unmined cobalt ore and unimportant occurrences of silver. It is highly probable that the last silver vein is still to be discovered, but until there is a material increase in the price of silver, there is no incentive or justification for undertaking further detailed exploration to discover new veins or to eliminate the few remaining possibilities.

Assessment and development work was performed during the summer on a number of groups of claims in Ontario and Quebec, without favourable results. Most of these claims were staked in 1931 or during the winter of 1932. Exploration of the group adjoining the Beattie will be done this summer.

Developments in the Michigan oil field have been favourable during recent months, following the bringing-in of a producer on one of the locations in which the company has a 51 per cent. interest. Considerable offset drilling is now being done by companies owning adjacent properties. There are indications that a new major pool has been found, which will add materially to the value of the company's interest in the immediate vicinity and in other townships along the main axis of the structure.

No active work was done on the Robb-Montbray group of claims in Quebec. Several leasing offers were declined. The Robb-Montbray Company has $12,000 in cash and $90,000 in Dominion of Canada bonds, the income from which is sufficient to cover current expenses and engage in moderate field work.

Underground work at the Beattie is progressing rapidly and satisfactorily. Two shafts have recently been completed, and connected, the main operating level being established at 500 feet. Assays from the shaft in the ore body and from development work at three levels are about the same grade as exposed in the 220-foot level crosscut, where 107 feet of ore assayed $4.41. Definite and reliable averages will not be obtainable until other crosscusts have been driven. The main hoisting shaft, located outside the ore body, encountered ore of average grade at a depth of 600 feet, while sinking for a sump. At a final depth of 627 feet, the ore was exposed over the full width of the shaft. Diamond-drilling had previously indicated ore of irregular widths and assays near the top of a faulted zone at a depth of 750 feet vertically below the collar of the shaft, which is 400 feet south of the shaft in the main ore body. The fault was encountered in the south shaft at 500 feet and will cut the main ore body at a depth of about 900 feet below surface. The age relationship between the fault and the ore is not definitely known at present, but there is some evidence that the fault is post-mineral, in which case there is favourable expectation of finding additional ore at depth through future workings at the main shaft.

Construction of the 600-ton flotation unit has been completed, and it is expected that both mine and mill will be ready for operation about May 1.

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 is manager.

The 1932 report is as follows:—

Drifting and crosscutting	feet	982
Sinking	feet	11
Raising	feet	32
Ore hoisted	tons	19,503
Silver shipped	ounces	1,376,139

During the year an average of 97 men was employed.

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, and W. A. O'Flynn is manager. One hundred and eleven men are employed.

The development and production for the year is as follows:—

Drifting	feet	4,738
Raising	feet	629
Diamond-drilling	feet	3,360
Ore hoisted	tons	30,894
Silver shipped	ounces	1,657,952

Out of the total tons of ore hoisted, 1,202 tons were taken from the old mine and the remainder from Cross Lake mine. There were 4 men engaged in diamond-drilling during the year.

R. E. Perry

The Aladdin Cobalt mine, in Coleman township, district of Timiskaming, was leased to R. E. Perry.

From 833 pounds of ore shipped to Deloro, values of $283.84 in silver and $10.73 in cobalt were obtained.

C. W. Price

The Foster mine in Coleman township, district of Timiskaming, was leased to C. W. Price.

During the first six months of the year, ore and nuggets having a value of $557.50 in silver were shipped to Deloro; $171.38 in cobalt was obtained from 457 pounds of ore.

Sandoe and Moyle

The Temiskaming mine, in Coleman township, district of Timiskaming, was leased to Richard Sandoe and H. Moyle.

About 12 tons of ore shipped to the Temiskaming Testing Laboratories for treatment gave a value of $19,273 in silver. Fifteen bars of bullion valued at $8,007 were sold to the Deloro Smelting and Refining Company, Limited.

TALC

Canada Talc Company, Limited

The mine and mill of the Canada Talc Company, Limited, in Hastings county, were operated throughout the year. The officers of the company are: W. S. Morden, president; Roy Taylor, secretary; E. S. James, director.

The ore was mined from the 3rd and 4th levels. A total of 6,584 tons was hoisted and milled.

Roy Taylor, Madoc, is manager, employing an average of 24 men.

Geo. H. Gillespie Company, Limited

The officers of this company are: Geo. H. Gillespie, president; M. H. Ludwig, secretary-treasurer; Alexander Longwell, director.

The Henderson mine in Huntingdon township, Hastings county, was operated throughout the year. Development consisted of driving west on the 400-foot level to the end of the ore body. Some 5,813 tons of ore were hoisted and treated at the Gillespie mill.

Geo. H. Gillespie, Madoc, is manager. Five men were employed at the mine and 10 at the mill.

METALLURGICAL WORKS

Algoma Steel Corporation, Limited

The blast furnaces of the Algoma Steel Corporation, Limited, at Sault Ste. Marie, were operated as follows during the year 1932:—

Furnace	Days in operation	Product
		long tons
No. 1	97	26,363
No. 2	Idle all year.	.....
No. 3	Idle all year.	.....
No. 4	34	11,441

Jas. H. Bell is blast furnace superintendent.

Canadian Industries, Limited

During 1932, the sulphuric acid plant of this company, located at Copper Cliff, was operated for nine months only.

During the period of operation, only one of the three 50-ton per day acid units was used. These units manufacture acid from the converter gases produced at the smelter of the International Nickel Company. The nitre cake plant was not operated in 1932.

An average of ten men was employed during 1932. G. G. Vincent is works manager.

Deloro Smelting and Refining Company, Limited

The plant at Deloro operated throughout the year. Further improvements in process efficiency and reductions in general costs were secured, but market prices of cobalt products continued to decrease and the output was curtailed. The silver output for the year amounted to approximately 4,800,000 ounces.

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.

Ontario Refining Company, Limited

Operations at this plant, situated at Copper Cliff, were continued throughout the year 1932 on a reduced tonnage basis.

The various processes have already been described in previous departmental reports, but in addition to the production of the usual wire bar shapes, the company supplied a substantial quantity of vertically cast electrolytic copper cakes, billets, and phosphorized copper billets to its customers at home and abroad. These vertical shapes are made in patented water-cooled copper moulds, the company having the exclusive rights to this process in Canada.

Effective June 21, 1932, a 4-cent per pound tariff was placed on foreign copper by the United States. This barred any further shipment of the company's product there; but increased shipments to England tended to offset the loss of the American market.

Refined copper has been shipped from this refinery to practically all copper-consuming countries, and the ORC brand of copper is now well established throughout the world.

In addition to copper, the company produced gold and silver bars from its precious metals refinery. A small amount of high-grade powdered metallic selenium was sold. From its acid recovery plant reclaimed acid was returned for use in the electrolytic department, and the nickel residue turned over to the International Nickel Company.

F. Benard was appointed plant manager, in charge of all operations. An average of 310 men was employed during 1932.

Steel Company of Canada, Limited

The Steel Company of Canada, Limited, operated one furnace for 241 days, with a production of 77,801 gross tons of pig iron.

The average number of men employed was 60. R. A. Gillies is blast furnace superintendent.

The officers of the company are: Charles S. Wilcox, chairman of the board; R. H. McMaster, president; H. M. Jaquays, R. G. Wells, and H. T. Diplock, vice-presidents; H. H. Champ, vice-president and treasurer; H. S. Alexander, secretary; S. E. Le Brocq, comptroller.

MINING ACCIDENTS IN 1932

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

Accidents during 1932

During the year 1932 at the mines, metallurgical works, quarries, and clay, sand, and gravel pits regulated by the Mining Act, there were 1,475 accidents to employees reported to the Department of Mines up to January 16, 1933. Twenty-five fatalities arising out of 23 separate accidents were recorded.

These returns represent a decrease of 374 in the total number of casualties and a decrease of 12 in the number of men killed over the preceding year.

The report shows a fatality rate of 1.69 per thousand men employed, which is 1.26 per thousand lower than the average for the past twenty-five years.

There were 98 non-fatal accidents per thousand men employed, which is a decrease of 2 per thousand from the rate of 1931.

The percentage of non-fatal accidents followed by infection increased from 5.3 per cent. in 1931 to 6.5 per cent. in 1932.

Fatal Accidents

A comparison of fatal accidents for the past five years is given in the following table:—

Distribution	1928	1929	1930	1931	1932
Mines, underground	31	33	30	21	17
Mines, surface	2	2	3	8	0
Metallurgical works	4	2	11	1	1
Quarries	2	3	4	2	1
Clay, sand, and gravel pits	4	8	6	4	4
Total	43	48	54	36	23

By months the fatal accidents occurred as follows:—

Month	No. accidents	No. men killed
January	1	1
February	1	1
March	4	4
April	3	5
May	2	2
June	2	2
July	2	2
August	2	2
September	1	1
October	1	1
November	2	2
December	2	2
Total	23	25

Classifying the fatalities according to industries gives the following:—

Gold mines	16
Nickel mines	2
Silver mines	0
Copper-lead-zinc mines	0
Talc mines	1
Metallurgical works	1
Quarries	1
Sand, gravel, and clay pits	4
Total	25

ANALYSIS OF FATALITIES AT MINES, 1928–1932

Cause	1928	1929	1930	1931	1932
	per cent.	per cent.	per cent.	per cent.	per cent.
Fall of ground	6.6	14.3	45.6	31	21
Run of ore or rock	5.3	11.9	8.6	3.5	5.3
Shaft accidents	9.3	14.3	8.6	17.2	15.8
Explosives	12	28.6	8.6	6.9	31.6
Miscellaneous, underground	64	28.6	20	13.8	26.3
Surface	2.6	2.3	8.6	27.6	0

TABLE OF FATAL ACCIDENTS IN MINES, METALLURGICAL WORKS, QUARRIES, AND GRAVEL, SAND, AND CLAY PITS, 1908–1932

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
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
1929	55	17,145	1,849	18,994	2.89
1930	56	18,217	317	18,534	3.02
1931	37	17,820	447	18,267	2.03
1932	25	14,378	431	14,809	1.69

The comparative fatality rate per thousand men employed at mines, metallurgical works, quarries, and clay, sand, and gravel pits is as follows:—

	Men employed	No. killed	Rate per thousand
Mines	11,103	19	1.71
Metallurgical works	1,836	1	.54
Quarries	1,070	1	.93
Clay, sand, and gravel pits	800	4	5.00
Total	14,809	25	1.69

The occupation and nationality of the men killed at mines, metallurgical works, quarries, and clay, sand, and gravel pits are set out in the following table:—

Occupation	British	Ukrainian	Jugo-Slav	French	Rumanian	Pole	American	Total
Driller	3	1	.....	.....	1	1	.....	6
Drill helper	1	.....	1	.....	.....	.....	.....	2
Farm labourer	1	.....	.....	.....	.....	.....	.....	1
Fireman	1	.....	.....	.....	.....	.....	.....	1
Grizzly man	.....	.....	.....	1	.....	.....	.....	1
Labourer	.....	.....	.....	.....	.....	.....	1	1
Pit foreman	1	.....	.....	.....	.....	.....	.....	1
Scaler	1	.....	.....	.....	.....	.....	.....	1
Shaftman	2	.....	.....	.....	.....	.....	.....	2
Shift boss	1	.....	.....	.....	.....	.....	.....	1
Skiptender	1	.....	.....	.....	.....	.....	.....	1
Stope boss	1	.....	.....	.....	.....	.....	.....	1
Teamster	1	.....	.....	.....	.....	.....	.....	1
Timberman	2	.....	.....	.....	.....	.....	.....	2
Train conductor	1	.....	.....	.....	.....	.....	.....	1
Trammer	1	.....	1	.....	.....	.....	.....	2
Total	18	1	2	1	1	1	1	25

The ages of the men killed are as follows:—

17–20	21–25	26–30	31–35	36–40	41–45	46–50	Over 50	Total
1	4	5	6	6	0	2	1	25

Non-Fatal Accidents

The causes of non-fatal accidents at mines are shown in the following table:—

Cause	Surface	Underground	Total
Rock or ore at face, scaling, drilling, loading	.....	222	222
Fall of persons	54	108	162
Falling objects	33	98	131
Rock or ore at chute	.....	102	102
Tramming	2	95	97
Crushed between two objects	16	72	88
Fall of rock or ore from face, back, etc	.....	84	84
Flying objects, sledging, etc	11	71	82
Hand tools	25	30	55
Drilling machines	.....	50	50
Strain while lifting	15	35	50
Nails or splinters	5	36	41
Running into or striking against objects	5	36	41
Fall down shaft, winze, raise, or stope	.....	31	31
Machinery	24	1	25
Explosives	1	14	15
Cage, skip, or bucket	.....	5	5
Explosion of carbide	3	1	4
Burns	2	1	3
Electricity	3	.....	3
Poisoning from cyanide, mercury, etc	2	.....	2
Unclassified	2	1	3
Total	203	1,093	1,296

The causes of non-fatal accidents at metallurgical works were:—

Falling objects	15	Transportation	1
Fall of persons	9	Strain while lifting	1
Burned by slag, matte, or scrap	7	Machinery	1
Crushed between two objects	7	Cranes, ladles, hooks	1
Hand tools	3	Nails or splinters	1
Burns	3		
Flying objects, sledging, etc	2	Total	51

The causes of non-fatal accidents at quarries were:—

Handling material	21	Transportation	3
Fall of persons	14	Falling objects	3
Fall of rock	10	Hoists, derricks, elevators	3
Flying objects, sledging, etc	7	Nails or splinters	1
Machinery	6	Crushed between two objects	1
Strain while lifting	5	Unclassified	1
Hand tools	3		
		Total	78

The causes of non-fatal accidents at gravel, clay, and sand pits were:—

Fall of persons	7	Crushed between two objects	3
Falling objects	7	Strain while lifting	2
Transportation	4	Hand tools	1
Machinery	3		
		Total	27

Infection

Records show that infection followed in 95 cases out of a total of 1,452 non-fatal accidents.

Location	No. of accidents	Accidents followed by infection	Per cent. infection
Mines, underground	1,093	76	6.9
Mines, surface	203	12	5.9
Metallurgical works	51	4	7.8
Quarries	78	2	2.5
Gravel, sand, and clay pits	27	1	3.7
Total	1,452	95	6.5

Accidents from Explosives

Cause	Non-fatal		Fatal		Total	
	No. of accidents	Men injured	No. of accidents	Men killed	No. of accidents	Men killed or injured
Concussion from blast	1	2	.....	.....	1	2
Delayed too long lighting fuse	2	2	1	2	3	4
Drilled into explosives	3	4	1	2	4	6
Explosion while mucking	1	1	.....	.....	1	1
Explosion while sledging	1	1	.....	.....	1	1
Premature blast	1	1	2	2	3	3
Returned too soon to blast	1	1	.....	.....	1	1
Struck by rock from blast	3	3	.....	.....	3	3
Total	13	15	4	6	17	21

Electric Accidents

The following table shows the fatal accidents due to the use of electricity at mines, metallurgical works, and quarries during the last ten years:—

1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	Total
.....	1	3	.....	2	1	.....	6	.....	.....	13

The following table shows the voltage of the circuits on which the fatal accidents occurred:—

Volts	No. of accidents
110	3
220	1
550	6
2,200	3
Total	13

Classifying the accidents according to the industry shows the following:—

Mines, surface	5
Metallurgical works	5
Quarries	3
Total	13

Electric accidents during 1932 were reduced to 3 non-fatal. A further improvement has been made during the year in the type of disconnecting switches in service and also in the manner of operating. This has, no doubt, to a large extent removed the source of the greater percentage of accidents during the past few years.

During the year two fires originated underground in rubber-covered cables. The resultant damage was negligible in both cases, but it served as a warning against the general use of low-voltage rubber cables, not armoured, in the vicinity of timber or other inflammable material.

An effort is being made to develop a light metal armour which is not solvent in the acids of mine water, and which will not readily corrode. A light metal armour would be sufficient to prevent the spreading of fire, and would not add greatly to the cost or weight of cable. The replacement of open wiring with armoured cable would remove what is probably the greatest hazard of electric fires.

The following table shows the number of non-fatal electric burns during the last ten years.

1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	Total
9	9	6	5	10	4	14	10	7	3	77

The causes of non-fatal electric burns in 1932 were:—

Arc when opening switch under load	1
Rupture of fuse box	1
Working on generator brushes while running	1
Total	3

Underground Fires

Hollinger Consolidated Gold Mines, Limited

A fire occurred in No. 11 shaft of the Hollinger mine, shortly before noon, on August 20.

The cage tender, in passing, noticed smoke in the shaft above the 300-foot level. He stopped at the 200-foot level and turned a stream of water down the manway, which extinguished the fire.

Examination of the shaft after the fire showed that a rupture had taken place in a joint on a 250-volt D.C. power cable about 30 feet above the 300-foot level. The arc from this rupture had ignited the rubber covering of 3 three-quarter-inch, 3-conductor, 110-volt, cab-tire cables on light, signal, and telephone circuits installed in the manway.

These cables were burned for a length of about 25 feet, and the lining of the shaft was blackened by smoke but showed no evidence of charring.

A small fire, which caused considerable smoke and slight inconvenience, occurred on the 1,700-foot level of the Hollinger mine shortly after 7 A.M. on December 14.

A contract mucker, going to his working place near No. 18.2 crosscut, took off his jacket and wrapping it about his lunch pail left the bundle beside the track in M-4 crosscut. In some manner, probably through contact with the flame of his carbide lamp, the jacket became ignited and about 200 feet of the workings was filled with dense smoke.

One of the workmen was so affected by the smoke that he collapsed on coming off shift, although his partner did not seem to suffer any ill effects.

International Nickel Company of Canada, Limited

About 11.30 A.M. on March 3, the stope boss in charge of No. 23 stope, 2,800-foot level, Frood mine, wishing to inspect No. 23.8 chute from the stope, lowered a carbide light into the chute from the stope floor.

When the stope crew returned to work after lunch they found smoke issuing from the chute. Water was turned into the chute and the fire extinguished.

Examination later showed charred cribbing, which had probably been set afire by contact with the flame of the carbide light.

A fire was discovered by drill repairman Leach on November 3 in the temporary battery-locomotive charging station on the 3,100-foot level of the Frood mine. Leach summoned shift-boss Shannon, who was near by, and together they returned to the scene of the fire, which they found in the charging cable about 9 feet from the disconnecting switch. They pulled the 100-ampere square D switch and also the plug from the battery receptacle and the fire immediately diminished. They extinguished it by beating it out with a piece of plank. The station was equipped with a fire extinguisher but it was not found necessary to make use of it.

Examination of the cable showed about a foot of insulation burned, and the fire probably resulted from a short circuit due to faulty insulation.

The cable, which was a No. 2 cab-tire in use on a 250-volt D.C. circuit, was in good condition when installed in May but had probably been damaged through being run over by the locomotive while in service.

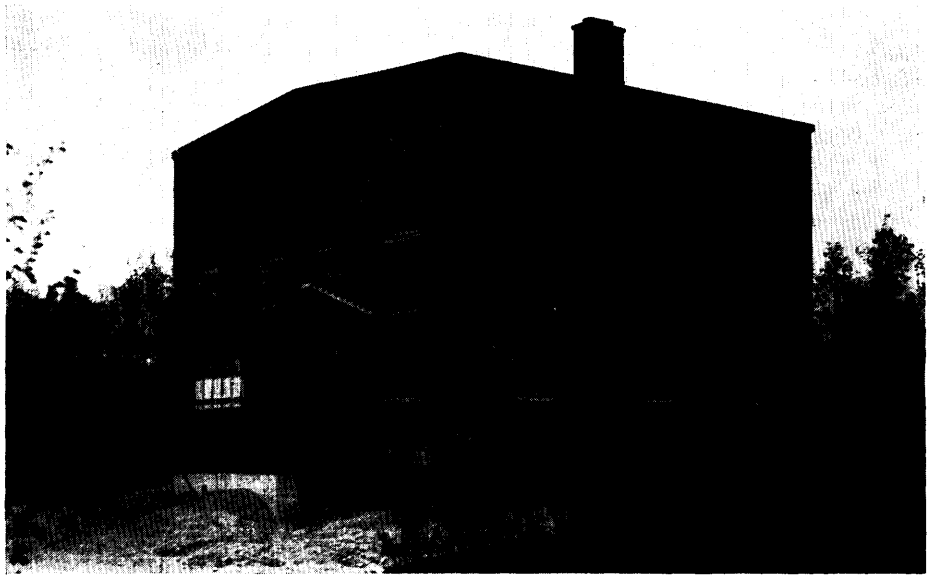
Summary of Rope Tests, 1932

The following is a summary of the tests made in the Wire Rope Testing Laboratories of the Department of Mines during 1932:—

Tests for Ontario mines under Act	263
Special informative tests for mines	18
Tests for wire-rope manufacturers	17
Tests for other manufacturers	10
Tests for other Government departments	5
Tests for mines outside Ontario	21
Total	334

Mine Rescue Stations

During the year mine rescue teams representing all the producing mines in the Porcupine, Kirkland Lake, and Sudbury areas received training at the mine rescue stations, or underground in mines of the respective districts.



Kirkland Lake Mine rescue station

An exhibit of mine rescue and first-aid equipment was made at the Canadian National Exhibition, which attracted considerable attention, and was the subject of much favourable comment.

CLASSES FOR PROSPECTORS, 1932-33

By E. M. Burwash

Introduction

The season just closed has developed the largest attendance on record for this work. The total registration of 1,667 for fourteen 8-day sessions, averaging 119 in each class, is 2.7 times the number in attendance last year, and 3.75 times the average for the preceding five years. The average daily attendance at the afternoon classes was 69.13 per cent. of the total registration, a very good average in this kind of work.

The outstanding feature of the season was undoubtedly the very great interest shown in Toronto, where the largest class ever held up to that time met in January. The registration was 460, but on the approach of the field season for prospecting it was found necessary in May to repeat the course, when the registration recorded reached 498. The total enrollment for the two sessions was, therefore, 958, and the average attendance was 71.2 per cent.

Conclusions already arrived at in past years are amply confirmed as to the factors on which public interest in this work depends. It is more evident than ever that the depression with its unemployment, low wages, and low prices, resulting in low mine costs and consequent prosperity of the gold industry is driving many to devote their energies to a field where the prospect of reward seems not too remote. The result cannot fail to be beneficial to the mineral interests of the province, if only by spreading intelligent views with regard to mining among a larger number of the enterprising working population. As to the types of men who now constitute the classes, one can only say that both in physique and intelligence they show improvement, since those who now find themselves without occupation are by no means confined to inferior types. And although it may be freely admitted that many of these men have not had previous experience of life and work in the forest of the north, they may well as time advances make varied and valuable contributions to the northward development of the province and the Dominion, and help to spread a knowledge of the problems and possibilities of the frontier through the more settled parts of the community.

Acknowledgments

As in previous seasons, the success of the classes has been very largely due to the able co-operation of the local officials of the Department of Mines at the different centres of mining activity, and to civic, fraternal, educational, and athletic organizations, who furnished very satisfactory accommodations, helped to secure them, or assisted in advertising. The Thunder Bay Chamber of Mines was especially active in that district. In connection with the second class held in Toronto during May, the newly organized Ontario Prospectors and Developers Association lent very effective co-operation by providing a series of guest speakers for brief addresses at the close of the afternoon sessions. Practical talks by such men as Walter E. Segsworth, J. E. Hammell, Robert Cockeram, Richard Pearce, Robert Gamble, Gilbert La Bine, Robert Jowsey, and W. H. Fairburn, could hardly be exceeded for stimulation and interest in any part of the mining world.

To all of these the writer must acknowledge his great obligations and tender his sincere thanks.

Analysis of Class Attendance

The following table will furnish more detailed information as to the work of the classes for prospectors in the various localities where they were held.

ANALYSIS OF CLASS ATTENDANCE, 1931–32

Place	Dates	Mineralogy (eight 2-hour periods)				Geology (five 1-hour periods)		Total student periods
		No. registered	Student periods	Attendance		Student periods	Average attendance	
				Average No.	Percentage of registration			
	1932							
Ottawa	Nov. 7–15	50	294	36.75	73.5	173	34.4	467
Sudbury	Nov. 17–25	34	184	23	67.6	151	30.2	335
Chapleau	Nov. 28–Dec. 6	35	135	17	48.21	127	25.4	262
Sault Ste Marie	Dec. 8–16	73	298	37.25	51.03	142	28.4	440
	1933							
Toronto	Jan. 5–13	460	2,854	356.75	77.554	1,380	276	4,234
Port Arthur	Jan. 16–24	68	382	47.75	70.22	243	48.6	625
Fort William	Jan. 26–Feb. 3	115	593	74.37	64.46	254	50.8	847
Fort Frances	Feb. 6–14	23	117	14.625	63.58	46	9.2	163
Kenora	Feb. 16–24	36	193	24.125	67	119	23.8	312
Sioux Lookout	Feb. 27–Mar. 7	28	124	15.5	55.35	106	21.2	230
Timmins	Mar. 13–31	68	317	39.625	58.27	245	49	562
Kirkland Lake	Mar. 23–31	106	489	61.125	58.21	196	39.2	685
Haileybury	April 3–11	73	342	42.75	58.56	177	35.4	519
Toronto	May 1– 9	498	2,834	354.25	71.13	1,160	232	3,994
Totals		1,667	9,156	.....	.....	4,519	.....	13,675
Averages		119	654	81.77	63.19	322.8	64.54	976.8
Averages 1931 and 1932		47	232	29.02	55.33	179.07	35.81	411.23

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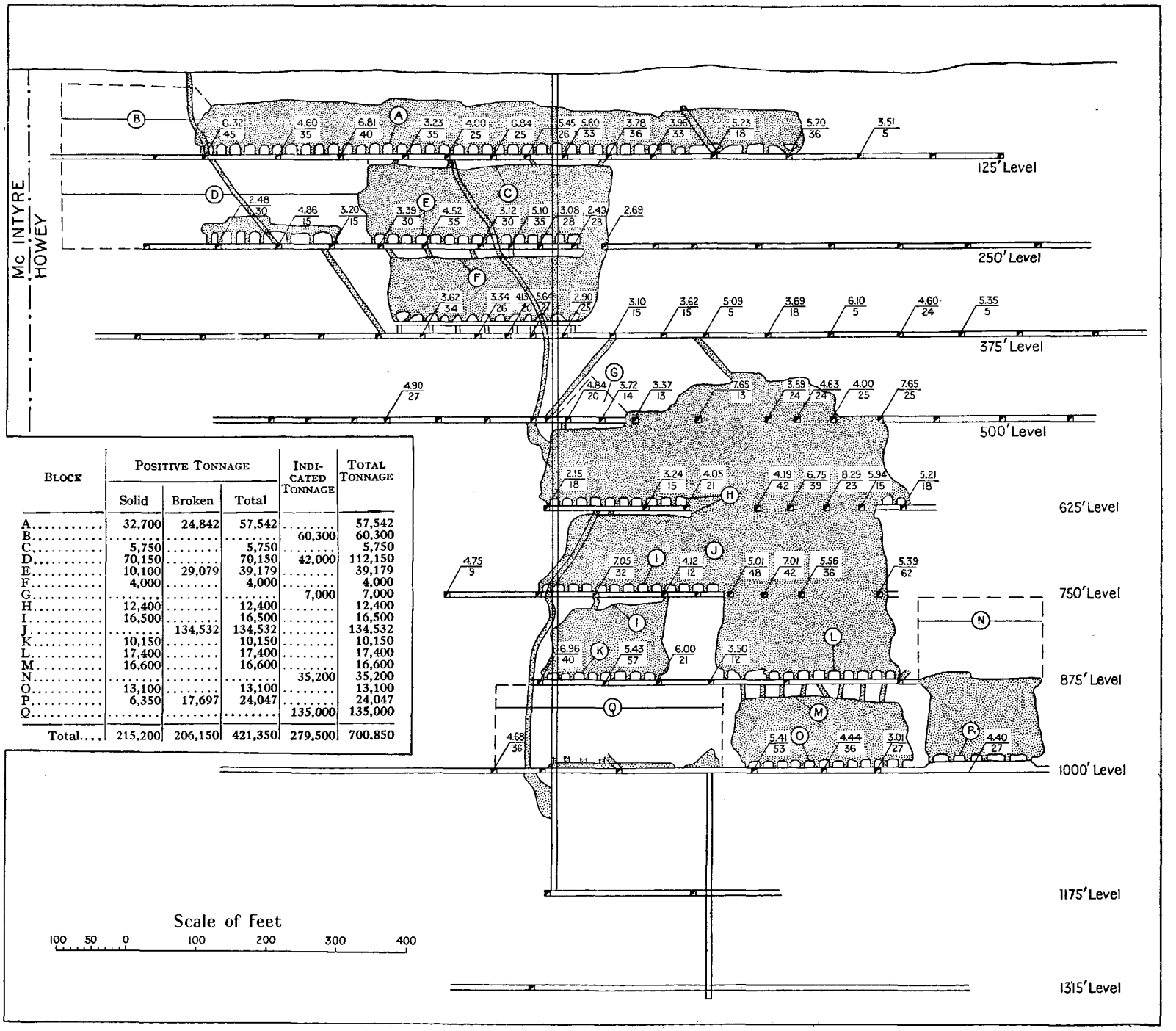
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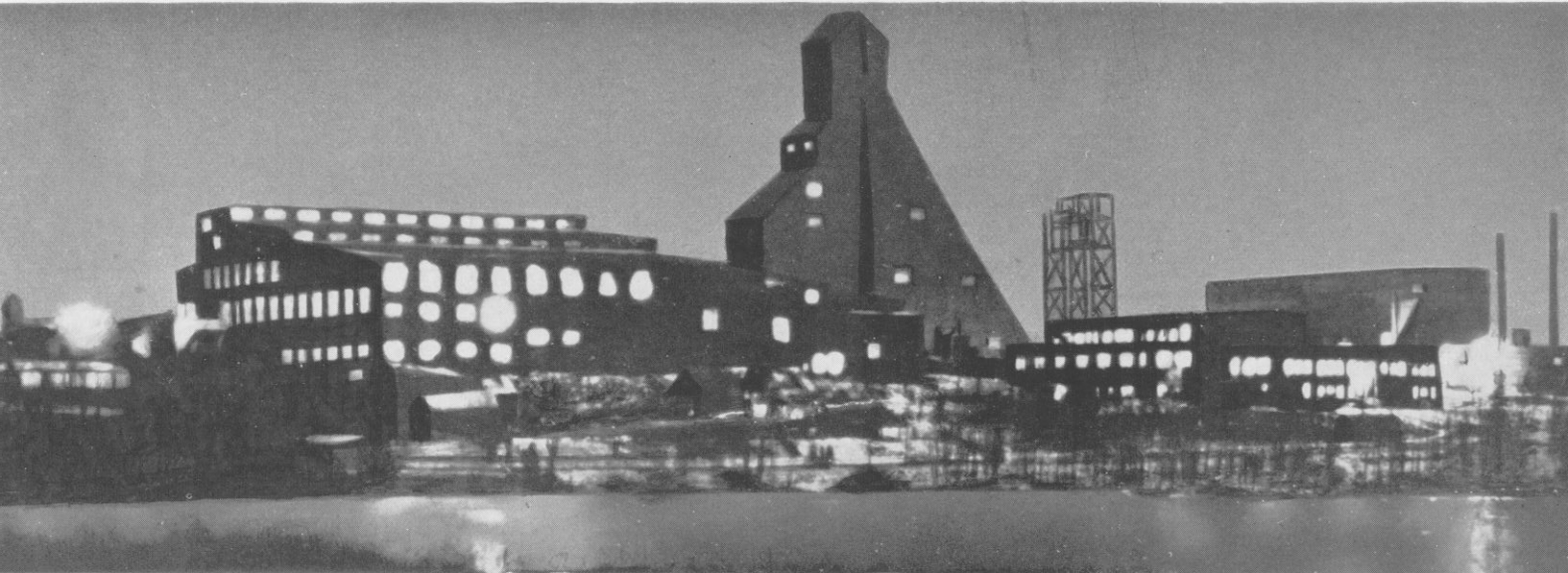


Block	Positive Tonnage			Indicated Tonnage	Total Tonnage
	Solid	Broken	Total		
A	32,700	24,842	57,542	.....	57,542
B	.....	.....	.....	60,300	60,300
C	5,750	.....	5,750	.....	5,750
D	70,150	.....	70,150	42,000	112,150
E	10,100	29,079	39,179	.....	39,179
F	4,000	.....	4,000	.....	4,000
G	.....	.....	.....	7,000	7,000
H	12,400	.....	12,400	.....	12,400
I	16,500	.....	16,500	.....	16,500
J	.....	134,532	134,532	.....	134,532
K	10,150	.....	10,150	.....	10,150
L	17,400	.....	17,400	.....	17,400
M	16,600	.....	16,600	.....	16,600
N	.....	.....	.....	35,200	35,200
O	13,100	.....	13,100	.....	13,100
P	6,350	17,697	24,047	.....	24,047
Q	.....	.....	.....	135,000	135,000
Total	215,200	206,150	421,350	279,500	700,850

HOWEY GOLD MINES, LIMITED

Vertical longitudinal section, January 1, 1933





PROVINCE OF ONTARIO

DEPARTMENT OF MINES

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

FORTY-SECOND ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XLII, PART II, 1933

Erosion and Sedimentation at Point Pelee

By

E. M. KINDLE

APPENDIX: BEACH PROTECTION AND RECLAMATION

By

W. R. Rogers

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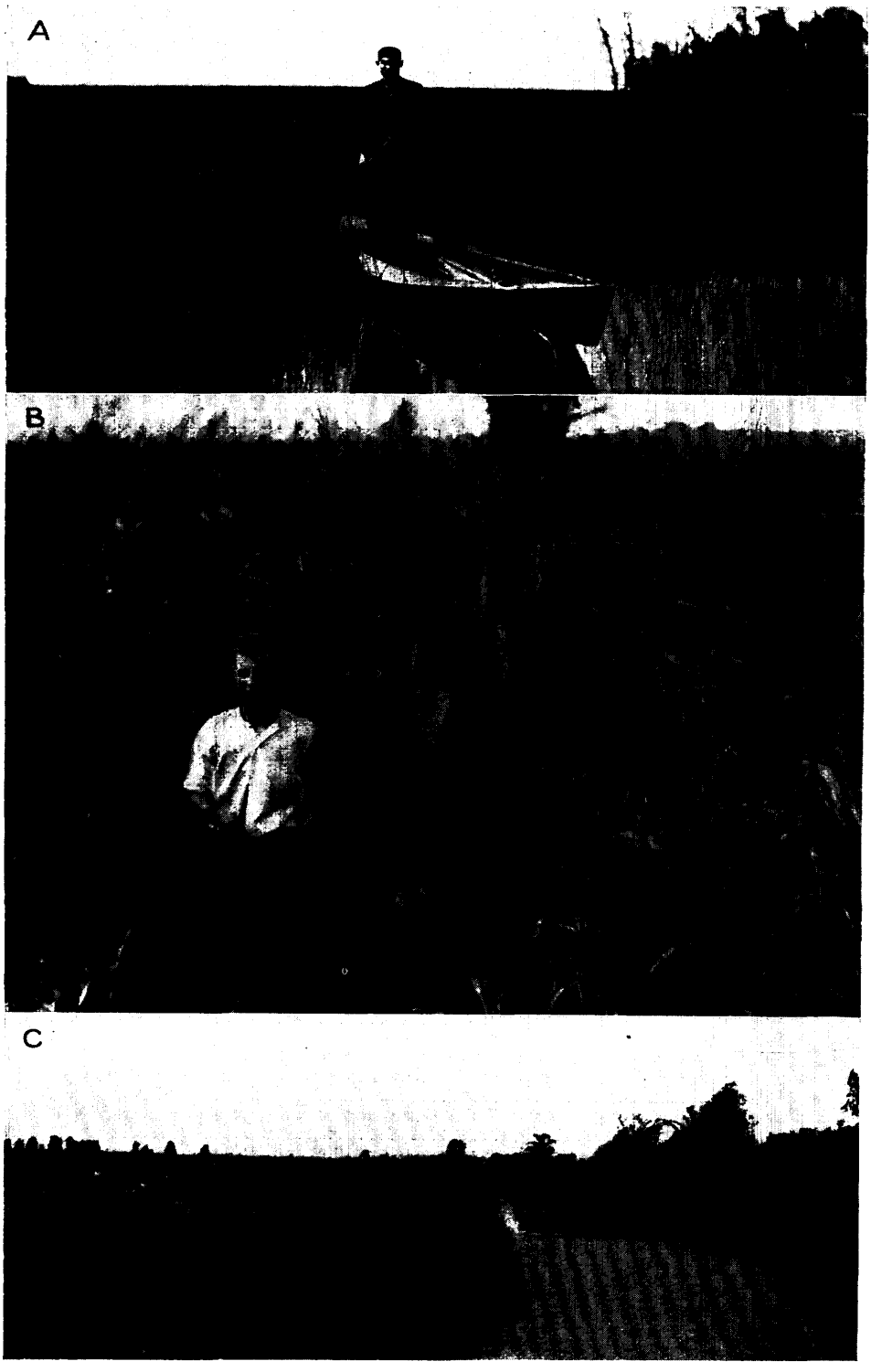
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TOPOGRAPHICAL MAP

(In pocket at back of report)

Map No. 42*a*—Map of Point Pelee and Adjacent Lake Bottom Deposits. Scale, 1½ miles to the inch.

Photos by P. A. Taverner



Views showing (A) marsh land, (B) wild rice, and (C) field of onions on reclaimed land, with drainage ditch.

Erosion and Sedimentation at Point Pelee[1]

By E. M. Kindle

Introduction

Some thirty miles east of the Detroit river, the most notable foreland in the western half of Lake Erie projects due south about nine miles into the lake from the Canadian shore. This is Point Pelee, a great wedge-shaped cusp, the product of winds, waves, and currents and composed entirely of unconsolidated sediments. (See insert facing page 2.) An extensive triangular marsh bordered by narrow sand bars, which widen toward the south, originally formed the major part of Point Pelee. Open ditches and pumping stations have converted much of this great marsh into the finest type of farm land. A little more than six square miles (6.04) of the southern part of the marsh and the timber-covered area bordering it have been set apart as a national park and wild-life sanctuary. Vast numbers of birds use Point Pelee and the adjacent shores of Lake Erie as a point of departure and arrival in crossing the lake during the spring and autumn migrations.[2]

Sand spits may be regarded as geological weather-vanes pointing out the relative strength of the currents and waves from different directions that have been concerned in their formation. They give the same kind of information about the average direction of the movement of sand and gravel in their vicinity that isolated trees often supply about the general trend of strong winds by the set of their branches and trunks. Point Pelee has, therefore, considerable interest for the student of sediments and offers a vantage ground for the study of sediment distribution by currents in the western part of Lake Erie.

The writer visited Point Pelee first during the summer of 1918, in company with K. M. Cameron, now Chief Engineer, Department of Public Works of Canada, who was concerned with the problem of checking the shore erosion on the east side of the foreland, which, if not checked, then seemed likely to eventually endanger the life-saving station near the end of the point. Two subsequent visits, the last in 1931, have been made to Point Pelee. During the summer of 1918 a detailed study of the distribution of the lake bottom material in the vicinity of the foreland was made under the writer's direction by the late E. J. Whittaker, who received much assistance through the co-operation of D. H. Philp and other Public Works engineers. Preparation of the lake bottom map yielded a considerable amount of information concerning the strength and persistence of lake currents, which as distributors of sediments are comparable with tidal currents. These and other factors in the history of Point Pelee will be discussed here, together with the source, character, and distribution of bottom deposits. K. M. Cameron has kindly given the writer access to various maps and reports resulting from surveys of Point Pelee and the adjacent waters.

[1]Published with the permission of the Director, Geological Survey of Canada, Department of Mines, Ottawa.

[2]Manly Miner describes a flight of hawks on the morning of September 19, 1931, as follows: "Circling flocks could be seen with the naked eye in any direction. . . . By counting the number in a single flock, I estimated that between 10,000 and 20,000 hawks were passing within sight." (Can. Field Naturalist, Vol. 46, Nov., 1932, p. 191.)

Old Beaches

It is in the more southerly forested portion of the point that its history is most clearly recorded. The angular southern end of the marsh is bordered on the east by a very narrow zone of sand, which seldom rises more than 8 or 10 feet above lake level. West of the marsh the sand belt averages half a mile in



Fig. 1—Key map showing the location of Point Pelee in the western part of Lake Erie.

width for two miles north of the tip of the point and rises in places into low rounded dunes 20 or more feet above lake level. Farther north the sand ridge border narrows to a width of 60 to 100 feet. Near the southern end of the marsh can be distinguished several of the individual barrier beaches which have been successively added on the west side of earlier beaches and which comprise the half mile of forested sand belt lying west of the marsh. (See map No. 42*a* in pocket.) The innermost or oldest of these have a northwest-southeast trend and

are truncated by the shore line on the east side of the point, while the more westerly ones approach more closely the present trend of the spit.

Point Pelee began evidently with the building of two sand bars, one on the east and one on the west side of the extensive wedge-shaped area of marsh and low land reclaimed from the marsh which forms most of the foreland, thus delimiting it from the lake. (See insert facing page 2.) To these, other bars were added by the waves and currents of exceptional storms on the west side and probably on the east side. But during the more recent history of the point erosion has more than kept pace with accretion on the east side.

Factors in Shore Erosion

Point Pelee is a by-product of the erosion of the lake shore to the east and the west of it. This shore, which in the western third of the lake consists of glacial till, is generally retreating where unprotected by artificial means. The rate of shore retreat is conditioned by a number of factors. Some of the most important of these are: (1) size of waves and wind velocity and direction, (2) depth of water in front of shore, (3) rise of water due to wind pressure, (4) stage of lake level, (5) interruption of the movement of littoral or shore drift.

Storms sweep Lake Erie nearly every year with a wind velocity of 50 to 60 miles per hour. A striking example of the enormously destructive character of waves produced by exceptional storms is furnished by the "Christmas storm," which swept the New Jersey coast in December, 1913. During this storm the wind attained a velocity of 123 miles per hour and houses collapsed under wave action on the Sea Bright beach at the average rate of one every 15 minutes.[1]

Waves usually break and dissipate their energy when they come into water of a depth equal to the wave height. Hence the deeper the water near the shore the larger the waves which can attack it and the greater the damage they will cause.

Rise of the water under the influence of on-shore gales is frequently a factor of the greatest importance in shore erosion. It was the operation of this factor which led to the destruction of the city of Galveston, Texas, some years ago. Heavy easterly gales are capable of raising the water level in the western part of Lake Erie 6 or 7 feet above the level of maximum low water produced by westerly gales. Mosely has recorded some of the results of the banking up of the water at the west end of Lake Erie in the great storm of 1861. In Sandusky, the waves from this storm lifted the railroad track near the shore from its bed and pushed it in places 20 feet away.[2] Storms have occurred that banked up the water at Point Pelee sufficiently to force it over parts of the forested area at the south end.

Records of the Department of Railways and Canals and the Hydrographic Service from 1860 to 1932 show the maximum difference in the levels of Lake Erie to be approximately 5 feet. Examples of high- and low-water cycles between these years are shown on the graph (Fig. 2). The lake level stood exceptionally high in 1862, 1876, and 1913, reaching levels exceeding 574 feet above mean sea level. In the years 1895, 1896, 1901, and 1902, it fell below 571 feet. Storms that occur during the low-water periods have relatively small effect in shore erosion, while storms that coincide with a high-level stage of the lake are certain to produce destructive shore erosion. The disastrous storm of 1861, the results of which Mosley[3] has recorded for the shore at Sandusky, Ohio, came in a year

[1]D. W. Johnson and W. S. Smith, N.J. Geol. Surv., Bull. 12, 1914, p. 33.

[2]E. L. Mosely, "Formation of Sandusky Bay and Cedar Point, Ohio," Proc. Ohio Academy Sci., Vol. 4, pt. 5, 1905, p. 181.

[3]Ibid.

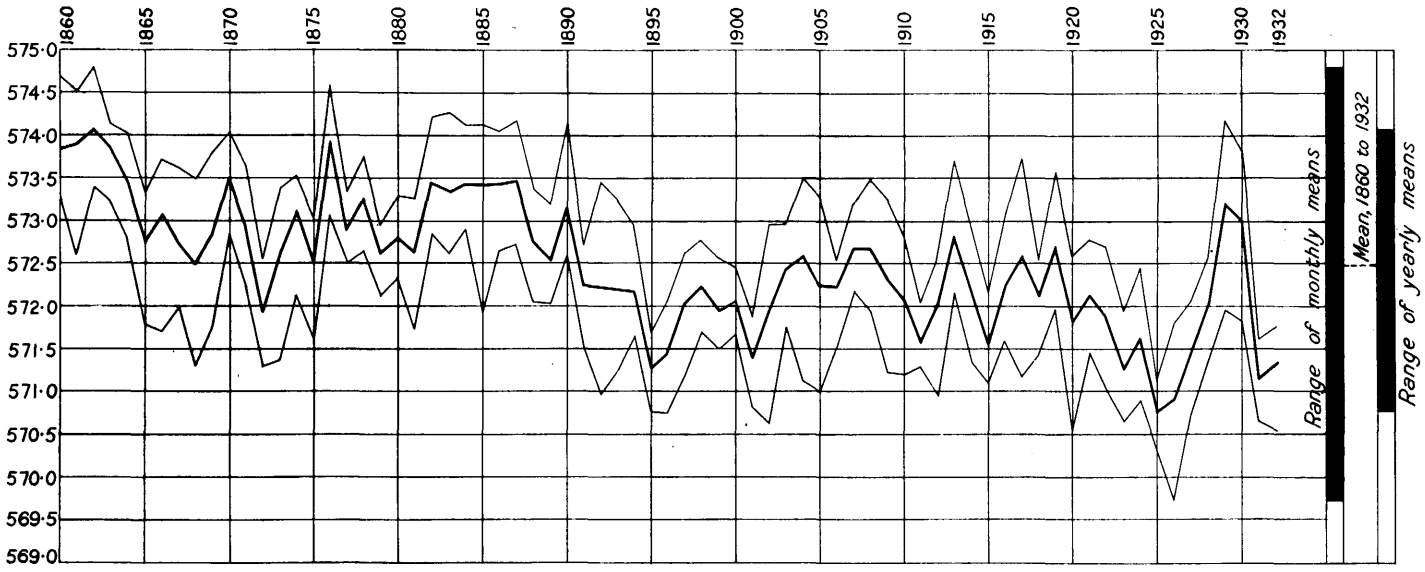


Fig. 2—Water surface elevations of Lake Erie from 1860 to 1932 (yearly means, also maximum and minimum monthly means of each year) as recorded by the Department of Railways and Canals and the Canadian Hydrographic Service, Department of Marine, Ottawa. Elevations in feet above mean sea level are referred to U.S. Lake Survey datum of 1903 adjustment. High water of 1838 was 575.11 feet above mean sea level.

when the lake level was near its maximum stage. The records well illustrate the magnitude of the results when three factors, high-water stage, wind direction, and wind velocity, all unite in producing exceptionally high water and violent wave action at the shore line.

The building of many groynes during the last fifteen years at points subject to strong erosion has materially reduced the effective power of wave-cutting on the north shore of Lake Erie.

Source of Materials

Glacial till underlies the sand, gravel, and marsh deposits of the Point Pelee foreland and forms the shore both east and west of Point Pelee for a considerable distance. The erosion by wave action of the glacial-clay shore affords a continuous supply of sand and gravel sorted by wave action from the till. This material is also contributed by brooks and ravines which in places breach the clay cliffs. (See photograph C on page 6.)

The cliffs east of Colchester about 20 miles northwest of Point Pelee furnish important evidence regarding the retreat of parts of the north shore of Lake Erie. One corner of an old stone church east of the village was found by measurement in June, 1918, to stand only 11 feet from the top of nearly vertical cliffs of clay about 60 feet high. It appears certain that the cliffs have been eroded back at least 100 feet since the church was built. (See photograph A on page 6.)

An old gas well on the lake shore southeast of Leamington furnishes definite evidence of the rapid rate of shore retreat at a point a few miles northwest of the base of the Point Pelee foreland. This well when drilled in 1899 was located on the inner side of a wagon road passing near the lake shore. When seen by the writer in 1918, the casing stood out in the lake about 25 feet from shore, thus showing a retreat of at least 40 feet in about 20 years, approximately 2 feet per year. (See photograph B on page 6.) Other parts of a lake-shore road are said to have disappeared near the old gas well in the same period. D. H. Philp, Public Works engineer, with reference to lake-shore erosion east of Point Pelee and south of Wheatley wharf, makes the following remarks:[1]—

> Owners of the property say they have known whole strips of bank 16 feet wide and 50 to 100 feet long to be undermined and drop into the lake. I myself during the month of August, 1918, saw a strip from 1 to 5 feet wide and 400 to 500 feet long disappear. From station 22E to station 18E I was told a man had to move his fence back in the last two years about 200 feet and I saw the beach washed away for a width of about 10 feet. The beach here was sand and gravel.

Littoral Drift

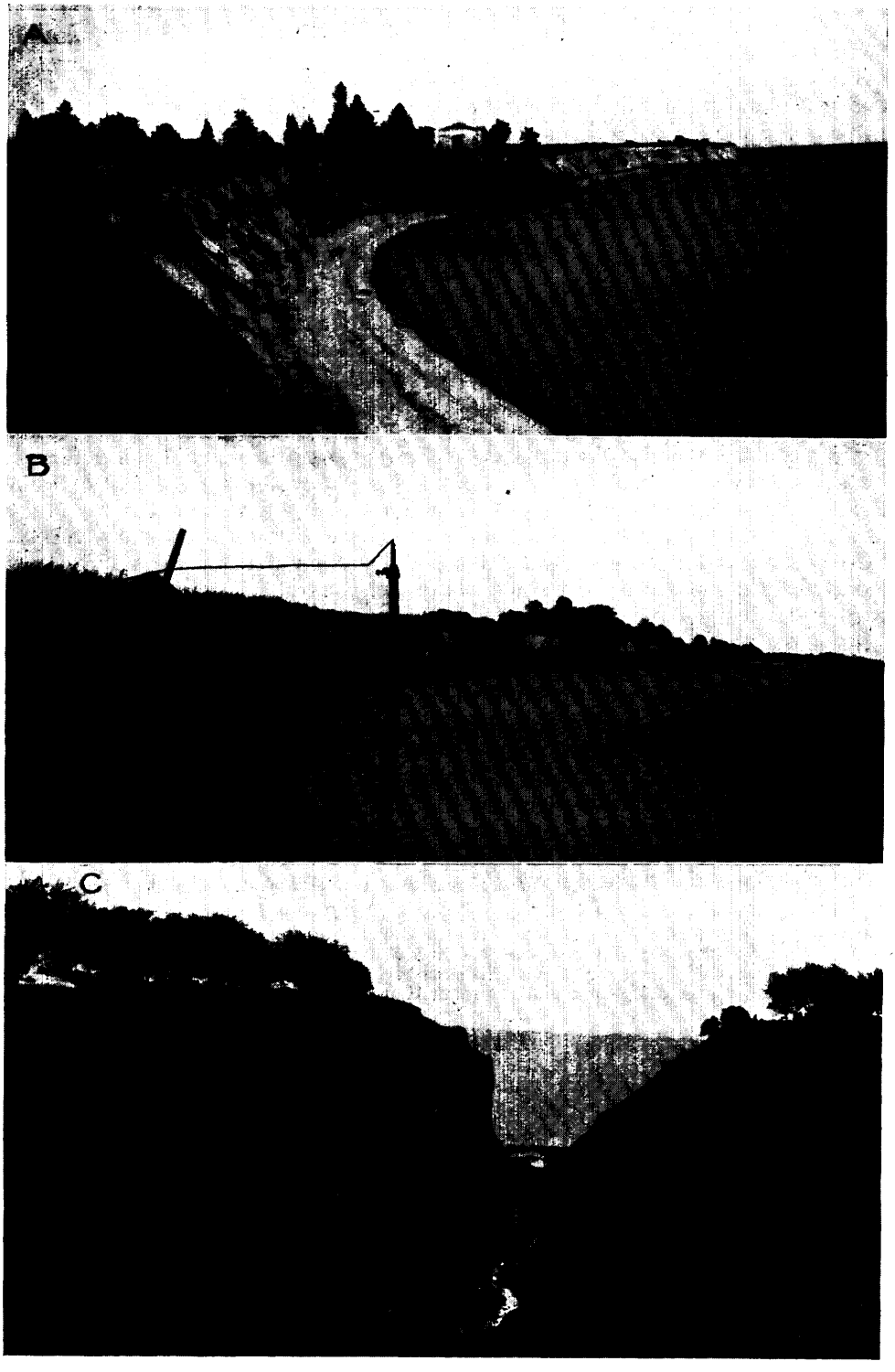
Most of the sand, gravel, and rock debris small enough to be handled by waves and currents moves chiefly in one directon on most parts of the sea coast.[2] This direction is known as the direction of littoral drift. A similar movement of shore materials takes place along the shores of large lakes.

Johnson and Smith found, in studying the erosion of the New Jersey beaches after the storms of 1913 and 1914, that "some kind of current or currents move sand prevailingly northward along the seaward side of the bar toward Sandy Hook spit."[3] At points where shore-line currents meet and other conditions favour, bars or spits of sand or gravel are built out into the water. Usually the resulting spit points or curves decidedly up or down the shore line according to

[1]Manuscript report on survey of shore lines near Point Pelee.

[2]D. W. Johnson and W. S. Smith, "Recent Storm Effects on the Northern New Jersey Shoreline, etc.," N. J. Geol. Surv., Bull. No. 12, 1914, pp. 41, 43.

[3]D. W. Johnson and W. S. Smith, op. cit., p. 41.



A. View from Colchester pier showing old stone church 11 feet from retreating clay cliffs. (Photo by K. M. Cameron.)

B. Old gas well west of Point Pelee, which when drilled about 1899 was on the shore about 16 feet from the water.

C. Eroded trench started by an artificial drain, lake shore east of Point Pelee.

the relative strength of the opposing currents or set of the waves. But in the case of the spit at the south end of Point Pelee the opposing currents are so evenly balanced that the spits extend straight out into the lake. Point Pelee is comparable in its development to the well-known headland on the southeast coast of England called Dungeness headland, which has been pushing forward from the English coast into the sea since the time of Queen Elizabeth at the average rate of six yards a year. "Dungeness headland is a striking example of the arrest of eroded material travelling in one direction, in this case from north to south, by other material travelling in another direction—namely from west to east."[1] Point Pelee is a typical example of the lagoon-marsh stage of a cuspate foreland where V-shaped bars enclose an extensive marsh. It is comparable in shape with Gaspee point[2] in Narragansett bay, Mass.

Currents

Southward-moving currents near the tip of Point Pelee are generally present even in quiet weather. Sometimes these currents set southward with high velocity. The dangerous character of the currents for bathers near the extreme tip of the point has lead the park authorities to post notices warning bathers against bathing near the southern tip of the spit. Various observations have been made on the rate of this current, using submerged canvas-covered frames attached to a float with a small flag. The rate of movement over a measured distance was timed. One observation on the west side made when the lake was perfectly quiet except for a long swell showed, in water 50 feet from shore and about 8 feet deep, a southward current of 1.79 miles per hour. Three other observations on the west side showed the velocities ranging from 0.97 miles to 1.11 miles per hour. An observation made on the east side just after a heavy storm showed a south current of 1.62 miles per hour. This observation was made on the same day that a current of at least 3 miles per hour was observed 150 yards south of the tip of Point Pelee running west. Five hundred feet north of the Dummy light, a current of 1.91 miles per hour was measured in water 18 to 20 feet deep with the float at a depth of 15 feet. In the same locality on another day a pulsating current was noted; the motor boat running at 2½ to 3 miles per hour in surveying work would lose headway entirely, and then as the current slackened it would bound forward. A reversal of current was also observed during one 45-minute observation period, the current changing from a strong easterly current to one from the west. The pound fishing nets afford a convenient means of determining the direction and approximate strength of the undercurrents near Point Pelee. The lines of pound stakes run out at intervals from both the east and west shores, and the nets hanging down from them are swung out in the direction of the current. As these nets have a considerable quantity of lead attached to keep them vertical, very frequently a rough idea could be formed as to the strength of the current by noting the extent of their departure from the vertical position.

At the end of Leamington dock, about 7 miles west of the base of Point Pelee, an eastward current was observed on one occasion, which was estimated to have a velocity of 1½ miles.

At times the undercurrents set in a direction opposite to the wind direction, as the following abstract from notes by E. J. Whittaker[3] indicates:—

[1]E. R. Matthews, "Coast Erosion and Protection," 1918, p. 27.
W. V. Lewis, "The Formation of Dungeness Foreland," Geog. Jour., Vol. LXXX, 1932, pp. 309-324.
[2]F. P. Gulliver, "Cuspate Forelands," Bull. Geol. Soc. Amer., Vol. VII, 1896, p. 415, Fig. 9.
[3]E. J. Whittaker, notebook.

While on board the Public Works Steamer, Nokomis, which was anchored to a pound stake just in front of the life-saving station, the following current observations were noted:—

All day there had been a steady wind from the southwest which had resulted in considerable swells from that quarter. About three o'clock the wind dropped down and the waves subsided to a long rolling swell. About 6 P.M. the wind began once more to blow violently, this time from about southwest by south. The Nokomis was anchored in ten feet of water and her bow was tied by 15 feet of rope to the pound stake. Ordinarily, the boat would have stood away to the north from the pound stake owing to the wind. But so great was the force of the undercurrent that she stood out directly to the south with stern right in the very teeth of the wind.

At Grubb's reef[1] on a day when there was very little wind, which was from the east, the boat was observed to swing into the wind with the 35-pound sampler down, and then drag the sampler bouncing over the boulders. Current here was 1½ miles per hour in a direction opposite to the wind direction.

The current velocities that have been measured near the point are doubtless much lower than those which prevail during heavy storms when current measurement is impracticable. At such times considerable changes in the shape and position of the unforested tip of the spit sometimes occur during a single storm. At the light-ship on the southeast shoal near Point Pelee, current readings were taken with a Gurley meter three times daily from November, 1918, to December, 1919, during the navigation season. Only east and west currents, which frequently reverse their direction, were found during this period. The currents generally attain the higher velocities some hours after the maximum strength of gales. The highest velocity given in the record is 2.33 miles per hour east following a southwest gale.

D. H. Philp in his manuscript report on surveys made at Point Pelee makes the following remarks:—

Under the lower wind velocities or on calm days the direction was east or down lake, unless after a west blow when the current ran west, evidently to even the level in the lake. During a heavy east blow I have seen the current running west for some hours then turn and run east, or up against the wind. The time may vary from 4 to 8 hours. Generally about this time a heavy backset began on the west shore running as much as 8 or 10 feet up the beach.

Small floats started at the point during a north-northeast or northwest wind went southerly along the line almost directly over the shoal until lost to view. Only on two days, June 27 and 28, during a strong south wind, did the current run north at the extreme point and this was only local for a few hundred feet.

Philp's observations on currents on the two sides of the point are also significant. He states:[2]—

The currents on the east and west shore of the point, with the two exceptions mentioned, were invariably south. From my observations of currents it is judged that the highest current velocities exist at the time of high winds and heavy seas, and of course then it is impossible to secure definite measurements of their velocities because of the broken water. I noticed only during storms, that the wave action together with the then existing current moved material along the shore or did any damage to the bank. The current then seemed invariably to run south, and we must conclude that such material moved in that direction. Buoys, ? feet by 4 feet by 6 inches anchored to 100-pound weights, which were placed near the bar for surveying purposes, were swept away by a mid-June gale, while one with a 150-pound weight drifted about for some days and then disappeared.

Wave and Current Transportation

It is difficult to discriminate sharply between the work of waves and currents near the shores. In stormy weather the combined action of the two is capable

[1]E. J. Whittaker, notebook.
[2]D. H. Philp, manuscript report, 1918.

of moving heavy objects on the bottom. During the summer of 1918, a buoy placed near the tip of Point Pelee with a 150-pound weight was moved by a single storm 200 yards south and 150 yards west of its original anchorage. This considerable movement of a weight was probably accomplished by the combined action of current undercutting on the lee side and wave-lifting.

The only observed example of current transportation up the east side of the point relates to a water-soaked log, which floated just awash and was, consequently, not affected by the wind.

> This waterlogged piece of wood was originally observed not far south of the life-saving station on the west side of the point. Shortly afterwards it was observed on the shore only 100 feet from the end of the point. A big storm then came up from the southwest, and the log's movements were not noticed till several days later, when it was found high up on the beach on the east side of the point just opposite the house of Captain Wilkinson, having thus travelled around the point during the storm.[1]

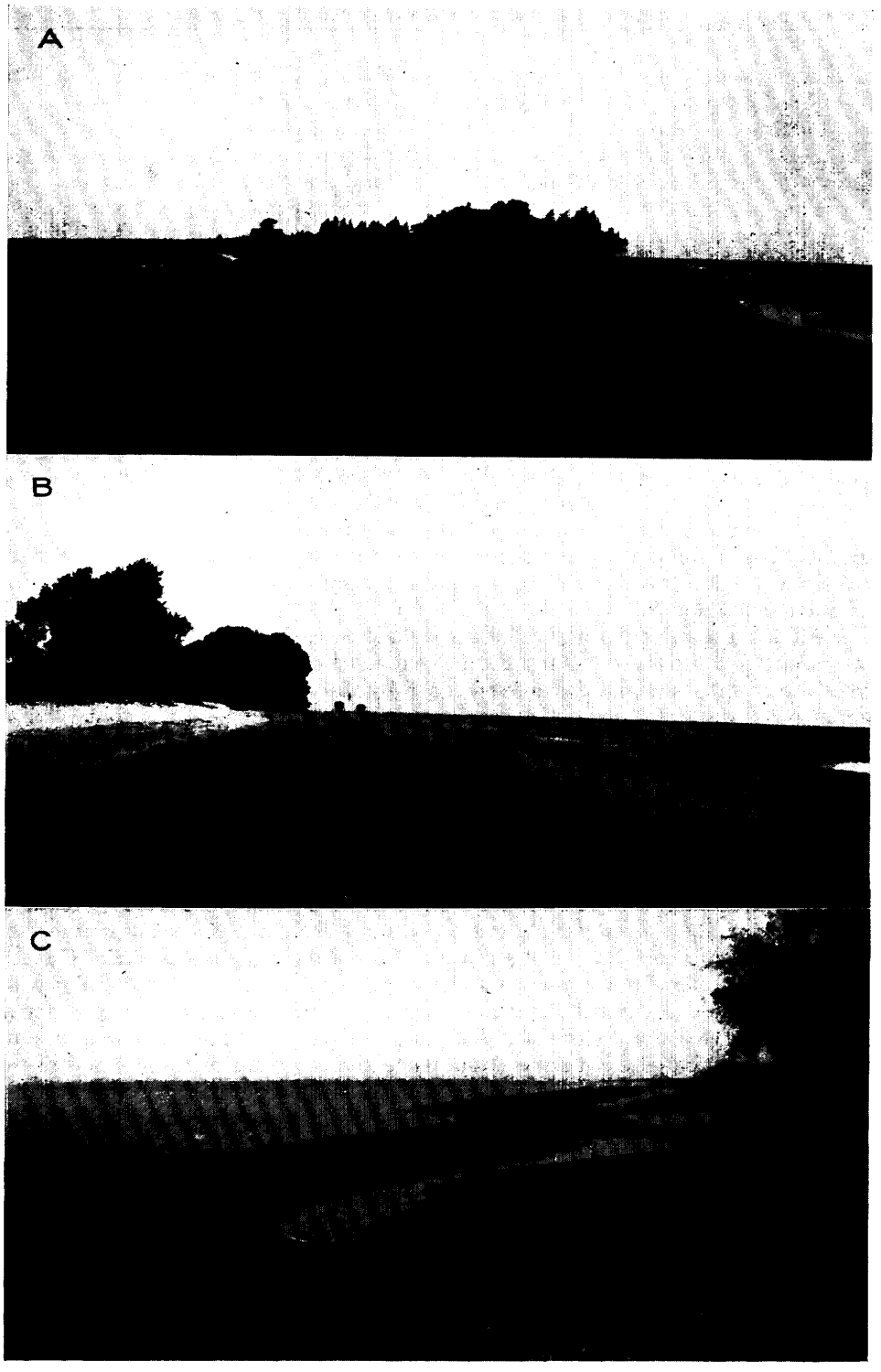
Observations of current behaviour and movement of materials at close quarters south of the point were made by Whittaker on two or three occasions. One observation at this dangerous locality was made while passing around the point in rough weather in a small boat. He rowed across the bar about 250 yards south of the point and when just over the bar observed that "the current was moving the gravel with great rapidity. Gravel consisted of material half an inch in diameter."

All of the available evidence indicates that no sediments move north toward the point from the lake. Philp found that marked stones placed on the shore were drawn into the lake and moved south by the action of the waves, or rather undertow and current set up by the heavy winds. He also states that "late in June two boats loaded with coal sank about seven miles out in a southeast direction from Point Pelee but up to his departure at the end of the season none of this coal had been washed ashore, which seems a proof that the current which I noticed running north on both shores was but local and the general direction to be south."[2]

Geologists sometimes fail to take account of or recognize the existence of currents in dealing with the foreland structures of inland lakes. The cusps of Lake Cayuga have been attributed to wave action, neglecting altogether the work of the lake currents.[3] Observations of a strong current in Lake Ontario during a dead calm[4] first convinced the writer of the important rôle played by currents in the movement of lake sediments. The obvious and spectacular results of wave work, which is abundantly displayed both in accretion and erosion, are apt to give it undue prominence and importance in the mind of the geologist who has not engaged in lake-bottom sampling during stormy weather when the currents are really active. At the shore line, waves do more work than currents and along shore move heavy shingle which could not be transported by currents. But in estimating the relative importance of wave and current work in building foreland structures, the fact should not be overlooked that lake currents may be transporting sand and gravel in a direction opposite to that of wave movement, even in stormy periods. In the case already cited of the stern of an anchored boat being pulled into the teeth of a violent wind by a southward-moving current on the west of Point Pelee, the current was moving sand in a direction opposite to that of wave movement.

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[1]E. J. Whittaker, notebook.
[2]D. H. Philp, manuscript report.
[3]R. S. Tarr, "Wave Formed Cuspate Forelands," Amer. Geol., Vol. 22, 1898, pp. 1-12.
[4]E. M. Kindle, "Note on Bottom Currents in Lake Ontario," Amer. Jour. Sci., Vol. 39, 1915, pp. 192-196.



A. Forested tip of the point looking north, 1918.
B. Lake shore on the east side of the point, 1919.
C. East shore of the point, 1919. The gravel bordering the pools of water was added by a single easterly gale.

Oscillations of Lake Surface

No systematic record of the oscillations of the lake surface was kept during lake-bottom work. But a single observation made August 11, 1918, by Whittaker on a change of lake level at Kingsville, he records as follows:—

> There is a long, gently sloping beach here with only six inches of water 15 feet from shore, and in consequence a slight lowering of the water level leaves quite a stretch of beach exposed. On this day, about 3 P.M., a large stretch of bare beach previously covered by water was noted. These oscillations had a complete period of about four minutes. There was a light swell running outside the harbour with a little wind from southwest by west. Total variation in level of water was only 6 inches. The most impressive part of this incident was the regularity and also the speed of change in level. This continued for at least two hours, when a heavy breeze came up starting breakers on the shore which obscured any oscillation effects.[1]

Considerable changes in lake level may result from wind pressure over short periods. Whittlesey called attention long ago to such changes. The greatest monthly fluctuation, due doubtless to wind pressure, recorded by Whittlesey is 5 feet, and the greatest daily fluctuation 4⅓ feet.[2]

The oscillations that are important from the standpoint of shore erosion are the considerable changes that slowly develop over a period of years and result in successive high- and low-level stages of the lake surface continuing for a series of years. These general fluctuations are independent of the annual fluctuations analogous to the high and low water of large rivers. The annual fluctuations Whittlesey found to have a mean of 1 foot 1½ inches over an observation period of sixteen years. The high-water cycles of 1913 and 1917, with a minimum low level in 1915, are typical examples of the general fluctuations. The high water of 1917 resulted in serious erosion at Point Pelee which nearly removed the sand bar protecting the east side of the marsh 2½ miles north of the point. It is only during the prevalence of these high-water cycles that serious erosion is likely to take place at Point Pelee.

Westerly Migration of Point

Study of the Point Pelee spit shows that the sands now composing it have travelled largely down the west shore. The earliest stage of this spit is represented by an old beach bordering the southwest side of the marsh enclosed by the north arms of the spit. This old beach line and another just west of it trend south 25° to 28° east (mag.) instead of nearly south as the present shore line of the spit does. The west side of the spit has been and appears to be still building westward. The east side, however, has for a long period been retreating westward. This is indicated by the diagonal truncation of the old west shore beaches by the present east shore beach. In other words, there has long existed a tendency towards a gradual westerly migration of the point, changing its original orientation from south 28° or more east to its present orientation of nearly due south.

The character of the beach on the two sides of Point Pelee contrasts strongly. On the east a sand beach only a few yards wide for considerable stretches separates the forested border from the water in quiet weather, while in stormy weather the waves cross this in places and have been recently undercutting forest trees along a 300-foot stretch of the shore. (See photograph C on page 10.) After heavy storms pieces of peat of various sizes up to 2 by 4 feet have been found on the beach of the east shore, having been separated from the lake bottom by wave

[1]E. J. Whittaker, notebook.
[2]Chas. Whittlesey, "Variations in Level of the Lakes," Can. Jour. and Proc., Vol. II, 1854, p. 26.

action. The peat bed from which they come is now covered by the lake and represents a former eastward extension of the marsh, the protecting sand bar having moved westward to its present position. One striking example was observed in 1931 of a silver maple tree (*Acer saccharinum*), three feet in diameter, which reached about half its present size while growing on the west or marsh side of the barrier sand bar and the remainder of its growth after the shifting of the bar had buried its trunk to a depth of about four feet. This bit of tree history is disclosed by recent erosion which leaves more than half of the roots of the still upright tree exposed. Two distinct sets of roots were uncovered in 1931 with 3½ feet of rootless trunk separating them. (See Fig. 3.) The great abundance of roots at two levels, the higher leaving the trunk where it thickens rapidly to nearly twice the diameter of the lower rootless 3 feet, is interpreted as follows: (1) growth for 30 or 40 years at the eastern border of the marsh inside the sand bar; (2) rapid burial of the trunk to a depth of 4 feet by waves carrying sand over the protecting bar into the marsh during one or more storms; (3) development of a second set of roots near the warm surface of the sand;

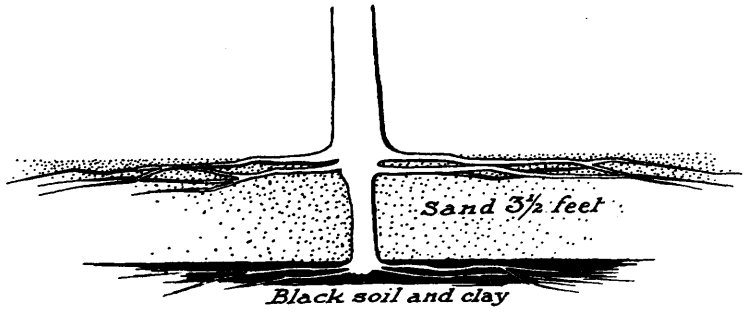


Fig. 3—Roots of silver maple showing stages of east shore erosion on the point.

(4) erosion of the sand bar for 30 years or more until at present the tree stands at the edge of the lake.

On the west side of Point Pelee a gravel or sand beach, 200 to 250 feet wide, rising from the water's edge, generally lies between the lake and the forested zone of oak and cedar. This wide belt of sand and gravel is without vegetation, except for occasional patches of shrubs near the forest border. It gives the impression of a growing shore line, as strongly as the east shore indicates a receding shore line. It is only near the tip of the forested part of the point that the contrast of the east and west sides is not very pronounced. Strong erosion was in progress on both sides of the forested end of the point in 1918, as was indicated by recently uprooted trees. Recent attempts to check erosion around the forested tip of the point include the placing of wire weirs about 2 feet high at right angles to the shore line and the planting of rows of willows 4 to 5 feet apart over a 20-foot border of beach just outside the zone of indigenous trees. The willows are protected by a large-meshed wire carpet, through which they are growing.

Several of the early maps of the Great Lakes region have been examined for the purpose of learning whether they furnish evidence concerning the shifting of the position of the southern half of Point Pelee during the last three centuries. The Nicholas Sanson map of 1656 is like those which followed it during the remainder of the Seventeenth Century, too crude to have interest in this connec-

tion. Two of these early maps were published in 1703, one by Delisle in Paris, and the other by Lahonton in The Hague. Both show Point Pelee, but disagree strikingly as to its orientation. Delisle's[1] map shows three islands near the south end of Lake Huron which probably never existed and which tend to discredit this map as to coast-line features. A French map, *Carte des Lacs du Canada*, prepared in 1744 by N. Bellin from the charts and journal of R. P. de Charlevoix,[2] shows in considerable detail the geography of the Great Lakes, including canoe routes from the Ottawa river to James bay and Lake Huron. On this map Point Pelee is given a southeasterly trend. Another Eighteenth Century map,[3] the Lake Erie portion of which is here reproduced (see



Facsimile of a French map depicting Point Pelee trending southeast.

photograph above), clearly shows the foreland pointing to the southeast. The orientation of Point Pelee recorded by this 178 year old map corresponds well with the inference which study of very recent changes in the shore line appears to justify. If no interference had been offered by man with the natural course of the agencies that have for many years been in operation, a prediction could be made with some confidence that Point Pelee would eventually point southwest.

[1]L. C. Karpinski, Bibliography of the Printed Maps of Michigan, 1804-1880, with a series of over 100 reproductions of maps constituting An Historical Atlas of the Great Lakes and Michigan, 1931, p. 47.

[2]Ont. Bur. Mines, Vol. XIX, pt. 2, p. 4.

[3]Partie Occidentale de la Nouvelle France ou du Canada, par M. Bellin Ingenieur du Roy et de la Marine, Pour seruir a L'Intelligence des Affaires et de l'Etat present en Amerique, communique au Public par les Heritiers de Homan, en L'an 1755.

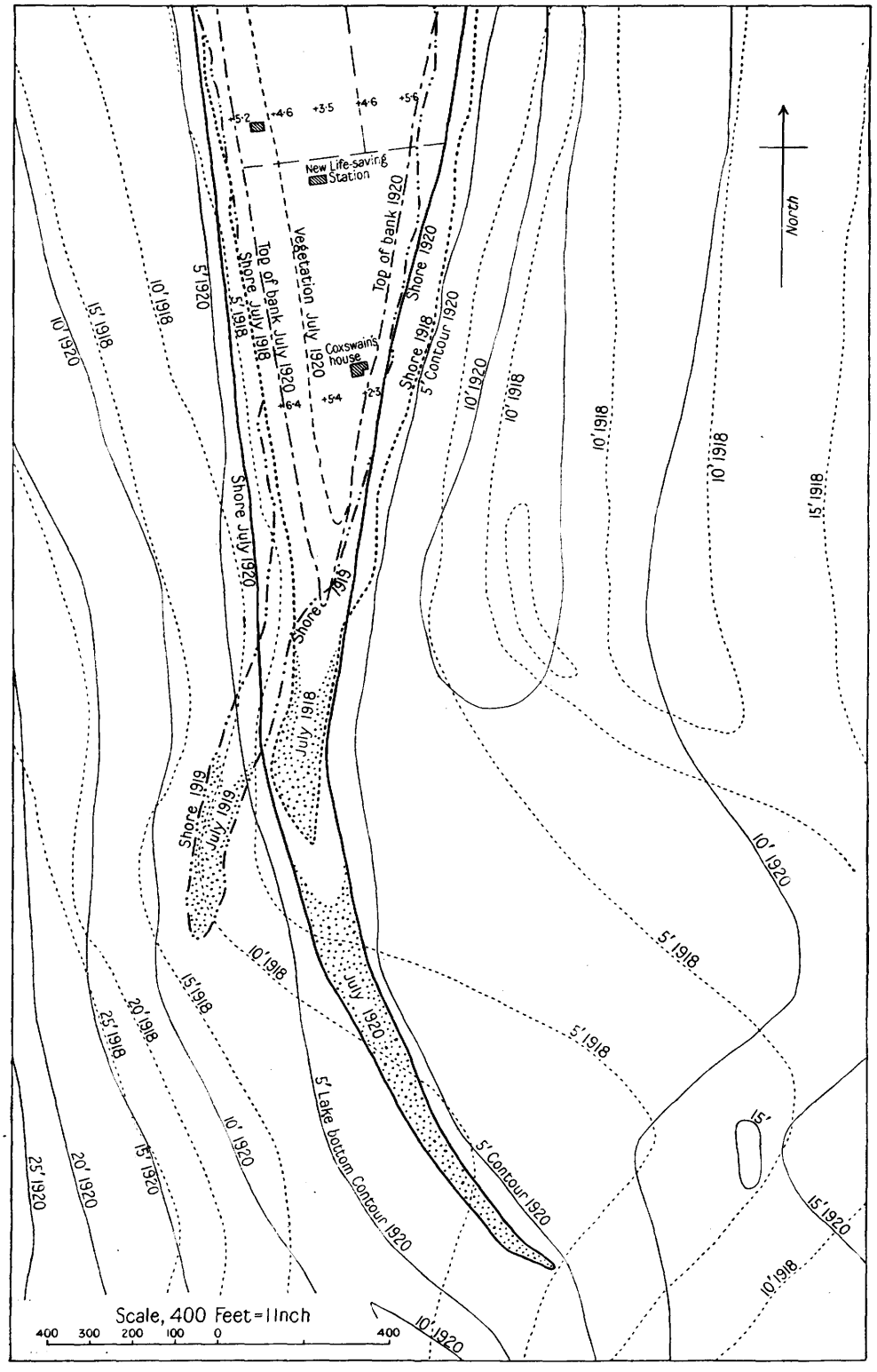


Fig. 4—Point Pelee, showing shifting positions of sand spits and lake bottom contours in 1918, 1919, and 1920, from surveys of the Department of Public Works, Canada.

Periodic Changes at the Tip

The very considerable net results of shore-line changes of the Point Pelee foreland as a whole, covering a long period, which have been outlined above, are based on other kinds of evidence than precise surveys. But the changes that involve chiefly the unforested tip of the spit, which take place from year to year and shift it, sometimes in an easterly and sometimes a westerly direction, are accompanied by great changes in the length of the spit. These and the width of the point near the southern limit of vegetation are determinable by successive surveys. Comparison of the 1889 with the 1917 survey shows a decrease in the width of the point of about 150 feet. The extent of changes as regards the length of the unforested sand spit have been ascertained by comparison of seven surveys, which are separated by intervals of from 1 to 15 years.[1] A summary of these surveys showing the length of the tip of Point Pelee as measured from a base line near the lower end of the spit gives the following results:—

	Feet
1889	2,850
1904	1,350
1909	1,600
1910	2,575
1912	2,100
1916	1,200
1917	1,475

The extreme lengths of 1889 and 1910 occurred in low-water years, but the water was higher in 1889 than in 1910 by nearly half a foot, and the 1889 spit is longer than the 1910 spit. The water in 1917 was nearly 1 foot higher than in 1916, when the point was the shortest recorded by surveys. It thus appears that the greater lengths of the spit correlate with periods of relatively high water. Between July, 1918, and July, 1920, the length of the spit increased 1,800 feet. Most of this increase occurred in one year, as the 1919 survey showed a length of only about 200 feet more than in 1918. The extent of such changes for a 3-year period following 1917 has been definitely ascertained by a series of three surveys made at 12-month intervals under the instructions of K. M. Cameron, Chief Engineer, Department of Public Works of Canada. A survey of the shore line, which was made first in 1918, was repeated for two consecutive years. Parts of a plan of the results of these surveys are here reproduced (Figs. 4 and 5). Figure 4 shows that the position of the shore line shifted considerably near the tip of the point in successive years. It shows that in July, 1920, the spit south of the vegetation line was nearly three times its length in July, 1918. The spit made in 1920 a long sweeping curve to the east, while in the preceding year it was inclined to the west (Fig. 4). Changes in the position of the shore line on the east side of the point north of the forested tip amounted in places to about 150 feet in an east and west direction. On the more stable west shore the maximum annual change in the position of the shore line was under 100 feet. In some places the contours moved shoreward and in others lakeward in the 2-year period (Fig. 5).

In addition to annual changes these surveys have shown that great changes in the length of the point may take place in a single season. Four surveys of the point were made during June, July, and August, 1918, by D. H. Philp, Public Works engineer. The survey of June 21, which was made at about the

[1]Survey of G. McPhillips, D.L.S., July 30, 1889; U.S. Lake Survey, 1904; Newman Survey, June 28, 1909; Purser Survey, September, 1910; Baird Survey, September, 1912; Public Works Canada, May, 1916; Public Works Canada, October, 1917.

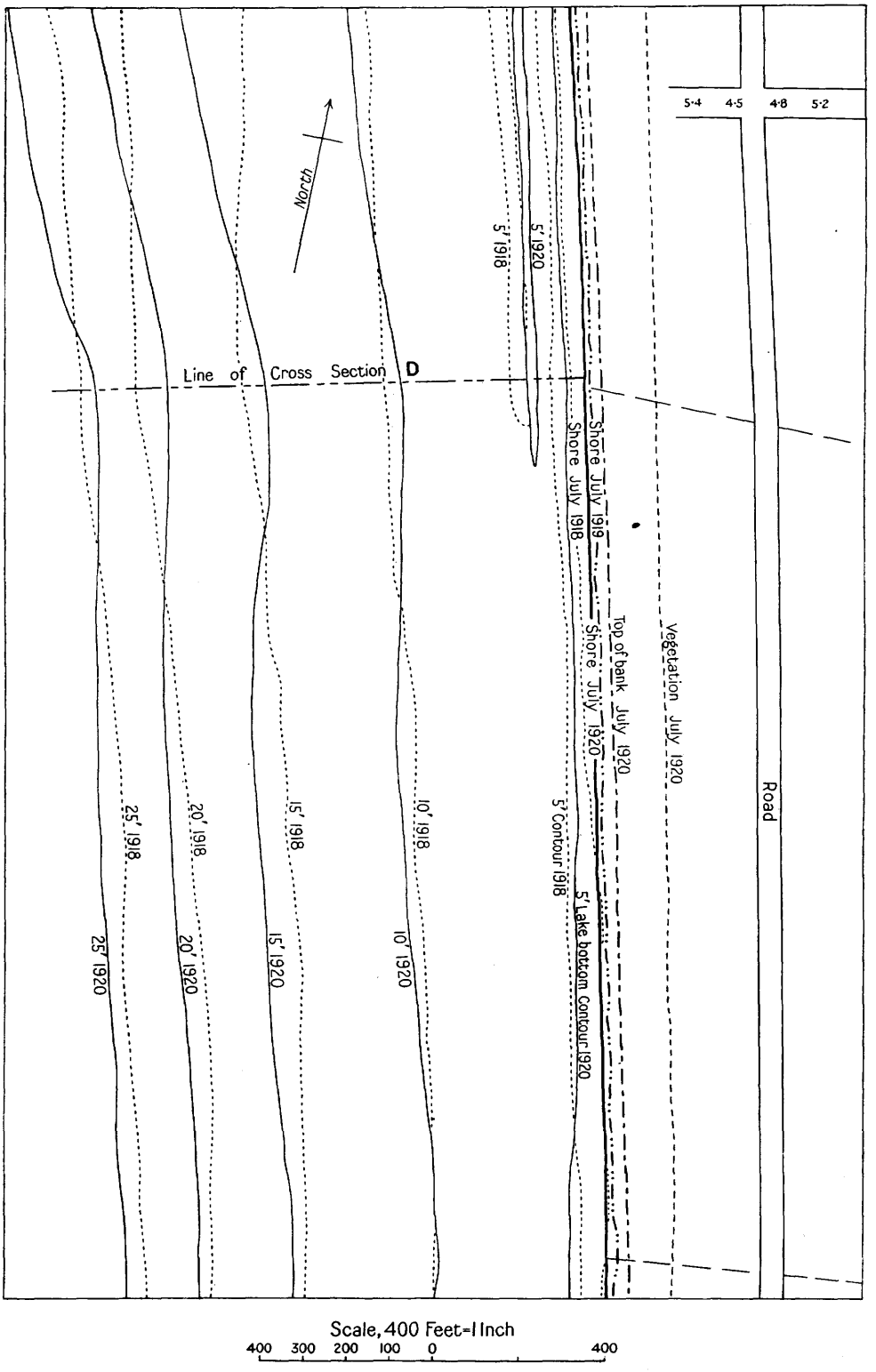


Fig. 5—Detailed plan of part of the west shore of Point Pelee showing lake bottom contours in 1918 and 1920, from surveys of the Department of Public Works, Canada. For location of area, see insert facing this page.

time of highest lake level for the season, showed the tip extending 250 feet farther south than at any other time during the summer.

Bottom Deposits

The Point Pelee foreland, which is an expression of the southward building activity of waves and currents, represents only a part of their constructive work. The greater part of the waste from shore erosion east and west of the base of the foreland has been spread out in broad sheets of lake-bottom sand on the two sides of the foreland. (See map in pocket.) The narrow spit itself continues south under water for several hundred feet, as shown by the photograph from the air. (See insert facing page 2.)

The surveys of the bottom adjacent to Point Pelee by the Public Works' engineers demonstrate that great changes in the distribution of bottom sediments take place each year.

The composite map showing bottom contours as well as shore lines discloses great changes in the position of the 5-foot lake-bottom contours that occurred during the 2-year period separating the two surveys represented. These contours, which are based on parallel transverse lines spaced at 500-foot intervals south of the point and soundings at 25- to 40-foot intervals, show a bottom topography for 1920 that differed greatly from that of 1918. Evidently waves and currents had shifted the position of the sand and gravel deposits over most of the bottom within 25 feet of the surface during the 2-year period covered by the two surveys. The considerable changes in beach topography for this period were paralleled by still greater alterations of bottom topography. (Figs. 4 and 5.)

The general tendency of the contours was to move outward on the west side, particularly along shore just above the tip of the spit. Along one of the lines of sounding, the contours, except the 5-foot one, moved west 100 to 300 feet. The greatest westerly migration is just opposite where the shore showed maximum westward growth. This westerly migration was most pronounced west of the tip of the point where the 15-foot contour of 1920 nearly coincides with the 25-foot line of 1918, and the 25-foot line of 1920 is 200 to 300 feet west of the position of that contour in 1918 (Fig. 4). Farther south the relations of the contours have changed completely, showing a shifting of most of the bottom deposits. Near the extreme north end of the west side where there was some erosion, the 5-foot bar moved in.

On the east shore the westerly movement of the contours is pronounced opposite the parts of the shore line that have been most eroded. Near the coxswain's house the shore lost 100 feet in the two years preceding the later bottom survey. Opposite this point the 10-foot bar has moved shoreward (west) more than 300 feet.

Near the north end of the map where the shore line has grown or about held its position, the contours have moved east, the 15-foot line being more than 400 feet east of its 1918 position.

With one exception all of the eight bottom profiles (Fig. 6) along lines at right angles to the east and west sides of the point show a more gentle gradient in 1920 than in 1918. Profile B shows a 5½-foot decrease in depth 900 feet from shore; for 1920 as compared with 1918. Profile E shows a decrease of 6½ feet from shore, and profile A shows a 7-foot decrease 1,400 feet from shore and a 6-foot increase 100 feet from shore.

The profiles show in no case a uniform gradient lakewards. They disclose instead a series of slight depressions parallel with the coast line separated by

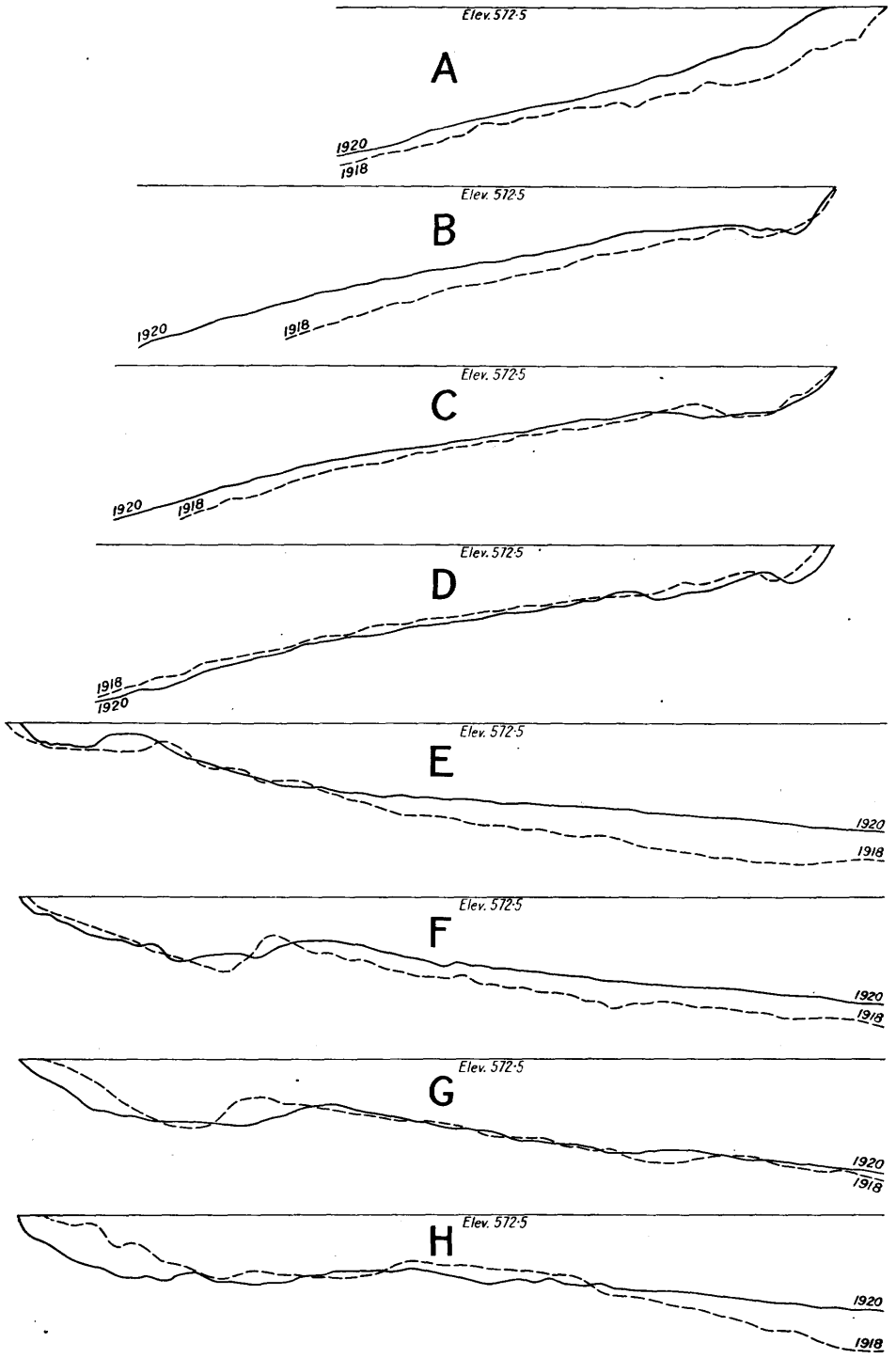


Fig. 6—Bottom profiles on east and west sides of Point Pelee, from surveys by the Department of Public Works, Canada. The mean water surface 1860 to 1919 was 572.53 feet above mean sea-level. Scale of profiles: horizontal, 300 feet to the inch; vertical, 30 feet to the inch.

nearly flat ridges. The best defined of these ridges lies on the east side, 300 to 400 feet from shore, and has a maximum elevation of about 6 feet above the trough on its landward side. On the west side the inner and most prominent ridge lies from 125 to 250 feet off shore and shows a height of only 2 or 3 feet above the adjacent trough. The position of these troughs and ridges differs materially in the two sets of profiles. The ridges probably represent lines along which during many storms wave movement of sand landward and undertow transportation of sediments lakeward neutralized each other and more sediment was deposited than elsewhere. The position of such zones of balanced forces would vary with the strength and direction of the waves.

The mobility and evanescent character of sand deposits under two or three fathoms of water is established by a study of these maps, which show that sandy sediments may be moving about for long periods before they become stabilized as geological formations through burial under other sediments and consequent removal from the zone of current- and wave-shifting.

A zone of islands, which includes Pelee island with a north-south length of 8 miles, Kelly island, and the Bass islands, extends between Point Pelee and the Marblehead peninsula on the south shore of the lake. These islands, no doubt, play a part during stormy weather in stimulating current action in the passages between them. The widest of these, Pelee passage, lying between Point Pelee and Pelee island, has a width of 8 miles. Much of the bottom between the tip of Point Pelee and the island consists of bed rock and boulders, and the remainder is almost entirely gravel or gravel and sand. The deepest part of the Pelee passage, which falls within the seven-fathom line, shows gravel bottom. This coarse bottom must be ascribed to the exceptionally strong currents that, within the limits of the passage, sweep most of the sand and finer sediments beyond it. The narrow band of sand which borders the east and west shores of Point Pelee widens out into a fan-shaped area with an unknown southerly extent. (See map in pocket.)

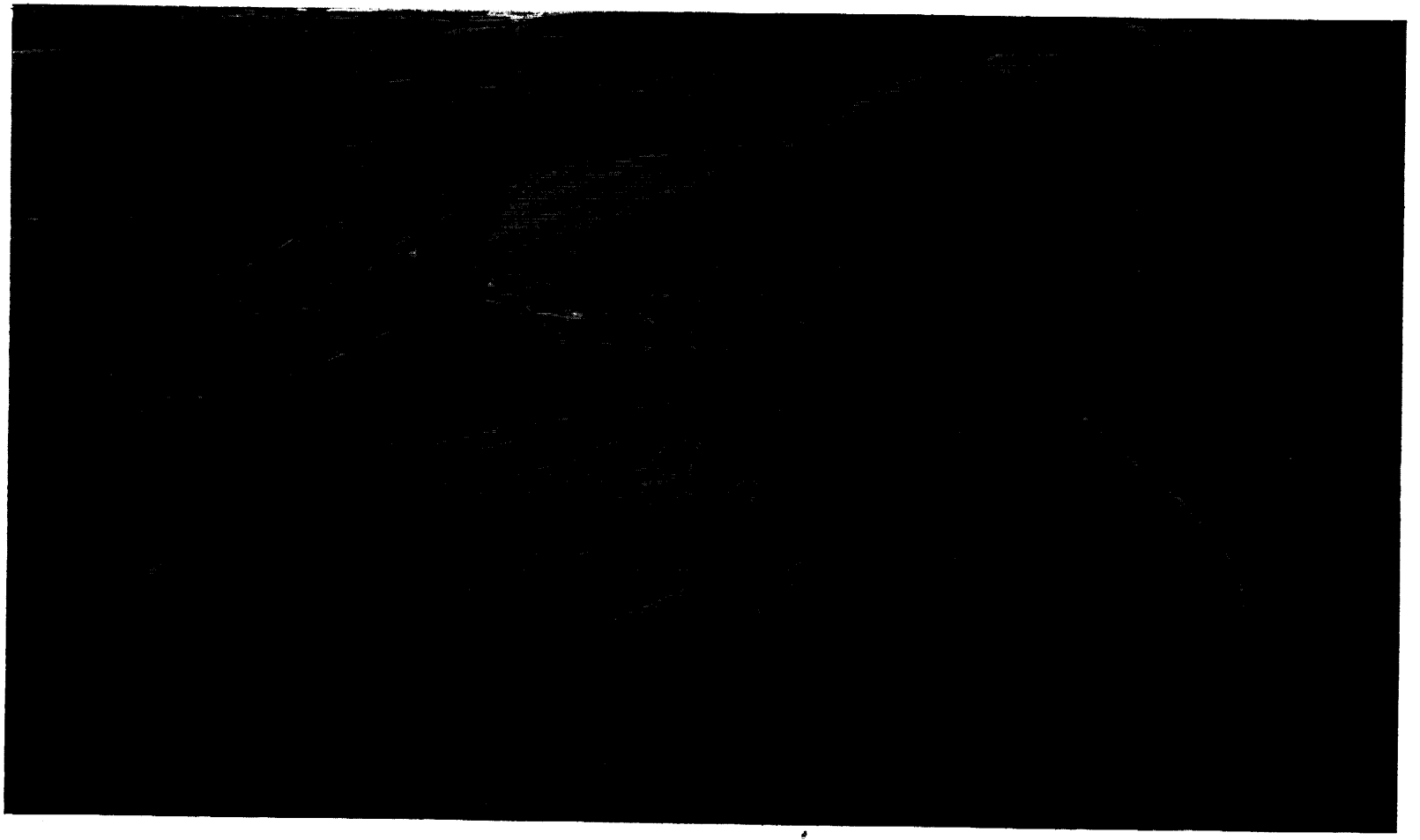
The wide clay belt that borders the sand zone for some 10 miles to the east of Point Pelee is formed of grey clay presumed to be glacial till and represents a zone where currents are sufficiently strong to prevent any notable accumulation of sediments. This area of no deposition is more than twice the size of the Point Pelee foreland. A similar but much narrower clay belt borders the west side of the sand zone on the west side of Point Pelee.

The soft mud zone which lies lakeward of the other zones, in its contact with the clay and sand zones on the eastern side of the map cuts across bottom contours in a striking way. It appears from the independence of depth control shown by this fine-textured sediment, that strength or weakness of currents, rather than wave action, which correlates closely with depth, is the dominant factor controlling its distribution on the lake bottom. (See map in pocket.)

Dead shells were found abundantly at various points during the bottom sampling. Because of the exposure of both sides of the foreland to heavy wave action, molluscan shells are probably more common on the adjacent sandy bottom sediments than on similar bottoms in more protected situations. Professor Baker's elaborate study of molluscan habitats in Oneida lake lead him to conclude "that the habitats producing the largest number of species are those with a sandy or rocky bottom in an exposed situation. Of those habitats having 10 or more species 8 are exposed points or shores where the number of species ranges from 10 to 17."[1]

[1]Frank Collins Baker, "The Relation of Mollusks to Fish in Oneida Lake," New York State College of Forestry at Syracuse University, Tech. Pub. No. 4, Vol. XVI, No. 21, 1918, p. 287.

Photo by the Canadian Air Force



Island in Slave river showing lateral growth on the right and erosion on the left side. Successive annual additions (indicated by curved lines of forest trees) have followed the cutting of the river bend into the mainland on the right, while cutting across the ox-bow has initiated erosion on the left side of the island.

The shell that outnumbers all others combined on the shore of Point Pelee is *Pleuroceras acutum rafinesque*. This shell is generally found around the shores of the Great Lakes where wave action is strong but is unknown in the smaller lakes. In the marsh, the pond snail *Limnaea stagnalis* abounds in waters separated from those of the lake, where it is unknown, only by a narrow sand bar. These two shells are representatives of two sharply contrasted adjacent molluscan assemblages, the one living in the exposed sand, gravel, and boulder bottom bordering the foreland, the other confined to the black mud and associated vegetation of the shallow ponds or lakes within the borders of the marsh.

Gravel Dredging *versus* Erosion

Development of the use of concrete in building operations created a new demand for gravel, one of its constituents. This produced a good market for the gravel deposit south of Point Pelee spit and resulted several years ago in the granting of leases for dredging the lake-bottom gravels south of the point. For a number of years the deposit has been exploited extensively for use in Detroit and other lake-shore cities. Since 1917, gravel dredging has been limited to areas 5,000 feet or more south of the point.

In an MS report, dated December 14, 1917, A. J. Stevens, Acting District Engineer, Department of Public Works of Canada, summarized the results of his study of all the surveys and plans which had been made of the point from 1847 to 1917 with the object of recording changes shown by them. The following abstracts are from this report:—

> The plan of 1847 shows a small passage through the bar north of the Dummy. In 1877 this had increased, and in 1909 showed a further increase in width and depth. . . .
>
> It should be noted that the 1877 and 1909 surveys both showed increases in width and depth of the small passage through the bar indicated by the 1847 survey. These changes developed before the gravel-dredging period began.

The very active erosion which occurred on the east side of the point in 1917 led to a strong sentiment in some quarters in favour of cancelling the dredging leases. It was believed by many who were interested in the future of Point Pelee as a protection to shipping, a preserve of a southern type of flora and fauna, and as some of the best agricultural land in Canada, that the foreland or a considerable part of it was in imminent danger of destruction as a result of the daily removal of ship-loads of lake-bottom gravel from the area south of the spit. Both dredging and erosion were in progress simultaneously in 1917, and it is not surprising that a relationship of cause and effect was assumed by some to exist between them.

This simple explanation, however, overlooked the fact that while erosion was active on the east side, accretion was in progress on the west side. If gravel dredging was causing erosion on the east shore why should it not also produce erosion on the west shore? The structure of the point south and west of the lower portion of the marsh shows conclusive evidence that the growth toward the west has been in progress for a long period, just as the evidence already presented points toward the work of erosion having been active on the east side long before any gravel had been dredged. The writer had studied and described,[1] previous to his acquaintance with Point Pelee problems, a spit on the Arctic coast of Alaska where, as at Point Pelee, erosion is in progress on one side and accretion on the other. The Point Hope spit is unique on the northwest coast of

[1]E. M. Kindle, "Notes on the Point Hope Spit, Alaska," Jour. Geol., Vol. XVII, 1909, pp. 178-189.

Alaska, as Point Pelee is on the Lake Erie shore, in being the only spit which projects any notable distance into the water at right angles to the trend of the coast line.

At Point Hope the northwest shore is being cut away rather rapidly while the south shore is being built up. The ruins of an ancient Eskimo village, which is being undercut by the waves, afford indisputable proof of the encroachment of the sea on the northwest side. We have also the testimony of a missionary, Dr. John Driggs, who has resided for 18 years near the north shore of the point. He states that 185 feet would be a very conservative estimate of the amount of cutting which has occurred on the north shore during the period of his residence [2]

Comparison of conditions of erosion and accretion at these two widely separated spits is instructive, because we find the two contrasted agencies of destruction and building in progress in both. But in the case of the Arctic spit, neither dredging nor any other human activity can be claimed to have been even a small factor in the erosion. At Point Hope we have the testimony of a resident that about 185 feet of one shore has been cut away in 18 years, just as we are informed that much of the east side of Point Pelee has disappeared within the memory of men now living. The differential growth which can be seen both at Point Hope and Point Pelee is not an unusual phenomenon in connection with land forms built from unconsolidated sediments. It can be seen in scores of sand islands in the Slave river in northern Canada. Where a youthful sand island without timber lies in mid-stream the phenomenon is seen under the simplest conditions. During the high-water season, bank-cutting at the upper end of the island takes place while the slack current at the lower end is building a spit, the combined result being a slow migration of the island downstream. When the sand island occurs in a curving section of the river, the strong current on the inside and the relatively weak current on the outside of the bend results in cutting on one and growth on the opposite side. The resulting lateral migration of the island is akin to the westward shifting of Point Pelee, which has been in progress for a long period, although the wave factor is absent in the case of the islands. (See photograph on page 20.)

It has already been shown in this paper that the currents trend south on both sides of Point Pelee, and in the area south of the point east or west. It appears, therefore, that practically all of the sediments move along the sides of the point in a southerly direction, and in the area immediately south of it either in a westerly or an easterly direction. In the absence of any evidence of a northward movement of sediments over the bottom at Point Pelee, removal of gravel from the bottom 5,000 feet or more south of the timbered end of the point appears to be a negligible factor in shore erosion on the east side of Point Pelee.

[1] E. M. Kindle, op. cit., p. 182.

APPENDIX

Beach Protection and Reclamation

By W. R. Rogers

The protection of lake shores and river banks from erosion has always presented difficult problems. About 1922, a method was developed which depends on the planting of willow poles, placed in more or less horizontal rather than vertical position, along the slope of the shore or bank. After considerable negotiation, the Ontario Government through its Department of Mines contracted with the Natural Process Engineering Company, of Waterloo, to protect by this patented system an experimental or demonstration stretch of 2,800 feet on the east side of Point Pelee fronting concession B, township of



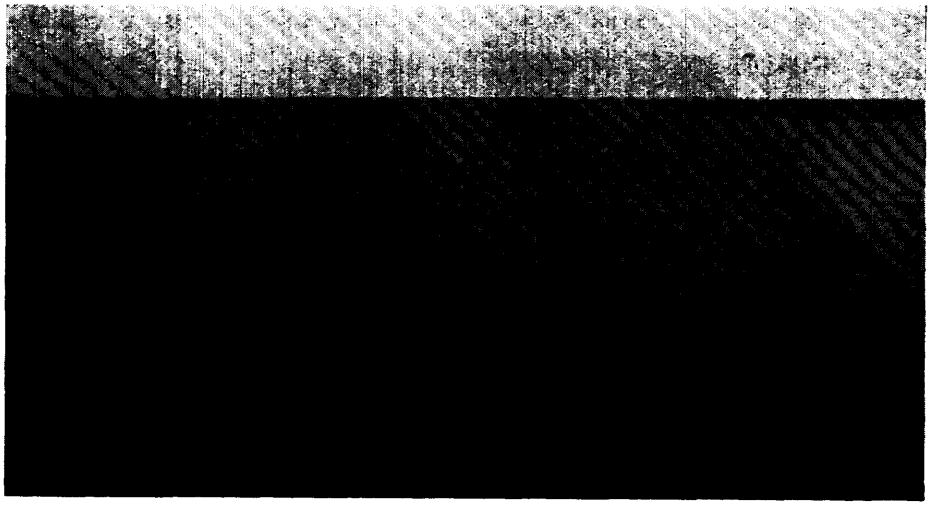
Method of planting willow poles. These poles are placed in shallow trenches at 4-foot intervals and then anchored by placing wire fencing at right angles to the poles and securing it with staples, after which the trenches are filled in with sand.

Mersea, and extending south from the pumping station, which is located on the line between concessions A and B. The planting was done in the spring of 1931. At the same time the National Parks Branch, Department of the Interior, Ottawa, took similar action in regard to three stretches of shore line, 2,800 feet in all, closer to the point on the same side of Point Pelee. There was also a small private contract let covering a portion of the shore line fronting concession II, about 3 miles to the northeast of the Ontario Government section. In all, about 6,000 feet of lake frontage was so protected in 1931. The willow poles were placed in shallow trenches at 4-foot intervals parallel to one another, with their axes pointing a little north of east, whereas the shore line runs approximately north and south.

Supplementing the planting of willow poles, the lower ends of which were placed about 60 feet from the edge of the lake, wire-mesh groynes were placed

at 100-foot intervals along the beach. These consisted of 30-foot lengths of highway type interlocking guard fence, 24 inches in width, supported by angle-iron posts. The groynes were anchored 10 feet from shore and ran out 20 feet into the water, pointing a little north of east. Their function is to trap any driftwood or floating material as well as moving sand and gravel due to the wash of the lake, and generally to protect the willows until they become established. Inspection in 1932 showed that the groynes had not proved effective; in most cases the wire mesh had been knocked down by wave and ice action, and the supporting posts were bent over or had disappeared entirely.

As to the effectiveness of this willow-planting experiment, it is too early to judge. It is hoped that the tree growth will act as a sand-collector and gradually elevate the beach. Roots and stems of the willows tend to hold the sand firmly in place and thus provide a barrier against wave action during storms. The

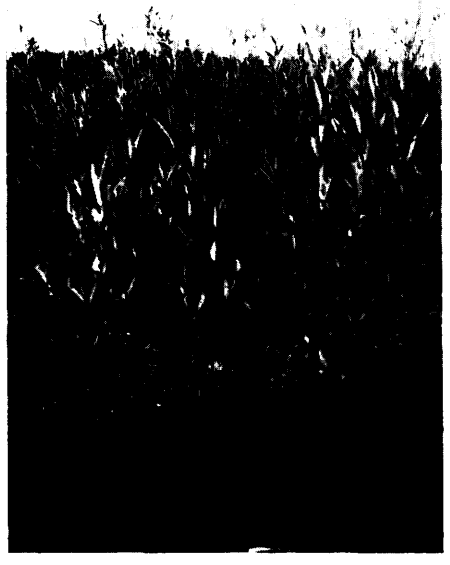


Beach protection by groynes of interlocking mesh, highway guard rail type, projecting about 20 feet into the water. These met with disaster through wave and ice action, proving quite unsuited for the conditions.

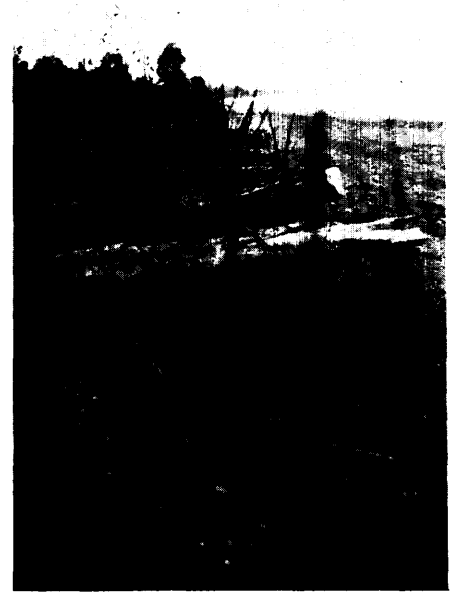
sponsors of this method of beach protection claim that the willows should be cut down in about ten years to permit new dense growth from the stumps. Suckers do not develop from the white willow, hence the growth is confined to the original planting. During departmental inspections in August and September, 1932, of the 2,800 feet of planting opposite concession B, where breaks in the dike protecting cultivated onion fields had occurred, owing to high water and storms in 1929 and 1930, it was observed that the willows had taken root, and shoots above ground had reached an average height of three feet, a better growth than on the National Park beach to the south. This represents the growth during two seasons, about one foot having been attained the first year. Some undermining had taken place over a stretch about 100 yards long, exposing the ends of the willow poles, which protruded out of the sand as much as 3 feet in places, although for the most part only a few inches to a foot of the poles were bared. On the whole the planting has withstood the storms very well.

An examination made in April, 1933, by J. F. McFarland, inspector of sand and gravel dredging operations, indicates that both erosion and accretion took place during the winter of 1932-33 on the east shore of Point Pelee. He reports as follows:—

Beginning approximately 600 feet south of the pumping station and for a distance of 750 feet south, the willows have been partly washed out and in many cases the ends now protrude out of the sand some 6 feet. The roots of the willows are exposed over this distance, and the wire fencing used to tie the willows together, which was formerly well covered with sand, is now plainly visible. The beach in front of the willows has been cut away by the currents and wave action, and at its widest point is now not more than 30 feet. In some places the ends of the willows are only 10 feet from the water's edge. Last fall, the beach at this point had an average width of from 50 to 75 feet. The Natural Process Engineering Company, about the middle of April,



Willows in front of concession B showing an average height of 3 feet after two seasons' growth.



Undermined willows with ends exposed as much as 3 feet, fall of 1932

placed some 400 bags filled with sand in front of the willows in an endeavour to stop further erosion and act as a protection to the willows. The efficacy of these sand bags is not apparent, and in many cases they have been knocked out of place by wave action.

I also examined the beach at several points from the extreme end of the point as far north as concession IV, a distance of about 10 miles, in order to obtain information regarding the general condition of the shore line and the growth attained by the willows planted by the Dominion National Parks Branch. Some 1,400 feet of the east beach was planted, beginning almost opposite the marine rails extending eastward from the Life Saving Station on the west shore and continuing around the tip of the point and up the west beach for a distance of about 150 feet. The willows at this point, with the exception of about half a dozen which have been partly washed out, have made good growth and have reached an average height of 2½ to 3 feet. The willow poles are now covered with a foot or more of sand. In addition to the willows planted by the Natural Process Engineering Company, the Parks Branch has planted upright willows over an area about 500 feet long by 100 feet wide, south of the end of vegetation at the extreme south end of the point. These upright willow poles are 3 to 4 inches in diameter and about 8 to 10 feet long, and have been planted to a depth of about 3 feet. During my visit, the extremely long sand spit usually extending out into the lake for several hundred feet was not in evidence, but the beach had built up considerably and was much wider than last year.

Proceeding northward, I visited the east beach about one mile north of the point. Here, the sand beach has almost entirely disappeared, and the bank is being rapidly eroded. Large

trees, some as thick as one foot in diameter, had fallen into the lake. The bank at this point rises abruptly about four feet above the level of the lake and, in some cases, the beach is not more than 4 or 5 feet wide.

I also examined the willows planted by the Dominion Parks Branch along the east beach about two miles south of the old hotel opposite the line between concessions C and D, where two stretches of about 700 feet each were put in, several hundred feet apart. These willows are making good growth, and the beach has increased in width about 100 to 150 feet. The ends of the wire groynes, which extended into the water at the time the willows were planted, are now 75 to 80 feet inland from the water's edge. The willows have an average height of about 3 feet.



Temporary protection with sand bags provided in the spring of 1933 for exposed willow poles, some of which overhang the undermined sand bank as much as 6 feet.

At the Wright property in concession I, the beach has been cut away considerably and is now about 40 feet wide, or half the width it was last year, while at the Carr subdivision in concession II, the beach is now only approximately 15 feet wide where last fall it was fully 75 feet. In front of the Marentette property, just south the line between concessions II and III, where some willow planting was done by the private owners, the willows have for the most part been washed out and entirely dislodged, and the water's edge is only 15 feet away from the ends of the willows. A few of the willows have rooted well and have reached a height of about 5 feet. At another point in front of this property, only 6 feet separates the ends of the willows and the water's edge. On the Pulley subdivision in concession III, about half the beach has been cut away, and it is more than 40 feet wide at this point.

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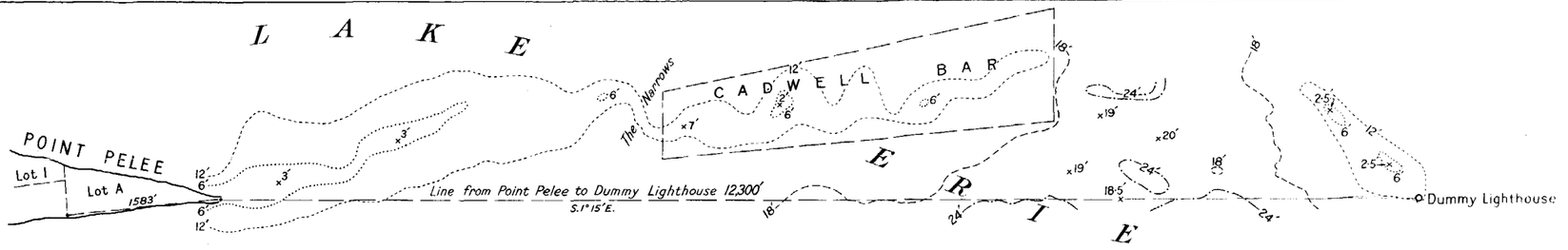
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PLANS
OF
POINT PELEE AND ADJACENT SHOALS
AS SURVEYED IN 1909 AND 1920

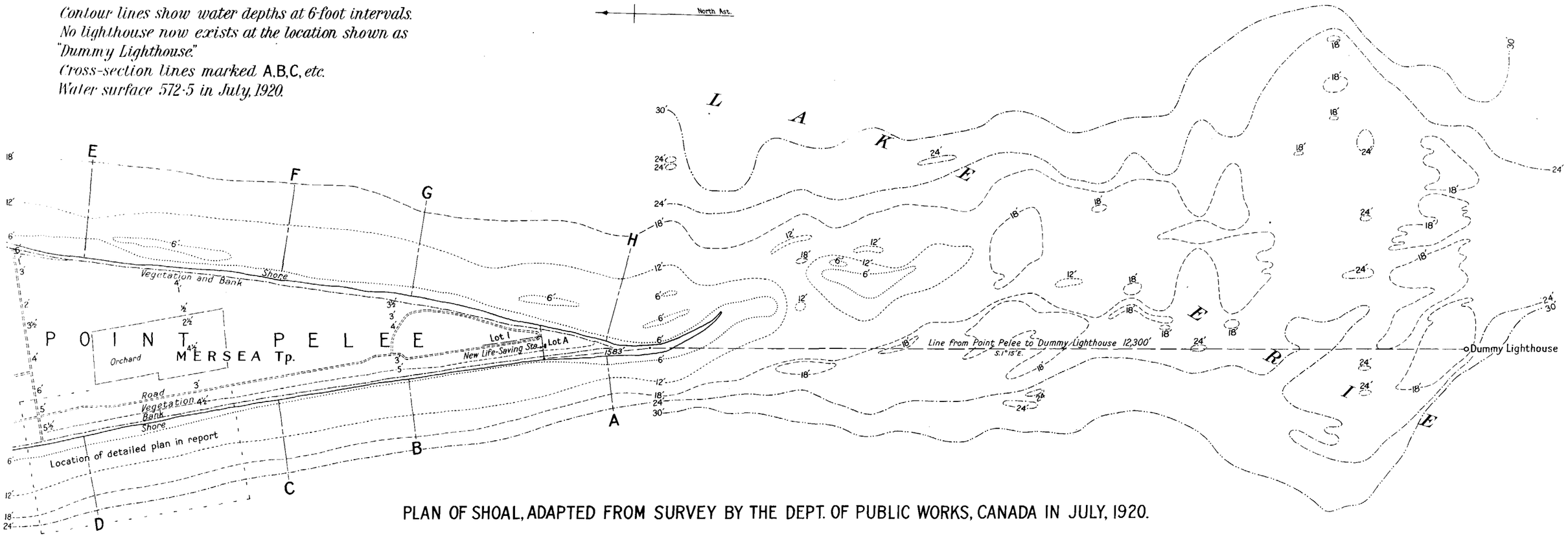
Scale : 1500 feet = 1 inch

1500 1000 500 0 1500 3000

Contour lines show water depths at 6-foot intervals.
No lighthouse now exists at the location shown as "Dummy Lighthouse."
Cross-section lines marked A,B,C, etc.
Water surface 572·5 in July, 1920.



PLAN OF SHOAL, ADAPTED FROM SURVEY BY J.J. NEWMAN, O.L.S. IN JUNE, 1909.



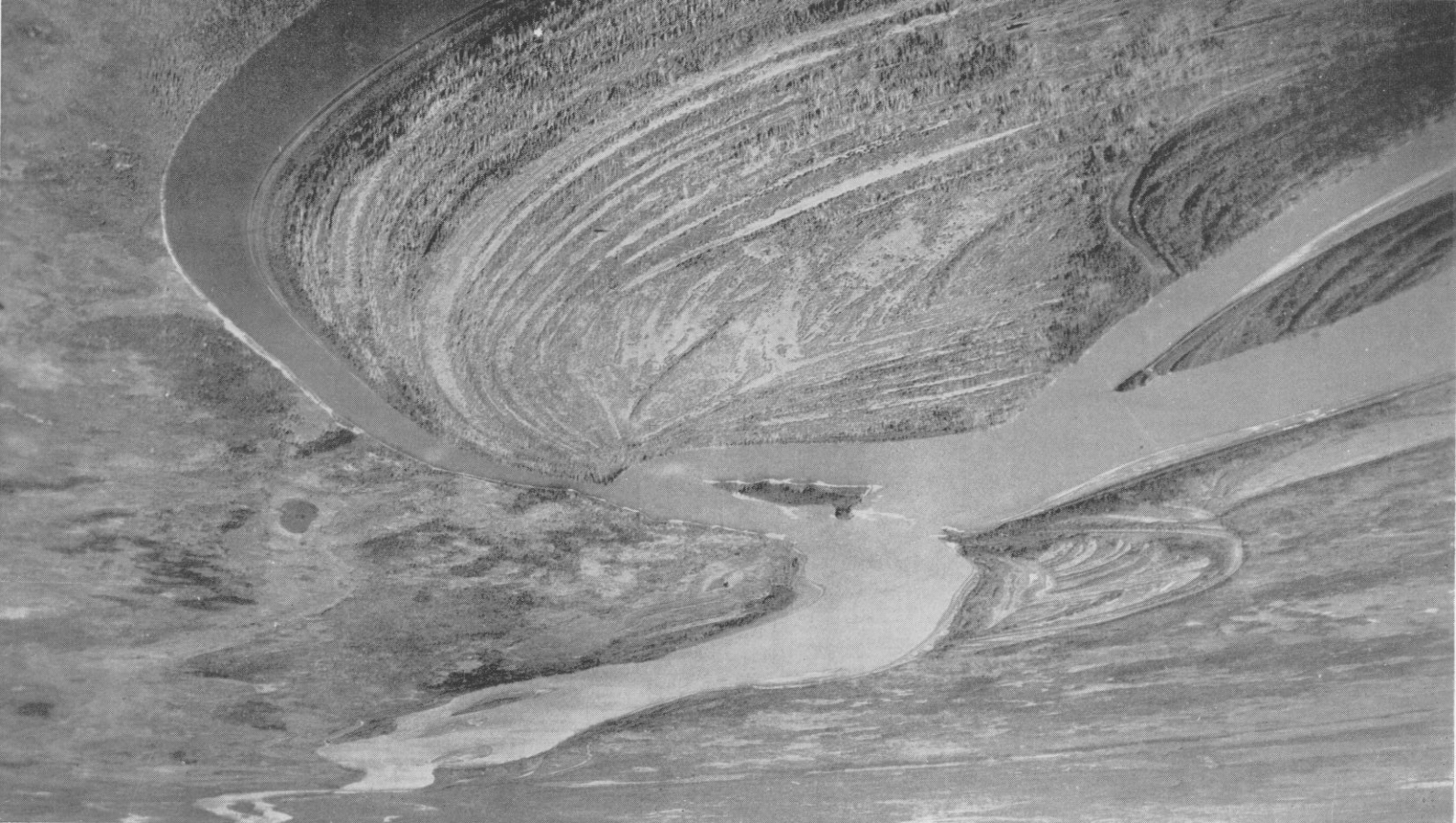
PLAN OF SHOAL, ADAPTED FROM SURVEY BY THE DEPT. OF PUBLIC WORKS, CANADA IN JULY, 1920.


A


B


C


Sault de Niagara
Fort
Village de Tontenatanis
Fort Pontchartrain
Village de Hurons
LAC St CLAIRE
Village d'Outouais
Pont Temis
Les Petits Ecores
Le Petit Lac
La Pointe au Pin
Rivieres Inconnues
La Pointe aux Feuilles
Riviere Rouge
Grands Ecores
La Pte Pelee
La Longue Pointe
Le Detroit
I. des Serpens Sonnettes
R. aux Oies
R. des Miamis
LAC ERIE'
Toute cette coste n'est presque pas connue
Portage
R. de Kanaraon
PAYS DES ERIE'S
Qui ont été detruit par des Iroquois
R. Chouanons
R. Chouanons
Village Attiouandaron
R. aux Roseaux
Village de Loups Attiouandaron
Village de Gachimantes
PARTIE OCCIDENTALE
de la
NOUVELLE FRANCE
ou du
CANADA



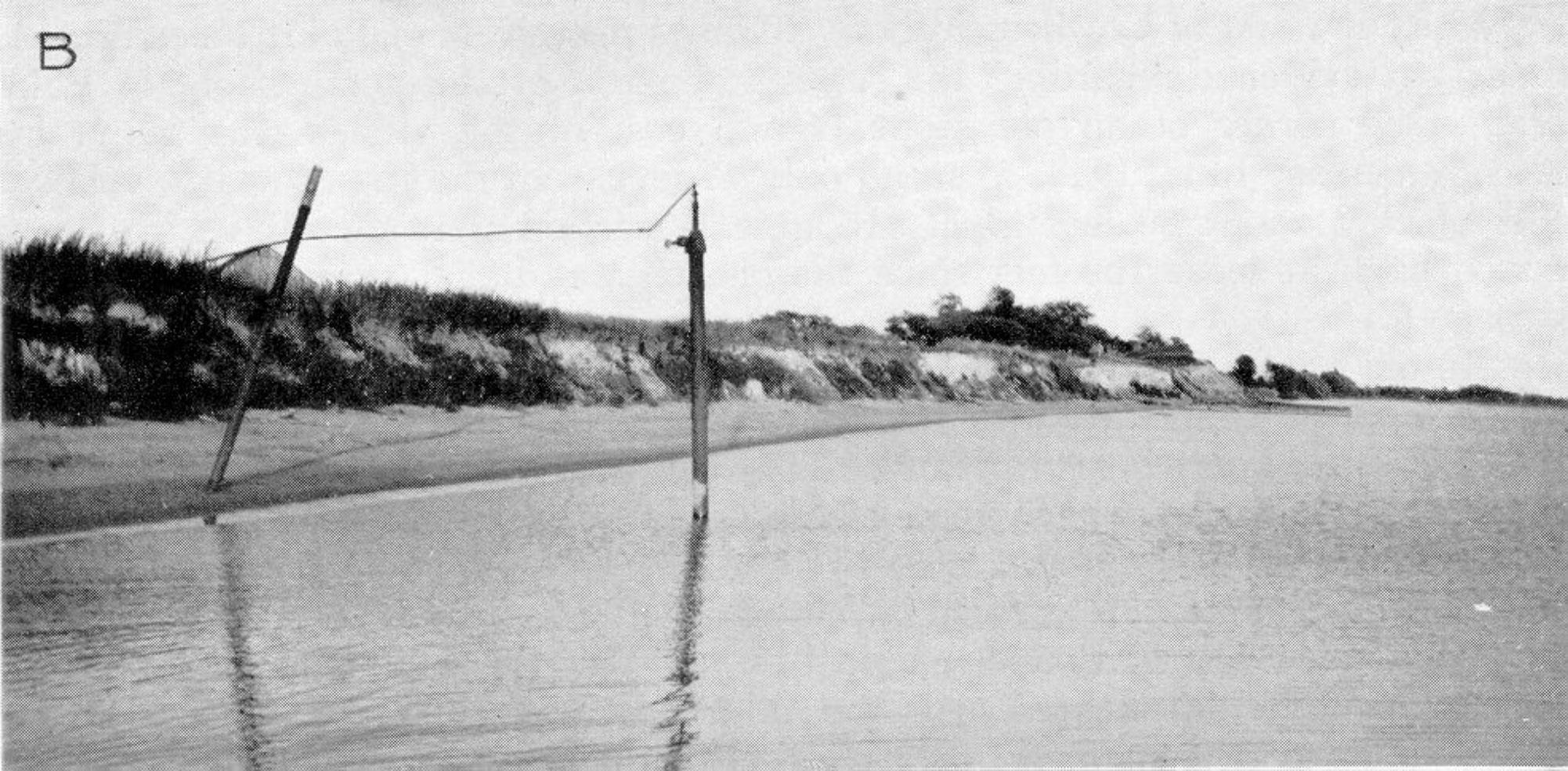









A


B


C

PROVINCE OF ONTARIO

DEPARTMENT OF MINES

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

FORTY-SECOND ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XLII, PART III, 1933

A Technical and Economic Investigation of Northern Ontario Lignite, with 7 Appendices, by the Ontario Research Foundation - - 1-45

Lignite and Refractory Clay Deposits of the Onakawana Lignite Field, by W. S. Dyer and A. R. Crozier - - - - - - - - - 46-78

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1933

PREFACE

For many years the presence of lignite on the James Bay slope in Northern Ontario has been known. Several occurrences outcrop on the rivers of the Moose River basin, but until recent years they were thought to be interglacial in age and consequently of very limited extent and economic importance. However, Dr. W. S. Dyer, after completing his geological survey of these rivers in the summers of 1927 and 1928, was convinced that the lignite deposits were Cretaceous in age and recommended that a drilling programme be undertaken at Blacksmith rapids on the Abitibi river, now known as the Onakawana deposit, to prove the extent and commercial possibilities of the lignite.

The success attending the drilling programme, which was begun by the Ontario Department of Mines in 1929, was so encouraging both as to the extent of the deposit and the quality of fuel as determined by preliminary tests conducted by the Mines Branch Laboratory, Ottawa, that the Government decided to fully test the merits of this new fuel supply. In consequence the Ontario Research Foundation in the spring of 1930 was asked to make a detailed technical study of possibilities of the lignite as a fuel for domestic and industrial use, particularly to serve the needs of Northern Ontario.

The results of this research work are embodied in the report prepared by officers of the Ontario Research Foundation. Their findings preface the detailed geological report by W. S. Dyer and A. R. Crozier, of the Ontario Department of Mines, who conducted all the preliminary work. The geological report also deals with the refractory (fire) clays that are associated with the lignite deposits. Convenient railway facilities are provided by the extension of the T. & N. O. railway from Cochrane to Moosonee, while exploitation of the new fuel supply awaits a return to normal economic conditions.

The reports above mentioned are now in press and together constitute Part III of Volume XLII, Report of the Ontario Department of Mines for 1933. This reprint embraces only the first section of the departmental report.

CHARLES MCCREA,
Minister of Mines.

DEPARTMENT OF MINES,
Toronto, October, 1933.

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LETTER OF TRANSMISSION

ONTARIO RESEARCH FOUNDATION
47 QUEEN'S PARK,

Toronto, December 19th, 1932.

THE HON. CHARLES MCCREA,
Minister of Mines,

DEAR SIR:

I have the honour to present for your consideration a report entitled "A Technical and Economic Investigation of Northern Ontario Lignite."

The investigation covered by this report was commenced at your request three years ago by the Ontario Research Foundation. Sufficient progress has been made to justify our presenting an interim report to convey our findings and to enable you to determine future policy regarding the deposit.

To those associated with this Foundation the work has been a constant source of scientific interest, and our pleasure in the performance of it has been greatly enhanced by the opportunity presented of working in close co-operation with your Acting Deputy, Mr. T. F. Sutherland, and his technical colleagues. We wish to acknowledge gratefully their generous assistance.

The laboratory and plant researches have been carried out by Mr. C. Tasker and Mr. G. A. Revell working under the direction of my colleague Dr. A. E. R. Westman. These gentlemen have, in my judgment, rendered distinguished service to your Department and to this Foundation.

We are greatly indebted to Dr. T. H. Hogg of the Hydro-Electric Power Commission of Ontario for his invaluable assistance in the consideration of methods and costs associated with the mining of lignite.

The Lurgi Company of Frankfurt-am-Main, Germany, have at all times co-operated with the Foundation, and no charge was made for those plant tests conducted in co-operation with this company in Europe.

My colleagues share with me in an acknowledgment of the help we have received from the sustained interest shown by our Chairman, Sir Joseph Flavelle, and our Vice-chairman, Mr. Holt Gurney, in this investigation.

Faithfully yours,

H. B. SPEAKMAN, *Director.*

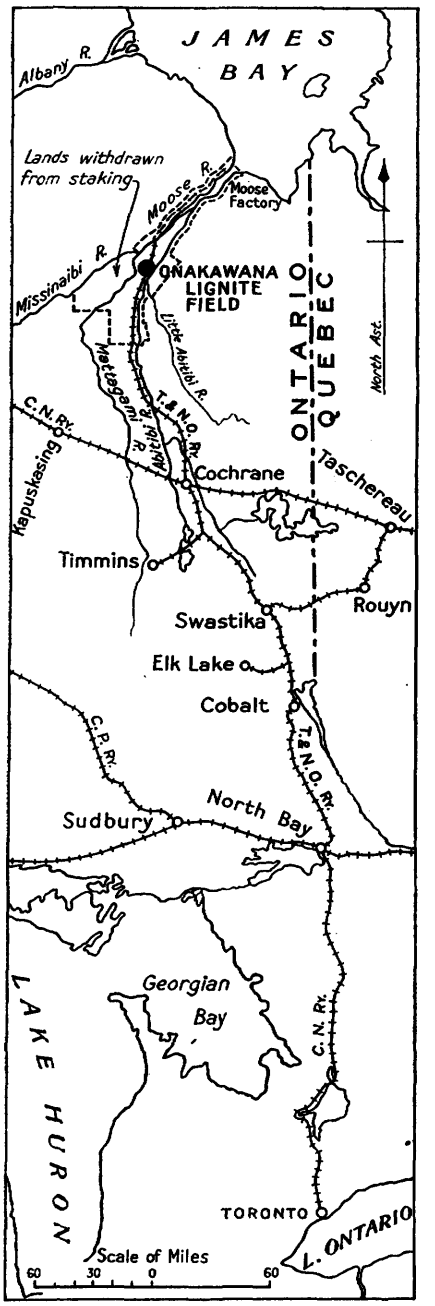


Fig. 1—Key map showing location of the Onakawana lignite deposit and the areas withdrawn from staking by Order-in-Council.

A Technical and Economic Investigation of Northern Ontario Lignite

By the Ontario Research Foundation

Introduction

For many years traders and Indians in the vicinity of Moose Factory have known of the existence of lignite, which outcrops on the west bank of the Abitibi river close to Blacksmith rapids. The rapids are approximately 60 miles from Moosonee, 126 miles from Cochrane, 380 miles from North Bay, and 608 miles from Toronto.

During the summer of 1929 exploratory drilling was carried on in this locality by the Ontario Department of Mines. The results obtained indicated the presence of a substantial body of lignite, and the Ontario Research Foundation was requested by the Minister of Mines, Hon. Charles McCrea, to undertake a technical and economic study of this deposit.[1]

Immediate steps were taken to secure competent persons to carry out these investigations. Through the kind co-operation of Dr. F. S. Sinnatt, Director of Fuel Research, London, England, the Foundation was able to engage Cyril Tasker for this work. Later Mr. Tasker was given the assistance of G. A. Revell, a graduate of Queen's University.

An advisory committee under the chairmanship of the director of the Foundation has met at frequent and regular intervals to co-ordinate and direct the various lines of research. It has been our privilege and pleasure to have associated with the staff of the Foundation on this committee the Acting Deputy Minister of Mines, T. F. Sutherland, and several of his technical colleagues.

During the past two years a series of technical reports covering various aspects of the problem have been prepared by officers of the Department of Mines and of the Research Foundation. The Foundation has received generous co-operation in research and reports from kindred bodies and private corporations. As complete a record as possible has been secured covering the mining, processing, and marketing of lignite in Western Canada, the United States, Germany, and Australia. A list of these reports and documents is given in Appendix II to this report, and they are available for reference at the Ontario Research Foundation.

Purpose and Scope of Report

The information now available makes it possible to report to the Government with regard to: (1) the extent and character of the deposit; (2) mining methods and their cost; (3) methods for the processing of raw lignite; (4) the characteristics of certain lignite products; (5) the technology and economics of present fuel utilization by railroads, industry, and domestic users in that

[1]The expenses associated with the investigations carried out by the Research Foundation are summarized in Appendix I.

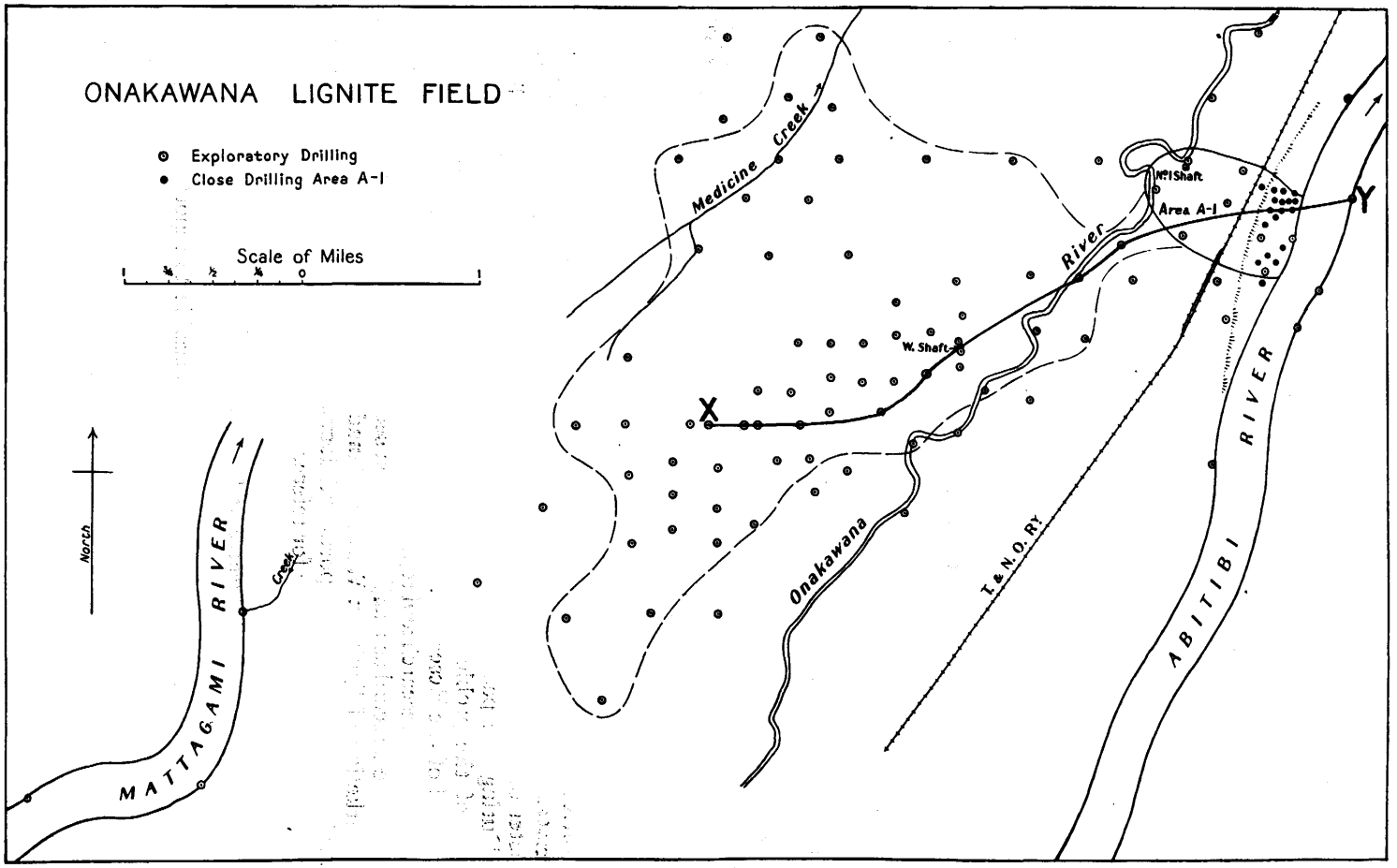

ONAKAWANA LIGNITE FIELD
Exploratory Drilling
Close Drilling Area A-1
Scale of Miles
North
MATTAGAMI RIVER
Creek
Medicine Creek
River
W. Shaft
No. 1 Shaft
Area A-1
Onakawana
T. & N. O. Ry.
ABITIBI RIVER

FIG. 2

portion of Northern Ontario lying between Taschereau, Hearst, Onakawana, and North Bay; (6) transportation rates.

A careful study of these points by the Ontario Research Foundation has led to the conclusion that no final answer to the request of the Government can be given until larger quantities of lignite products are available for consumption on a commercial scale by the Temiskaming and Northern Ontario Railway, by industries in this economic area, and by domestic users. The cost of such further work would be $60,000, and details are given in Appendix VII. The Foundation desires to place the available information in the hands of the Government, accompanied by a request for a sufficient appropriation to complete this investigation.

Geology

The area in which the lignite deposit occurs is a part of the low-lying flat country extending north from the Canadian National railway to James bay. Owing to the surface covering of muskeg, 4 feet in thickness, the flat topography, and the heavy rainfall, travelling and transportation are difficult except in the winter months. The recent extension of the T. and N. O. railway traverses the area.

On the west side of the river near Blacksmith rapids, approximately 6 square miles of ground have been tested for lignite (see Fig. 2). Drilling at 1,000-foot centres, 116 holes have been put down to points below the seams. Two shafts have been sunk, and drifting has been done along the seams. This exploratory work, systematic sampling, and chemical and physical analyses of the deposit have supplied the necessary data for a quantitative estimate of the lignite in the area, its nature and properties.

Fig. 3, which is based on section X-Y, Fig. 2, indicates the general position and thickness of the lignite, which occurs in two parallel seams separated by a clay-sand parting. Variations in thickness and slope are characteristic of the deposit. Generally speaking, the seams dip towards the west and away from the outcrop. The upper seam is only found in about 1½ square miles in the centre of the deposit. Where the upper seam has an average thickness of 25 feet, the overburden-lignite ratio is relatively favourable to development. The lower seam averages 20 feet in thickness and occurs throughout the area. It thins out rapidly at the boundaries of the deposit.

Comparison of Upper and Lower Seams

Representative samples of lignite from the deposit can be readily separated into three distinct types, to which the names woody, peaty, and earthy have been given. Woody lignite is strong and compact and retains its structure to a marked degree. Peaty lignite is compact and coherent *in situ*. It is suggested that it is derived from the green and more tender portions of the plant material that gave rise to the deposit, and that on this account it is weak and structureless. Earthy lignite is a compressed mass of small particles. Exposure to the air causes rapid disintegration of the material.

The chemical properties of the three types of lignite are summarized in Table I. Attention is called to the high ash content of earthy lignite. This quality, with other characteristics that will be mentioned later, makes earthy lignite of no economic value at the present time.

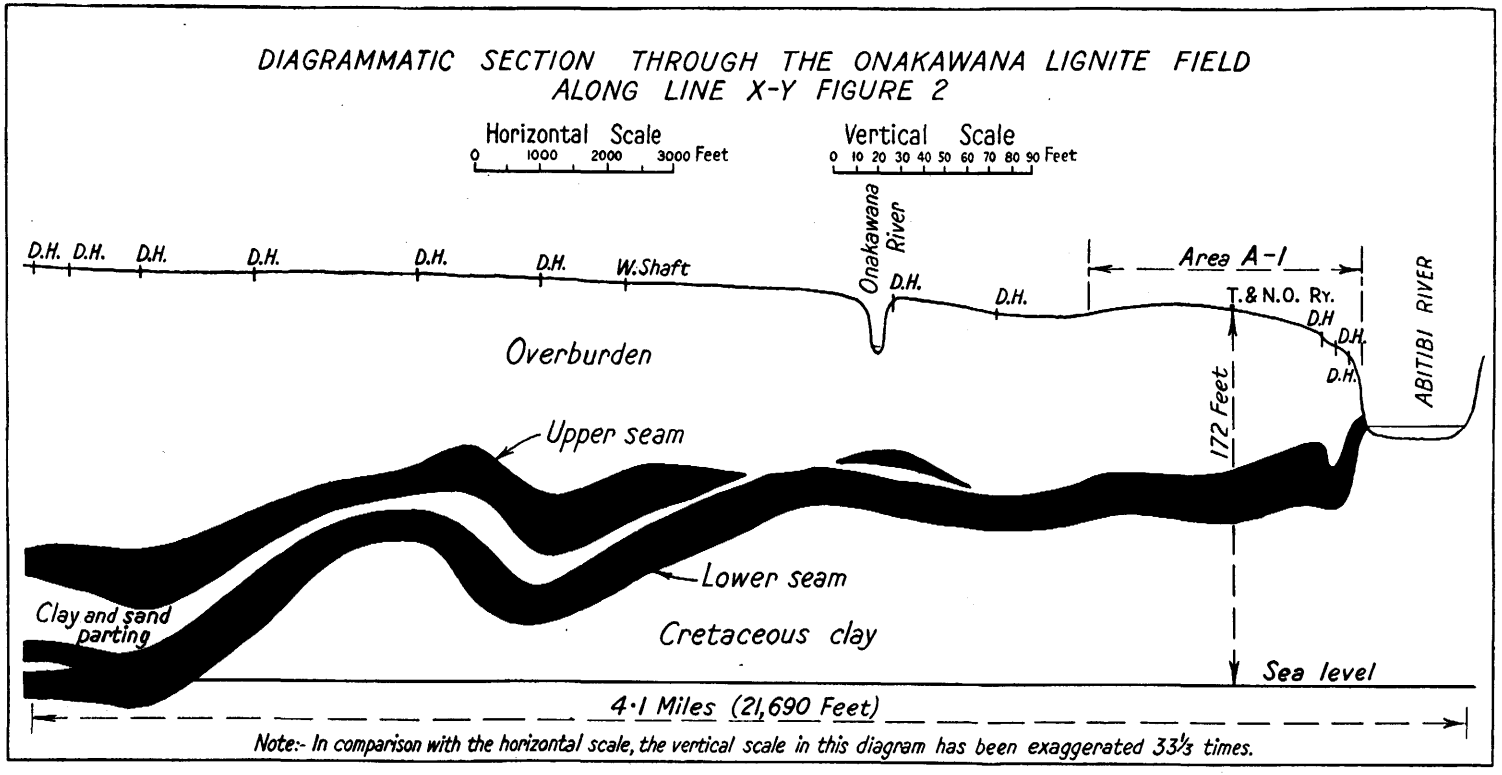

DIAGRAMMATIC SECTION THROUGH THE ONAKAWANA LIGNITE FIELD
ALONG LINE X-Y FIGURE 2
Horizontal Scale
0 1000 2000 3000 Feet
Vertical Scale
0 10 20 30 40 50 60 70 80 90 Feet
D.H. D.H. D.H. D.H. D.H. D.H. W.Shaft
Onakawana River
D.H. D.H.
Area A-1
T.& N.O. Ry.
D.H. D.H. D.H.
ABITIBI RIVER
Overburden
172 Feet
Upper seam
Lower seam
Clay and sand parting
Cretaceous clay
Sea level
4·1 Miles (21,690 Feet)
Note:- In comparison with the horizontal scale, the vertical scale in this diagram has been exaggerated 33⅓ times.

FIG. 3

TABLE I—CHEMICAL PROPERTIES OF THE THREE TYPES OF LIGNITE

	Woody	Peaty	Earthy
UPPER SEAM AS MINED:			
Moisture.....per cent.	50	50	50
Ash.....per cent	4.8	5.45	7.85
Calorific value, B.t.u.[1] per lb.....	5,435	5,295	4,880
LOWER SEAM AS MINED:			
Moisture.....per cent.	50	50	50
Ash.....per cent.	4.4	5.2	11.9
Calorific value, B.t.u. per lb.....	5,435	5,310	4,500

[1]One British thermal unit (B.t.u.) is the amount of heat required to raise the termperature of one pound of water one degree Fahrenheit.

The three types are rather intimately mixed throughout the deposit, and no practical mining method could avoid taking the mixture. Fortunately the survey work done in shaft No. I and W shaft (see Fig. 2) indicated that the lower seam contains relatively a high proportion of woody and peaty lignite, 76 per cent. as compared with 28 per cent. of woody and peaty in the upper seam.

This fact suggests the advisability of mining the lower-seam lignite in the initial stages of any development. A particularly favourable area is A-1 (see Figs. 2 and 3), for the following reasons: The overburden has been partially removed by erosion and a terrace runs parallel to the river; only lower-seam lignite is found in the area; closer drilling has made more information available concerning this locality; the railway crosses the area; and the wide river valley is available for the disposal of stripped overburden. For these reasons the Foundation has formulated a plan for mining development in this area, which will be outlined in the following pages.

Fig. 4 is a detailed plan of area A-1, which covers about 300 acres and is divided by the railway and terrace bank into 3 sections. From the logs of 24 holes in the area various approximate calculations can be made, particularly the tonnage of lignite available and the overburden-lignite ratio. These figures are given in Table II.

TABLE II—ESTIMATE OF LIGNITE AND OVERBURDEN IN AREA A-1[1]

Area	Lignite[2]	Overburden	Ratio
	gross tonnage	cu. yds.	
Between Abitibi river and terrace.....	1 880,000	5,150,000	2.7
Between terrace and railway.....	1,000,000	3,380,000	3.4
Total between Abitibi river and railway.....	2,800,000	8,530,000	3
West of railway.....	4,740,000	14,670,000	3.2
Total.....	7,620,000	23,200,000	3

[1]Estimate by officers of Ont. Dept. Mines.
[2]A ton of lignite as mined has a volume of approximately 1 cubic yard.

In strip-mining only about 85 per cent. of these quantities could be recovered. On the basis of a mining and processing development involving 300,000 tons of raw lignite per annum, there is sufficient lignite east of the railway to last for 8 years, and in area A-1 as a whole for 20 years.

Although area A-1 has been drilled more closely than the remainder of the known deposit, the Foundation recommends as a preliminary to any large mining operations a topographical survey of area A-1 accompanied by more drilling at 200-foot centres.

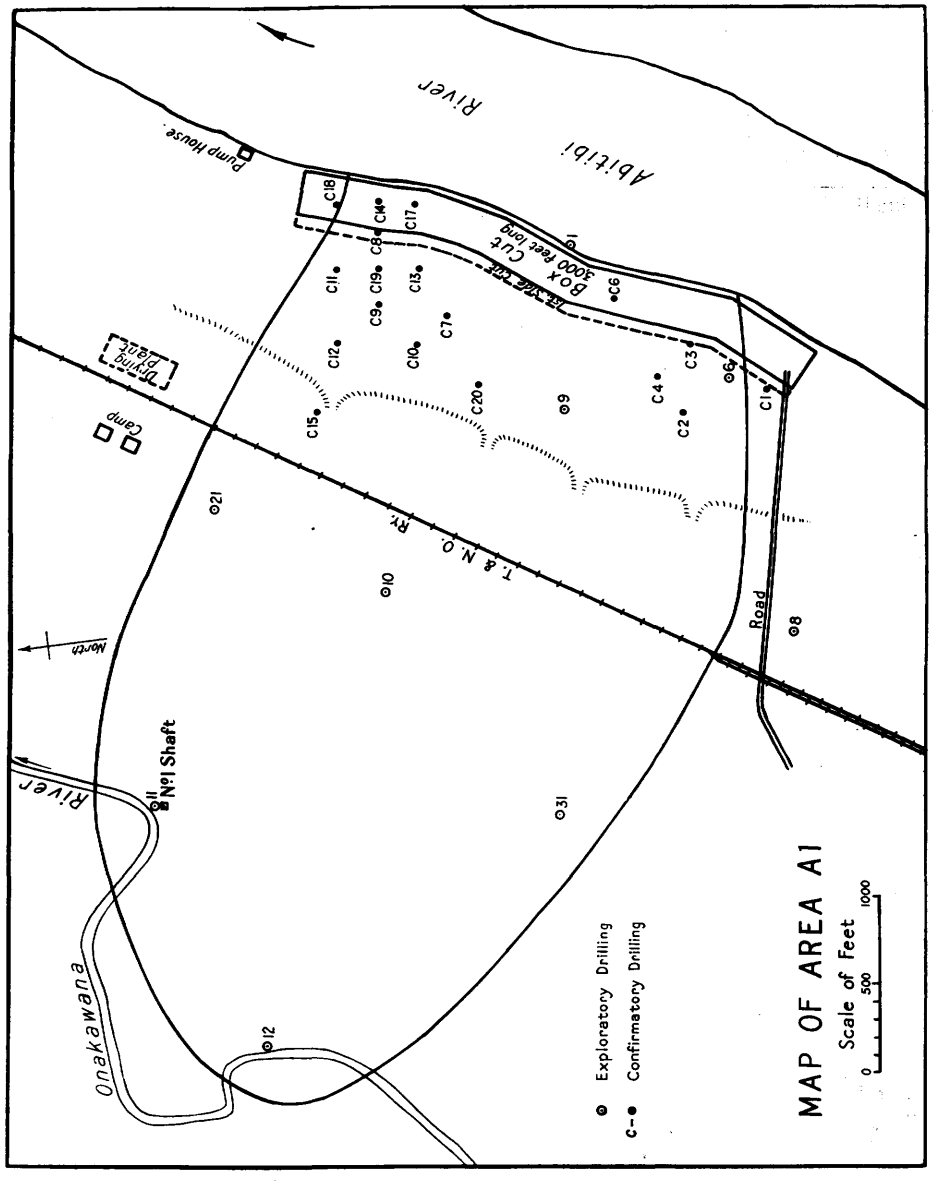


FIG. 4

Mining

The nature and location of the lignite make sound and efficient mining methods of supreme importance in any commercial development. It was necessary to look outside the Department of Mines and the Research Foundation for the necessary technical knowledge and experience. Three independent

reports were asked for and received from the following: (1) The Marion Steam Shovel Company, Limited, a leading and reliable firm of manufacturers of equipment; (2) J. Klitzing, the technical director of the Ilse Mining Company, Germany, a recognized authority in Europe on the mining and process of lignite; (3) Dr. T. H. Hogg, of the Hydro-Electric Power Commission of Ontario. Dr.

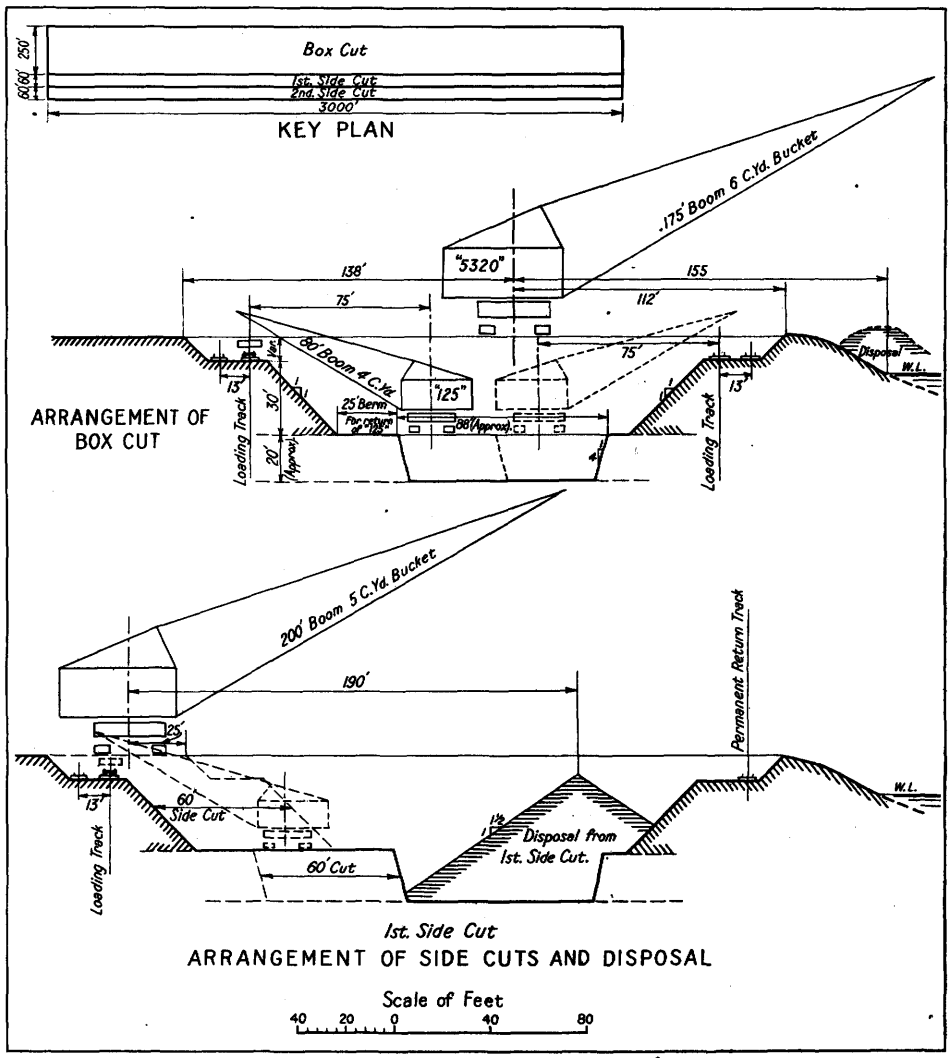


Fig. 5—Diagrammatic sketch of the drag-line and train-haul layout for strip-mining.

Hogg is familiar with conditions in Northern Ontario and eminently qualified to advise on operations involving the removal of large quantities of overburden.

There is substantial agreement in these reports with regard both to methods and costs. The scheme now to be described is based on Dr. Hogg's report, since it contains more complete cost schedules and is more specific in recommending procedure.

Strip-mining

In Fig. 5 the essential features of the mining operations are shown. The overburden and then the lignite are removed in open cuts by means of large electric shovels. This method of operation, strip-mining, is new to Northern Ontario and raises important questions which may materially influence costs. For how many months in the year can such operations be conducted? The overburden must be piled. How high can these spoil piles be, and at what angle? Railway tracks cannot rest on the clay, and gravel ballast must be provided; actual operations may disclose gravel beds in the overburden and effect a considerable saving.

Scale of Operation.—Strip-mining is a highly mechanized operation in which low-cost figures depend on high capacity and constant, steady production. Where the product is used seasonally, storage facilities must be provided. The suggested output of 300,000 tons of raw lignite per annum is based on an analysis of: (1) the depth of overburden, (2) the potential markets, (3) the known lignite reserve in area A-1, and (4) the capital required.

The proposed scheme contemplates the opening up of a box-cut 250 feet wide and about 3,000 feet in length close to and running parallel with the Abitibi river (see Fig. 3). A large electric shovel, Marion type, will be converted to drag-line operation and located on ground level. In one movement it removes overburden from the open cut, swings, and throws the material over the river bank. This fill should resist the infiltration of water from the river into the pit. A smaller shovel commences operations two months later and is located on the seam. The lignite is scooped from the bottom upwards and deposited in dump cars for removal to the processing plant. When the box-cut is completed, side-cutting will commence on the west side, each strip being approximately 60 feet wide. This overburden is used to back-fill the original box-cut, and it is here that the difficulty arises regarding the angle of the banks. Banks of 1.5:1 are recommended, and in the third and subsequent years of the operation rehandling of some of the spoil has been allowed for in operating costs. This item may be reduced in actual operations, depending on the nature of the overburden.

By advancing westwards on a 3,000-foot front and producing 300,000 tons of raw lignite per year, that part of area A-1 lying between the railway and the Abitibi river would be stripped in 8 years. In the seventh year it would be necessary to move the T. and N.O. line a short distance in the immediate vicinity of the deposit.

If winter operations by the large shovel are possible, the output can be materially increased, or so organized that storage charges will be reduced.

Mining Capital

Equipment of the type mentioned is available in Canada at the present time in a used but sound condition. It can be purchased for the price indicated in Table III. Any further reduction in the cost of such equipment will be reflected in the unit cost of raw lignite. The initial capital charges for mining are summarized in Table III.

TABLE III—MINING CAPITAL

Mining equipment purchased at a discount	$294,900	
Other mining equipment, buildings, etc.	46,700	
Freight	37,100	
Erection	5,100	
Ballast (gravel)	10,000	
		$393,800
Equipment for rehandling spoil		60,500
Power-generating equipment[1]		40,000
Total capital		$494,300

[1]Capital for steam generation is included in processing capital.

Annual Mining Costs

In Table IV the estimated annual costs for mining the raw lignite are shown. The figures are based on ten years' operations. Annual charges of 10 per cent. for depreciation on durable equipment, from 10 to 33 per cent. on the less durable equipment, and 6 per cent. on the initial capital are allowed. Conservative provision has been made for maintenance and renewals.

TABLE IV—AVERAGE ANNUAL COST OF MINING LIGNITE

(Assumed production, 300,000 tons per year for 10 years)

Interest and depreciation[1]	$98,000	
Maintenance and parts	31,000	
Management, etc.	25,000	
		$154,000
Labour (¼ unskilled)	$81,500	
Ballast (gravel)	20,500	
Fuel	8,000	
		110,000
Average annual cost		$264,000

Average annual production, 300,000 tons.
Mining cost per ton of raw lignite, 88 cents.

Cost per Ton of Lignite

In Table V the data in Table IV has been rearranged to present an analysis of the cost per ton of raw lignite.

TABLE V—AVERAGE MINING COST PER TON OF RAW LIGNITE

(Assumed production, 300,000 tons per year for 10 years)

	cents	
Interest and depreciation	32.7	
Maintenance and parts	10.3	
Management, etc.	8.3	
		51.3
Labour	27.2	
Ballast (gravel)	6.8	
Fuel	2.7	
		36.7
Total		88

Summary of Mining Costs

The following is a summary of Tables III, IV, and V:—

Mining capital	$494,300
Average yearly cost	$264,000
Cost per ton of raw lignite	88 cents

Costs in the United States

It is helpful to consider at this point certain figures relating to the stripping and mining of coal in the United States. The figures in Table VI have been secured from Information Circular No. 6,383 (1930), United States Bureau of Mines.

[1]On all mining equipment, turbo-generators, and part of boiler plant required for power generation.

TABLE VI—COST OF STRIPPING AND MINING COAL IN SIX LOCALITIES IN THE UNITED STATES

Location	Depth of overburden	Coal, thickness	Daily production	Total cost of stripping and mining
	feet	feet	tons	cents per ton
Tennessee	20 to 30	2½	500	70
Montana	30	24	2,250	88[1]
Illinois	36	3	1,250	100
Illinois	30 to 60	5 to 10	4,500	115[2]
Ohio	40	4½	2,000	105 to 137[1]
Alabama	16 to 26	3½	300 to 500	89 to 154[1]

[1]Blasting of overburden practised at 2.75 to 6.4 cents per cubic yard.
[2]Blasting of coal probably contributes 6 to 10 cents per ton.

Officers of the Research Foundation, through the courtesy of T. A. Russell and R. A. C. Henry, were permitted to study the cost figures for the removal of material similar to the overburden at Onakawana by the Beauharnois Power Corporation. A study of all the available reports leads to their conclusion that Dr. Hogg's estimate is conservative and sound.

Processing of Raw Lignite

Statement of Problem

What are the properties of the raw lignite that would be obtained by the operation already described, and has it any commercial value? It contains 50 per cent. moisture, and it is not a homogeneous material. The material disintegrates rapidly on exposure to the atmosphere. It contains 5,215 B.t.u. per pound, in comparison with 13,500 to 14,000 B.t.u. per pound in the bituminous coals burned in Northern Ontario. Such material cannot be transported economically and compete on a price basis. The present combustion equipment of railways, factories, mines, and homes could not handle raw lignite.

Raw lignite can only be used successfully, from the technical and economic viewpoints, at the deposit. Australian experience has shown that in special boiler plants it could be used to raise steam for electric power development. The present position with regard to electric power in Northern Ontario rules out this possibility. We must therefore explore the various methods for the processing of raw lignite, keeping as our objective the production of a higher-grade fuel that could complete in the area under consideration.

Sources of Information

For two years laboratory research on this problem has been in progress at the Research Foundation, and this work provided the necessary background for a series of plant-scale tests, which were conducted in Europe during the spring of 1932. About 105 tons of lignite secured from operations at shaft W were packed in air-tight steel barrels and dispatched to Europe. Mr. Tasker was in Europe when the barrels were opened, and he visited the various plants and supervised the experimental runs. The products of these tests were carefully packed under his directions and shipped to Toronto. Full reports giving technical details of the runs were supplied to the Foundation, and in each case the operating company assisted the Foundation to work out cost schedules for these processes using Onakawana lignite.

Briquetting without Binder

A large proportion of the lignite that is mined, processed, and used in Germany is in the form of briquettes manufactured without a binder. They are substantial-looking blocks with a smooth surface, measure 7 by 2¼ by 1¾ inches, and weigh about 18 ounces. They are made by reducing the moisture content of the raw lignite by evaporation in dryers, and then passing this material through continuous presses. The briquettes can be shipped in the ordinary way, and the losses due to fracturing are not excessive. Exposure to ordinary rain does not cause them to disintegrate. For a fuller description of dry-briquetting, see Appendix III.

Test runs were made at two separate plants in Germany to explore the possibility of making similar briquettes from Northern Ontario lignite. Samples of each run were kept, carefully labelled and packed, and returned to Toronto, and these briquettes have been analysed and tested. For several months their behaviour under exposure to climatic changes has been observed. It has been found that they are weak and could not be transported without excessive fracturing. Unlike the German briquettes they disintegrate rapidly when submerged in water.

At the present time this method cannot be recommended to the Province. Research work in the laboratories of the Foundation suggest that the difficulties encountered are not insurmountable. This experimental work should be continued, because in the event of there being any industrial development at the deposit large quantities of earthy material will be available that can only be used economically along these lines.

Briquetting with a Binder

A brief description will be given of the standard Lurgi process for the manufacture of briquettes. For fuller technical details, see Appendix IV. The raw lignite is dried to the desired moisture content, and then falls by gravity into another section of the oven. During this second period of heating the lignite gives up a large proportion of its content of gas, light oils, and tar, which can be separated and recovered. The coke is then cooled, ground, mixed with the pitch binder, heated to a known temperature, and fed into the briquetting press.

The German tests with Northern Ontario lignite using methods similar in principle to the above were successful. Samples of char (coke) and briquettes were returned to Toronto and examined. A summary of their properties is given in Table VII.

TABLE VII—PROPERTIES OF CHAR, BRIQUETTES, AND ANTHRACITE

	Raw lignite	Lignite char, screened	Lurgi char, briquettes	American anthracite	Welsh anthracite
Moisture.....per cent.	50	5	4.5	3.4	2.2
Volatile constituents.....per cent.	20.7	12	20	6.2	7.8
Ash.....per cent.	6.2	14.3	12.9	13.9	4.9
Sulphur.....per cent.	.8	1.10	1	.91	1
Heating value, B.t.u. per lb.....	5,215	11,540	12,000	12,370	14,110
Bulk density, lbs. per cu. ft.....	50	30	38	55	51

The briquettes are substantial, strong, and attractive in appearance. They could be shipped easily without loss and burned in existing equipment.

Technically, the process has proved a success. The economics of the process lead to the conclusion that such briquettes produced at the deposit for $10.89 per ton cannot compete in Northern Ontario. Quite obviously they cannot replace bituminous coal, and the price differential is not sufficient to overcome the competition of Welsh anthracite in the domestic market.

Fleissner Desiccation Process

The objective of any drying process for raw lignite is to remove the maximum amount of moisture when considered in relation to the economics of the process. The heat value of the product is higher than in the raw material, and the percentage of ash content is increased. Selective screening may enable certain sizes of product to be removed containing a relatively high quantity of ash.

During most industrial processes of this type rapid disintegration takes place, and the output of fine sizes is large. These have a limited market. The Fleissner process, called after the inventor, the late Professor Hans Fleissner, of Vienna, successfully overcomes this difficulty. It is being used commercially in Austria, Hungary, and Czechoslovakia, and Mr. Tasker performed his tests under standard conditions in Czechoslovakia.

The essence of the process is that woody and peaty lignite is charged into a steel vessel which will withstand a pressure of 400 pounds per square inch. The internal pressure is reduced by pumping out air. Steam is allowed to enter, and the pressure gradually rises to 400 pounds per square inch and is maintained for 90 minutes. By releasing the steam into another vessel the charge comes back to atmospheric pressure, and by applying a vacuum the products are dried and allowed to cool. The products are passed through a screening plant and sized.

Since the products of the Fleissner tests were returned to Canada a careful study of their chemical and physical properties has been made. With the limited facilities available at the Research Foundation, burning tests have also been performed. It can be stated that Fleissner dried lignite is an excellent fuel and must play a prominent part in any commercial development of the deposit.

Flue-Gas Dried Lignite

The moisture content of raw lignite can be reduced from 50 to 15 per cent. by passing it through revolving drums heated by flue gases. Before entering the dryer the lignite is crushed to sizes less than 1½ inches. Under the conditions existing at the deposit the flue gases could be made by burning raw earthy lignite. Any flue gases available from boiler plant could also be used. The process is technically possible and from an economic standpoint merits further consideration.

The product of this process is small in size and consequently has a limited industrial use. Other things being equal it could be used successfully in pulverized fuel firing plants. After further drying at the consumers' plant it might be used in smelting operations. It cannot be stored for long periods, and any large-scale operations of this type depend on the securing of long-term contracts.

Summary of Processes

1. Briquetting without a binder is economically attractive but technically impossible at the present time.

2. Briquetting with a pitch binder is technically possible, but the costs are uneconomic in Northern Ontario.

3. Fleissner dried lignite is a splendid fuel and offers possibilities for industrial and domestic utilization..

4. Flue-gas dried lignite can be made relatively cheaply. It has possibilities for a large consumption by a few industries in Northern Ontario.

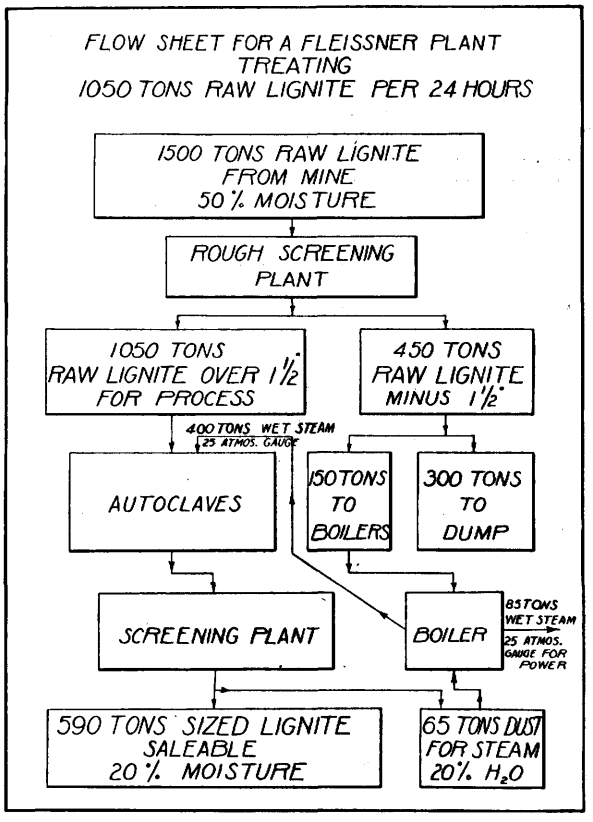


FIG. 6

Processing Costs

In Figs. 6 and 7 a diagrammatic representation is given of the two possible processes for converting the raw lignite into a marketable fuel.

Fleissner Process (*Scheme A*).—The whole output of 300,000 tons of raw lignite is screened, and 210,000 tons are treated by the Fleissner process. To adjust the plant to mining operations and sale of the products, it is proposed to operate it for 200 days, treating 1,050 tons per day. One-third of the output would be stored for sale during the four months in which no lignite is mined. It will be observed that approximately 118,000 tons of lignite containing 20 per cent. moisture and of salable sizes would be produced.

TABLE VIII—COSTS OF SCHEME A, FLEISSNER DRYING PLANT

Capital Costs:	
Screening plant for raw lignite	$10,000
Drying plant	136,500
Boiler plant (20 tons steam per hour)	110,000
Screening plant for dried lignite	40,000
	$296,500
Contingencies and unaccounted for, 20 per cent	59,300
Total capital costs	$355,800
Yearly Costs:	
Raw lignite, 300,000 tons at 88 cents	$264,000
Screening of raw lignite and fuel to boilers	27,060
Labour	21,024
Material	2,100
Fixed charges, 15 per cent. on $325,800[1]	48,870
	$363,054
Licence fee, 118,200 tons at 6½ cents	7,683
Total yearly costs	$370,737
Cost per Ton of Finished Product:[2]	
Raw lignite, 2.54 tons at 88 cents	$2.23
Screening before drying and fuel to boilers	.23
Processing (labour, 18 cents; material, 2 cents)	.20
Fixed charges	.41
Licence fee	.065
Total cost per ton	$3.135

Flue-Gas Drying Process (*Scheme B*).—Eighty per cent. of the output of the mine passes through drum driers heated by flue gases, and a yearly output of 134,000 tons of salable fuel is contemplated. To ensure continuous operation of the plant, one-third of the daily output of raw lignite produced during 8 months active mining would be stored in a stock-pile.

TABLE IX—COSTS OF SCHEME B, FLUE-GAS DRYING PLANT

Capital Costs:	
Crushing and screening plant	$4,200
Drying plant (2 drum driers)	71,500
Motors and fittings	12,500
Buildings and erection	44,000
Eventualities and rounding off	7,800
Total capital costs	$140,000
Yearly Costs:	
Raw lignite, 300,000 tons[3] at $1	$300,000
Transport of 60,000 tons to boilers and dump	1,800
Labour	14,400
Material and repairs	6,000
Fixed charges, 15 per cent. on $140,000	21,000
Total yearly costs	$343,000

[1]No fixed charges on screening plant for raw lignite, and on $20,000, the cost of that portion of the boiler plant producing steam for power production. These charges have already been allowed for in screening and power costs.

[2]Free in cars at plant.

[3]Produces 134,000 tons dried lignite.

COST PER TON OF FINISHED PRODUCT:

Raw lignite, 2.24 tons at $1	$2.24
Boiler fuel and waste	.01
Labour	.11
Material and repairs	.04
Fixed charges	.16
Total cost per ton	$2.56

The costs associated with the mining operations dominate these schedules. In the section on strip-mining (page 7), reference was made to certain unknown

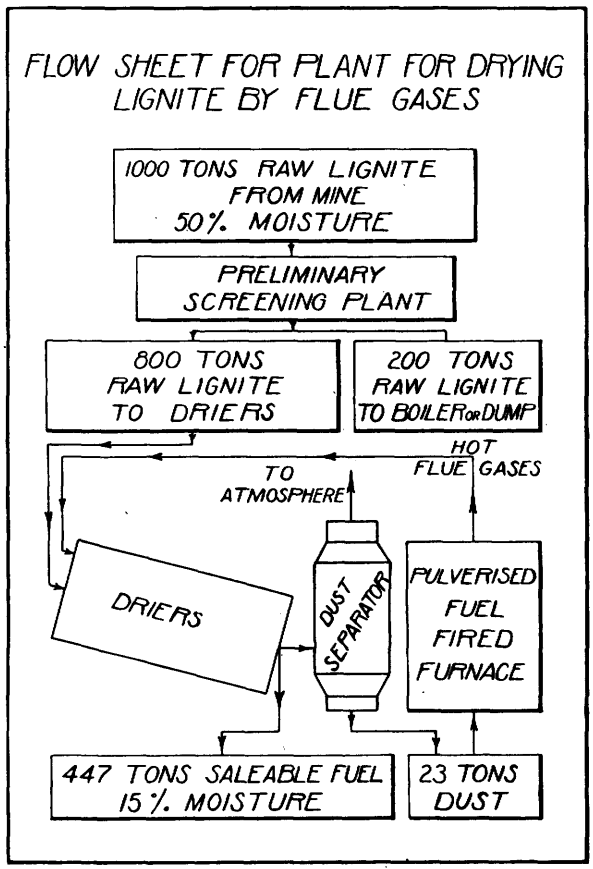


FIG. 7

factors in mining that may lead to a more favourable cost position. Any such changes would influence considerably the cost of finished products. For example, a reduction of 5 cents per ton in the cost of raw lignite would mean a reduction of 12.7 cents per ton in the cost of Fleissner dried lignite and of 11 cents per ton in the cost of flue-gas dried lignite.

General Expense and Total Costs

To the mining and processing costs must be added certain items of general expense associated with mining preliminaries, administration and sales, operating

capital, etc. These items will now be considered briefly. The relevant data are given in Table X, and the total costs per ton of product are summarized in Tables XI and XII.

TABLE X—GENERAL EXPENSE AND STORAGE

Yearly production	Scheme A (118,200 tons Fleissner lignite)			Scheme B (134,000 tons flue-gas dried lignite)		
	Capital cost	Yearly cost	Cost per ton	Capital cost	Yearly cost	Cost per ton
			cents			cents
Drilling	$15,000	$2,400	2	$15,000	$2,400	1¾
Administration, etc.	14,000	16,440	14	10,700	4,712	3½
Interest during market development	5,000	800	¾	.....	.....	.....
			cents			
General expense	$34,000	$19,640	17	$25,700	$7,112	5¼
Seasonal storage	115,000	35,000	30	.....	.....	.....

TABLE XI—TOTAL COSTS, SCHEME A
(Yearly production 118,200 tons Fleissner lignite)

	Capital	Yearly cost	Cost per ton of product
Mining	$494,300	$264,000	$2.23
Processing	355,800	106,737	.91
General expense	34,000	19,640	.17
Storage	115,000	35,000	.30
Sub-total	$999,100	$425,377	$3.61
Operating capital	50,000	3,000	.02½
Total	$1,050,000	$428,500	$3.64

TABLE XII—TOTAL COSTS, SCHEME B
(Yearly production 134,000 tons flue-gas dried lignite)

	Capital	Yearly cost	Cost per ton of product
Mining	$494,300	$264,000	$1.97
Boiler	25,000	.....	.....
Processing	140,000	43,000	.32
Stock-piling	30,000	36,000	.27
General expense	25,700	7,112	.05¼
Sub-total	$715,000	$350,112	$2.61¼
Operating capital	30,000	1,800	.01⅓
Total	$745,000	$352,000	$2.63

Mining Preliminaries

Before mining operations are commenced in area A-1 the Foundation recommends that a further 100 drill-holes at 200-foot centres be put down to points below the seam. A sum of $15,000 is included as a capital charge for this

work. It has been assumed that the timber on the area would carry the cost of clearing the ground.

Administration and Sales

In determining the mining cost provision was made for camps and offices. A sum of $10,000 per annum was allowed for legal fees, workmen's compensation, bank charges, etc. Provision was made for a mine manager and a clerical and technical staff sufficient for the entire development. Incorporation taxes on a capital of one million dollars are included, and a sum equal to 1½ per cent. of the capital is included to cover interest charges during construction. No general fund is provided to take care of contingencies, and no royalties payable to the Ontario Government are added.

Storage

The storage of raw lignite or Fleissner lignite is an expensive undertaking owing to the relatively low heat value of these fuels and their bulky character. Every effort should be made to reduce this procedure to a minimum and to perform it under the simplest conditions conducive to efficient handling. Under Scheme A the Foundation recommends the storage of Fleissner lignite according to the following programme: If 80 per cent. of the year's production were shipped at a steady rate throughout the year, and 20 per cent. shipped in the 6 months, October to March, storage for 50,000 tons of dried lignite must be provided. Under Scheme B a steady demand for the product has been assumed, and the storage charges shown are for raw lignite.

Balances between Production and Sales

An assured market for the bulk of the products must be secured before the development is undertaken. The character of the operations involved rules out the possibility of proceeding with mining and processing and then conducting a sales campaign. There is, however, some inherent flexibility and opportunity for adjustment between production and sales. By working extra shifts, mining and processing can be temporarily increased by 20 per cent. It has been assumed that 30 per cent. of the first year's output would be delayed and subsequently taken care of by these methods. A sum of $5,000 is set aside as capital to provide the interest charges associated with this postponement.

Utilization of Products

Let us assume that cars loaded with the two products are available on the siding at Onakawana. What characteristics other than cost will influence their sale to railways, industries, and domestic consumers in Northern Ontario? An understanding of this discussion will be facilitated by a glance at Table XIII, in which lignite products are compared with imported competitive fuels.

TABLE XIII—COMPARISON OF LIGNITE PRODUCTS AND IMPORTED FUELS

	Fleissner lignite, average sample	Flue-gas dried lignite, average sample	Bituminous coal		Anthracite	
			American	Nova Scotia (Noranda)	American	Welsh
Moisture.....per cent.	20	15	1.5	1.2	3.4	2.2
Volatile constituents.per cent.	35.7	37.1	40.5	34.7	6.2	7.8
Ash.....per cent.	6.8	8.5	7.5	7.5	13.9	4.9
Sulphur.....per cent.	.75	.80	3.50	3.40	.9	1
Heating value, B.t.u. per lb..	8,890	9,110	13,500	13,980	12,370	14,110
Bulk density, lb. per cu. ft...	32	35	50	48	55	51

Before discussing Fleissner lignite and flue-gas dried lignite separately, certain generalizations can be made. The mechanical equipment used by the T. and N.O. Railway, in such industries as paper-mills, mines, and smelters, and in homes, has been designed and purchased for high-grade bituminous coal, anthracite, or wood. Success in the sale of lignite products depends on their ability to replace these fuels with the minimum of mechanical alterations or additions. Speaking generally, the consuming public are satisfied with the quality and price of the fuels obtainable. To associate a replacement programme with large capital expenditure, even allowing a saving in current expenditure, would condemn the project.

Processed lignite is a bulky fuel, and its heat value per pound is roughly nine-fourteenths that of bituminous coal or anthracite. A locomotive tender or industrial bunker when full of lignite products will contain approximately 43 per cent. of the heat units contained in an equal volume of bituminous coal. To do the same work with similar equipment, a man using lignite must handle about 1½ times the weight and 2⅓ times the bulk of bituminous coal. He must also remove 1¼ times the weight o ash.

The moisture content of these products is much higher than that of coal, and this fact reduces still further the heat value. The B.t.u. figures in Table XIII express the maximum available heat during combustion, but in practice this amount is never developed. The reduction from the theoretical figure is influenced by the moisture content of the fuel. Heat is required to evaporate and drive off the water at the flue-gas temperature, usually 600°F. When a fuel contains 20 per cent. moisture, about 3 per cent. of the available heat is used up in this way.

Utilization of Fleissner Lignite

Locomotive Firing.—Fuel is by far the most expensive single item purchased and used by the railways For many years there has been steady improvement in the design of locomotives leading to the efficient burning of high-grade expensive fuel. High fire-box temperatures are maintained, and more than half the heat transfer takes place in the fire-box by radiation. In all locomotives there is loss of heat from sparking, the amount varying with the type of fuel and the draft in the fire-box.

Sub-bituminous coals are used by the railways in certain parts of the United States for locomotive firing. These coals resemble Fleissner lignite in chemical composition, but they are heavier. Locomotives are fitted with spark arresters and the grates and ash pan of the fire-box are specially designed, all for the purpose of reducing losses by sparking.

Fleissner lignite is used in the Hungarian State Railways in mountainous country. It is mixed with bituminous coal in the proportions 1:1 to 3:1 (lignite to coal).

The average coal consumption by the T. and N.O. Railway for the past three years was 103,000 tons, of which 85,000 tons was burned in locomotives. If Fleissner lignite, larger sizes, could be used exclusively on the railway, there would be an assured market for from 150,000 to 160,000 tons per annum. This would require the mining of 3,000 tons of raw lignite per working day. This is roughly twice the output contemplated in Scheme A. In addition, the Canadian National Railways uses about 36,000 tons of bituminous coal between Taschereau and Hearst.

Having shown the existence of a potential market for more than the proposed output of Fleissner lignite, what are the possibilities of securing it? Very careful

consideration must first be given to very definite disadvantages associated with the burning of Fleissner lignite in a locomotive:—

1. The lower bulk density, 32 pounds per cubic foot as compared with 50 pounds for bituminous coal, lowers the capacity of the existing tenders both in terms of weight of fuel and available heat units. The number of coaling points would have to be increased proportionately, approximately 2⅓ times.

2. During normal operations, 50 per cent. more fuel by weight per hour must be fed to the fire to secure the same heat output. On steep grades, could the hand-fired locomotive operate under these conditions? Stoker-fired locomotives might overcome this problem, and at present there are six of these in use on the T. and N.O. railway.

3. Fleissner lignite has a lower specific gravity than coal, and there is greater danger of spark losses. The loss in efficiency might be quite considerable. A railway executive in conference with officers of the Research Foundation stated that this factor alone would reduce the efficiency of a locomotive from 100 to 70. The average boiler efficiency of a modern locomotive is 55 per cent., so that if we accept these views lignite products might only give 40 per cent. efficiency. These predictions might be contradicted by experience, provided certain mechanical changes are made in the locomotives. The grates can be modified slightly at moderate expense in the workshops of the company. A fine-mesh anti-spark device should be inserted in the front end of the locomotives; the total cost of these changes is estimated at $600 per locomotive.

Without in any way minimizing the points raised in the preceding paragraph, mention should be made of certain properties of Fleissner lignite which may partially overcome these objections:—

1. It is low in sulphur, and the ash content is not high.

2. The high content of volatile matter, oils, etc., 36 to 38 per cent., is considered by some railway authorities to be advantageous. The fire can be forced at critical points in the run, and this advantage more than compensates for any loss in over-all efficiency.

3. There is no question that Fleissner lignite is a free-burning fuel, and this quality may enable sufficient lignite to be burned per hour to give a heat value equal to that of the normal consumption of bituminous coal. It may also allow greater flexibility in the rate of combustion.

Outside the field of fuel technology or the economics of this problem, there is the obvious fact that at present all the coal burned on the railway enters the Province. The lignite deposit is on Crown land, which is traversed by the railway.

The conclusion of the Research Foundation with regard to this most important section of our problem is that no final decision can be arrived at until sufficient quantities of Fleissner lignite are available to permit test runs by T. and N.O. locomotives under the joint supervision of the Railway and the Foundation. At least 200 tons of material would be required, and a convenient stretch of line for these tests would be Porquis Junction to Timmins.

Industrial Possibilities.—The most important centres for coal consumption for industrial purposes are listed below:—

Industry	Place	Miles from Onakawana	Miles from Key Harbour
Paper mills	Iroquois Falls	160	418
	Smooth Rock	156	256 (M)
	Kapuskasing	196	217 (M)
Smelter	Noranda, P.Q.	274	411
Mines	Porcupine-Timmins	186	444
	Kirkland Lake	220	356
Miscellaneous	Schools, court-houses, and other public buildings.		

M—Michipocoten Harbour.

Paper mills use fuel for steam-raising and are generally equipped with furnaces designed to burn bituminous coal in pulverized form. During the last few years there has been an increasing tendency, however, to install electric boilers, owing to the abundance of hydro-electric power. The condition has markedly reduced, at least temporarily, the consumption of coal, and it is impossible to predict the future. From a purely technical point of view, Fleissner lignite should create few problems. The high content of volatile matter and the tendency of the particles to disintegrate and burn rapidly favour the possibility of maintaining the capacity of installed equipment. It should be possible to use coarser particles and thus allow more material to pass through the pulverizer. The high moisture content is not a hindrance to successful pulverization, and in practice it could be reduced by using pre-heated air in the mills. The market for bituminous coal has shrunk in recent years from 125,000 tons in 1929 to 60,000 tons in 1931. The Foundation recommends the use of about 200 tons of Fleissner lignite for trials at the paper mills. If the 1931 tonnage could be replaced by Fleissner lignite, it would create an annual market for 75,000 to 80,000 tons.

The smelter of Noranda Mines uses 90,000 tons of the best quality Nova Scotia bituminous coal. It is pulverized and used in reverberatory furnaces, which must maintain very high temperatures. The company buys Nova Scotia rather than American coal because of its higher heat value and ease of grinding. Their concern for efficiency in the attainment of the desired temperatures is shown by their decision to dry the coal to a moisture content of below 1 per cent. before grinding. Provided technical efficiency can be maintained, the company would welcome any reduction in fuel costs and would co-operate in any attempt to bring this about. It is very doubtful whether Fleissner lignite could be used in these furnaces. If the moisture content were still further reduced from 20 to 2 per cent., there would be a stronger possibility. The company is willing to co-operate by carrying out trials in a small furnace fired with pulverized fuel if 50 tons of Fleissner lignite could be supplied. The possible market, 140,000 tons per annum, is larger than the proposed initial output.

The gold mines are consumers of bituminous coal for steam-raising, mostly for heating purposes. The coal is of American origin and is supplied to the fires by underfeed screw stokers of the "Iron Fireman" type. In Western Canada lignite has been used successfully in underfeed stokers of the plunger type, but no information is available regarding the possibility of using the screw-type with lignite products. The present consumption of coal by the mines is approximately 25,000 tons per annum.

The facts regarding the domestic market are difficult to secure. In large buildings bituminous coal is burned, using industrial equipment. During recent years there has undoubtedly been an increase in the use of wood in the homes with a corresponding reduction in the use of coal. There is still a moderate use of imported anthracite, and on a price basis Fleissner lignite could compete. The domestic furnace firepot has been designed to take dense fuels such as anthracite. If the change is made to Fleissner lignite, a householder must find room in the furnace at night for an amount of lignite equal to 2½ times the volume of anthracite normally used to keep the house warm until the morning. In spite of the knowledge of this condition through experience in Western Canada, the manufacturers of domestic furnaces are not supplying specially designed lignite furnaces. Certainly they are not in the homes in Northern Ontario, and it is doubtful whether they would be installed even to take advantage of a cheaper fuel. By-product coke, which suffers from the same disadvantage, has not replaced more expensive fuels. The domestic market is comparatively a small part of the market. It is at present occupied by several fuels and a great variety of types of equipment. To penetrate this market it would be necessary to carry out the appropriate trials in such equipment, to be followed by a carefully planned educational campaign.

Fuel Value and Utilization of Flue-Gas Dried Lignite

Flue-gas dried lignite would contain only a small amount of material larger than 1½-inch cubes, and could not be used as a locomotive fuel.

A lignite product with the composition and properties indicated in Table XIII might be used successfully in industrial plants using pulverized fuel. The following factors should be borne in mind in the consideration of this possibility:—

1. Processed lignite can be pulverized at a low cost owing to its physical characteristics and the opportunity presented to use coarser particles in the furnace.
2. The moisture content of flue-gas dried lignite could be easily reduced to 7 per cent. by the consumer previous to its pulverization. This product would then have a heat value of 10,000 B.t.u. per pound.
3. The finished product would burn rapidly.
4. In comparison with the Fleissner process the capital costs and processing costs are low, as is shown in the estimated cost per ton of product. There is a much greater economic possibility of adjusting the process to market demands, thereby avoiding the storage of finished products.
5. Flue-gas dried lignite cannot be stored for any length of time owing to the danger of spontaneous combustion. Continuous operation of the plant to fill long-term contracts for the product should be aimed at.
6. During very wet weather the product could not be transported long distances in open cars without increasing the moisture content of this hygroscopic material. Suitable equipment at a small additional cost could be used.
7. The production and sale of flue-gas dried lignite depend ultimately on the running of plant-scale burning tests of this material and the reaction of Noranda Mines and the paper companies to the results obtained.

Conclusion

On purely technical grounds it has been shown that there can be no assured market for processed lignite in Northern Ontario until successful commercial trials have been run using representative material in the existing fuel-burning equipment.

Railway Transportation Charges

It is unnecessary in this report to enlarge on the important rôle played by the railway freight rate in determining the cost to the consumer of a bulky, low-priced commodity such as fuel. Experience has shown that rates cannot be calculated by an independent investigator on a strictly mathematical basis, using distances between points and rates quoted in other localities. Terminal charges and haulage charges must be included. Professor Lesslie Thomson[1] states that freight rates on coal in Canada are made up of terminal charges varying from $0.90 to $1.50 per ton, and haulage charges varying from 0.3 cents to 0.7 cents per ton per mile.

Practically the whole of the economic area considered in this report is served by the T. and N.O. Railway. The Foundation communicated with G. W. Lee, Chairman of the Commission administering this railway, and requested a set of rates for processed lignite from Onakawana to the chief centres of fuel consumption in the area. It was made clear that while the Foundation did not require rates approved by the Board of Railway Commissioners of Canada, it would be necessary to use the quoted rates in the report to be forwarded to the Government. In reply, Mr. Lee gives the rates that are summarized in Table XIV, but states, "I feel safe in saying that there would be some reduction in these rates, but cannot tell you what it would be and think, for the purpose of your report, that you had better use the rates submitted."

TABLE XIV—APPROXIMATE FREIGHT RATES FOR PROCESSED LIGNITE

From Onakawana to	Miles	Rate per net ton
Cochrane	126	$1.90
Timmins	187	2.20
Kirkland Lake	220	2.30
Noranda	274	2.60
Cobalt	276	2.70
North Bay	380	3.10
Kapuskasing (via C.N.R.)	196	3.10

These are "regular rates in force on coal at the present time," and analysis of the figures shows that they are made up of $1.20 for terminal charges and haulage charges at the rate of 0.5 cents per ton per mile.

On the basis of these rates and the costs that have been discussed in the previous sections of this report, a series of figures has been obtained showing the cost of Fleissner lignite and flue-gas dried lignite in cars at various points in Northern Ontario. This information is contained in Table XV.

[1]Proceedings, Symposium on Fuel and Coal, McGill University, Montreal, 1931, pp. 445-447.

TABLE XV—PRICE, ON SIDING, OF FLEISSNER DRIED AND FLUE-GAS DRIED LIGNITE

(Freight structure based on present commercial rates quoted by the T. & N.O. Railway)

Place	Selling price per ton of bituminous coal	Cost on siding of equivalent weight of	
		Fleissner dried lignite[1]	Flue-gas dried lignite[1]
On T. & N.O. Ry.:			
Cochrane	.....	$8.75	.....
Iroquois Falls	$7.60	8.91	$7.08
Timmins	7.75	9.23	.....
Kirkland Lake	8.50[2]	9.39	.....
Noranda	8.40	10.08	8.16
Cobalt	8.50[2]	10.00	.....
North Bay	8.50[2]	10.65	.....
On C. N. Ry.:			
Kapuskasing	7.56	10.65	8.77

[1]No allowance has been made for the storage or handling of the larger bulk of lignite.
[2]Includes agent's commission of about 50 cents per ton.

The cost figures are for amounts of lignite products having the available heat value of 1 ton of bituminous coal. They do not include any additional charge for the handling or storage of the greater bulk of material, and any indicated price differential in favour of lignite products must cover this item.

The above comparative prices for lignite products and bituminous coal show quite definitely that on the basis of existing freight rates the lignite deposit could not be developed on a self-supporting basis.

In view of the statement contained in the correspondence with Mr. Lee that the present rates would be reduced, the Research Foundation has made enquiries into the costs associated with the movement of coal on railways. The Research Foundation concludes that the T. and N.O. Railway would be justified in quoting a rate for the movement of lignite products on its own system of 0.5 cents or less per ton per mile.

On the basis of the recommended rate, the figures in Table XV have been revised and are shown in Table XVI.

TABLE XVI—RECOMMENDED PRICE, ON SIDING, OF FLEISSNER DRIED AND FLUE-GAS DRIED LIGNITE
(Freight rates of one-half cent per ton per mile used)

Place	Selling price per ton of bituminous coal	Cost on siding of equivalent weight of	
		Fleissner dried lignite[1]	Flue-gas dried lignite[1]
On T. & N.O. Ry.:			
Cochrane	.....	$6.75	.....
Iroquois Falls	$7.60	7.08	$5.31
Timmins	7.75	7.24	.....
Kirkland Lake	8.50[2]	7.49	.....
Noranda	8.40	8.09	6.24
Cobalt	8.50[2]	7.93	.....
North Bay	8.50[2]	8.75	.....
On C. N. Ry.:			
Kapuskasing[3]	7.56	8.64	6.82

[1]No allowance has been made for the storage or handling of the larger bulk of lignite.
[2]Includes agent's commission of about 50 cents per ton.
[3]Based on one-half cent per ton per mile to Cochrane and $1.20 per ton from Cochrane to Kapuskasing.

The comparative prices for bituminous coal and Fleissner lignite show an advantage in favour of the latter fuel, but bearing in mind the technical reservations which could not be included in the estimates, the Foundation is of the opinion that Fleissner lignite cannot compete in the industrial market. There are possibilities of savings in mining, processing, and freight rates, but these are problematical. Flue-gas dried lignite can compete on a price basis in large industrial plants in which pulverized fuel is used.

Other Considerations

In the earlier chapters of this report reference has been restricted to the technical and economic factors which have a direct bearing on any immediate commercial development. If we take a larger and broader view there are other considerations of importance which should be briefly mentioned.

At the present time Northern Ontario is supplied with coal from points outside the Province. Fuel famines have occurred in the past, and a situation might develop again in which the Onakawana deposit would be an extremely valuable economic asset. Its value as a contingency reserve will be increased if the commercial tests recommended in this report and described in Appendix VII are successfully carried out.

A moderate commercial development of the deposit would bring additional freight to the T. and N.O. Railway; and provided certain technical difficulties are overcome, the railway would secure cheaper fuel. A small ceramic industry could be developed at the deposit using clays in the overburden and lignite products. This plant could produce and supply to the north country structural clay products, especially the drain-tile which is badly needed at reasonable prices by the farming community.

In this attempt to estimate the immediate commercial possibilities of the Onakawana lignite deposit, the Research Foundation has been compelled to restrict its attention to present economic conditions. Certain changes may

take place in the future, but in some cases at least these are dependent on political consideration, e.g. the Federal subsidy on Nova Scotia coal used industrially in Ontario may in the near future be discontinued.

Conclusions

Near Blacksmith rapids on the Abitibi river, 60 miles south of Moosonee, a large body of lignite exists. It lies at an average depth of 65 feet below the surface and is covered with boulder clay, Cretaceous clay, and sand. The deposit occurs in two seams and covers an area of approximately 6 square miles. The lignite in its raw state contains 50 per cent. water, and in this condition is of no economic importance at the present time.

Good second-hand equipment can be purchased in Canada at the present time for strip-mining operations at the deposit. No unusual mining problems of a technical character can be foreseen, and three independent authorities have agreed in substance as to the methods and cost of mining raw lignite. The mining costs contained in this report are based on the recommendations of T. H. Hogg, and he estimates the cost of raw lignite to be 88 cents per ton on the basis of mining 300,000 tons per annum.

Several processes have been tested on a plant scale with a view to obtaining lignite products that could be transported and used by railways, industrial consumers, and householders. Two of these processes, the Fleissner process and flue-gas drying, have been investigated to the point of estimating the cost of the products to consumers in various centres in Northern Ontario.

Fleissner lignite is an excellent fuel containing 20 per cent. moisture and 9,000 B.t.u. per pound. It can be transported without excessive breakage losses, and when necessary it can be stored without danger from spontaneous combustion. This fuel could be delivered to the T. and N.O. Railway at Onakawana for $3.30 per ton, and at this price could compete with imported American coal. Certain technical uncertainties exist, however, with regard to its use in locomotives. There are no serious technical problems associated with the use of Fleissner lignite in industry, but unless the price to the consumer can be reduced by (1) an increase in total production, (2) lower freight rates, or (3) economies in production costs, Fleissner lignite cannot compete in the industrial market. Greater success can be expected in the domestic field if successful trials in standard equipment are conducted.

Flue-gas dried lignite cannot be used as a locomotive fuel or in domestic furnaces. In furnaces burning pulverized fuel, this material might be burned with no loss in efficiency and at a considerable saving in cost to the consumer. The paper mills and the smelter operated by Noranda Mines offer a potential market.

The Ontario Research Foundation cannot recommend any immediate commercial development of the lignite deposit. On the basis of the evidence submitted in this report, they feel justified in recommending a further expenditure of $60,000 to mine and process sufficient lignite to test adequately the burning of lignite products in locomotives, and in industrial and domestic furnaces. The results from these tests, in conjunction with the material embodied in this report, will permit a final conclusion as to the possibilities of commercial development in the near future, and will in any case establish the value of this deposit to the Province of Ontario as a contingency fuel reserve.

APPENDIX I

Cost of Lignite Investigation

The total cost of the research work carried out by the Ontario Research Foundation, from January 1, 1930, to October 31, 1932, in connection with the development and utilization of the Northern Ontario lignite deposit was $31,832.86. This can be divided under two main headings, e.g. general research programme, conducted in the laboratories of the Foundation and at the deposit; and European tests.

The following statement outlines the division of the costs under these two main headings:—

GENERAL RESEARCH PROGRAMME:		
Salaries	$14,281.78	
Chemicals, apparatus and supplies	2,948.52	
Freight, express, and sundry	986.95	
General overhead (secretarial, gas, water, electricity, etc.)	2,800.00	
Travelling	2,189.16	
Total		$23,206.41
EUROPEAN TESTS:		
Air-tight containers	$1,985.21	
Freight (rail and ocean)	1,953.11	
Travelling	1,988.95	
Magdeburg briquetting tests	39.23	
Kohlenveredlung tests	2,081.58	
Lurgi Company's charges re briquetting and Fleissner tests	578.37	
Total		$8,626.45
Total cost of investigation		$31,832.86

It is interesting to note the extremely low figure charged by those who conducted the tests in Europe. In the case of the Lurgi Company, in particular, no account was rendered except to cover out-of-pocket expenses.

APPENDIX II

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APPENDIX III

The Dry Briquetting of Northern Ontario Lignite in a Standard Exter Press

The amorphous brown coals of Central Europe and of the State of Victoria, Australia, are amendable to briquetting without the addition of any external binding material, the application of this process having had far-reaching economic results. The German brown coal industry produced in 1929 over 42 million metric tons of briquettes, requiring the mining of about 75 million tons of raw brown coal; and the State Electricity Commission of Victoria, Australia, in 1931-32, produced about 360,000 tons of briquettes, requiring the mining of nearly 800,000 tons of raw brown coal.

The process consists in taking the raw coal as mined, crushing it to any desired extent, drying to a moisture content of 10 to 20 per cent., and then subjecting it to high pressure, averaging 16,000 to 20,000 pounds to the square inch, in a continuously operated, suitably designed press. No binding material is added to the coal, and it is not fully understood why some brown coals briquette more easily than others. The briquettes are made in various shapes depending on whether they are for the domestic or industrial markets.

The opinion of certain European engineers conversant with this dry-briquetting process, followed by experiments carried out in the laboratories of the Foundation, led to the hope that this method of treatment might be applied successfully to certain parts of the Northern Ontario lignite seams, even though other Canadian lignites had not hitherto been successfully treated in this way. The presence of so large a proportion of earthy lignite in the upper seam was an added incentive for examining the possibilities of this process.

Material Sent for Test

The material sent for test was roughly screened at the shaft to remove pieces over 1-inch size and thus ensure, as far as possible, that most of it was earthy lignite. Some 24,000 pounds of screened lower-seam and 7,000 pounds of screened upper-seam lignite were sent to Germany. About 5,000 pounds of upper-seam lignite as mined, i.e. without any screening, was also included in the shipment. The analysis of the screened material is given below.

As mined	Upper seam screened	Lower seam screened
Moisture.....per cent.	49.8	50.6
Ash.....per cent.	9.4	11
Calorific value, B.t.u. per lb.....	4,770	4,640

Tests at Maschinenfabrik Buckau-R. Wolf, Magdeburg, Germany

Preliminary tests made in a hydraulic press produced a dense briquette but one which disintegrated rapidly when placed in water.

A series of 8 tests, using in all about 19,500 pounds of raw lignite, was made in the experimental plant, and while such conditions as the size of the coal particles, speed of the press, stroke of the stamp in the press, and the steam supplied to the mould, were kept constant throughout the tests, the following conditions were varied to ascertain their effect on the quality of the briquettes: (1) The moisture in the coal entering the press was varied from 13 to 21.7 per

cent. by varying the steam pressure at the driers from 1.3 to 2.2 atmospheres. (2) The stamp entrance varied from 90 to 100 mm. (3) Four different shapes of moulds were used, each of which gave a different total pressure and a different rate of application of pressure.

Results of Tests.—The first briquettes made had a very poor appearance and little strength. When the pressure was changed by altering the mould shape, the briquettes adhered together on leaving the mould. Reducing the moisture content and keeping the same pressure did not overcome this difficulty.

In the next test, the pressure was again changed and the adhesion was less, but when the lignite was dried down to 13 per cent. moisture and the same pressure used, the adhesion increased. With a high moisture content (21.7 per cent.), and another change in the pressure applied to the coal, the best briquettes made in this series of tests were produced.

None of the briquettes were strong enough to withstand commercial handling, and none of them were waterproof. On placing them in water, they were completely disintegrated in approximately 5 minutes, while briquettes made from German and Australian brown coals will stand many hours in water without disintegrating.

Tests at the Grube Marga, Senftenberg (near Dresden), Germany

The remaining raw lignite, about 16,500 pounds in all, was sent to the Marga briquette factory where, under the direction of Herr Klitzing, the Director, three tests were made in one of the standard commercial Exter presses.

In the first test, some 6,000 pounds of screened upper-seam lignite, similar to that used in the tests at Magdeburg, were dried down to about 13 per cent. moisture and put through the press. The briquettes had a fair appearance but were not strong enough for commercial use and were in no way waterproof.

In the second test, some 4,800 pounds of lower-seam unscreened lignite, containing admixed clay and woody and peaty material, were crushed and dried to about 16 per cent. moisture and put through the press. The briquettes were no more satisfactory than those from test No. 1, and plainly showed the presence of clay. The press "laboured" badly.

In the third test, some 5,700 pounds of screened upper-seam lignite were dried and put through the press. No really satisfactory briquettes were produced.

Analyses of Raw Coal and Briquettes

Eleven barrels of briquettes were returned to Toronto, one from each of the 8 tests at Magdeburg and from the three tests at Grube Marga. Two barrels of German raw brown coal and two of German brown coal briquettes were also returned for examination. These samples weighed in all about 5,700 pounds.

The analyses of the Northern Ontario lignite as sent for test and of some of the products returned to Toronto are given in Table XVII.

TABLE XVII—ANALYSES OF RAW COAL AND BRIQUETTES

	Raw Coal			Briquettes			
	Lignite as sent for trial	Michel brown coal	Marga brown coal	Magdeburg test No. 8	Marga test No. 1	Michel brown coal	Marga brown coal
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Moisture	49.8	48	57.3	22.3	13.6	16	16.5
Volatile matter	18.1	25.2	22.2	28.4	30.7	43.6	43.8
Fixed carbon	22.7	21.6	17.5	35.5	41.1	30.5	34.3
Ash	9.4	5.2	3	13.8	14.6	9.9	5.4
Sulphur	.43	1.2	.35	1.14	.53	5.67	.87
Calorific value, B.t.u. per lb.	4,770	5,720	4,635	7,400	8,135	9,450	8,750

On distillation, the German brown coals give a much greater yield of tar than the Northern Ontario lignite. This is reflected, in the analyses, in the higher volatile matter content of the German briquettes.

Weathering Tests

Samples of the briquettes returned from Germany were placed on shelves fixed to the wall on the roof of the Research Foundation building. These shelves have a southern exposure and, to protect the contents from direct rain, an overhanging cover was fitted. The briquettes have been exposed for about nine months (from mid-March), and at the time of writing those made in the first three tests at Magdeburg show decided signs of weathering but have not disintegrated, while those made in tests Nos. 4 to 8 at Magdeburg show considerable disintegration. The briquettes made from Northern Ontario lignite at the Grube Marga show considerable distintegration, as do the Michel brown coal briquettes; but the Marga brown coal briquettes are only slightly affected and still retain their smooth, shiny surface.

Laboratory Research Work at the Foundation

During the time the tests were being made in Germany, Mr. Revell was carrying out laboratory work on dry briquetting at the Foundation, and some of the results he obtained are referred to briefly below, the details being given in the series of reports made on the work which are on file at the Foundation:—

1. Screen analysis showed that the finest sizes of material gave the highest ash contents on incineration. It was also found that when air-dried to 25 per cent. moisture, nearly 30 per cent. of the material in the samples examined was under 200-mesh size.

2. In view of the widely accepted theory that the percentage of the lignite or brown coal extractable by means of carbon disulphide is a criterion of the briquetting properties by this process, tests were made on samples of the Northern Ontario and Saskatchewan lignites and on available samples of German brown coal. The results showed: brown coals, 5.1 per cent. and 10.7 per cent. extractable; Saskatchewan lignite, 0.3 per cent.; Northern Ontario lignite, 0.6 per cent.

3. A laboratory press was designed and constructed. Briquettes were made, and the influence of different factors on their strength was studied. These are briefly discussed below:—

(*a*) *Effect of Pressure of Formation.*—Pressures varying from 2.5 to 16.8 tons per square inch were used, the results obtained indicating that the compressive strength increased to a marked extent as the pressure of formation increased.

(*b*) *Effect of Particle Size.*—The compressive strength increased decidedly as the particle size decreased.

(*c*) *Effect of Increase of Fines.*—As the percentage of material below 60-mesh size increased, the compressive strength increased greatly.

(*d*) *Effect of Moisture Content.*—The optimum moisture content was shown to be between 9 and 18 per cent. with a probable increase in the strength of the briquette as the moisture content approached 18 per cent.

(*e*) *Effect of Press Temperature.*—By far the strongest briquette was made when the press temperature was maintained at about 100°C. Above 100°C., the evolution of gas and water vapour broke up the briquette. Good briquettes were made with the press temperature at 50° and 75°C.

In order to carry out the examination of the products returned from Germany the above work was discontinued in April, 1932, and has not as yet been resumed. The experiments made have shown that the briquetting of Northern Ontario lignite without a binder is not technically impossible, and in view of the large quantities of earthy material that would be available at the deposit in case of any development, and for which there is not at present any commercial outlet, this work should be continued. If, at a reasonable cost, briquettes could be made which would withstand sufficient handling to allow of their being used in the vicinity of the deposit, they might find an outlet in a subsidiary industry such as a ceramic plant.

APPENDIX IV

The Carbonization of Lignite and Briquetting of the Char

To make a product with a high heat value to compete with anthracite, lignites are sometimes subjected to carbonization and the resulting char briquetted. The carbonization effects the removal of all the moisture and most of the volatile matter of the raw lignite, but does not result in the removal of any inorganic matter, so that the char has a much higher ash content than the raw lignite. Selective screening can be used to remove fine-sized material of high ash content, thereby improving the material to be briquetted. The gas produced is used up on the plant, and the tar is generally distilled to produce pitch. The light oils, if sufficient in quantity, are treated for the production of various chemical products, and the liquor is generally run to waste.

Types of Carbonization Processes

Carbonization systems can generally be classified under one of two headings:

1. *Internal Heating* where carbonization is effected by means of hot gases sweeping through the material.

2. *External Heating* where the material is carbonized by passing through a metal retort, which is heated by gases burning in flues surrounding the retort.

Tests Made in Europe

In the tests made in Europe, 32 tons of Northern Ontario lignite were carbonized by a system using internal heating, and 43 tons by a system using external heating.

Raw Material for Carbonization

To make a high-grade artificial fuel from Northern Ontario lignite, as much as possible of the earthy lignite should be removed before carbonization. In a commercial plant, about 20 per cent. by weight of the raw lignite as mined would, therefore, be screened out. This 20 per cent. would probably consist of 15 per cent. earthy material and 5 per cent. peaty, so that the material going to the carbonizing plant should have an analysis of the following order:—

Moisture	50 per cent.
Ash	5.6 per cent.
Calorific value	5,280 B.t.u. per lb.

This is rather better material than was sent to Germany for tests, but the difficulties attached to the mining and screening under the conditions existing at shaft W account for the difference.

Systems Tested on Northern Ontario Lignite

The two systems of carbonization selected for the plant-scale trials with Northern Ontario lignite were the Lurgi system (Lurgi Gesellschaft für Wärmetechnik, m.b.H., Frankfurt-am-Main, Germany), which uses internal heating, and the Kohlenveredlung or K.V.G. system (Kohlenveredlung and Schwelwerke, A.G., Berlin, Germany), which uses external heating.

Lurgi System

The carbonization is carried out in a shaft furnace comprising three zones: (1) the drying, (2) the carbonizing, and (3) the coke-cooling zone. In the

drying zone the raw lignite is dried by means of hot gases to 5 per cent. moisture and suffers partial disintegration thereby. The lignite passes by gravity to the carbonizing zone where carbonization is effected by hot gases produced externally to the furnace and pulled through the lignite by an exhauster, the temperature of carbonization being regulated as desired. The char produced passes to the coke-cooling zone where it is partially cooled before being withdrawn from the furnace. It has then to be treated immediately in an inertization plant where, by passing a large quantity of air through it, sufficient oxidation takes place to prevent any subsequent self-heating. The char is then completely cooled and sprayed with water until it contains about 5 per cent. moisture. The tar and oils produced are recovered separately. The lignite does not yield sufficient gas to effect both drying and carbonizing, so that additional gas has to be provided from a producer using raw lignite as fuel.

Products Recovered.—The products recovered from one ton (2,000 pounds) of lignite of the composition previously given would be as follows:—

Product	Pounds	Per cent.
Dry char	640	32
Dry tar and light oils	36 (3.6 gals.)	1.8

Char.—The analysis of the char leaving the inertization plant would be approximately as follows:—

Moisture	5 per cent.
Ash	16.6 per cent.
Calorific value	11,200 B.t.u. per lb.

If the char were treated in a pneumatic cleaning plant, some 10 per cent. by weight of fine dust with a high ash content would be removed. The 600 pounds of char remaining would have an analysis as follows:—

Moisture	5 per cent.
Ash	14.3 er cent.
Calorific value	11,540 B.t.u. per lb.

Tar.—By straight distillation, the tar would probably yield about 28 per cent. of pitch, equivalent to 10 pounds per ton of raw lignite carbonized. According to the figures quoted later by Kohlenveredlung for pitch production by oxidizing the tar previous to distillation, this yield might be increased to 25 pounds per ton.

Kohlenveredlung System

In this system the raw lignite is first crushed to a convenient size and dried to about 15 per cent. moisture in a revolving drum heated by flue gases. The dried lignite is screened to remove the finest size material, which, together with the dust removed from the vapours leaving the drier, constitutes some 10 per cent. by weight of the dried material. These screenings may be burnt to provide flue gases for heating the drier. The dried screened lignite is then carbonized, passing through the retorts by gravity.

The liquid products of carbonization are condensed, while the gas is collected and used for heating the retorts. The char is withdrawn continuously and passed to an inertization plant where, by treatment with air, it is sufficiently oxidized to prevent subsequent self-heating.

Yields.—With raw lignite of the following analysis, moisture 50 per cent., ash 5.6 per cent., each ton would give, after treatment in the flue gas drier, 1,057.5 pounds of sized dried lignite, containing 15 per cent. moisture and 8.5 per cent. ash; and 117.5 pounds of dried dust, containing 15 per cent. moisture and 19 per cent. ash.

Based on the results of the tests made in their plant, Kohlenveredlung would guarantee from the sized lignite the following products on carbonization:—

	Pounds
Char (dry)	588
Tar (dry)	41½
Light oils (dry)	6¾

Char.—The char leaving the inertization plant would have an analysis approximately as follows:—

Moisture	5 per cent.
Ash	14.8 per cent.
Calorific value	11,620 B.t.u. per lb.

Since the drying and screening of the lignite prior to carbonization would remove some material with a high ash content, the Kohlenveredlung char would have a lower ash content than the Lurgi char. It would also be of a more even grain size, so that it is not considered necessary or advisable to subject this char to pneumatic cleaning.

Tar.—Kohlenveredlung confidently anticipate, as a result of their experience, that by oxidizing the tar prior to distillation, a pitch yield of 70 per cent. by weight, equal to 29 pounds per ton of lignite carbonized, can be obtained.

Carbonization and Briquetting

The use of char in the form in which it leaves the carbonizing plant is very restricted, so that the general practice is to briquette it, using pitch as the binder. Pitch is used because it is the best binding material yet discovered for use in fuel briquettes, and because it has a heating value as high as or higher than the material being briquetted.

The char produced from Northern Ontario lignite is, unfortunately, very porous and, to produce strong, satisfactory briquettes, requires a fairly high proportion of binder. The tests made with both samples of char showed that 10 per cent. pitch, i.e. 10 pounds pitch to 90 pounds char, is necessary to produce satisfactory briquettes.

The analyses of briquettes made from the two chars, using 10 per cent. pitch as binder, are as follows:—

	Lurgi briquettes	Kohlenveredlung briquettes
Moisture.....per cent.	4.5	4.5
Ash.....per cent.	12.9	13.3
Calorific value, B.t.u. per lb	12,000	11,950
Briquettes produced per ton of raw lignite carbonized...lbs.	666	688

Briquettes containing 10 per cent. of pitch binder are not smokeless on combustion unless subjected to a second heat treatment at a temperature of about 400°C. This treatment while effective in producing a smokeless fuel

(almost an artificial anthracite) involves a loss of combustible volatile matter and a consequent loss in weight, and adds, of course, to the cost of manufacture.

Processing Costs

A plant carbonizing 200 tons of lignite per day and operating 8 months (240 days) would produce a sufficient quantity of briquettes to satisfy the present domestic market in Northern Ontario. The yearly production would be 16,170 tons. Some 60,000 tons of raw lignite, as mined, would be needed although only 75 per cent. of this (48,000 tons) would be carbonized. Under such a scheme the remaining lignite mined (240,000 tons) would be treated in a Fleissner drying plant and would produce 94,560 tons of salable sizes of dried lignite per year. About one-quarter of the total output of briquettes and one-third of the total make of Fleissner dried lignite would have to be stored to take care of the market demands when the mining and processing plants were not in operation.

In working out the costs for carbonization and briquetting, the Lurgi system has been chosen, as it calls for a lower capital expenditure per ton of material treated than the Kohlenveredlung system.

These costs are set out in Table XVIII:—

TABLE XVIII—COSTS FOR A LURGI CARBONIZATION AND BRIQUETTING PLANT

(Yearly production, 16,170 tons of briquettes)

Capital Costs	
Carbonizer, gas producer, condensation plant, foundations and erection, buildings, conveyers, inertization plant and spares	$155,000
Duty on German equipment	30,000
Briquetting press (10 tons per hour), bunkers, cooling belt, pitch tank, buildings, including duty	78,000
Total capital costs	$263,000
Yearly Costs	
Carbonizing:	
Raw lignite, 60,000 tons at 88 cents	$52,800
Screening to give 48,000 tons to carbonizer	5,280
Labour and supervision, 240 days	13,976
Lignite for gas producer	2,904
Repairs and material	2,400
Screening of char to remove fines	810
Fixed charges, 15 per cent. on $185,000	27,750
Total carbonizing costs	$105,920
Gives 14,555 tons of char at $7.28 per ton.	
Briquetting:	
Char, 14,555 tons	$105,920
Labour, 202 days	2,590
Steam	500
Material and repairs	8,900
Pitch (10 per cent. by weight), 1,617 tons at $25	40,425
Fixed charges, 15 per cent. on $78,000	11,700
Total briquetting costs	$170,035
Gives 16,170 tons of briquettes at $10.52 per ton.	

TABLE XIX—COST PER TON OF BRIQUETTES
(Free in cars at plant)

Raw lignite, 3.71 tons at 88 cents		$3.26
Screening, etc.		.33
Carbonizing:		
Labour	$0.86	
Producer fuel	.18	
Repairs, etc.	.15	
Screening char	.05	
Fixed charges	1.72	
Total		2.96
Briquetting:		
Labour	$0.16	
Steam	.03	
Repairs	.55	
Pitch	2.50	
Fixed charges	.73	
Total		3.97
Total cost		$10.52

Changes in Costs.—If the tar produced from each ton of lignite carbonized gave, on treatment, 25 pounds of pitch worth $20 per ton, i.e. $25 less $5 for cost of production, the price of the briquettes would be reduced by 74 cents per ton.

If the cost of raw lignite were reduced by 5 cents per ton, the cost of briquettes would be reduced by about 20 cents per ton.

The capital and yearly costs for treating the remainder of the output in a Fleissner drying plant are given in Table XX below:—

TABLE XX—COST PER TON OF FINISHED PRODUCT FOR A FLEISSNER DRYING PLANT
(Yearly production, 94,560 tons dried lignite)

Capital costs—complete plant	$300,000
Yearly costs	302,200
Cost per ton of finished product	3.20

This cost is 6 cents per ton higher than that given in Scheme A.

General Expense and Total Costs.—The items that have to be added to the cost per ton of finished product to take care of such general expenses as mining preliminaries, administration and sales, storage of finished product, operating capital, etc., have been discussed in the report, but for convenience the total costs are summarized below:—

TABLE XXI—TOTAL COSTS FOR CARBONIZATION AND BRIQUETTING PLANT[1] AND FOR FLEISSNER DRYING PLANT[2]

	Capital	Yearly cost	Cost per ton of product	
			Char briquettes	Fleissner lignite
Mining	$494,300	$264,000	$3.26	$2.23
Processing	563,000	208,235	7.26	.97
General expense	37,300	19,968	.26	.17
Storage	98,000	30,000	.....	.32
Sub-total	$1,192,600	$522,203	$10.78	$3.69
Operating capital	70,000	4,200	.11	.02½
Total	$1,262,500	$526,500	$10.89	$3.72

[1]Yearly production, 16,170 tons briquettes.
[2]Yearly production, 94,560 tons dried lignite.

Utilization of Char and Char Briquettes

Lignite char has 5 per cent. moisture, 12 per cent. volatile matter, 14.3 per cent. ash, and 11,540 B.t.u. per pound. The combustion of lignite char in the form in which it leaves the carbonization plant is limited, because of the fine-grain size of the material, to travelling grates of special design. It may be used in the form of pulverized fuel, but even then its use is practically limited to the neighbourhood of the carbonizing plant. Because of its physical characteristics neither open cars nor box-cars could be used for shipping. The only satisfactory way would be to use special tank cars. The material could then be finely ground at the plant and shipped as pulverized fuel ready for use in the customer's plant.

Fuel Value of Char Briquettes.—The following table gives a comparison of the available heat per pound and per cubic foot of lignite char briquettes and some competing fuels:—

TABLE XXII—COMPARISON OF AVAILABLE HEAT OF LIGNITE CHAR BRIQUETTES AND SOME COMPETING FUELS

	Lignite char briquettes	U. S. anthracite, stove size	Welsh anthracite, screened	U. S. low volatile (smokeless) coal, forked lump
Bulk density, lbs. per cu. ft.....	38	55	51	51
Gross calorific value, B.t.u. per lb...	12,000	12,370	14,110	14,080
Available heat per lb. of fuel, B.t.u.	11,660	12,000	13,360	13,590
Relative weight of fuel to equal 1 lb. U. S. anthracite, lbs.....	1.03	1[1]	.90	.88
Available heat in 1 cu. ft. of fuel, B.t.u.....	443,080	660,000	681,360	693,090
Relative bulk of fuel to equal 1 cu. ft. of U. S. anthracite, cu. ft.....	1.49	1	.97	.95

[1]Generally speaking, the amount of unburnt material present in the refuse after burning American anthracite is high, while in the refuse produced from the burning of char briquettes, the proportion of unburnt material is very low. This would, in practice, increase the efficiency of char briquettes as compared to American anthracite.

Locomotive and Industrial Use.—Price considerations alone make it impracticable to consider the use of char briquettes as either locomotive or industrial fuel.

Domestic Use.—Table XXII gives a comparison of available heat per pound and per cubic foot of lignite char briquettes and some competing fuels. From it we see that, weight for weight, char briquettes are equivalent to American anthracite on a heat basis, but are not equal to Welsh anthracite or low volatile coal. The briquettes are not so dense as anthracite and, therefore, on a heat basis, they occupy about 50 per cent. more volume than anthracite. On combustion in a furnace, they create a great amount of radiant heat, are easily ignited, and readily answer to changes in draft conditions.

Briquettes made with a pitch binder are not smokeless unless made so by a second heat treatment; therefore, on first charging a quantity into a furnace, the production of some black smoke is inevitable. This makes it less desirable to charge the fuel in large quantities and is a disadvantage as far as domestic furnaces are concerned.

Summary.—Unless briquettes could be produced at a lower cost than appears likely from the data given in Table XXI, there is no possibility at present of their finding a ready sale in the domestic markets of Northern Ontario. Should

it appear at a later date that, by a reduction in mining and processing costs, especially in the cost of the binding material, briquettes could be made at a much lower cost, it would be advisable, before embarking on the erection of any plant, to have a fairly large quantity of lignite carbonized and the char briquetted at the Lurgi plant at Bienfait, Saskatchewan, or at Lehigh, North Dakota, so that the briquettes could be tried out in household stoves in Northern Ontario before being placed on the open market.

APPENDIX V

The Desiccation of Northern Ontario Lignite by the Fleissner Process

The raw lignite contains, as mined, 50 per cent. moisture and, for use in the industrial centres of Northern Ontario, would have to be transported some 150 to 200 miles. In order to keep as low as possible the cost of transport, per ton of useful, heat-producing material, and to make products more nearly resembling the fuels at present being used in the industrial plants, some of the moisture must be removed at the deposit before shipping. Any drying process naturally involves a loss of weight, and the following table shows the effect of drying one ton of raw lignite, containing 50 per cent. moisture, down to various final moisture contents:—

TABLE XXIII—YIELD PER TON OF RAW LIGNITE WITH VARIOUS PERCENTAGES OF MOISTURE

Moisture in Final Dried Product Per cent.	Yield per Ton[1] of Raw Lignite[2] Pounds
30	1,429
25	1,333
20	1,250
15	1,177
10	1,111
5	1,053
0	1,000

The effect of this on the cost per ton of the finished product is obvious.

Tests were made on a small industrial plant in Czechoslovakia with about 12 tons of screened lower-seam lignite mined from shaft W. The results were very satisfactory, and some 4,500 pounds of the resulting dried product were returned to Toronto for examination and tests. The application of this process to lignite from area A-1 is discussed below.

Raw Material

Using lower-seam lignite and screening out all the earthy material and the smaller pieces of peaty material, some 30 per cent., by weight, of the raw lignite would be removed. The remaining 70 per cent. would be made up of 50 per cent. woody and 20 per cent. peaty lignite (all percentages based on weight of raw lignite as mined), and the composition of the material going to the autoclave would be as follows:—

Moisture	50 per cent.
Ash	4.8 per cent.
Calorific value	5,380 B.t.u. per pound

Product

Drying to a final moisture content of 20 per cent. would give 1,250 pounds of dried lignite per ton of material treated. This would have an average analysis as follows:—

Moisture	20 per cent.
Ash	7.7 per cent.
Calorific value	8,775 B.t.u. per pound

[1] 2,000 pounds.
[2] 50 per cent. moisture.

By screening out the dust, which is estimated from experience to be 10 per cent. of the total weight of dried lignite, the following products would be obtained:—

TABLE XXIV—YIELDS PER TON OF RAW LIGNITE[1] TREATED IN AUTOCLAVE

Size	Weight	Moisture	Ash	Calorific value
	lbs.	per cent.	per cent.	B.t.u. per lb.
Over ¼ inch	1,125	20	6.8	8,890
Under ¼ inch	125	20	15.4	7,845

[1]50 per cent. moisture.

By further screening, this material over one-quarter inch size can be divided up into various fractions as the market requirements demand, and the largest size material would probably have an analysis as follows:—

Moisture	20 per cent.
Ash	5.5 per cent.
Calorific value	9,030 B.t.u. per pound

Fuel Value of Fleissner Dried Lignite

The following table gives a comparison of available heat per pound and per cubic foot of Fleissner dried lignite and some competing fuels:—

TABLE XXV—COMPARISON OF AVAILABLE HEAT OF FLEISSNER DRIED LIGNITE AND SOME COMPETING FUELS

	Fleissner lignite		U. S. bituminous coal	Nova Scotia bituminous coal (Noranda smelter)	U. S. low volatile coal	U. S. anthracite
	Average of all salable sizes	Railway sizes				
Bulk density, lbs. per cu. ft.	32	32	50	48	51	55
Gross calorific value, B.t.u. per lb.	8,890	9,030	13,500	13,980	14,080	12,370
Available heat per lb. of fuel,[1] B.t.u.	8,210	8,325	12,950	13,265	13,590	12,000
Relative weight of fuel to equal 1 lb. of U.S. bituminous coal, lbs.	1.58	1.55	1	.98	.95	1.08
Available heat in 1 cu. ft. of fuel, B.t.u.	262,720	266,400	647,500	636,720	693,090	660,000
Relative bulk of fuel to equal 1 cu. ft. of U. S. bituminous coal, cu. ft.	2.47	2.43	1	1.02	.93	.98

[1]Available heat after allowing for evaporation of moisture and water produced by the burning of the hydrogen in the fuel. Flue gas exit temperature taken as 600°F.

APPENDIX VI

The Drying of Lignite by Flue Gases

The main purpose in drying lignite by means of flue gases is to remove as much as is economically feasible of the extraneous moisture in order to increase the heating value per ton of material. This increase in heating value is proportional to the degree of drying, with the added advantage that, the lower the moisture content of the dried product, the smaller is the proportion of the total heat used during combustion to evaporate the moisture. No direct reduction in the amount of inorganic matter takes place, so that the percentage ash content is higher in the dried product. Selective screening may remove the finest sizes of material, which generally have the highest ash contents.

Tests Made

In connection with the carbonization tests made by the firm of Kohlenveredlung, A. G. (Berlin), on the Onakawana lignite, some 42 tons of the raw lignite were dried by means of flue gases in revolving drum driers, the moisture content of the lignite being reduced from about 50 to 15 per cent.

Application to Lower-Seam Lignite

In applying this method of processing to the lower seam lignite for the production of an industrial fuel, it would improve the product if as much as possible of the earthy lignite were removed by screening prior to the drying. If this were done, the raw material going to the driers should consist of 10 parts woody, 5 parts peaty, and one part earthy lignite, and should have an analysis as follows:—

	Per cent.
Moisture	50
Ash	5.1

To facilitate drying, the raw material should be crushed to pieces not larger than about 1½-inch cube before entering the drier, and there would be a loss of perhaps 5 per cent. by weight of the raw material in the form of fine dust carried out by the vapours leaving the drier and not recoverable economically. Waste flue gases from a boiler plant, supplemented if necessary by the products of combustion of waste earthy lignite, could be used. The process would be comparatively cheap.

Product

The dried product would have an analysis as follows:—

Moisture	15 per cent.
Ash	8.5 per cent.
Sulphur	.80 per cent.
Calorific value	9,110 B.t.u. per lb.

Utilization of Product

A comparison of the available heat per pound and per cubic foot of flue-gas dried lignite and some competing fuels is given in Table XXVI below. It will be seen that 1.53 pounds of flue-gas dried lignite are necessary to give the same quantity of available heat as 1 pound of United States bituminous coal, and that 2.18 cubic feet of dried lignite contain the same available heat as 1 cubic foot of United States bituminous coal.

If the lignite were further dried at the point of consumption to 2 per cent. moisture, the figures would be, 1.30 pounds of lignite equals 1 pound bituminous coal, and 1.85 cubic feet of lignite equals 1 cubic foot of bituminous coal. These factors have an important bearing on the relative value of the dried lignite in terms of dollars and cents in comparison with the competing fuels. The increased weight and bulk of lignite to be handled for any given heat output would, of course, mean increased handling and costs, but it is difficult to estimate this in terms of dollars and cents.

TABLE XXVI—COMPARISON OF AVAILABLE HEAT OF FLUE-GAS DRIED LIGNITE AND SOME COMPETING FUELS

	Flue-gas dried lignite		U. S. bituminous coal	N. S. bituminous coal (Noranda smelter)
	As produced 15 per cent. moisture	After further drying to 2 per cent. moisture		
Bulk density, lbs. per cu. ft.....	35	35	50	48
Gross calorific value, B.t.u. per lb.....	9,110	10,500	13,500	13,980
Available heat per lb. of fuel,[1] B.t.u....	8,485	9,980	12,950	13,265
Relative weight of fuel to equal 1 lb. of U. S. bituminous coal, lbs.....	1.53	1.30	1	.98
Available heat in 1 cu. ft. of fuel, B.t.u..	297,000	349,300	647,500	636,720
Relative bulk of fuel to equal 1 cu. ft. of U. S. bituminous coal, cu. ft.....	2.18	1.85	1	1.02

[1]Available heat after allowing for evaporation of moisture and water produced by the burning of the hydrogen in the fuel; flue-gas exit temperature taken as 600°F.

APPENDIX VII

Pilot Plant

The calculations made of the cost of erecting a pilot Fleissner plant, and mining and processing 3,000 tons of lignite, are based on the best estimates available at the present time. The dried lignite would be used for making combustion tests in locomotives, and industrial and domestic furnaces.

The cost of stripping 10,500 cubic yards of overburden, mining 3,000 tons of lower-seam lignite from area A-1, and putting it into cars at Onakawana, is based on a schedule drawn up by T. H. Hogg. It calls for the use of a three-quarter cubic yard shovel and four 5-ton trucks for hauling overburden and lignite.

The plan of operation calls for the erection at the Abitibi canyon of an autoclave of 100 cubic feet net capacity, capable of treating 20 tons of raw lignite per 24 hours, complete with trommel screen, bucket conveyer, and bunker for raw lignite; and intermediate bunker, trommel screen, etc., for dried lignite. A portable belt conveyer is included for general work on the plant. Steam is provided by a 2,500-kilowatt, 2,300-volt electric steam generator, provided with the necessary transformer, controls, breakers, etc., for giving the required voltage from the 12,000 volts available.

The Abitibi canyon is considered to be the most suitable place for this plant, since electric power, competent electricians, workshops, and buildings for housing the plant and for the staff, offices, and laboratories are available.

The erection of the pilot plant is estimated to take two months; and the processing of 2,000 tons of screened raw lignite would take about four months (25 working days per month). The combustion tests could, however, begin about two weeks after the processing commenced. One month is allowed for delays and contingencies.

No freight costs on either raw lignite from Onakawana to the canyon, or on processed lignite from the canyon to the industrial plants, etc., have been included, since it is presupposed that these tests would be carried out in co-operation with the Temiskaming and Northern Ontario Railway.

No salaries have been included for the members of the Foundation staff at present working on the lignite investigation, these being covered by the 1932-33 allocation from the Ontario Department of Mines.

Summary of Costs

A.	Mining of 3,000 tons of raw lignite	$12,670
B.	Capital cost of pilot plant	30,000
C.	Operating costs	17,330
	Total costs	$60,000

The costs, in detail, are set out below:—

A. MINING 3,000 TONS OF RAW LIGNITE

Labour	$2,700
Rental of equipment	5,000
Labour transportation	600
Freight—shovel, trucks, and miscellaneous	1,050
Loading and unloading	200
Fuel (gasoline)	450
Blasting charges	270
Loading lignite on to cars	750
Engineering, management, miscellaneous, and contingencies	1,500
Total mining costs	$12,670

B. CAPITAL COST OF PILOT PLANT

Raw lignite conveyer	$500
2 Trommel screens	625
1 Portable belt conveyer	1,000
Freight on above from Hamilton	250
Raw lignite bunker (wood)	250
Autoclave, 100 cu. ft. capacity[1]	3,125
2,500 kw. electric boiler[1]	6,650
Transformer, etc.[1]	7,500
Switches, breakers, etc.[1]	5,500
Feed water pump and motor[1]	1,000
3 Motors[1]	400
Wiring, etc.[1]	500
Bunker for dried lignite[1]	500
Lagging for boiler and autoclave	450
Cost of erection	1,750
Total capital cost	$30,000

C. OPERATING COSTS

(Producing 1,100 tons of Fleissner dried lignite)

SALARIES AND WAGES (6 months):	
1 Engineer	$1,080
1 Engineer	750
12 Labourers	5,400
1 Machinist	600
1 Cook	750
1 Cookee	450
1 Accounts clerk	750
Boarding costs, 23 men (6 months)	3,900
Insurance	250
Transportation, subsistence, etc.	700
Power	2,500
Laboratory supplies	200
Total operating costs	$17,330

[1]Delivered prices at Fraserdale.

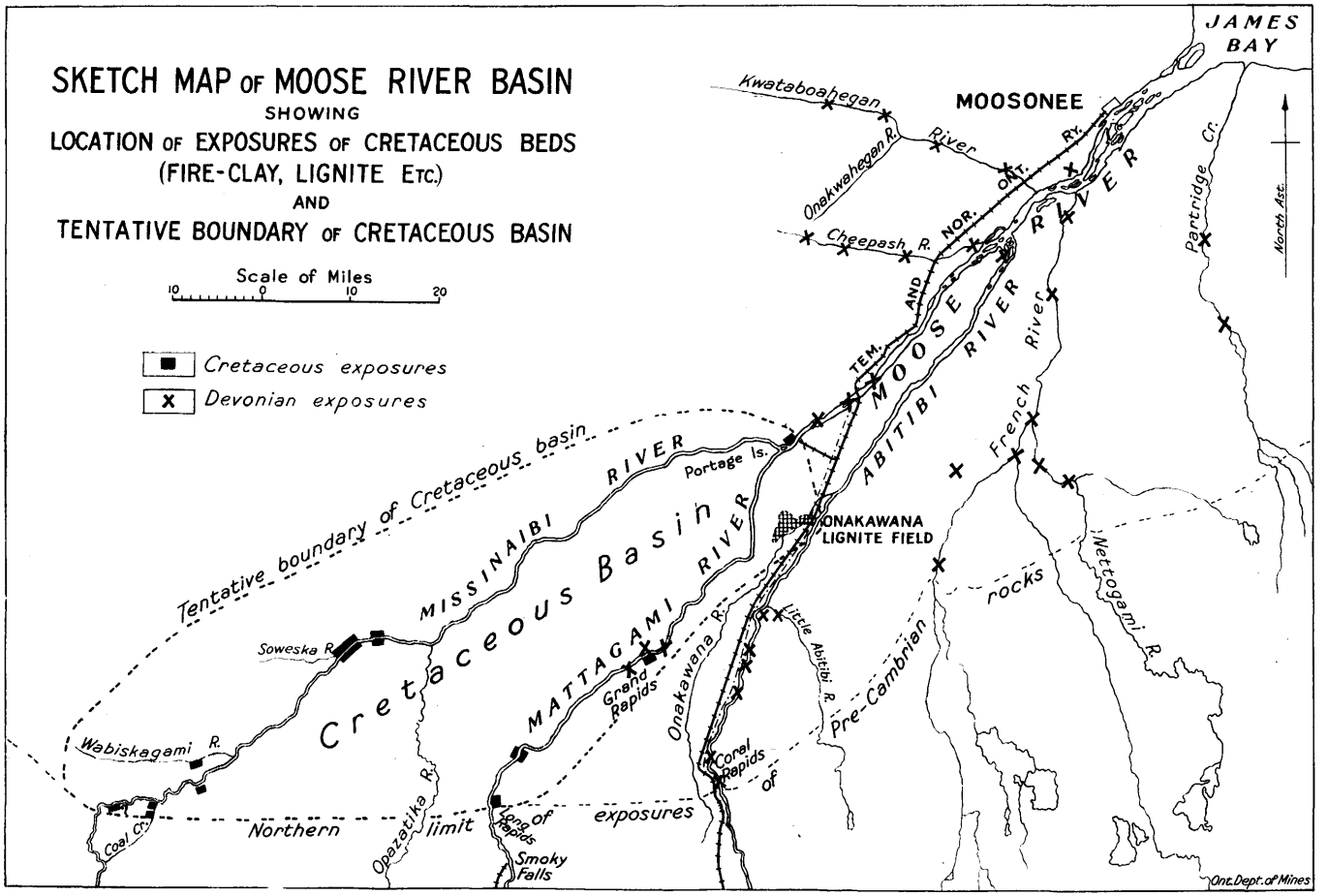

SKETCH MAP OF MOOSE RIVER BASIN
SHOWING
LOCATION OF EXPOSURES OF CRETACEOUS BEDS
(FIRE-CLAY, LIGNITE ETC.)
AND
TENTATIVE BOUNDARY OF CRETACEOUS BASIN
Scale of Miles
10 0 10 20
Cretaceous exposures
Devonian exposures
JAMES BAY
MOOSONEE
Kwataboahegan River
Onakwahegan R.
Cheepash R.
ONT.
NOR.
RY.
AND
TEM.
MOOSE RIVER
ABITIBI RIVER
Partridge Cr.
North Ast.
French River
Portage Is.
ONAKAWANA LIGNITE FIELD
Tentative boundary of Cretaceous basin
MISSINAIBI RIVER
Cretaceous Basin
MATTAGAMI RIVER
Soweska R.
Wabiskagami R.
Coal Cr.
Grand Rapids
Onakawana R.
Little Abitibi R.
Coral Rapids
Pre-Cambrian rocks
Nettogami R.
Northern limit of exposures
Opazatika R.
Long Rapids
Smoky Falls
Ont. Dept. of Mines

FIG. 1

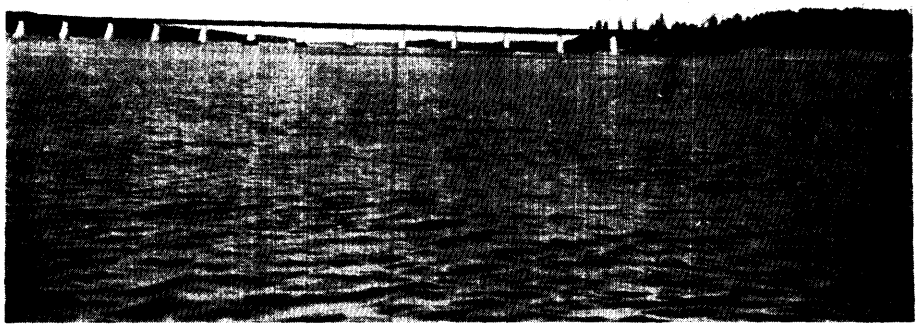
Lignite and Refractory Clay Deposits of the Onakawana Lignite Field

By W. S. Dyer and A. R. Crozier

Introduction

History of Exploration and Development

For many years lignite has been known to occur in the Moose River basin. Previous to the present development, however, it had been found largely as fragments or as irregular seams in the refractory clay, and it was considered doubtful whether any definite seams of economic proportions existed. In 1926, a large area comprising 1,096 square miles along the Abitibi, Mattagami, and



Moose river bridge (T. and N.O. Railway), looking downstream. A fill connects Mike island, on the right, with the mainland.

Moose rivers was withdrawn from staking by the Ontario Government, and the Department of Mines decided to make a thorough geological survey of the territory. Accordingly the field seasons of 1927 and 1928 were spent by the writers in making geological traverses of these rivers and many of their tributaries. The result of this work was a clearer understanding of the Cretaceous beds with their lignite, sand, and refractory clay, the gypsum of the Moose river, the iron of Grand rapids, and the oil possibilities of the region. The lignite of Blacksmith rapids (Onakawana) was shown to be of Cretaceous age and to occur, not in thin superficial beds as was previously thought, but in structural basins with some chance of being thick and extensive. It was decided that an exploratory drilling programme would be worth while. Blacksmith rapids was chosen as the locality of the first drilling, and the first hole was begun on June 22, 1929. The first year's drilling was so favourable in locating lignite that further money was voted; and drilling was continued and underground work started. Exploratory drilling was continued until April, 1931. Meanwhile,

the James Bay extension of the Temiskaming and Northern Ontario railway was being pushed northward from Island Falls; it reached the lignite field in the spring of 1930, and tidewater at Moosonee in 1931. At the end of 1930, a second shaft was started about 1½ miles southwest of the first in a locality where, according to the drilling, the lignite seams were thickest. Underground exploration was continued until October, 1931, and was in charge of W. F. Fancy. The shaft was sunk to a depth of 136 feet and 1,276 feet of drifting was done on two levels.

Several tons of lignite from the first shaft were shipped for testing to several places. This early testing was done chiefly by the Mines Branch, Department of Mines, Ottawa, which has always given most willing co-operation. In the spring of 1930, C. Tasker was appointed to the staff of the Ontario Research Foundation to work in co-operation with the officers of the Ontario Department of Mines on ways and means of utilizing the lignite. The chemical and physical survey of the lignite seams in shaft W were made by Mr. Tasker, and he also supervised the sampling of the seams and the large-scale tests which were made in Europe in the winter of 1932.

In the summer of 1930, a preliminary geophysical survey was made of a small part of the lignite field. The party was headed by Professor L. Gilchrist of the Department of Physics, University of Toronto, assisted by R. H. Hawkins of the Ontario Research Foundation. Afterward the work was continued by Mr. Hawkins under the supervision of Dr. A. E. R. Westman, Chief of the Chemical and Metallurgical Division of the Ontario Research Foundation. The electrical methods that were tried first were not found to be particularly successful, and in the summer of 1931 A. H. Miller, of the Dominion Observatory, Ottawa, was invited to make a preliminary torsion-balance survey of part of the field. This method was more successful, and the work was continued for four months. It is expected that it will prove especially useful in giving an idea of the thickness of lignite and overburden between exploratory drill-holes.

In the summer of 1930, J. Klitzing, an eminent European lignite expert, director of the Ilse Mining Company of Germany and an adviser to the Australian Government on lignite operations, paid a short visit to the field and subsequently submitted an exhaustive report on the Onakawana field, covering possibilities and methods of stripping and general economic considerations. He advised German methods of stripping, using endless-chain bucket dredgers and overburden bridge conveyers, and, for beneficiation of the lignite, chiefly low-temperature carbonization and briquetting. In 1930, H. Littlefield, coal-stripping expert of the Marion Steam Shovel Company, visited the property and wrote a report giving details and costs of stripping the overburden and mining the lignite by electric shovels.

The by-product value of the fire clay that is associated with the lignite has not been overlooked. In 1926, R. J. Montgomery, Professor of Ceramics, University of Toronto, explored the Mattagami and Missinaibi rivers for fire clay and subsequently wrote a report[1] covering the subject. Since then he has been called upon to test samples of refractory clay sent in by the writers,[2] and has supervised semi-commercial and commercial tests. E. R. Davey, one of Professor Montgomery's graduate students, served on the temporary staff of the Ontario Department of Mines from May, 1931, till May, 1932. He carried on studies of the clay in the laboratories of the University of Toronto under the supervision of Professor Montgomery.

[1]Ont. Dept. Mines, Vol. XXXVII, pt. 6, 1928, pp. 1-69.
[2]See pp. 79-87.

In the winter of 1932, further drilling was done in the attempt to find a deposit of fire clay that could be easily recovered by open-pit mining. This was unsuccessful, but some measure of success was attained in checking the lignite seams and in working out a small area of lignite under shallow overburden.

All geological and exploratory work, including drilling, observations of the lignite seams, and overlying and underlying measures in underground exploration, sampling of the refractory clay, and a certain amount of sampling of the lignite has been under the direction of the writers.

Acknowledgments

The writers wish to acknowledge the assistance and encouragement given them by the officials of the Temiskaming and Northern Ontario Railway, the H. F. McLean Construction Company, Limited, and the officials and merchants of Cochrane. Very able assistance was rendered by University students and others who served on the geological staff. Foremost among these were W. Gerrie, A. D. Williams, and B. C. Coles.

Scope of the Report

One progress report has already been published[1] covering operations to May 31, 1930. At that time only 50 out of 116 of the exploratory holes had been drilled, underground operations had not been started at shaft W, and the deep drill-hole A to the pre-Cambrian had not been completed. Moreover, the Ontario Research Foundation had not commenced its investigations. The present report gives the results of all this new work, including the most recent conception of the geology of the field as based on it. The first 50 logs were given in the Progress Report above mentioned, and in this report the data obtained from the holes drilled since then are shown in the sections facing page 66. Refractory clay deposits are also described.

It is impossible at this time to publish all the memoranda and reports that have been written on the Onakawana lignite field. These are very numerous, and some of them are voluminous.

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Geology

The geology and structure of the Onakawana lignite field has already been dealt with in papers on the geology of the Moose River basin.[1] Accordingly the Pleistocene and Cretaceous formations only will be described in full in this report; the Cretaceous because it contains the economic deposits of lignite and refractory clay, and the Pleistocene because it forms the overburden on these deposits.

The general character and thickness of the Devonian formations, which underlie the Cretaceous, are given in drill-hole A. These formations do not outcrop in the immediate vicinity of the lignite field. Drill-hole A is located in the middle of the field, two miles west of the T. and N.O. railway, at a point where it was thought that the thickest Devonian section would be obtained.

PHYSICAL FEATURES

The physical features of the Onakawana lignite field are typical of the James Bay coastal plain, of which it forms a part. The final geological event in the region was the invasion of the Northern sea immediately after the retreat of the last ice-sheet. This levelled out any inequalities that had existed in the till-sheets and deposited the marine (Champlainian) clay over most of the country north of the pre-Cambrian escarpment. The general surface is very flat, but a gentle northeastward decline in altitude exists; at the foot of the escarpment at Coral rapids the surface of the plain is 340 feet above sea level; 25 miles to the north at Onakawana it is 175 feet above sea level; and at James bay, 75 miles northeast of Onakawana, the plain meets sea level.

Owing to the flatness of the country, drainage is very imperfect. Only on the banks of the rivers is the run-off sufficient to allow normal forest growth. Over the areas between these rivers, wet muskeg 2 to 6 feet deep prevails, and the trees are small and scrubby.

The rivers of the region, which did not start their work until after the deposition of the marine clay, have cut valleys into the till-sheets, and in several places into the underlying Cretaceous and Devonian beds. The Moose River basin is drained by numerous rivers, which show a fan-shaped pattern tending to converge into the trunk river, the Moose. Three valleys cross the Onakawana lignite field: The largest is the Abitibi, which is 1,200 feet wide and 50 feet deep; next comes the Onakawana, about 150 feet wide and 30 feet deep; finally, there is Medicine creek, with a rather broad but very shallow valley, which has its source in the swamps in the southwestern part of the lignite field.

A feature of considerable economic importance is the terrace on the west side of the Abitibi river. This terrace, which is 1,200 feet wide and 15 feet lower than the plain above, reduces the thickness of the overburden above the lignite in this area.

DESCRIPTION OF FORMATIONS

The following summarized log of drill-hole A gives the measures penetrated in the central section of the field, the surface of which is 186½ feet above sea level.

[1] W. S. Dyer, Trans. Roy. Soc. Can., 3rd ser., Vol. XXV, sec. IV, 1931, pp. 85-99.

Log of Drill-Hole A, Onakawana Lignite Field

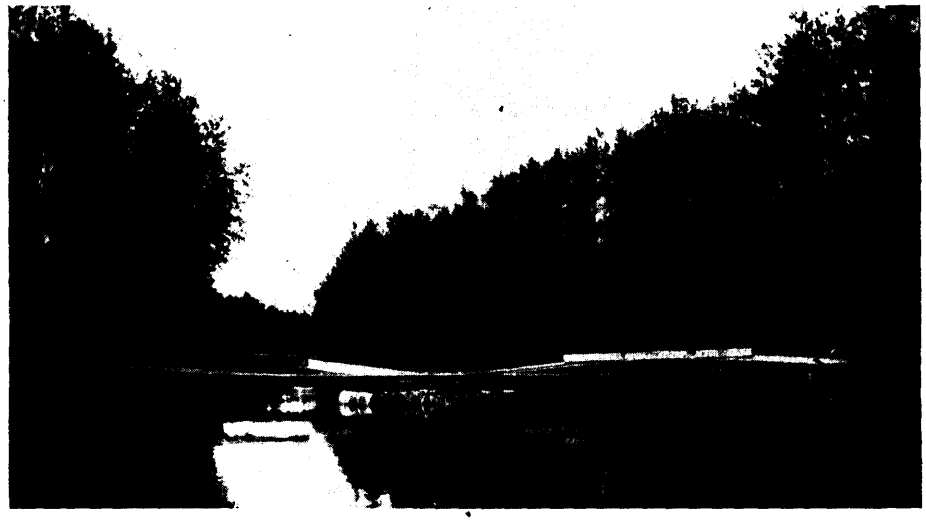
Description	Depth	Thickness	Formation	Geological subdivision
	feet	feet		
Muskeg	0–6	6	.....	Recent
Grey plastic clay (marine, Champlainian)	6–22	72	.....	Pleistocene
Grey boulder clay	22–80			
Refractory clay	80–123	170	Mattagami	Lower Cretaceous or Upper Jurassic
Lignite	123–146			
Refractory clay	146–148			
Lignite	148–151			
Refractory clay and white quartz sand	151–173			
Lignite	173–194			
Dark-grey lignitic clay	194–212			
Light-grey and cream plastic clay	212–250			
UPPER MEMBER: Interbedded pale greenish-grey clay and grey shale	250–318	285	Long Rapids	Upper Devonian (Portage)
MIDDLE MEMBER: Dark-grey bituminous shale with thin bands of greenish-grey clay	318–415			
LOWER MEMBER: Pale greenish-grey to grey shaly clay, with bands of dark bituminous shale and hard concretionary material	415–535			
UPPER MEMBER: Interbedded buff and grey porous and cavernous limestone and calcareous shale. Brecciation common	535–655	301	Williams Island	Upper and Middle Devonian (Tully-Hamilton)
MIDDLE MEMBER: Red gypsiferous shale, grey calcareous shale, and gypsum	655–687			
LOWER MEMBER: Massive grey shale	687–836			
Buff fossiliferous limestone	836–873	37	Abitibi River	Middle Devonian (Onondaga)
UPPER MEMBER: Interbedded buff limestone breccia; buff porous and cavernous limestone; and grey shale	873–936	154	Moose River	Middle or Lower Devonian
MIDDLE MEMBER: Interbedded grey and buff shale; buff granular limestone; mostly carrying gypsum or veins of selenite	936–995			
LOWER MEMBER: Green, granular, arenaceous limestone and calcareous sandstone; reddish sandstone and coarse gritstone; mostly carrying veins of gypsum and selenite	995–1,027			
Greatly weathered, syenitic gneiss, granite gneiss, etc	1,027–1,057	33	.....	Pre-Cambrian
Weathered pink granite gneiss	1,057–1,060			

Pleistocene

The uppermost Pleistocene formation is the marine (Champlainian) clay, which underlies the muskeg. It is a grey, plastic, sometimes silty clay, with, in places, lenses of sand and fine gravel. Few shells were found in the drilling, but in the shaft sunk to the lignite they were quite abundant. At drill-hole A the

thickness of the marine clay was 16 feet, but in the lignite field in general it ranges from 5 to 35 feet. Since it represents the post-glacial Champlainian marine invasion, the land must have risen 180 feet since its deposition.

Underlying the marine clays and forming an erosional contact with the underlying Mattagami formation of Cretaceous age, is the glacial series. In its typical development the series consists of two till-sheets divided by an interglacial series of sands, gravels, and stratified clays. The upper till-sheet is in general lighter-coloured and sandier than the lower. This is due to the fact that during the first advance, the ice-sheet overrode and digested the lignite and dark refractory clays of the Mattagami formation; whereas during the second advance of the ice, the lower till-sheet or interglacial series was cut into. The upper till-sheet, therefore, consists chiefly of reworked interglacial or glacial sands and clays, but the lower has a large admixture of reworked lignite and refractory clay.



Crossing on the Onakawana river southeast of shaft W.
The trees are chiefly poplar.

Glacially striated and soled pebbles and cobbles are abundant throughout both till-sheets, but large boulders are comparatively rare.

The glacial series varies greatly throughout the Moose River basin, both in thickness and character. At drill-hole A it apparently consists entirely of boulder clay, no interglacial beds being distinguishable. At shaft W, the section through the glacial series was as follows:—

	Feet
Grey sandy till	12–33
Grey interglacial silty clay	33–59
Dark-grey to black boulder clay	59–73½

Large boulders were rare except from 63 to 66 feet, where a bed of boulders 2 to 3 feet in diameter was found. In the northwestern part of the lignite field the interglacial series is thick (up to 50 feet) and consists chiefly of sand and fine gravel.

At the gravel pit on the Moose river, opposite Portage island, the interglacial series is strongly developed and consists almost entirely of gravel and sand with

a thickness between 40 and 50 feet. The lower till-sheet, which is below water level, is 15 to 20 feet thick, and the upper one in some places is not more than 10 feet thick. Cross-bedding in the gravel indicates deposition by strong currents, which moved in the opposite direction from the present Moose river. Scoured and water-worn lumps of lignite and refractory clay have been found in the gravel.

On the Mattagami river west of the lignite field the glacial deposits are very thick, in one drill-hole reaching 280 feet. They consist of three till-sheets with two series of sands and clays (possibly interglacial) between them.



T. and N.O. Railway gravel pit on the east bank of the Moose river opposite the lower end of Portage island. The bank rises 58 feet above water level of the river, which is 100 feet above sea level at this point. The top 15 feet is overburden of marine and glacial clays. The steam-shovel face of gravel is about 40 feet, and boring indicated an additional 20 feet of gravel below the bottom of the pit. The grade of material varies from sand at the south end to coarse gravel at the north, which consisted largely of rounded limestone fragments. The quantity of the gravel diminished and quality deteriorated as excavation into the bank proceeded.

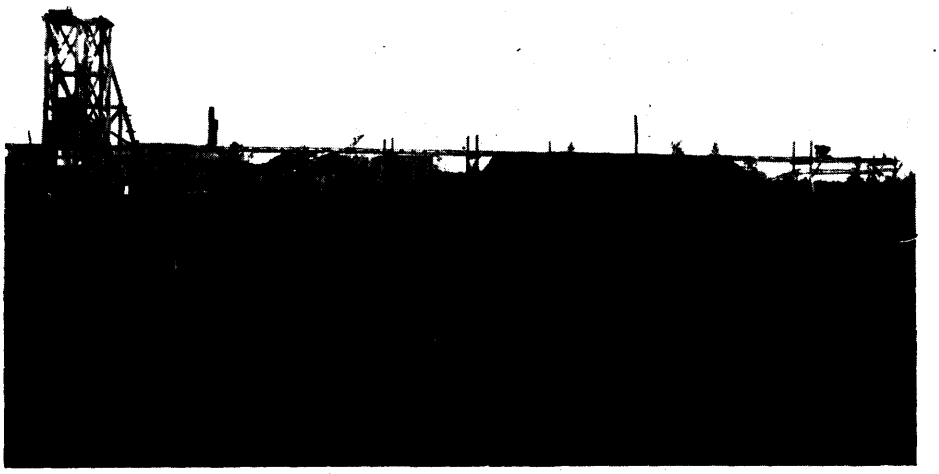
A. P. Coleman, who visited the Moose River basin in the summer of 1930, has some interesting statements to make regarding the Pleistocene formations. The following report is from a personal communication to the writer:—

Going north from Cochrane, morainic country with some kames and varve clay is observed from the train. At the escarpment near Abitibi canyon, pale yellow silt, to the thickness of 150 feet in places, is covered by a few feet of boulder clay on the level of the plain at 710 feet above the sea. At the foot of the canyon the silt is seen resting on a lower boulder clay, sometimes 25 feet thick and very stony, so that it must be interglacial. No fossils were found in the silt and no evidence as to its source. It does not resemble other interglacial beds in Ontario. The silt stands up in very steep slopes when channelled by rain erosion, but it becomes plastic when wet and makes a treacherous foundation for heavy structures.

Along the lower course of the Abitibi, deposits of a very different kind occur: first sand, and then gravel, the latter being post-glacial and containing marine shells, mostly *Saxicava* and *Macoma*. The highest point at which such shells were collected was at the railway gravel pit near Sextant rapids, 430 feet above the sea.

Below this a variety of deposits occur. Near the Onakawana camp a cliff shows 12 feet of silt over 9 feet of marine clay with shells, resting on a sandy boulder clay; while across the river, well-stratified peaty clay is found. Farther down, at the junction of Little Cedar creek with the Abitibi, a cliff shows about 25 feet of the same peaty clay between two boulder clays. This interglacial clay extends for half a mile on the west bank of the river also. Peat collected from it, when washed to remove clay and examined with a lens, was proved to contain mosses, spruce needles, and fragments of other leaves. It resembles peat from the well-known interglacial beds of Scarborough.

Near the bridge over Mattagami river, two boulder clays were seen at a number of points, sometimes separated only by a boulder pavement, at others by sandy beds from which springs ooze out. Above the upper till, marine clay with shells occurs in many places, and sometimes upon it sand or gravel with freshwater shells, such as *Unio* and *Succinea*. Over all, in some places, boulders were scattered, suggesting a third boulder clay, largely removed by later erosion. This is well seen near Maher's camp below the bridge; and in compact clay at the camp, probably interglacial, four species of marine shells were collected. None of the sections referred to above displayed unmistakeable evidence that the marine beds are interglacial, but on the shore of the river at Moose Factory conclusive proof was found. Lead-coloured, well-stratified clay with marine shells rises about 4 feet above the river at low-water stages of the tide. The top of this



Headframe at shaft W, with lignite dump on the right (summer, 1931).

clay has been squeezed and crumpled, and angular pebbles have been pressed into it by the passage of an ice-sheet over it, so that it must be interglacial.

Attention may here be directed to the finding of marine shells beneath the boulder clay many years ago by Dr. Parks on a tributary, Kwataboahegan river, and also to a statement to the same effect by Dr. Bell at a still earlier time.

Some of the drill-holes sunk in examining the lignite deposits at Onakawana show two or three sheets of till separated by stratified sand or clay or gravel; but so far as I am aware, no fossils have been found to prove the interglacial character of the stratified beds.

Three types of interglacial materials were collected in my brief visit to Moose river, a silty variety at the edge of the escarpment, peaty clay from the lower Abitibi river, and marine clay with shells, as just mentioned; but they have not been found in the same section at any of the localities, and their relation to one another is very uncertain. The silt, which is found much higher than the others, is probably the latest, and there is reason to believe that the peaty clay, corresponding to the Scarborough clay, is the oldest, the marine interglacial time coming midway. In southern Ontario, on the St. Lawrence and Ottawa rivers, marine interglacial beds occur beneath glacial deposits and probably belong to the Sangamon interglacial stage; while the Toronto interglacial formation, beneath two sheets of till, is of Yarmouth age. The two fossiliferous interglacial deposits of the Moose River region probably correspond to those just mentioned; but the silt of the Abitibi canyon seems to be later and does not match with any known interglacial stage in southern Ontario.

Cretaceous-Mattagami Formation

The Two Lignite Seams with Clay Partings.—In the last progress report the geological sections show two seams of lignite with a thin clay parting between them. At that date no underground work had been done at shaft W and the continuity of the clay parting had not been proved, so that it was doubtful whether to regard the lignite as one thick seam with discontinuous clay lenses or as two seams divided by a thin parting. The underground work at shaft W has proved that the lignite is in two main seams. Not only is the clay parting

fairly regular and continuous, but the physical properties of the two seams are different.

This division into two seams with a clay parting is also clearly shown in drill-hole A and in several of the holes around it. That this division cannot be traced throughout the field may be accounted for in many ways. In the first place, glacial erosion has carried away the upper seam altogether from many parts of the field, particularly from around the margins. Then, in some places, the upper seam appears to lie directly on the lower without an intervening parting. Again, in some parts of the field, especially the extreme western part, the lignite is found in several thin seams, and correlation with the two main seams is difficult if not altogether impossible. Finally, at a few drill-holes it was impossible to log accurately the measures penetrated.

The lower seam maintains a fairly uniform thickness, between 14 and 22 feet, throughout the eastern and middle parts of the field; in the southwestern part of the field, it is somewhat thicker, between 25 and 30 feet. The upper seam, having been affected to a greater degree than the lower by glacial erosion and disturbance, shows much greater variation in thickness. Its original thickness appears to have been about 25 or 30 feet, but in many places part or all of it has been eroded; in other places, such as in the area south of shaft W and at drill-holes Nos. 36, 58, 59, and 83, it is much thicker, from 40 to 43 feet.

As already noted, the middle parting is variable, ranging from a few inches to 50 feet in thickness. In the latter case, the zone is made up of clay, sand, and thin lignite seams. Very often a considerable thickness of white quartz sand makes up a portion of the parting. It was noticeable that this parting never contained impure sands, and practically all samples of clay collected from it were highly refractory. There was a tendency for the parting to increase in thickness, i.e. for the lignite seams to diverge, toward the west, and also for increasing amounts of sand to appear in this direction. In the extreme westerly drill-holes in the lignite field (No. 93, etc.) the lower seam is present, but the upper one has either diverged widely from the lower and has been eroded or has changed laterally into thin-bedded clays, sands, and lignite. It is possible that this thick parting of sand and clay may be found to be correlatable with the white sands and light-coloured sedimentary kaolin found on certain parts of the Mattagami and Missinaibi rivers. At certain holes varying thicknesses of refractory clay have been found above the upper lignite seam. The greatest thickness found was 42 feet, at drill-hole A. A considerable thickness of Cretaceous measures must have been carried away in the long erosion period between the Cretaceous and Pleistocene periods, or by the ice-sheets.

Clay Underlying the Lignite and the Contact with the Devonian.—Underlying the lower lignite seam there is always dark-grey or black clay, usually 5 to 10 feet in thickness, but sometimes as much as 20 feet. This is followed downward by pale-grey or cream clays.

The contact of the Mattagami formation with the underlying Long Rapids shales of Devonian age is peculiar. It was expected that this contact would have been clearly marked, since the two formations are very far apart in age. Owing to the fact, however, that there was probably little movement between Devonian and Cretaceous time in the Onakawana lignite field, and that the sediments of the lower part at least of the Mattagami formation were derived from the Long Rapids shale, the lower part of the Mattagami and the upper part of the Long Rapids are quite similar lithologically, and the contact between them can only be determined by close examination. The lower part of the Mattagami consists of pale-grey and cream clays, whereas the upper part of the Long Rapids

formation is made up of pale greenish-grey clay with thin bands of grey shale. The two formations can be distinguished by the slightly different colour of the clays, by the inclusion in the Devonian clays of thin bands of dark shale, and by the fact that the Devonian clays are somewhat more calcareous. The contact, however, is not obvious in drilling and has been missed in the holes that were not cored.

Origin of the Lignite and Refractory Clay.—In a recently discovered deposit it is very often difficult to determine definitely the origin of the coal until a great deal of work has been done. Extensive open pits or tunnels and shafts must be made in order to obtain a clear picture of the under clay and of the attitude of the vegetation, i.e. whether there are or are not vertical trunks and roots. Extensive drilling must also be done to determine whether the seams are uniform in thickness or extensive. In the case of the Onakawana deposits many of the criteria are undetermined or indecisive, but it may be stated that the weight of evidence so far obtained favours an autochthonous origin for most of the lignite. In the first place the great thickness of the seams is against a drift origin. Seams totalling 40 to 50 feet in thickness represent uncompressed vegetable material probably of as much as 8 times this thickness, or 300 or 400 feet. It is difficult to understand how this great mass of vegetation could have accumulated in a lake, or in a delta, especially as everything points to a low, flat topography in Cretaceous time. The comparatively low ash content of the lignite and the comparative freedom from laterally extending lenses of clay and sand within the two main seams also favours an *in situ* origin. Some thin lenses or strata of clay and mixed clay and lignite are present, however, which no doubt resulted from intermittent floodings of the swamp, and it is not improbable that the lignite in the main seams was augmented by in-drifting vegetation. The upper seam has more clay inclusions than the lower and may be partly of "drift" origin.

The lignite consists of three types of material: the woody, principally lignitized trunks and roots of trees; earthy, which, as its name implies, consists of material that crumbles in the hand; and peaty, an intermediate material consisting of numerous small stems of woody lignite in a matrix of compressed earthy material with a large content of fusain, or mineral charcoal. The peaty material resembles the surface muskeg in structure and was probably formed in a swamp of "low bog" type; the woody on the other hand probably represents the drier forest, or "high bog" type of swamp. Both of these materials, particularly the woody, were probably deposited during stages when the land was sinking fairly rapidly, allowing little time for the decay of vegetation; the Germans call this the *kurzfristige Senkung*[1] stage. The earthy material was probably deposited when the land was sinking slowly, allowing the vegetation to become decayed beyond recognition, conditions which the Germans call *langfristige Senkung.*[2]

Owing to the erratic erosion of the lignite by the ice-sheets and to the fact that it may have been disturbed in places by ice, the seams cannot be followed intact very far and criteria relying upon the extent and the uniformity of the seam are not decisive. The lower seam, which has been less disturbed, appears to maintain a fairly uniform thickness for four miles. The upper seam has been more extensively eroded and disturbed, and its original condition is impossible to determine.

The attitude of the tree trunks adds very little to a solution of the problem. It is true that no vertical tree trunks or roots have so far been found. The tree

[1]K. Pietzsch, Die Braunkohlen Deutschlands, Gebruder Borntraeger, Berlin, 1925, p. 80 *et seq.*
[2]Ibid.

trunks are all flat-lying but are apparently not oriented as might be expected if they had been laid down in a lake or river in which currents were active. Roots of trees are sometimes found in the lower seam, but are also for the most part in a horizontal position. The clay underlying the lignite is a black plastic clay, often containing irregular fragments of lignitized wood. It certainly does not look like an old soil, and it makes sharp contacts with the lignite. This is evidence more in favour of a "drift" than an *in situ* deposit, but it should be noted that the under clay has been seen over an extremely small area.

The fossil plants that have been found in the lignite are well preserved, even to the delicate ends of the leaflets; they either became embedded where they grew or were transported very short distances.

Fusain, or mineral charcoal, is abundant throughout both seams, particularly in the peaty type of lignite; but the presence of fusain is not evidence of either origin, since the origin of fusain itself has not been proved. Some geologists believe that it represents fragments of charcoal from actual forest fires; others believe it to be material preserved *in situ* but in a different manner from the remainder of the vegetation in the swamp.

The great seams of brown coal of Germany are considered to be autochthonous in origin. In a personal communication, J. Klitzing states that "the lower Onakawana seam can definitely be said to be autochthonous as is shown by the structure and appearance of the samples submitted to me." He regards the high content of fusain as a special proof of this origin. He believes the fusain was caused by forest fires and that it is impossible to conceive that this fibrous and friable material was moved by water and then deposited to form a sediment of the present structure. Mr. Klitzing was non-committal about the origin of the upper seam. The samples he received contained no lumps but only fine material, and he thinks it possible that originally there was only one seam and that the upper seam drifted to the present position, i.e. that the whole body of this upper seam was pushed over the lower seam by glacial action; a conception with which the writers are inclined to disagree.

In the Moose River basin there are two occurrences of lignite that are evidently secondary or allochthonous. The first is at Big rapids on the Missinaibi river, and the second on the Opazatika near Chausse creek. In both cases the lignite consists of rounded water-worn fragments of lignite in a matrix of sand and presents a strongly contrasting appearance to the Onakawana lignite. This drift lignite is probably interglacial in age.

As previously noted, *in situ* coal deposits are more likely to be extensive than drift deposits; and if the Onakawana seams can be shown to be of the former type, they, too, are more likely to be widespread or to have been widespread before glacial erosion took place.

The dark refractory clay has evidently been derived from the Upper Devonian shales and laid down as muds in lakes and lagoons, and the fluxes have been leached out by organic or carbonic acids derived from the vegetation. The white sands and mottled, bright-coloured clays of the western part of the Cretaceous basin (Missinaibi river, etc.) may have had a somewhat different origin. In their case it is possible that a residual deposit of kaolinized rock, or even of clean kaolin and sand, had accumulated on the pre-Cambrian highland to the south in the long period existing between the pre-Cambrian and the Cretaceous. Then in Cretaceous time the highland was re-elevated and rivers began to flow which cut into the kaolin and carried it down to be deposited in lakes at the foot of the highland. This origin is very similar to that of the secondary kaolin of Georgia, which these white sands and mottled clays resemble.[1]

[1]R. W. Smith, Sedimentary Kaolins of the Coastal Plain of Georgia, Geol. Surv. Georgia, Bull. No. 44, 1929.

Paleontology and Correlation.—The Mattagami formation was discovered and first studied on the Mattagami river between Long rapids and Grand rapids. Keele, McLearn, and Dyer all found plant remains in the lignite and associated clays and ironstone concretions, which upon identification left no doubt as to the age of the formation. The following species have been identified by W. A. Bell, of the Geological Survey, from the Mattagami formation of the Mattagami river:—

Nilsonia cf. *densinerve* (Fontaine).
Brachyphyllum mclearni, Bell.
Pityophyllum graminaefolium (Knowlton).
Cladophlebis cf. *albertsi* (Dunker).
Cladophlebis virginiensis, Fontaine.
Onychiopsis(?) sp.
Sphenopteris sp.
Geinitzia reichenbachi (Geinitz).
Elatocladus (*Sequoia*?) *smittiana*, Heer.

Bell contributes the following notes:—

The age of the deposit, as inferred from this assemblage, is considered to be either Upper Jurassic or Lower Cretaceous, with preference towards the latter on account of the presence of the species *Pityophyllum graminaefolium*, which is abundant and widespread in the Kootenay.

One species, *Pityophyllum graminaefolium*, of the above list has been found in the Onakawana lignite field at two localities: The first is in the lignite seam at the exposure farthest downstream on the west side of the Abitibi river; the second locality is in sands at a depth of 83 feet, immediately above the upper lignite seam in shaft W. Another species, *Brachyphyllum mclearni*, was found in the summer of 1931 in siderite concretions in the clay on the north side of Moose river opposite Portage island. The sediments are also so similar in both areas that there is little doubt that we are dealing with the same formation.

No fossils have been found as yet in the light-grey, mottled clays and white quartz sands of the Mattagami and Missinaibi rivers; hence their age has not been proved. Since they are closely associated geographically with the black clays and lignite and their geological history is similar, it has always been assumed that they are of the same age. They may, however, be a little older or younger than the Kootenay.

STRUCTURAL GEOLOGY

The Cretaceous measures of the Onakawana lignite field occur in a well-defined structural basin developed in the Devonian rocks. At drill-hole A, the top of the Abitibi River formation is 649 feet below sea level; whereas, 17 miles to the north at Murray island on the Moose river the same horizon outcrops at an approximate elevation of 90 feet above sea level, and 18 miles to the south, at Long rapids on the Abitibi, this horizon outcrops approximately 180 feet above sea level. Toward the margin of the basin the inward dip of the outcropping formation is obvious; thus along the Moose river from the gypsum deposits near Murray island southwestward to Portage island, the southwestern dip of the rocks causes successively younger formations to outcrop in order: the Moose River, the Abitibi River, the Williams Island, and the Cretaceous. The same thing is seen on the Abitibi from Long rapids northward, where the Abitibi River formation is succeeded by the Williams Island, then by the lower, middle, and upper members of the Long rapids, and finally by the Cretaceous.

The Cretaceous beds on the Mattagami river at Great bend and the foot of Long rapids have been shown in previous publications to lie within the structural

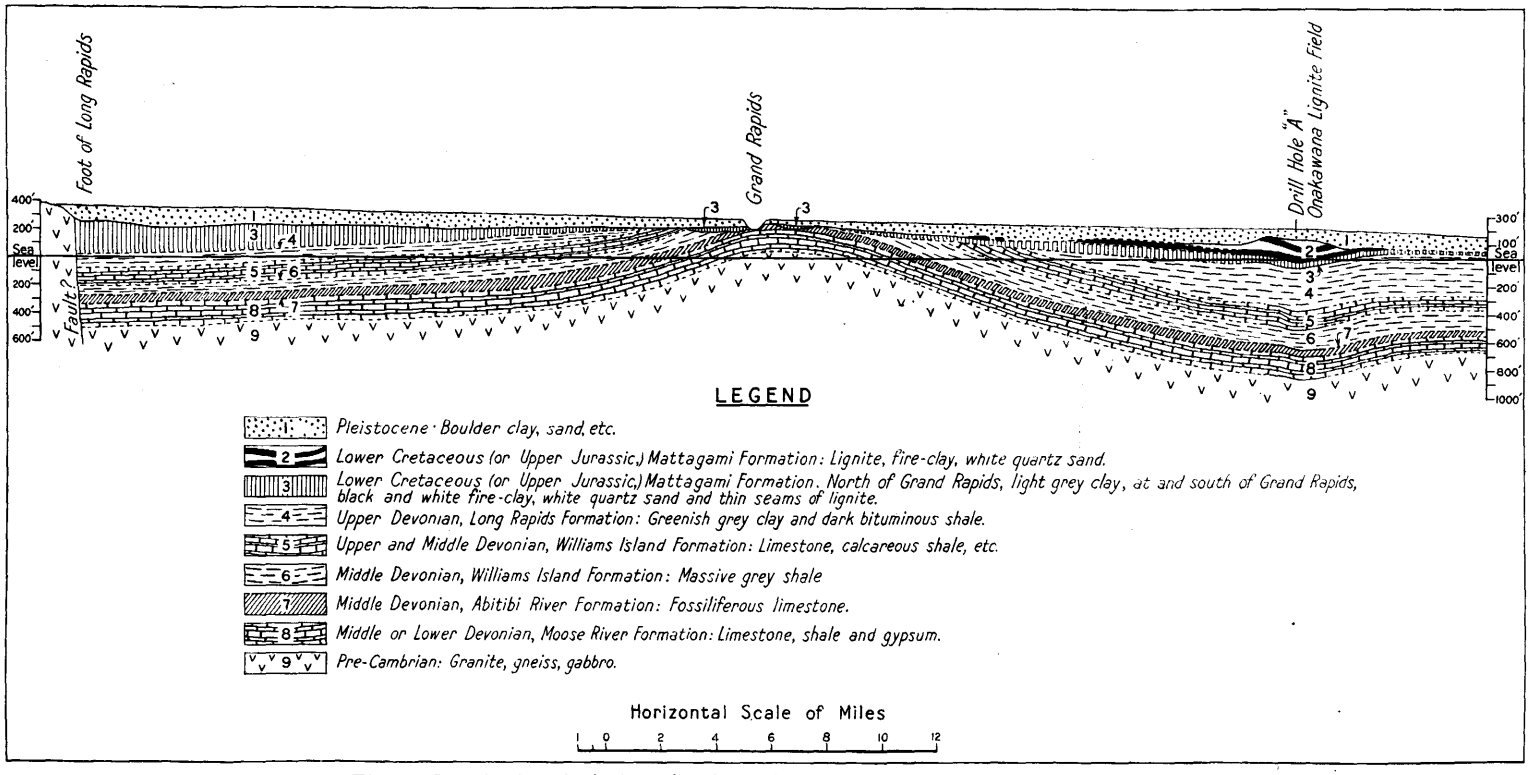


Fig. 2—Idealized geological section from the foot of Long rapids on the Mattagami river to drill-hole A, Onakawana lignite field.

basin that extends from Grand rapids to the foot of Long rapids. This basin probably extends to the Missinaibi river; it is probable also that these structural basins are parts of one large basin, the boundaries of which are quite unknown except at a few isolated localities. Around the margin of the basin a few broad anticlines or folds are known, such as at Long rapids on the Abitibi river, at Grand rapids of the Mattagami river, and at the gypsum deposits on the Moose.

There is very little evidence of faulting in the rocks of the region. The upper lignite seam has apparently undergone some thrust-faulting at low angles, brought about by tangential pressure by the continental ice-sheets, as will be described later in this report. There is also some evidence of a post-Cretaceous fault of considerable displacement at the foot of Long rapids in the Mattagami.

The structure within the Cretaceous in the lignite field is well shown in the structure contour map based on the bottom of the lower lignite seam (Fig. 3). This map shows westward dips of 50 to 75 feet per mile in the eastern part of the field, southwest dips in the northern part of the field, and north or northwest dips in the southern part of the field. Minor irregularities are evident.

The age of formation of the broad structural basin at Onakawana has an important bearing on the geological history of the lignite field and the Moose River basin in general. In previous publications the evidence for post-Cretaceous crustal movement has been presented. In brief, it is that the structure of the Cretaceous beds in the lignite field resembles the eastern part of a basin and appears to conform to the basin structure developed in the underlying Devonian rocks. The interval between the lower lignite seam and a horizon marker in the underlying Long Rapids shales (contact between the upper and middle members) is approximately the same in all the drill-holes drilled to this horizon; this suggests conformity. The lower lignite seam also appears to maintain a uniform thickness over any undulations that occur, even up to the highest elevations at which it has been found in the field, thus suggesting that it was originally laid down on a flat surface and afterwards folded. The supposed fault at the foot of Long rapids of the Mattagami river, if really a fault, is also evidence of post-Cretaceous movement.

That some of this movement took place during the deposition of the lignite, or rather between the time of deposition of the two seams, is indicated by the divergence of the seams toward the west in the Onakawana lignite field.

It has been suspected that folding occurred in pre-Cretaceous time, but it was not until the siderite deposits at Grand rapids were closely studied in the summer of 1931 that definite evidence of this was obtained. The siderite was found to occur as concretionary masses in Cretaceous beds of refractory clay, lignite, and white quartz sands. The Cretaceous beds (evidently Mattagami formation) lie on an old reworked land surface developed in Middle Devonian limestone. Since they lie on Upper Devonian shales in the lignite field, overlapping on different Devonian formations is evident and pre-Cretaceous crustal movement is proved. From evidence on hand, indications are that the pre-Cretaceous movement was greater than post-Cretaceous movement. There is a suggestion also that certain areas, such as the Onakawana lignite field, were not so affected, and that in these areas the land sank periodically, i.e. after the deposition of the Devonian, probably during the Cretaceous, and also after the Cretaceous.

SUMMARY OF GEOLOGICAL HISTORY

The sequence of geological events in the Moose River basin judging from facts obtained to date appears to be as follows: In the first place, the pre-Cambrian formed a land surface, which in Devonian time sank below sea level allowing an

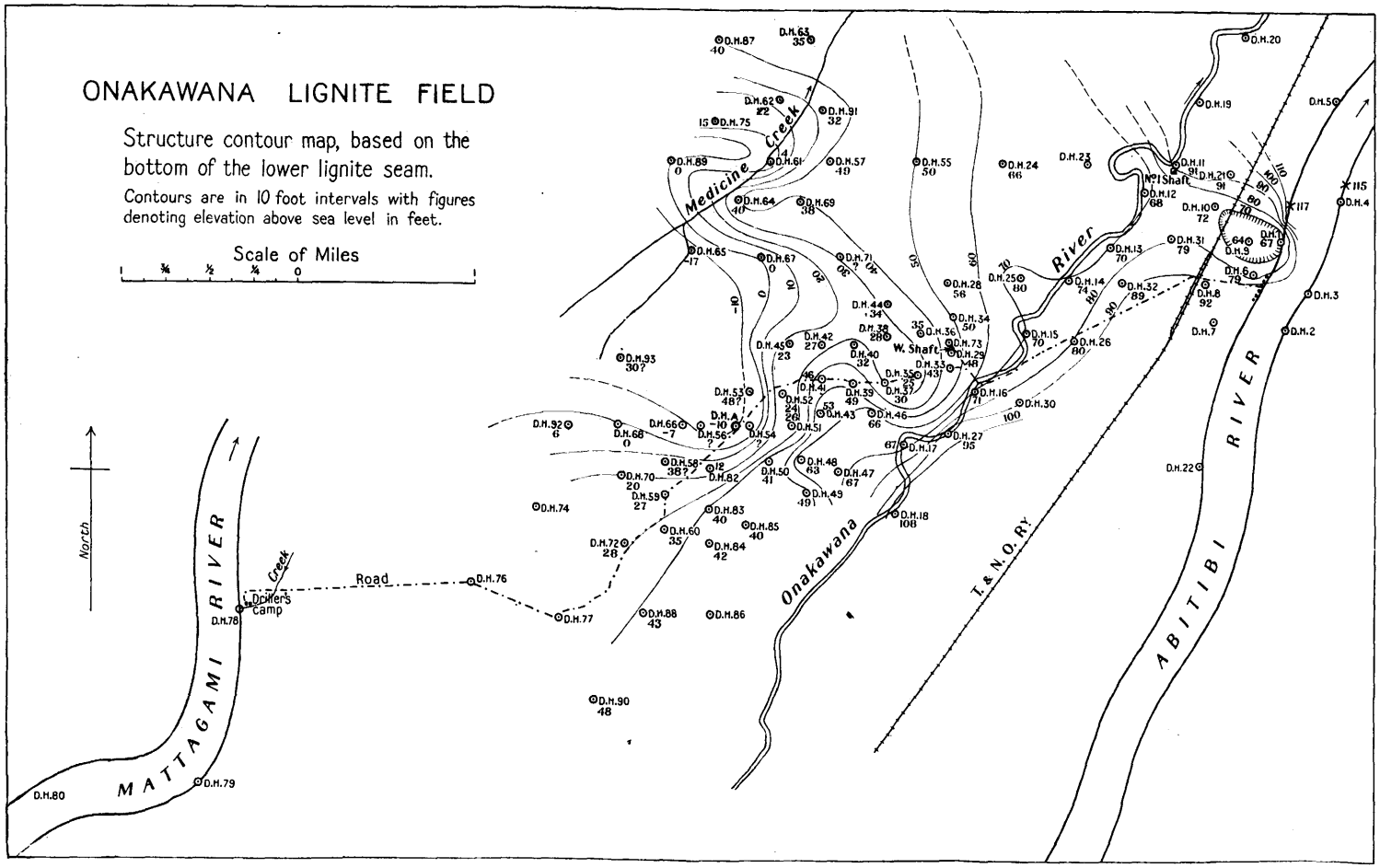

ONAKAWANA LIGNITE FIELD
Structure contour map, based on the bottom of the lower lignite seam.
Contours are in 10 foot intervals with figures denoting elevation above sea level in feet.
Scale of Miles
¾ ½ ¼ 0
North
Medicine Creek
River
No. 1 Shaft
W. Shaft
Onakawana
T. & N. O. Ry.
ABITIBI RIVER
MATTAGAMI RIVER
Creek
Drillers Camp
Road
D.H.80
D.H.79
D.H.78
D.H.77
D.H.76
D.H.90
D.H.88
D.H.86
D.H.74
D.H.22
D.H.3
D.H.2
D.H.4
D.H.5
D.H.20
D.H.19
D.H.23
D.H.24
D.H.25
D.H.30
D.H.18
D.H.93
D.H.87
D.H.63
D.H.62
D.H.91
D.H.75
D.H.89
D.H.61
D.H.57
D.H.55
D.H.64
D.H.69
D.H.65
D.H.67
D.H.71
D.H.28
D.H.44
D.H.34
D.H.36
D.H.38
D.H.73
D.H.29
D.H.33
D.H.35
D.H.37
D.H.39
D.H.41
D.H.43
D.H.45
D.H.42
D.H.40
D.H.52
D.H.51
D.H.46
D.H.53
D.H.A
D.H.66
D.H.68
D.H.56
D.H.54
D.H.58
D.H.82
D.H.70
D.H.59
D.H.50
D.H.48
D.H.47
D.H.49
D.H.83
D.H.60
D.H.85
D.H.72
D.H.84
D.H.27
D.H.17
D.H.16
D.H.15
D.H.26
D.H.14
D.H.32
D.H.13
D.H.31
D.H.12
D.H.11
D.H.21
D.H.10
D.H.9
D.H.8
D.H.7
D.H.6
D.H.1
D.H.92
D.H.68
D.H.74
D.H.72
D.H.90
D.H.88
D.H.86
D.H.76
D.H.77
D.H.78
D.H.79
D.H.80
115
117

FIG. 3

influx of the sea from the north. Most of the major periods of the Devonian are represented by a maximum thickness of sediments of 1,058 feet.[1] After Devonian time the sea receded, and the sediments were gently folded and finally eroded, probably to a flat or nearly flat peneplain. It was not until Lower Cretaceous time that the land sank low enough to receive a fresh load of sediment, and not even then did it sink low enough to allow an invasion of the sea, since the Cretaceous sediments are considered to be freshwater or certainly not more than brackish. What probably occurred was that in Lower Cretaceous time the peneplained Devonian sediments were covered by swamps and shallow lakes or lagoons in which lignite and refractory clay were formed. This swamp and lagoon terrain may have been widespread over the James Bay lowland and may even have reached Manitoba. This is suggested by the recent discovery by Professor S. R. Kirk, of the University of Manitoba, of Lower Cretaceous sediments in an erosion pocket in Ordovician limestone at Sylvan, Manitoba. In a letter to the writers, W. A. Bell, of the Geological Survey of Canada, says that a plant fragment of the species *Pityophyllum graminaefolium* was found in carbonaceous sandy sediments of the same lithological character as sediments in which the same species was found in the Mattagami formation at Onakawana. Dr. Bell thinks the Sylvan occurrence is Mattagami in age.

It is possible that depressions existed in the old Devonian surface in which the deposition of refractory clay and lignite may have been to some extent localized, but such depressions would have been shallow and transient.

After Lower Cretaceous time and possibly to some extent during this time, the sediments were again folded. This movement was not so great as the pre-Cretaceous movement but was more important economically, because the folding caused depressions in which that part of the Cretaceous sediments that is still preserved to us escaped subsequent erosion.

At some period after the Lower Cretaceous the land rose again and subsequently an era of erosion set in, which culminated in the irregular and severe erosion of the continental ice-sheet. There was plenty of time after the deposition of the refractory clay and lignite for deep erosion, but evidently this was not so severe as supposed or else the Cretaceous measures must have been at the time considerably thicker than now.

After the retreat of the ice-sheets, the sea once again advanced over the land, smoothing it out to its present flat topography and depositing the marine (Champlainian) clay, the most recent geological formation in the region. The last event was a differential elevation of the land, which lifted the marine clay to an elevation of 180 feet above the sea at Onakawana.

Exploration of the Lignite Field by Drilling and Shaft-Sinking

Forty-six exploratory holes have been drilled since the last report was written, as well as 20 check-holes. The total number of holes in and near the Onakawana lignite field is now 116, with a footage of approximately 17,000 feet.

Subdivision of the Field Based on Results of Drilling

The lignite field is divided into 12 parts. These 12 parts or subdivisions are grouped into two classes. In class A the ratio of thickness of overburden to lignite is 4 to 1 or under, and in class B the ratio is higher than 4 to 1. Data on each of these subdivisions are given in the following table. In this table, the

[1]This figure is arrived at by adding together the maximum observed thickness of each formation, irrespective of locality.

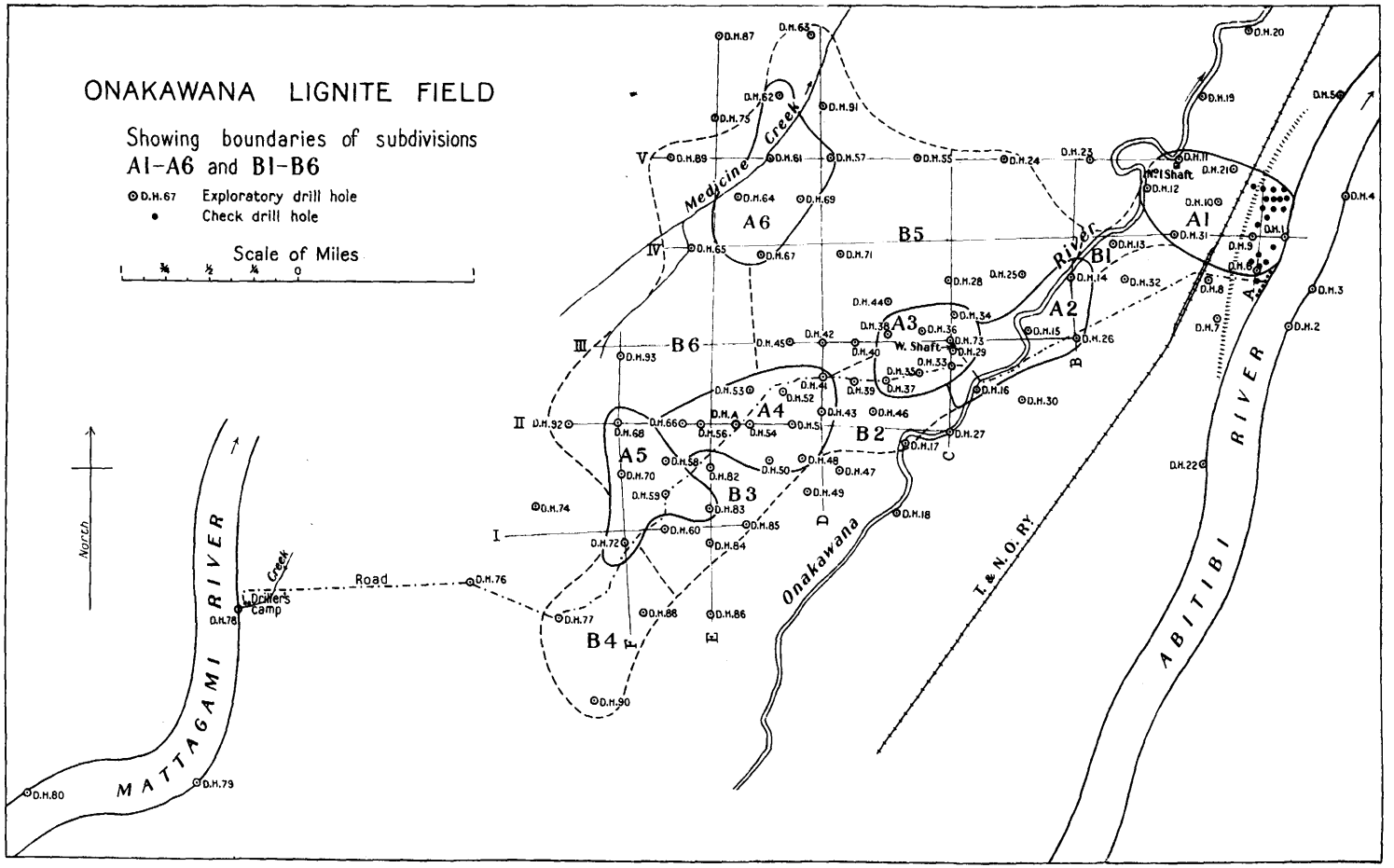


Fig. 4—Key plan showing position of section lines A to F (see Fig. 6) and I to V (see Fig. 7).

figures for average thickness of overburden and of lignite have been calculated directly from the logs. It is a question whether or not thickness of overburden should include clay partings, since much of the clay is refractory and might be regarded as a by-product. In the compilation of the table the overburden is regarded as the material on top of the first lignite seam of minable thickness. With regard to the lignite the boundary of the field has been drawn at the 10-foot limit for thickness, and within the boundary isolated seams under 5 feet in thickness are disregarded.

No tonnages are given. Estimates of tonnage have very little significance, since the drill-holes are merely exploratory.

TABULATED DATA OBTAINED FROM LOGS OF DRILL-HOLES

Subdivision	Acreage	No. of drill-holes	Range in thickness of overburden	Average thickness of overburden	Range in thickness of lignite	Average thickness of lignite	Ratio of overburden to lignite in round figures
			feet	feet	feet	feet	
A-1	300	25[1]	32–81	60	13–36	20	3 : 1
A-2	200	4	70–84	76	14–24	20	4 : 1
A-3	175	8[1]	74–102	84	29–64	48	2 : 1
A-4	300	9[2]	72–124	106	25–47	33	3 : 1
A-5	210	6	59–99	78	41–65	53	1½ : 1
A-6	265	6	79–119	98	22–53	31	3 : 1
B-1	50	1	.....	82	.....	13	6 : 1
B-2	150	3	.....	106	.....	13	8 : 1
B-3	200	4	.....	125	.....	20	6 : 1
B-4	200	3	.....	125	.....	20	6 : 1
B-5	1,300	9[2]	.....	115	.....	15	8 : 1
B-6	800	4	.....	150	.....	15	10 : 1

[1]One shaft.

[2]Two drill-holes in subdivision A-4 and one in subdivision B-5 are not included in the table because of indecisive results.

Notes on Subdivisions A-1 and A-3.—Although the lignite is not so thick in subdivision A-1 as in some of the others, the thickness of overburden is less. This is very important when considering stripping, especially in the initial stages, since the cost of stripping rises more than proportionately to the increase of overburden. The seam in this subdivision is the lower one, which at shaft W was found to be better than the upper, showing lower ash content and higher content of woody material. The upper seam has been largely if not altogether eroded.

One shaft (No. 1) was sunk in the subdivision, the location of which coincided with drill-hole No. 11. Results at this shaft have already been described.[1]

Twenty check-holes at about 300-foot centres have been drilled in the eastern end of this subdivision. They indicate that the seam is present and not seriously disturbed by the ice, but that erosion has been more or less erratic. The lignite was penetrated in every hole except two, and these were outside the boundary of the field. In the part of the subdivision lying between the Abitibi river and the 15-foot terrace that parallels the river, 1,200 feet to the west, the overburden ranges from 32 to 67 feet and averages 50 feet, and the lignite ranges from 13 feet to 36 feet and averages 20 feet.

[1]W. S. Dyer, The Onakawana Lignite Deposit, Moose River Basin, Ont. Dept. Mines, Vol. XXXIX, pt. 6, 1930, pp. 1-14.

Judging by the drilling, subdivision A-3 can perhaps be regarded as the best in the field from the standpoint of thickness and uniformity of the lignite seams, but the overburden is considerably thicker than in subdivision A-1, and the upper seam is largely earthy and poor in grade. The boundaries of the subdivision are drawn close to the drill-holes, but it is possible that more ground could be included in a stripping operation. The refractory clay parting between the two coal seams and the refractory clay bed above the upper seam at some of the drill-holes may

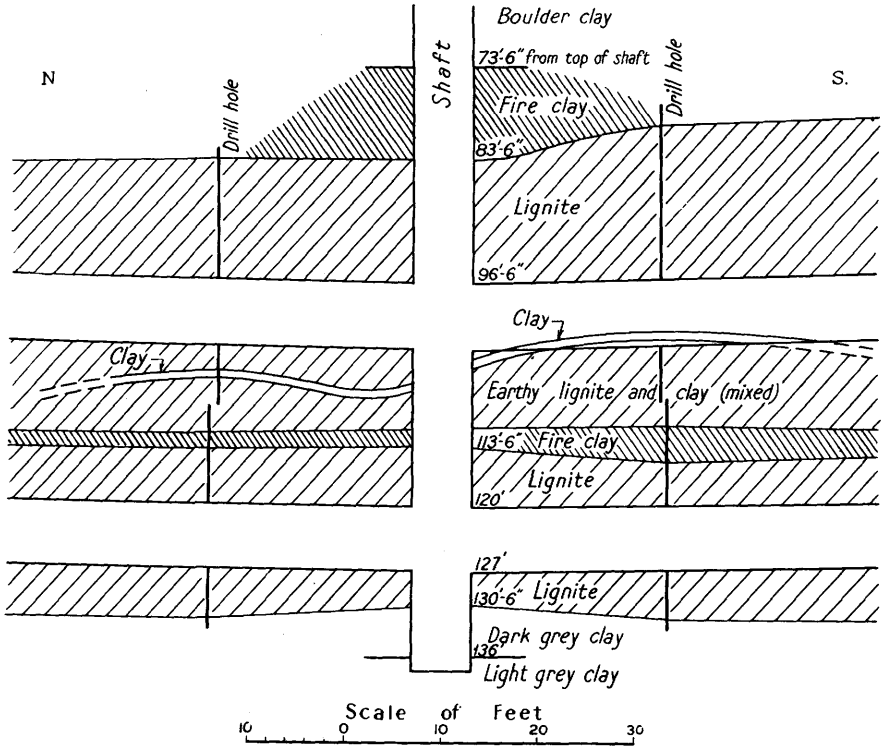


Fig. 5—Vertical section through shaft W.

have some value as a by-product. Shaft-sinking operations are discussed later in the report.

Cross-Sections.—Two sets of sections based on drilling results have been drawn, one set running north and south at about half-mile intervals, and the other east and west at about the same intervals. In these sections, dotted lines are drawn to show a possible correlation of the beds. This correlation, however, can only be regarded as tentative.

Shaft-Sinking Operations

Results at shaft No. 1 have been described in a previous publication. Shaft W was located near drill-hole No. 29 because the lignite was thicker there than elsewhere in the field. Measures passed through are shown in the following detailed log:—

Log of Shaft W	Depth from ft.	in.	to ft.	in.
Sphagnum moss, etc	0		1	
Muskeg	1		4	
Grey marine clay	4		6	9
Silt (marine)	6	9	6	11
Marine clay (silty) with a few shells	6	11	10	2
A layer of fossilized plants lying horizontally in a matrix of sand	10	2	10	5
Grey marine sand containing roots and branches of trees and a few shells	10	5	11	10
Marine sand and gravel containing many shells and some fossilized plant remains; forms a well-defined undulating contact with the underlying boulder clay	11	10	12	1
Hard brown boulder clay; few large boulders, largest noticed being 1½ feet in diameter	12	1	21	
Hard sandy boulder clay	21		23	2
Sandy boulder clay or till showing some tendency to cave; largest boulder noticed 3 feet in diameter	23	2	27	6
Very sandy till; no large boulders; water comes into shaft much stronger at this depth causing the till to run	27	6	31	6
Interglacial series: At the top is an irregular bed of water-bearing sand with fossilized wood fragments, varying in thickness up to 4 feet within the shaft; below the sand is a sandy clay of pronounced grey colour; stratification is visible above a depth of 49 feet and is caused by alternating layers of clay and thin lenslike layers of fine white sand; below 49 feet there is a tendency to massiveness with a few small lenses of fine white sand; the clay is easy to pick and is not sticky, but shows a tendency to slough when wet	31	6	59	
Grey, rather plastic boulder clay showing a sharp undulating contact with overlying interglacial clay	59		61	
Grey hard sandy boulder clay that had to be picked; many boulders up to 6 inches in diameter and one or two larger ones	61		64	6
Black boulder clay with small lenses of black fire clay and many fragments of lignite; the contact with the overlying boulder clay is sharp and well defined, but undulating and with a north dip of 20°; this clay stood up well, was hard, and had to be picked; from 63 feet 6; inches a nest of igneous boulders (1 to 3 feet in diameter) occurred mucking was very slow and difficult	64	6	66	
Very hard dark-grey boulder clay in which many boulders were found; this clay was very cement-like, and only with jack-hammer and powder could progress be made; a pick would penetrate less than an inch at a stroke; the clay does not adhere to shovels and shows little tendency to slough	66		70	7
Very black plastic boulder clay or reworked refractory clay; easy to handle with pick and shovel; showed a slight tendency to adhere to the shovel; but did not run or slough	70		71	7
Black plastic refractory clay; the contact with the overlying boulder clay very uneven and irregular, showing a dip of 1 inch in 10 inches to the southeast	71	7	72	7
Black plastic refractory clay with thin films of white silt; very easy to pick or shovel and does not run or slough to any extent	72	7	79	
Black lignitic refractory clay with more silty layers than overlying clay; the lower foot is quite sandy; easy to pick and shovel and does not slough or run; the lower foot contains Cretaceous fossil plants	79		83	4
Lignite, largely earthy and peaty but with some woody; stood up well; the contact with the overlying refractory clay is sharp and horizontal	83	4	103	6
Soft lignite and clay mixed; contact with overlying lignite and underlying refractory clay uneven and irregular; the top of this zone is at a depth of 103 feet 6 inches in the south wall of the shaft and 106 feet 6 inches in the north wall; these beds showed caving and sloughing	103	6	112	
Black refractory clay showing even horizontal contact with underlying lignite and irregular contact with overlying mixed zone	112		113	6
Lignite; mostly hard and woody; makes sharp, even, and horizontal contact with unedrlying clay	113	6	130	6
Dark-grey plastic clay	130	6	136	
Light-grey plastic clay	136		136	3

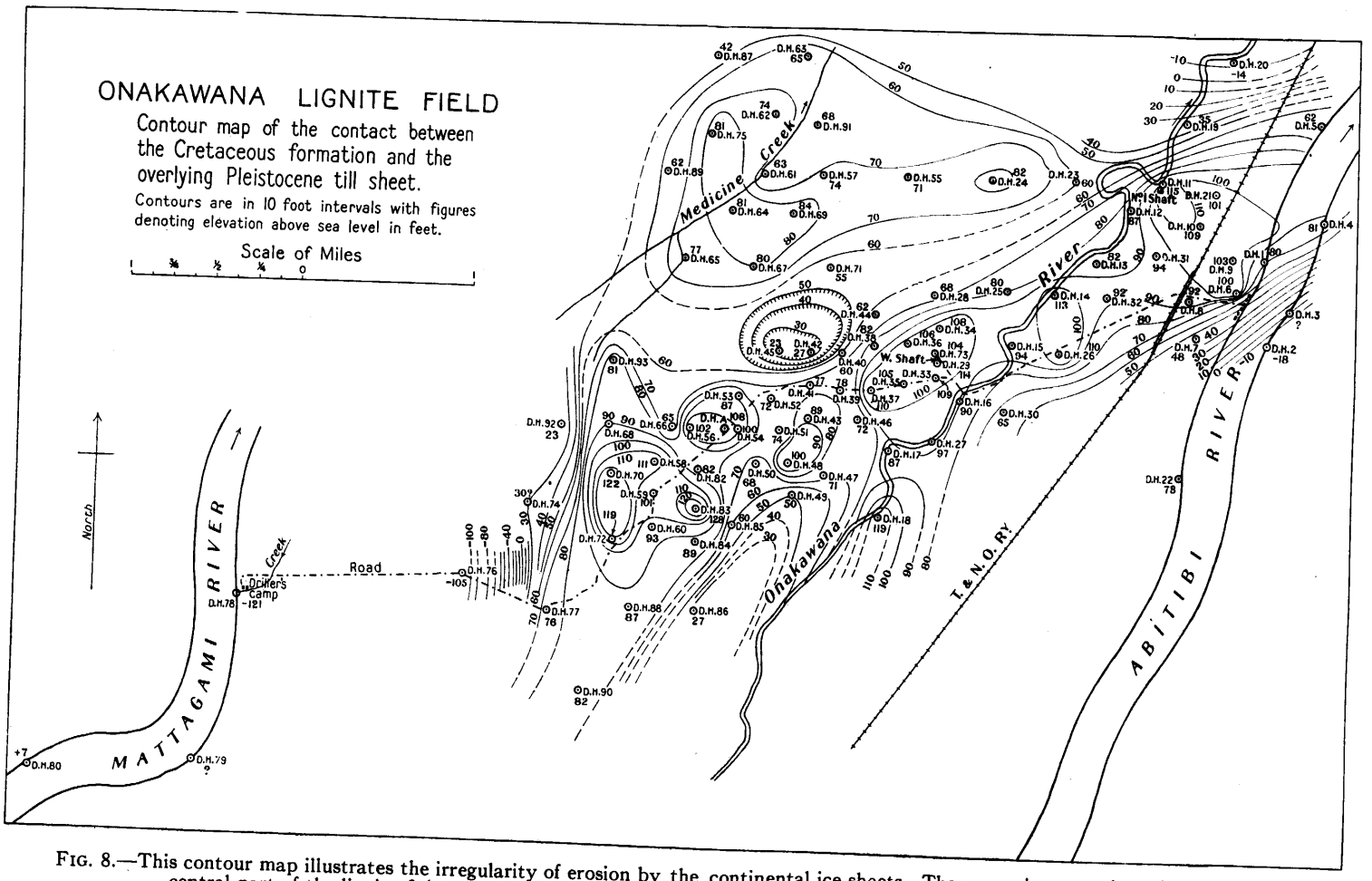


FIG. 8.—This contour map illustrates the irregularity of erosion by the continental ice-sheets. The approximate surface elevation of the central part of the lignite field is 180 feet above sea level, the till sheet varying from 30 to 300 feet in thickness.

The lignite and the refractory clay partings and irregularities in the seams are described in other sections.

Two tunnels were run, the lower approximately in the middle of the lower seam, and the upper in the middle of the upper seam. The plan and cross-section of the shaft and tunnels are shown diagrammatically in Fig. 5. The total lengths of the tunnels when drifting ceased was as follows:—

	Feet
Upper tunnel, north of shaft	325
Upper tunnel, south of shaft	254
Lower tunnel, north of shaft	389
Lower tunnel, south of shaft	308
Total	1,276

Before discontinuing mining operations, 10 tons of fire clay for testing were mined from the parting between the two seams and stored at the shaft. For the samples of lignite for the German tests, sumps were sunk below the bottom of the lower south and lower north tunnels, and a raise was put up at the end of the lower south tunnel for 35 feet above the roof of the tunnel. The section in the raise, in ascending order, measured from the roof of the tunnel, was as follows:—

	Feet
Refractory clay	0–2
Soft lignite with some clay	2–6
Carbonaceous clay	6–7
Lignite	7–19
Carbonaceous clay	19–20
Lignite with 3-inch diagonal band of clay	20–37
Lignite (by auger hole from top of raise)	37–41
Refractory clay (by auger hole)	41–43

Since there is 17 additional feet of lignite belonging to the lower seam (7 feet in the walls of the drift and 10 feet below the floor of the drift), the total amount of lignite at this locality is 54 feet.

Effects on Cretaceous Measures of the Passage over Them of the Continental Ice-Sheets

Erosion

One of the facts first learned about the lignite deposit at Onakawana was that erosion by the continental ice-sheets had been irregular. Further drilling has given additional proof of this. The variation in the thickness of the lignite is due in large measure to this erosion. Just how erratic the erosion was can be seen from the contour map based on the contact of the Cretaceous beds and the boulder clay (Fig. 8).

There is very little regularity to the erosion; just one feature worth mentioning stands out. A zone of moderately thick boulder clay (40 to 100 feet) extends from the lignite outcrops at Blacksmith rapids in a west-southwesterly direction for 4 miles to drill-holes Nos. 70 and 72, where it ends abruptly in the deep boulder-clay trough at drill hole No. 76. Along this zone of moderately thick boulder clay lie the best parts of the lignite field. The zone is bounded on the northwest and southeast by troughs of thicker boulder clay (100 to 175 feet), which also show a tendency to run in a northeast-southwest direction. North of the northwest trough at Medicine creek, there is an area of somewhat thinner boulder clay. Thus there is a suggestion of alternating zones of thick and less thick boulder clay, running northeast-southwest, but there is nothing

very regular about the zoning, as can be seen from the contour map. The zones may or may not be present in other parts of the Cretaceous basin.

At shaft W, a series of auger-holes was drilled into the roof of the upper tunnel. Refractory clay was found above the upper lignite seam at each hole, and the top of the seam was found to be nearly horizontal. This indicated that erosion in the vicinity of the shaft was not erratic. The drill-holes around the shaft tended to corroborate this observation. In these holes, depths to the top of the Cretaceous varied within very narrow limits. The check-drilling in the eastern end of subdivision A-1 indicated a somewhat greater lack of uniformity of erosion. Some instances of quite erratic erosion with increases in thickness of boulder clay up to 40 feet in a distance of 200 feet were observed. However, tunnelling in the lignite seam at shaft No. 1, which amounted to 125 feet, did not disclose any evidence of erratic erosion.

In summing up, it may be stated that, although erratic erosion is always a danger, necessitating close check-drilling before commencing any major operation, it has been indicated that there are areas where erosion is not particularly erratic and where stripping operations for lignite may be carried on successfully.

Is Severe Glacial Disturbance of the Type Known in Some of the German Brown-Coal Fields Present at Onakawana?

In some of the German brown-coal fields that were glaciated there are local instances of intense disturbance by ice. Such features as buckling and thrust-faulting, with attendant duplication of lignite seams, may be seen.[1] J. Klitzing, who made a short visit to the Onakawana lignite deposit in 1930, thought that such disturbance might be present at Onakawana and considered it likely that originally there was only one seam in the area and that where two or more seams are found, the cause is duplication of one seam by low-angle thrust-faulting. The following excerpts are taken from Mr. Klitzing's report:—

> It may be assumed as probable that the brown-coal seam that was deposited in the Cretaceous formation was originally a continuous seam of uniform thickness. The conditions of the ice age caused radical changes here and, at any rate in the area where the trial borings have so far been carried out, gave rise to powerful glacial disturbances. In all probability the motion of the ice cap has given rise to folding and crumbling of the seams, to intrusions, and in part to complete erosion of the original formations. During this process the Cretaceous clays which underlaid or limited the lignite seam formed the sliding surface on which movement took place, and these clays in part filled up cleavage fissures in the lignite seam. . . .
>
> There are strong fluctuations in the coal deposit. The profiles determined by borings show that the lignite seam rapidly thins out or completely disappears at individual points, and that at other places there have been upthrusts of two or more seams or parts of seams, which in some cases have come to lie directly on one another again, but in other cases are separated from each other by more or less thick layers of clay and sand. In general the lower seam, which is the original seam first formed here, shows greater continuity than the seams above it which have probably been intruded in individual masses on the top of the lower seam.

It is not safe to make too definite a statement concerning the extent and intensity of glacial disturbance until more is learned about the field, either by further check-drilling or by opening strip pits, but in the opinion of the writers the weight of evidence so far obtained is against Klitzing's conception of universal and intense disturbance of the lignite seams.

In the first place evidence at shaft W points toward the original existence of two main lignite seams and is against Klitzing's idea of the duplication of one seam by glacial disturbance. At shaft W, the upper and lower seams are quite different in physical and chemical character, the upper containing much more earthy material with higher ash than the lower. These differences appear to be

[1]K. Pietzsch, Die Braunkohlen Deutschlands, Gebrüder, Barntraegger Berlin, pp. 55-58.

due to a different mode of deposition. The bedding in the upper seam is clearly seen in the shaft and is horizontal, although not so regularly horizontal as in the lower seam. The writers have reached the conclusion that two seams of lignite were originally present, that the lower seam has not been disturbed and the upper one only to a moderate extent.

In drill-hole A,[1] the lignite is overlain by 43 feet of refractory clay, which in turn is overlain by 80 feet of boulder clay, etc., and hence would appear to be sufficiently deep to have escaped glacial disturbance. Two seams are present, the upper seam 28 feet thick and the lower 21 feet, divided by a parting of refractory clay and sand 22 feet thick.

Data obtained on the elevation of the bottom of the lower lignite seam, which is embraced in the structure contour map (Fig. 3, page 62) and the cross-sections (Figs. 6 and 7, inserts facing page 66), indicate that nothing very violent in the way of folding or faulting of the seams has taken place.

If intense glacial disturbance of the seams with thrust faults and buckling of comparatively large magnitude had occurred, clay would likely have been brought up from below the lignite, and Pleistocene boulder clay and sand from above would have been mixed with the seams. In fact, Mr. Klitzing suggests this in his cross-sections. This, however, does not appear to be the case. In only one small area (drill-holes Nos. 9 and C-20) was Pleistocene boulder clay or sand included with the lignite. At all other drill-holes, seams of sand or clay interbedded with the lignite were either clean plastic refractory clay or white silica sand, both of which were evidently Cretaceous. Moreover, it does not appear that clay was brought up from below the lignite. This underlying clay is poor in grade, only 5 to 10 feet of it being dark-coloured or in the least refractory, the remainder, which has much the greater thicknesses being light-grey or greenish-grey and non-refractory. With very few exceptions, samples of clay from partings in the lignite seams that have been tested have been dark-coloured and distinctly refractory (fusion cones P.C.E. 28 to 33).

It is true that there are large areas where only the lower lignite seam is present, but in nearly all such areas boulder clay rests close to or directly on top of the lower lignite seam, and there is no evidence to prove that the upper seam was not present at one time and was subsequently removed by erosion.

It is not intended to infer, however, that no disturbance has taken place. In the Onakawana lignite field, evidence of minor disturbance has been observed, and at certain outlying points Cretaceous beds have been rather severely disorganized. This evidence is given in the following pages.

Clay Partings in the Lignite Seams, and Tangential Movements Brought About by Pressure of the Continental Ice-Sheets

The parting between the two lignite seams at shaft W is of two different types of materials. In the first place there is the continuous, more or less regular bed of dark-grey refractory clay immediately overlying the lower seam. It varies from 1 to 4 feet in thickness and maintains very nearly the same elevation all along the drifts. It is the normal type of plastic refractory clay and was undoubtedly deposited in the normal way along with the lignite seams. In the south lower drift where it could be clearly observed, it had a slickensided appearance, and the upper contact with the overlying zone was irregular; apparently some movement has occurred in this bed.

Above the regular bed of refractory clay is a zone of soft mixed lignite and clay, which also extends horizontally throughout the length of the drift and keeps

[1]See page 52.

the same position, i.e. directly above the bed of refractory clay. North of the shaft it is about 3 feet thick, but south of the shaft it increases to 8 and 10 feet. Samples of this mixed zone on analysis gave an ash content on the dry basis of 22 to 54 per cent. The character of this zone indicates movement of the one lignite seam along the other, on a plane that must have been flat or nearly so.

In the upper seam south of the shaft, another zone of clay and mixed lignite and clay was observed to incline slightly upwards and away from the middle parting the farther it was followed to the south. This indicates movement along a plane nearly flat but rising very slightly in a southward direction.

Further work will be necessary before the true nature of the movement or movements can be determined, but the best explanation is that the action of the continental ice-sheets caused the upper seam to be moved laterally for a moderate distance along the lower seam. The movement was to the south and along a plane either horizontal or slightly inclined upward. Some thickening of the upper seam due to this movement is indicated. At or just north of the shaft the thickness of the upper seam is 27 feet, whereas 175 feet south of the shaft the thickness is 40 feet. This sharp increase in thickness is much more likely to have been caused by ice-thrust than to be due to original variation in thickness of material.

Abnormal thicknesses of the lignite at other places were probably caused in the same manner, as, for instance, at drill-holes Nos. 83, 58, 59, and 36. In these cases, it was noticed that drill-holes to north showed the upper seam to be thin or broken and the overburden thicker than usual, suggesting an ice thrust from the north.

The abnormal thicknesses of lignite at certain of the drill-holes in subdivision A-1 appear to be caused by ice disturbance, probably by duplication or flat faulting. In those drill-holes where the lignite was over 20 feet in thickness, the lower 20 feet (approximately) was hard woody and peaty lignite, but above this the lignite was softer as if part of it had been disturbed. The lower 20 feet would represent the thickness of the original seam, and the upper part the portion that had been moved southward over it by faulting.

Vertical Clay Stringers and Small Clay Inclusions in the Lignite Seams

In addition to the regular clay parting between the two seams and the horizontal beds of mixed clay and lignite above it, which have been described, there is a third type of clay inclusion in the seams. This is the series of irregularly vertical stringers of clay in the upper seam. They cross the seam at various angles, sometimes cutting at right angles to the drift, at other times parallelling the walls. They are usually only one-half to one inch wide, and none over three inches has been seen. It was difficult to pick up all of these stringers, since shortly after drifting the walls become covered with lignite dust, and perhaps some of them have been missed. The number found in a length of 450 feet in the upper drifts was 22. The most satisfactory explanation of these stringers is that the seam settled and developed joints, due probably to pressure of the continental ice-sheets, and that the joints were subsequently filled with clay from above the seam. Irregularly vertical joints were seen in the lower seam as well, but very little clay was found in them.

A certain amount of clay appears also to be disseminated through the lignite of the upper seam, probably caused by infiltration of clay-bearing water. In a personal communication Mr. Klitzing described what probably happened in the following words:—

With regard to the intermediate layers of clay (middle continuous parting), it is to be said that these can be nothing but primary sediments which originated during the formation of the seam. On the other hand any intercalations in the form of lenses, furrows, filled-in fractures, etc., are very probably of glacial origin. When the continental ice-sheet approached and moved over the seam this was, of course, frozen to a considerable depth. The load and thrust of the continental ice-sheet fractured the frozen lignite seam so that fissures were caused in all directions, and possibly also horizontal hollows formed by the lifting of the contact surfaces. The water running off the ice trickled into these hollows and filled them gradually with sand and particles of clay before the frozen seam thawed.

Other Evidence of Glacial Disturbance

The outcrops of lignite on the west side of the Abitibi river at Blacksmith rapids[1] have a "humped up" appearance as if the seam had been squeezed by ice. At one of the two outcrops on the east side of the river, faulting of the lignite seam has taken place and at the other the lignite dips steeply to the north. A series of folds, with dips up to 10 feet in 100 feet, caused by movement of the ice-sheets is found in the northeast corner of subdivision A-1.

The logs of the drill-holes in the northwest part of the lignite field do not check as well as those in other parts of the field. Some great changes in short distances have been noticed. It is possible that this irregularity may be due in some measure to glacial disturbance.

The beds of Cretaceous refractory clay exposed on the Moose river opposite Portage island are disturbed from their habitual horizontal attitude; at one exposure the beds dip 75° S.W., at a second they dip 40° W. Since recent drilling has shown that glacial erosion near the exposure has been active and erratic, it now appears certain that the upturned beds are caused by ice thrust

At Great bend on the Mattagami river the refractory clay and lignite exposed in the banks dip sharply eastward. This is due either to slumping or to glacial disturbance. On Coal creek a 20-foot auger hole was sunk several years ago on an outcrop of black refractory clay.[2] This showed three beds of boulder clay between the beds of Cretaceous clay, which suggests disorganization of the Cretaceous formation by the ice-sheets.

Conclusion

The continental ice-sheets have so closely overridden the lignite that it cannot be expected that the seams at Onakawana will have entirely escaped some measure of severe disturbance. This will always be a source of danger, and check-drilling will in all cases be necessary. There is fairly good evidence, however, in the only parts of the lignite field where closely spaced holes have been drilled or shaft-sinking and tunnelling done that the lignite has escaped severe disturbance; and it is hoped that if severe disturbance is present at Onakawana it will be found to be local.

The Possibility of Finding Economic Lignite Seams Outside the Onakawana Field

The Cretaceous formation, with its deposits of lignite, refractory clay, and white quartz sand, outcrops on the rivers of the Moose River basin over an area of 1,500 square miles or more. Since no Devonian beds intervene, and since the Cretaceous exposures lie in what appears to be the same broad, shallow, structural basin, it is probable that the Cretaceous sediments are continuous

[1]W. S. Dyer, Geology and Economic Deposits of the Moose River Basin, Ont. Dept. Mines, Vol. XXXVII, pt. 6, pp. 47, 48.

[2]F. H. McLearn, Geol. Surv. Can., Sum. Rept., pt. C, 1926, p. 25.

between the exposures, except perhaps where cut through by glacial erosion. It has been stated[1] that the Cretaceous formation was probably once widespread and lay unconformably upon peneplaned Devonian rocks. The Cretaceous lies Upon Upper Devonian shales and clays in the Onakawana lignite field and upon Middle Devonian limestones at Grand rapids. It may even lie upon the pre-Cambrian, as indicated by the siderite masses of the Opazatika reported on by J. M. Bell[2]; similar siderite at Grand rapids is now known to be Cretaceous. The discovery of a Mattagami fossil plant species in Manitoba suggests that the Mattagami formation was once very widespread indeed. It probably extends much farther to the west than indicated by outcrops. For many miles to the west and north of the Missinaibi river the country is covered by boulder clay and muskeg, and underlying beds are never seen; large stretches here may be underlain by the Cretaceous. Isolated outliers of the Cretaceous may be found far outside the tentative boundaries of the basin.

Very little data are at hand to show in various localities what are the proportions of lignite, clay, or sand in the Cretaceous formation. Outcrops are small and widely scattered, and there has been very little drilling except at one locality. Observations to date indicate that the heavier lignite seams are in the eastern part of the basin and that to the west a larger proportion of the Cretaceous is made up of clay and sand. The few scattered outcrops and the small amount of drilling[3] between Grand rapids and the foot of Long rapids have shown considerable thicknesses of black carbonaceous and light-coloured refractory clay and white quartz sand, but only thin irregular seams of lignite, 1 to 3 feet thick; the thickest lignite seam, 6 feet, was reported by Baker in 1911, but has since been covered by talus slopes. The scattered outcrops and auger-holes along the Missinaibi river show white mottled refractory clay, white quartz sand, and some dark-grey fire clay with thin lenses of lignite. Vast stretches of the basin remain entirely untested by the drill, and only vague conjectures can be made of the character of the beds at any of the localities.

When the programme of exploratory drilling for lignite was suspended in April, 1931, it was not so much because the lignite seams had been observed to pinch out and disappear, but mainly because deep glacial erosion had cut through them and it was felt that considerable drilling would have to be done before the seams could be picked up again. There is little doubt that before erosion the seams must have extended farther in all directions. The only directions in which any evidence of thinning was obtained was toward the west and northwest (i.e. drill-holes Nos. 75 and 93); in other directions glacial erosion only is the cause of the thinning of the lignite.

One line of drill-holes was put down at 1-mile intervals for 4 miles to the southwest of the lignite field, but all these holes were in thick boulder clay. Not even a guess can be made of the dimensions of this thick boulder clay area nor of its configuration. There is a suggestion of a zone of shallower boulder clay and the presence of lignite to the southeast of the deep boulder clay area, i.e. in line with drill-holes Nos. 72, 88, and 90. On the Mattagami river in the vicinity of Little Grand creek, black boulder clay with quite large and numerous lignite fragments was found at water level, suggesting the presence of fire clay or lignite near by. It is possible, therefore, that economic lignite seams occur between drill-hole No. 90 and Little Grand creek.

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[1]See page 63.

[2]Ont. Bur. Mines, Vol. XIII, pt. 1, 1904, p. 150.

[3]One combined shaft and auger-hole reached a depth of 137 feet at Great bend, and a drill-hole at the foot of Long rapids a depth of 120 feet.

A favourable area to explore by drilling for an extension of the lignite field is to the south between the present tentative boundary of the field and the T. and N.O. railway, and especially south of drill-hole No. 18. Drilling was discontinued in this direction because of the thinning or disappearance of the lignite due to glacial erosion, but if a local reversal of dip occurred in the seams and the overburden was not excessive, there would be a good chance of locating an economic body of lignite.

The eastern boundary of the Cretaceous basin runs in a general northeast-southwest direction between the Mattagami river and the T. and N.O. railway, and from the lignite field to the foot of Long rapids. Its configuration and its distance east of the Mattagami are not known. There are possibilities of finding lignite or refractory clay deposits of economic dimensions in this stretch of country east of the Mattagami river. Owing to the proximity to the railway any deposit here would be of much greater value than any in the central or western part of the Cretaceous basin.

The presence of lignite seams aggregating 15 feet in thickness on the Moose river, near Portage island, is promising. This occurrence is 6 miles to the north of the Onakawana lignite field, and there is now some hope of finding lignite at other places between the two localities, although it is likely to be covered with fairly heavy overburden. The area north of drill-holes Nos. 19 and 20 does not look promising, since in these holes and in the two drill-holes near the mouth of the Onakawana river, the Pleistocene beds are thick.

There is little chance of finding lignite or refractory clay east of the Abitibi river. The regional westerly dip of the Cretaceous and Devonian beds if continuous to the east would carry the lignite far above the present land surface.

Of the western part of the basin little can be said. The country directly west and northwest of the lignite field does not look promising for lignite, although considerable thicknesses of Cretaceous clay, probably fire clay, occur. Still farther west, on the Missinaibi, there are large deposits of refractory clay. Lignite seams also undoubtedly exist, but how thick they are and how heavily covered by overburden no one can tell. The Mattagami river between Grand rapids and Portage island and the Missinaibi from the Opazatika to its mouth have been very carefully traversed on foot, but no sign of the Cretaceous was seen with the exception of the black boulder clay at Little Grand creek, previously mentioned. The rivers flow entirely through Pleistocene beds, boulder clay, interglacial clay, sand, or gravel.

To the writers it would appear unreasonable to assume that all the thick lignite seams were located in the first programme of exploratory drilling and in one small area. A vast area of Cretaceous remains entirely untested by the drill or by geophysical prospecting. Is it not possible that somewhere in the Moose River basin another lignite field like Onakawana exists, or what might be considered even more valuable, a field with larger stretches of shallow overburden? As for the refractory clay, the deposits are undoubtedly very large, but what is urgently needed is a deposit near the railway under sufficiently shallow overburden for recovery by stripping.

Refractory Clay Deposits

The refractory clay of the Onakawana lignite field has already been discussed in previous sections of this report. Its stratigraphical position, its origin, and its extent in the lignite field as well as throughout the Moose River basin have been outlined. It has been stated that there are two types of refractory clay: the dark, carbonaceous plastic clays, which occur along with lignite; and the vari-

coloured clays, including shades of white, light-grey, brown, and red, which occur with thick beds of white quartz sand. Only the dark clays occur in the eastern part of the Cretaceous basin (Onakawana lignite field and vicinity), and these will be described here. The light-coloured clays of the Missinaibi river form the subject of a paper by A. R. Crozier in this volume. For information concerning the clays of the Mattagami river the reader is referred to previous reports, a list of which is given on pages 49 and 50.

General Description of the Clays

In the lignite field refractory clay appears to be largely confined to two horizons: the first is between the two main lignite seams, and the second is above the upper lignite seam. Thirty-six samples from these two horizons were tested, the fusion cones being as follows:—

	No. of samples
1. High-heat duty, cone 31 and above (about 1680° C.)	13
2. Intermediate-heat duty, cones 28 to 31 (about 1615° to 1680° C.)	15
3. Moderate-heat duty, cones 26 to 28 (about 1595° to 1615° C.)	4
4. Low-heat duty, cones 19 to 26 (about 1520° to 1595° C.)	1
5. Semi-refractory, cones 15 to 19 (about 1440° to 1520° C.)	3

As noted previously,[1] there is always a considerable thickness of clay below the lower lignite seam. The clay from 5 to 20 feet is black to dark-grey and of some economic importance, since it is refractory, although not nearly so much so as the clay from the two horizons just mentioned; fusion points of cone 27 were obtained on some samples, while other cones ranged from 9 to 20. The light-grey, cream, and greenish-grey clay underlying the black clay is of little importance, since it is limy and low in refractoriness. Samples have a tendency to bloat and show surface scum. The fusion cones are from 4 to 9.

The refractory clays vary from a true ball clay to a plastic refractory type; no flint clays have been found. In general the clays are dark-grey to black due to admixture of carbonaceous material, which sometimes reaches nearly 15 per cent. They are fine-grained, quite plastic, very low in lime and other fluxes; and iron is not over 2 per cent. as a rule. The clays are massive, stratification being indicated only by interbedded lignite.

The following analyses were made in the Chemical Branch of the Ontario Department of Mines:—

	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.
Silica	52.45	49.56	55.04	59.94	51.40	50.40	62.50	50.12
Alumina	24.30	21.13	20.13	18.74	25.82	30.70	18.39	28.71
Ferric oxide	.37	2.60	1.83	3.47	1.88	.66	1.67	3.29
Ferrous oxide	1.99	.....	.....	.....	trace	trace	.62	.....
Lime	.67	.83	.80	.46	.52	trace	trace	.50
Magnesia	1.10	1.37	.89	1.90	.75	.31	1.34	1.40
Soda	1.11	.17	nil	.12	trace	trace	.48	trace
Potash	.69	3.12	1.98	3.67	1.48	.15	1.51	1.20
Phosphorus pentoxide	.14	.11	.05	.06	.10	.06	.03	.11
Titanium oxide	1.43	1.06	1.58	1.16	1.44	1.78	1.22	1.52
Manganese oxide	.03	trace	.05	.08	.02	.03	.02	.02
Ignition loss	15.72	20.23	17.75	10.32	16.62	15.96	12.22	13.51
Total	100.00	100.18	100.10	99.92	100.03	100.05	100.00	100.38
Estimated organic matter.....per cent.	7.32	12.93	10.85	3.82	7.72	5.36	5.87	4.14
Fusion cone	28½	28	28	14	30	33	16	30½

[1]See page 56.

No. 1. Shaft W, from above the upper lignite seam.
No. 2. From the outcrop on the Abitibi river 250 feet upstream from drill-hole No. 1, sample No. 178.
No. 3. Shaft W, between the two main lignite seams, sample No. 179.
No. 4. Shaft W, below lower lignite seam.
No. 5. Drill-hole A, upper horizon, 90 to 97 feet in depth, sample No. 142 A.
No. 6. Drill-hole A, middle horizon, 160 to 165 feet in depth, sample No. 142 B.
No. 7. Diagonal clay parting in lignite seam in shaft No. 1.
No. 8. From outcrop on north side of the Moose river on Portage island, sample No. 180.

Although a considerable amount of experimental work has already been done to determine the best method of manufacture of these clays and similar clays of the Mattagami river into fire brick and other ceramic products, still more is necessary. For instance, more large-scale commercial tests should be made; also it has been found that the clays vary considerably from place to place, and little is known about "blending" the various types.

There are beds of refractory clay in the central and southwestern parts of the lignite field (shaft W, drill-holes A, 70, etc.) thick enough and probably of sufficient extent to be economic, although the clay would have to be won by underground mining or as a by-product in the strip-mining of lignite, since it occurs under heavy burden. Unfortunately, no body of moderate- to high-heat duty clay sufficiently large to be worth mining has yet been found in the lignite field between the Abitibi and Onakawana rivers, where conditions are most favourable for an initial lignite operation. The semi-refractory to low-heat duty clays that underlie the lignite in this part of the field may, however, prove of importance for the manufacture of building brick and structural tile.

Description of Localities

Shaft W and Vicinity.—Good samples of clay for testing were obtained from shaft W.[1] At this shaft refractory clay occurs at two horizons, the lower between the two lignite seams (112 to 113 feet 6 inches in depth), and the upper above the upper lignite seam (71 feet 7 inches to 83 feet 4 inches in depth); the clay below the lower seam is non-refractory. The upper refractory clay horizon is not likely to be very continuous owing to its proximity to the erratic boulder clay overburden; nevertheless, it has been noted in 5 drill-holes surrounding the shaft, with thicknesses ranging from 2 to 9 feet. The refractory clay horizon between the two seams is more continuous than the higher horizon and is definitely present at 10 drill-holes around shaft W; its thickness varies from 1 foot to 21 feet.

Drill-Hole No. 70 and Vicinity.—Cored samples were recovered from drill-holes Nos. 70, A, 72, and 84. In this part of the lignite field, both the lignite seams and the refractory clay horizons are more irregular than at shaft W; the division into two main lignite seams is indicated, however, at the majority of drill-holes. The upper refractory clay horizon (above the upper lignite seam) is very thick at drill-hole A, 43 feet, but is not clearly defined at other holes in this section of the field. The parting between the lignite seams is generally present, but in this area often contains considerable thicknesses of white quartz sand; it reaches a maximum of 46 feet in thickness at drill hole No. 70, 28 feet being refractory clay and the remainder sand and thin beds of lignite.

Considerable reserves of high-grade clay are indicated in this particular area, but the clay beds change rapidly in thickness and character between drill-holes. Closer drilling is required before any adequate idea either of the character or quantity of the clay can be formed.

[1]See log, page 67.

Northwestern Part of Lignite Field.—Most of the drill-holes in the northwestern part of the lignite field show considerable thicknesses of clay although divided into several beds by seams of lignite and sand; but since none of the holes were cored no samples of the clay have been tested. Most of the clays may be assumed to be refractory, since their appearance and stratigraphical horizon is the same as the tested refractory clays of other localities in the lignite field.

Lignite Field East of Onakawana River.—There appears to be very little refractory clay in the lignite field east of the Onakawana river, which is unfortunate, since this part of the field would probably be chosen for an initial lignite operation. Apparently the lower lignite seam only has escaped erosion by the continental ice-sheets; even the clay parting between the two main seams is not present except in a very few drill-holes. Apparently the upper seam of lignite and the clay parting between the two main seams has been largely eroded by the continental ice-sheets. At drill-holes Nos. 6 and 9 refractory clay was penetrated that probably represents the middle-clay parting, but further drilling proved this occurrence to be local.

The only clay in this section of the lignite field that holds promise of being of value is the semi-refractory clay that immediately underlies the lignite seam. Some of this clay would appear to be suitable for building brick and structural tile, and it could be easily recovered as a by-product in the mining of the lignite.

Moose River at Portage Island.—Beds of Cretaceous age are exposed at three places along the north bank of the Moose river opposite Portage island. There is a gravel pit on the south side of the river at this locality, from which gravel was taken for ballast for the James Bay extension of the Temiskaming and Northern Ontario railway; a 6-mile spur connects the gravel pit to the main line. The most important exposure lies immediately north of the foot of Portage island, where a minimum thickness of 20 feet of grey and black refractory clay can be seen in several beds divided by thin beds of white quartz sand, siderite, and lignite. Below the exposed beds an auger-hole proved an additional 17 feet of refractory clay. Sixteen hundred feet downstream from the first exposure, there is a second small exposure of black refractory clay; an auger-hole here passed through 12 feet 6 inches of the clay and was bottomed in it. The third exposure is 1,500 feet still farther downstream; it also is a small exposure, but an auger-hole passed through 17 feet of dark-grey refractory clay and a 2-foot lignite seam.

In the winter of 1932, six holes were drilled in this area in the attempt to prove the extent of the clay. This drilling was disappointing in that it showed that glacial erosion had been very erratic and that only local bodies of clay, apparently too small for recovery, had been left. Although at the exposures of clay in the river bank overburden did not exceed 20 feet, drill-holes located not more than 100 feet distant from these exposures passed through thicknesses of overburden up to 100 feet before reaching clay.

However, drilling did prove that Cretaceous clay exposures are actually "in place" and that the Cretaceous clay underlay the Pleistocene at most drill-holes. Moreover, two drill-holes, Nos. P-3 and P-6, found lignite aggregating 15 feet in two seams. These lignite seams are very probably extensions of the seams of the Onakawana lignite field 6 miles to the south.

APPENDIX

LABORATORY CLASSIFICATION OF REFRACTORY CLAYS

By R. J. Montgomery

Clays from Shaft W

Horizon above the Upper Lignite Seam

Samples Nos. 164-1 to 164-9.—These samples are so nearly alike that it is scarcely worth while describing each one. Some difference is indicated by the drying shrinkage, burning shrinkage, and fusion point. The clay is dark-grey to black as received, and is smooth and plastic when water is added. At cone 010 the samples burned to a light-buff. All contained organic matter, which oxidized slowly. At cone 8 they burned to a dark-brown, and were steel-hard and well vitrified. Black coring was noticed in some of the samples, due to incomplete oxidation of the carbon in the short laboratory burn. This group is refractory enough to be considered for a third-quality fire brick and for bodies requiring a vitrified structure.

Samples Nos. 164-10 to 164-12.—These three samples are different and inferior in quality, largely because of the large amount of lignite material associated with the clay. The fusion points of Nos. 164-10 and 164-12 is lower because of the presence of mica. The porosity and shrinkage of the burned bodies is largely due to the lignite.

A screen test of sample No. 164-10 showed 15 per cent. lignite on a 200-mesh screen, and No. 164-11 probably contains more.

At cone 010 all three samples were very porous. The colour was buff with with iron spots, No. 164-12 being decidedly discoloured.

At cone 8 the samples were still porous and not steel-hard, although the body was solid and well burned. The texture suggests insulating brick to which carbon or other organic material has been added to increase the porosity. Sample No. 164-11 is the best in colour and shows less iron discoloration.

TESTS ON SAMPLES FROM SHAFT W

Sample No.	Depth	Fusion point P.C.E.	Dry linear shrinkage	Burned linear shrinkage	
				Cone 010	Cone 8
			per cent.	per cent.	per cent.
164-1	71 ft. 7 in. to 72 ft. 7 in.	28	8.2	3.1	10.5
164-2	72 ft. 7 in. to 73 ft. 7 in.	30	9	2.4	10
164-3	73 ft. 7 in. to 74 ft. 7 in.	27	6.5	3.8	10.7
164-4	74 ft. 7 in. to 75 ft. 7 in.	27	8	3.8	10.5
164-5	75 ft. 7 in. to 76 ft. 7 in.	28	8.8	5.4	10.8
164-6	76 ft. 7 in. to 77 ft. 7 in.	28	8.1	4.2	10.9
164-7	77 ft. 7 in. to 78 ft. 7 in.	29	8.7	5	11
164-8	78 ft. 7 in. to 79 ft. 7 in.	28	8.5	2.9	11.4
164-8a	79 ft. 1 in. to 79 ft. 7 in.	28	8.5	4.7	10.3
164-9	79 ft. 7 in. to 80 ft. 7 in.	28	9.5	4.9	15.4
164-10	80 ft. 7 in. to 81 ft. 7 in.	26	7.7	3.2	12.8
164-11	81 ft. 7 in. to 82 ft. 7 in.	28	5.9	2.1	4.7
164-12	82 ft. 7 in. to 83 ft. 4 in.	23	3.1	5	12.6

None of the samples received are of first quality; they range from second to third quality and below, if we consider cone 28 as the dividing line between those groups.

Horizon between the Lignite Seams

Sample No. 179.—This clay, which comes from 112 feet to 113 feet 6 inches in shaft W, is a dark-slate colour. The sample showed a splintery fracture and is medium hard. With the exception of carbon there was no other visible impurity. Plasticity was good, the water required for plasticity being 34 per cent. The clay is fine-grained, less than 1 per cent. being retained on a 200-mesh screen. The residue consists mostly of organic matter, with a little silica and mica. The drying linear shrinkage is 8.5 per cent. The fusion cone is 28. The burning linear shrinkage is as follows:—

	Per cent.
Cone 010	2.2
Cone 1	6.8
Cone 5	7.9
Cone 10	10.2

The clay is steel-hard at cone 1; it burns to a buff colour, which darkens as the temperature increases to cone 5, and is a dark-brown at cone 10. The body of greatest density is obtained at about cone 5.

Horizon below the Lower Lignite Seam

The following table gives the fusion cones of samples of dark-grey to light plastic clay taken from shaft W:—

TESTS ON SAMPLES FROM SHAFT W

Sample No.	Depth in shaft W	Fusion cone
	feet	
166-1	131½–132½	15
166-2	132½–133½	14
166-3	133½–134½	14
166-4	134½–135½	12
166-5	135½–136¼	10

As these clays are non-refractory, no further testing was done. Nos. 166-1, 166-2, and 166-3 did not show the presence of lime in the usual acid test, but Nos. 166-4 and 166-5 gave a slight reaction.

Clays from Drill-Hole A

Horizon above the Upper Lignite Seam

Sample No. 142-a.—This clay comes from 90 to 97 feet and is medium-grey as received. The plasticity is good, the water required for plasticity being 47 per cent. It is smooth and free from grit, and has a drying shrinkage of 9.1 per cent. At cone 02 (1095° C.) the burning shrinkage is 7.9 per cent. It is dense in structure, dark-buff in colour, and steel-hard. The clay has a long vitrification range, as it shows very little overfire at cone 10 (1260° C.). It is free from iron spots but has darkened slightly, with some additional burning

shrinkage at cone 10. The content of organic matter is high and is hard to expel. The fusion point (P.C.E.) is cone 30. This is a semi-ball clay or the bond clay type.

Horizon between the Lignite Seams

Sample No. 142-b.—This clay comes from 160 to 165 feet and is light-grey as received. The plasticity is good, the water required for plasticity being 42 per cent. It is very smooth, is free from grit, and has a drying shrinkage of 9.7 per cent. At cone 02 (1095° C.), the burning shrinkage is 13 per cent., being so high that the body tends to warp and show surface checking. The colour is a very light buff, and it is steel-hard. At cone 10 (1260° C.) the body shows some additional shrinkage but no overfire, and is still light in colour and free from iron spots. The vitrification range is very long. The organic matter is not so high as in sample No. 142-a and burns out. The fusion point (P.C.E.) is cone 33. The clay is a first-class ball clay and the first of this type to be discovered in this section. Some of the other samples from this section have been classed as a semi-ball clay but not as ball clay.

Sample No. 142-c.—This clay comes from 165 to 168 feet and is dark-grey as received. The plasticity is good, the water required for plasticity being 44 per cent. It is smooth and free from grit and has a drying shrinkage of 7.8 per cent. At cone 02 (1095° C.) the burning shrinkage is 6.7 per cent. and it is not steel-hard, the porosity being considerable and the surface showing scum with some iron spots. At cone 4 (1165° C.) the burning shrinkage increases to 7.9 per cent. The scum has been burned off, the colour is a grey-buff, and it is steel-hard, but shows an approach of overfire partly due to the organic matter that it contains. The organic matter is difficult to burn out in a short laboratory burn. The fusion point (P.C.E.) is cone 15.

Horizon below the Lower Lignite Seam

Sample No. 142-d.—This clay comes from 196 to 204 feet and is medium-grey as received. The plasticity is good, the water required for plasticity being 37 per cent. It is smooth and free from grit and has a drying shrinkage of 7.2 per cent. at cone 02 (1095° C.), and a burning shrinkage of 10 per cent., giving a high total shrinkage. The body is steel-hard, strong buff in colour, of vitrified structure, and free from iron spots. At cone 4 (1165° C.) the body approaches overfire, is still buff, and probably would still be a good body if the organic matter were properly burned out. The fusion point (P.C.E.) is cone 15.

Clay from Drill-Hole No. 70

The clays from hole No. 70 are all from the horizon between the two main lignite seams. They are refractory and with two exceptions are of No. 1 quality. They give a fusion point (P.C.E.) of cone 29 to 33+. They are of the plastic fire-clay type, which are used as bond clays and stoneware clays. They should be of value in glass-house refractories. They probably could be used in small amounts in whiteware, in which entire freedom from colour is not necessary. Iron spots do not show in most of the samples from this hole when burned to cone 8. The colour of the burned test pieces is light-buff. The following table gives the properties determined:—

TESTS ON SAMPLES FROM DRILL-HOLE No. 70

Sample No.	Depth	Fusion point (P.C.E.)	Dry linear shrinkage	Burned linear shrinkage	
				Cone 010	Cone 8
	feet		per cent.	per cent.	per cent.
151-1	89–90	29	2.8	1.7	6.1
151-2	90–91	30	7.3	2	6.2
151-3	96½–102½	32½	6.9	3.5	10.8
151-4	103–108	31	5.9	1.2	5.3
151-5	108–111	32½	6.5	1	5.6
151-6	111–113	33	7.6	2.4	7.6
151-7	113–118	33+	7.4	2	7.5
151-8	120–121	33	6.4	2.1	7.8
151-9	121½–123	33	6.5	2.2	7.7
151-10	123–125	32½	7.4	1.1	6.6

Sample No. 151-1.—This black carbonaceous clay contains some grit as noticed when grinding. It is plastic and has a low drying and burning shrinkage, giving a porous body at cone 8. It could probably be used without grog but is not a first-quality material, as the fusion cone is 29. The fusion cone showed iron spots and is not as good in quality as samples Nos. 151-3 to 151-10 from this same hole.

Sample No. 151-2.—The clay is a medium-grey, smooth, and plastic. The colour changes from a cream-white at cone 010 to a light-buff at cone 8, giving a good body of fair porosity The fusion cone showed iron spots, which had not developed at cone 8 and which indicate the presence of impurities that caused fusion at cone 30.

Sample No. 151-3.—The clay is medium-grey, smooth, and plastic. The colour changes from a cream-white at cone 010 to a light-buff at cone 8, the body still being rather porous. No iron spots show even at the temperature of fusion.

Sample No. 151-4.—The clay is a medium-grey and is smooth and plastic. The colour and porosity are about the same as in No. 151-3. No iron spots show even at the temperature of fusion.

Sample No. 151-5.—This clay is about the same as No. 3 in colour and porosity. It has no iron spots.

Sample No. 151-6.—The clay is grey in colour and smooth and plastic. While the colour on burning is about the same as No. 3, the body is denser at cone 8. It also does not show iron spots.

Sample No. 151-7.—The clay is about the same as No. 3 in colour and porosity. It has no iron spots.

Sample No. 151-8.—The clay is about the same as No. 6 in colour and porosity. It has no iron spots.

Sample No. 151-9.—The clay is about the same as No. 6 in colour and porosity. It has no iron spots.

Sample No. 151-10.—This sample is about the same as No. 2 above, except that it is more refractory. Iron spots show at cone 8 and on the fusion cone.

Clay from Drill-Hole No. 72

The clay sample from hole No. 72 is from above the upper lignite seam. It is a ball clay in type, burning to a dense structure at low temperature and being very refractory. It does not show iron spots. It is plastic and has a high drying and burning shrinkage. It probably could be used as a ball clay in whiteware. The following table gives the properties determined:—

TEST ON SAMPLE FROM DRILL-HOLE NO. 72

	Depth	Fusion point P.C.E.	Dry linear shrinkage	Burned linear shrinkage	
				Cone 010	Cone 8
Sample No. 152-1	feet 76–81	33+	per cent. 9.8	per cent. 4.3	per cent. 14.5

Sample No. 152-1.—This sample from hole No. 72 is of the ball-clay type. It is dark-grey as received and is smooth and plastic. The drying shrinkage is higher than the samples from hole No. 70. The ball-clay character also shows in the high burning shrinkage at cone 010 and cone 8. The body is well vitrified at cone 8, changing from a cream colour at cone 010 to a light-grey at cone 8. This is the second sample of ball clay tested from this section and is a definite addition to our knowledge of these clays.

Clay from Drill-Hole No. 84

The first three samples of this series are very refractory and high-grade fire clays. The refractoriness decreases with depth. Samples Nos. 161-1 to 161-3 are from the middle refractory clay horizon between the lignite seams, although the upper seam has been eroded at this particular locality. Sample No. 161-4 is from a parting in the lower lignite seam; and No. 161-5 is from below the lower lignite seam. The properties determined are:—

TESTS ON SAMPLES FROM DRILL-HOLE NO. 84

Sample No.	Depth	Fusion point P.C.E.	Dry linear shrinkage	Burned linear shrinkage	
				Cone 010	Cone 8
	feet		per cent.	per cent.	per cent.
161-1	101–101½	33	7.2	2.8	7.7
161-2	101½–103½	33	6.5	2.1	8.7
161-3	103½–104	33	7.7	2.8	8.5
161-4	127	18	9.8	3.6	17.2
161-5	162–163	5	6.7	1.1	Not det.

Sample No. 161-1.—The clay is medium-grey and is smooth and plastic when worked. At cone 010 the body is practically white with a slight cream tint; it is porous but of good strength. At cone 8 it is steel-hard and dense, but not vitrified. The colour is a light-buff showing a few iron spots.

Sample No. 161-2.—This sample is the same as No. 1.

Sample No. 161-3.—This sample is the same as No. 1.

Sample No. 161-4.—The clay is black as received and is smooth and plastic. At cone 010 it gave a good porous body, light-cream in colour. At cone 8 it becomes dark-brown and very dense, and has about reached its maximum burning temperature to give a good body. The shrinkage is very high. It would be of value as a low-temperature bond clay in body where the colour would not be objectionable.

Sample No. 161-5.—This clay is grey with a green tint, smooth, and plastic, and although of low refractoriness it does not show the presence of lime when tested with acid. At cone 010 it burns to a light-red porous body, but is not steel-hard. It could be used for brick and tile.

Clay from Drill-Hole No. 6

Sample No. 74.—This clay comes from 35 to 40 feet. It is dark-grey, smooth, and plastic.

Sample No. 101.—This clay comes from 40 to 54 feet. It is black, smooth, and plastic and has a little lignite running through it. At cone 02 it burns to a light-buff. At cone 5 it is buff, steel-hard, and dense, with a few iron spots.

Sample No. 102.—This clay comes from 75 to 81 feet. It is black, smooth, and plastic and contains a little lignite. At cone 02 it burns light-buff and is steel-hard. At cone 5 it is buff and dense, with a few iron spots.

TESTS ON SAMPLES FROM DRILL-HOLE NO. 6

Sample No.	Depth	Water for plasticity	Linear drying shrinkage	Shrinkage		Fusion cone
				Cone 02	Cone 5	
	feet	per cent.	per cent.	per cent.	per cent.	
74	35–40	.....	.....	.....	.....	29½
101	40–54	45	9.3	7.1	6.8	27
102	75–81	47.1	9.4	7.5	6.6	26

Clay from Outcrop on the Abitibi River

Sample No. 178.—This sample comes from an outcrop on the Abitibi river 250 feet upstream from drill-hole No. 1.

The clay is dark-grey in colour, fine-grained, and plastic. The drying shrinkage is 8.5 per cent. On burning to cone 5 the body is dense and strong, the colour being a medium-buff, free from iron spots. At cone 10 the colour deepens to a dark-brown. It is steel-hard at cone 1. The fusion point (P.C.E.) is cone 28.

Clay from Drill-Hole No. 1

These clays are all from points below the lignite seam.

Sample No. 79.—This clay comes from 56 to 61 feet. It is grey-brown, free from lignite, smooth and plastic. It is steel-hard at cone 02 and burns to a good buff colour.

Sample No. 80.—The clay comes from 56 to 61 feet. It is the same as No. 79.

Sample No. 81.—This clay comes from 61 to 63 feet. It is grey, free from lignite, smooth and plastic. At cone 02 the clay burned red but bloated out of shape and showed surface scum.

Sample No. 82.—This clay comes from 72 to 79 feet. It is mixed light- and medium-grey clay, free from lignite, smooth and plastic. At cone 02, it is the same as sample No. 81.

Sample No. 83.—This clay comes from 79 to 84 feet. It is light-grey and contains some rock fragments up to a quarter of an inch in size. Nine per cent. rock fragments, which looked like hard shale, was screened out in preparing the sample. The clay remaining was smooth and plastic, but bloated when burned at cone 02, burning red and showing surface scum.

Sample No. 84.—This clay comes from 79 to 84 feet and is about the same as No. 83.

Sample No. 85.—This clay comes from 84 to 94 feet and is light-grey, smooth, and plastic. It is free from lignite but contains a few rounded pebbles. At cone 02, it is the same as No. 83.

Sample No. 86.—This clay comes from 94 to 102 feet. It is light-grey, smooth, and plastic, and contains no pebbles or lignite. At cone 02, it is the same as No. 83.

Sample No. 87.—This clay comes from 102 to 110 feet. It is grey, smooth, and plastic, and contains no pebbles or lignite. At cone 02, it is the same as No. 83.

Sample No. 88.—This clay comes from 110 to 119 feet, and is the same as No. 87.

Sample No. 89.—This clay comes from 119 to 129 feet. It is grey, smooth, and plastic, and contains several pebbles a quarter of an inch in size. At cone 02, it is the same as No. 83.

Sample No. 90.—This clay comes from 129 to 135 feet, and is the same as No. 87.

Sample No. 91.—This clay comes from 135 to 139 feet. It is grey and free from lignite, but is slightly calcareous when tested with acid. At cone 02, it is the same as No. 83.

Sample No. 92.—This clay comes from 139 to 149 feet. It is the same as No. 87.

Sample No. 93.—This clay comes from 149 to 150 feet. It is grey, sandy, and low in plasticity. At cone 02 it gave a red sandy body but did not bloat.

Sample No. 94.—This sample comes from 149 to 154 feet. It is sandy material with some grey clay, and is slightly calcareous. At cone 02 it is red but shows surface scum. At cone 2 it is slightly bloated but is steel-hard.

Sample No. 95.—This sample comes from 154 to 159 feet. It is grey, free from lignite, slightly calcareous, smooth and plastic. At cone 02, it is the same as No. 83.

Sample No. 96.—This clay comes from 159 to 171 feet. It is the same as No. 87.

Sample No. 97.—This clay comes from 171 to 181 feet. It is the same as No. 87, except that it is slightly calcareous.

Sample No. 98.—This clay comes from 181 to 189 feet. It is the same as No. 87.

Sample No. 99.—This clay comes from 189 to 200 feet. It is the same as No. 87, except that it is slightly calcareous.

TESTS ON SAMPLES FROM DRILL-HOLE NO. 1

Sample No.	Depth	Water for plasticity	Linear drying shrinkage	Shrinkage		Fusion cone
				Cone 02	Cone 2	
	feet	per cent.	per cent.	per cent.	per cent.	
79	56–61	35	7.2	7.2	.....	15
80	56–61	34	7.3	7	.....	15
81	61–63	35	6.5	Bloated	.....	8
82	72–79	33.1	6.5	Bloated	.....	6
83	79–84	31.9	6.1	Bloated	.....	6
84	79–84	32	5.9	Bloated	.....	6
85	84–94	32.3	6.5	Bloated	.....	7
86	94–102	33.8	6	Bloated	.....	7
87	102–110	29.8	6.5	Bloated	.....	9
88	110–119	29.9	5.7	Bloated	.....	9
89	119–129	32.3	6.8	Bloated	.....	9
90	129–135	32.7	6.8	Bloated	.....	9
91	135–139	29.4	7.4	Bloated	.....	6
92	139–149	26.9	6	Bloated	.....	6
93	149–150	21.1	4.7	2.5	.....	5
94	149–154	18.4	5.2	3.4	2.1	9
95	154–159	29.1	7.1	Bloated	.....	4
96	159–171	33.6	8.8	Bloated	.....	4
97	171–181	33.9	8	Bloated	.....	6
98	181–189	33.1	7.6	Bloated	.....	6
99	189–200	29.4	6.6	Bloated	.....	5

The table gives the main physical properties including the fusion cone.

Nos. 79 and 80 give a fair reddish-buff body and might be classed as a low-grade stoneware or brick clay, having a possible commercial value.

Nos. 81 to 99 have a tendency to bloat and show surface scum and could not be recommended for commercial use. Nos. 93 to 94 are high in sandy material and did not bloat but showed scum. Sand additions might prevent bloating at the expense of plasticity, but the scum would still be present.

Clay from Drill-Hole No. C-8

Drill-hole No. C-8 was put down during the programme of check-drilling of fire-clay and lignite in the winter of 1932. It is 1,000 feet north of drill-hole No. 1. All the samples were from points below the lignite seam.

Depth, feet	Fusion cone
58½–61	27
63–65	20
65–67	19
67–70	19
70–72½	20
72½–74	20

Clay from Drill-Hole No. C-10

Drill-hole C-10 was put down during the programme of check-drilling of refractory clay and lignite in the winter of 1932. Drill-hole No. C-10 is 950 feet north and 250 east of drill-hole No. 9. All the samples were from points below the lignite seam.

Depth, feet	Fusion cone
77½–81	20
81–84	19
84–85½	18
85½–86	18
86–88	12

Clays from Moose River at Portage Island

Sample No. 171-A.—This sample is made up of 10 separate samples from the auger-hole 17 feet deep at the first exposure upstream.[1] The fusion point (P.C.E.) of these 10 varied from cone 28 to 29.

Sample No. 171-B.—This sample is made up of 11 separate samples from the first exposure upstream. The fusion point (P.C.E.) of this ranges from cone 28 to 30.

Sample No. 171-C.—This sample comes from the auger-hole 17 feet deep at the second exposure. It had a fusion point (P.C.E.) of cone 27.

Sample No. 180.—This is a larger sample from the same location as Nos. 171-A and B. It is dark-grey, evidently coloured by carbon or fine lignite. The plasticity is good, requiring 38 per cent. water. The drying shrinkage is 9.1 per cent. It burns to a good buff at cone 5, darkening to a grey at cone 10. Is free from iron spots and is steel-hard at cone 1. The fusion temperature (P.C.E.) is cone 30½.

Samples from Drill-hole P-3.—These samples were obtained by coring in drill-hole No. P-3. The fusion points (P.C.E.) were as follows:—

Depth, feet	Fusion cone
14–18	24
18–23	24
23–28	24
28–32½	27
40½–46½	26
59–62½	19

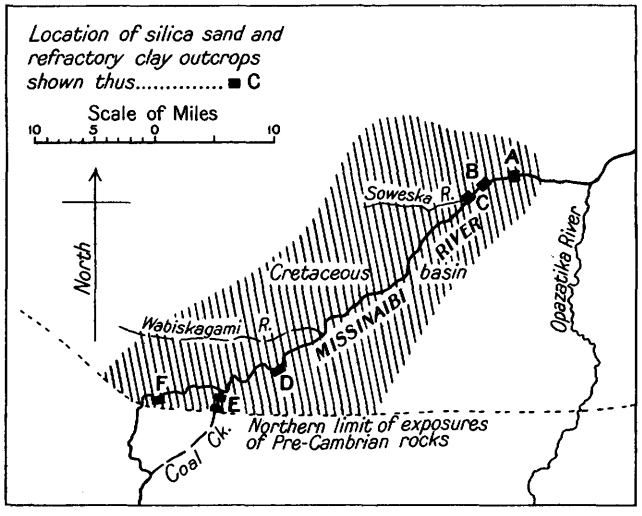
[1]See page 78.

Refractory Clay Deposits on the Missinaibi River

By A. R. Crozier

Introduction

In this report, the results of the summer's work of 1932 are given in detail. A previous report in 1926 by R. J. Montgomery and R. J. Watson described the pre-glacial occurrences along this river, but since that time prospectors have brought out many highly refractory samples of clay. Upon the strength of these recent findings, the Department of Mines undertook an intensive survey of the



Sketch map of part of the Missinaibi river showing relative position of Locations A to F.

Missinaibi and its tributaries with the view of ascertaining the commercial possibilities of the refractory clays in this area.

Test pits and auger holes were sunk in order to obtain samples and sections of the various occurrences. In all some 50 samples were taken of clay and silica sand kaolin. Fusion cone tests were run on 32 of the samples, of which 25 were over cone 30. The tests and classification of the clays were made by the Ontario Research Foundation under the direction of Dr. A. E. R. Westman.

Equipment and Method of Prospecting

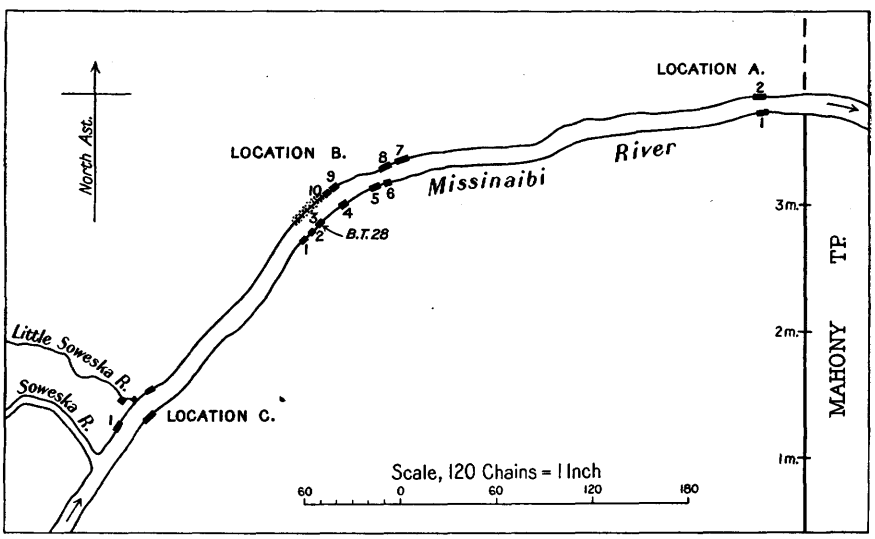
The equipment used for the field work consisted of shovels, picks, and a 2-inch hand ship-auger with a shaft adapted for extensions. The maximum depth to which the auger holes could be sunk was 23 feet. In many cases, conditions were such that 6 to 12 feet was the maximum depth.

The months of July and August were chosen as suitable for the field work. In these months, the water-level in the rivers is usually very low, and consequently

many pre-glacial exposures can be seen that otherwise would be covered by water. The shores of the Missinaibi and many of its tributaries were covered on foot as far as the contact, about 110 miles southwest of Moose River crossing. In this work, the writer was ably assisted by F. Hewett of the Ontario Research Foundation temporary staff.

Age of the Clay and Silica Sand Kaolin Occurrences

Although the age of the Missinaibi clays and silica sand kaolin deposits is not definitely determined, there is every indication that they are either Lower Cretaceous or Upper Jurassic. The refractory clays on the Mattagami have been definitely identified by their fossil content as Lower Cretaceous or Upper Jurassic, and are considered as belonging to the Mattagami series. The deposits



Map showing Mesozoic exposures at Locations A, B, and C, Missinaibi river.

on the two rivers are quite similar and in fairly close proximity to each other, thus suggesting the same age and possibly the same origin.

On the sketch map of part of the Missinaibi river,[1] silica sand and Mesozoic clay deposits are shown at Locations A, B, C, D, E, and F. At Location F, the clays have low fusion cones, melting at cone 8 to 17. It is possible that they are either Lower Cretaceous clays or weathered clay-shales of the Devonian and can be correlated with the Sextant Rapids formation. A description of these occurrences is given in the following paragraphs, together with logs, sections, and sketches.

Occurrences on the Missinaibi

Location A

Approximately 5½ miles upstream from the Opazatika river, or 1,200 feet upstream from the township of Mahony, grey sandy clay and silica sand are exposed on the right (south) bank, and white, grey, and red mottled clays on

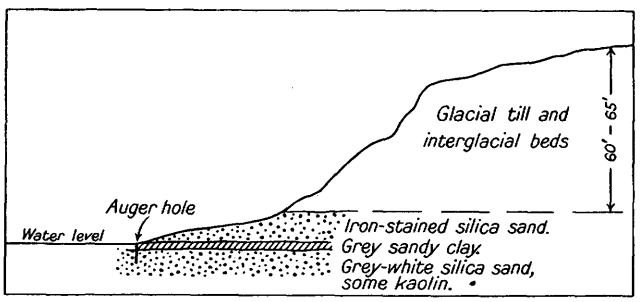
[1]For general map see Fig. 1, page 46.

the left. From an economic standpoint, these clays and silica sand are not very promising, since the exposures are quite small and overlain with heavy overburden. The banks of the river are not terraced to any great extent, and consequently the overburden rises quite steeply a short distance from the water's edge.

Exposure No. 1.—On the right bank, grey sandy clay and iron-stained silica sand, extending 5 feet above fairly low summer water-level, are exposed for a distance of 100 feet. At this particular point, the banks show very little terracing, and the overburden extends from 60 to 70 feet above water level.

The following section is taken from a test pit sunk at the contact between the glacial till and rusty silica sand to water-level and from the auger hole put down from the bottom of the pit:—

	Thickness, feet
Rusty silica sand	5
Grey sandy clay	1
Water-level.	
Grey-white silica sand with some kaolin (sample No. 35)	3



Sketch showing position of pre-glacial beds and overlying glacial till, Location A, Missinaibi river.

Exposure No. 2.—On the left bank opposite exposure No. 1, white-grey and red variegated clay outcrop in the bed of the river over an area of 25 by 15 feet. Since this showing was practically covered by water, pit-sinking and augering was very difficult. However, one auger hole reached a depth of 6 feet before being abandoned.

	Thickness	Sample No.	Fusion cone
	ft. in.		
Water-level.			
Grey-white clay (poor colour)	2 6	.....	.....
Red and grey variegated clay	3 6	No. 36	33–34

An attempt was made to extend the boundaries of this exposure, but test pits failed to reach refractory clay or silica sand beds.

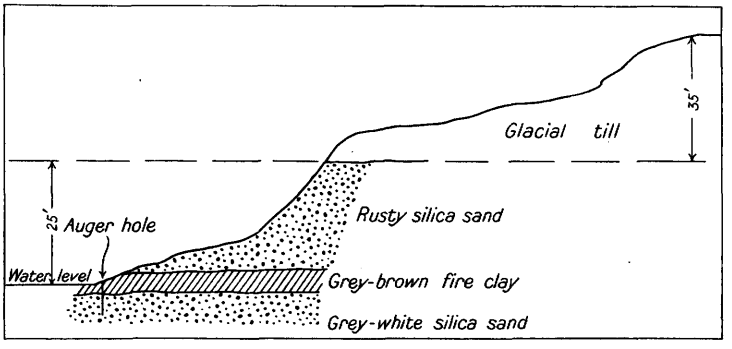
Twenty feet downstream from exposure No. 2, coarse silica sand with a little kaolin outcrops above water-level for 10 feet. Test pits and auger holes could not be completed, owing to the action of water on the sand.

One hundred yards and two hundred yards downstream, from exposure No. 2, small exposures of white-grey clay and silica sand with a little kaolin were

traced for a distance of 25 feet. The exposures were too small and unpromising to warrant any work.

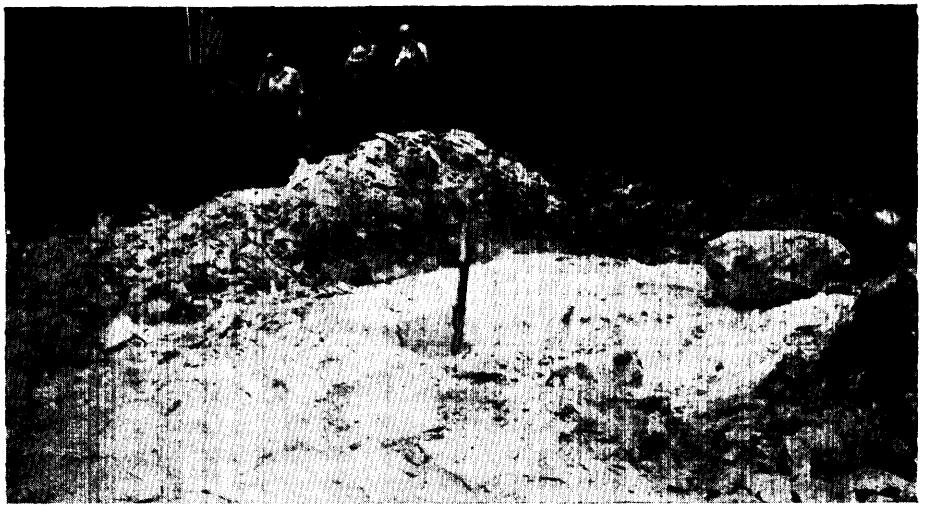
Location B

Possibly the most promising deposit of refractory clay in the area examined is the one exposed at this location. It is some 30 miles northwest of Smoky falls,



Sketch showing position of silica sand, clay beds, and overburden, exposure No. 1, Location B, Missinaibi river.

the terminus of the Spruce Falls railroad, and 38 miles from the nearest point on the Temiskaming and Northern Ontario railroad. The clays may be grouped under the light-coloured series of the Mattagami formation, although one or two small outcroppings of the dark series are present. The exposures are quite

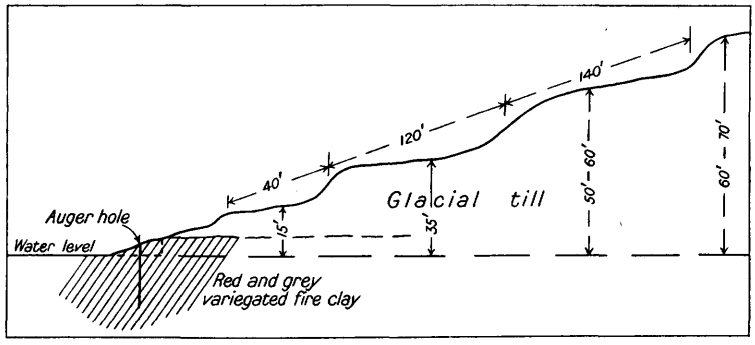


Sedimentary refractory clay on the bank of the Missinaibi river, Ruby-Sheppard claims, September, 1931.

numerous and can be traced intermittently on both sides of the river for a distance of 4,000 feet. From surface indications and the results of the preliminary work, there seems to be little doubt that a properly directed drilling programme would outline an extensive deposit of mottled red and grey refractory clay, and possibly seams of white refractory clay. Recent laboratory tests by the Ontario Research

Foundation have shown the clays to have quite high pyrometric cone equivalents, running from 30 to 35. The claims are known as the Ruby-Sheppard, and the property is held by the Ruby Oil and Coal Syndicate.

Exposure No. 1.—On the right bank, 950 feet upstream from bearing tree No. 28, black-grey plastic clay and silica sand are exposed either above or just below water-level for a length of 350 feet. At this exposure, the contact between



Sketch showing width of terraces at exposure No. 3, Location B, Missinaibi river.

the silica sand and glacial till is approximately 25 feet above summer water-level. The section from the top of the bank to water-level, and from there to the bottom of the auger hole, is as follows:—

	Thickness	Sample No.	Fusion cone
	ft. in.		
Glacial till	7	.....	.....
Silica sand (poor colour)	26	.....	.....
Black and brownish-grey plastic clay	3	No. 13 (upper 2 feet)	32
Water-level.			
Black and brownish-grey plastic clay with thin sand seams (a sixteenth to a quarter of an inch)	2 6	.....	.....
Grey-brown sandy clay	4	.....	.....
White silica sand, with some kaolin	6	.....	.....
Hole abandoned.			

Exposure No. 2.—On the right bank, 520 feet downstream from exposure No. 1, brown plastic clay extending two feet above summer water-level outcrops for a length of 40 feet. Five feet of badly iron-stained silica sand overlies the clay. The log of an auger hole is as follows:—

	Thickness, ft. in.
Brown plastic clay	2
Water level.	
Brown plastic clay	1 6
Fairly dark grey plastic clay	2
Light-brown plastic clay	1 6
Light-grey sandy clay	2
Red and grey variegated clay	3
Hole bottomed in clay.	
Total thickness of clay	12

Exposure No. 3.—On the right bank, 190 feet downstream from exposure No. 2, variegated grey, brown, and red clay, extending 6 feet above summer water-level at the highest point, can be traced for a distance of 50 feet. Two feet of silica sand overlies the clay on both sides just above water-level. At this particular point, there is considerable terracing for some distance away from the river, which affords an excellent opportunity for stripping and exploratory work.

A test pit and an auger hole sunk from the bottom of the pit at water-level gave the following section:—

	Thickness	Sample No.	Fusion cone
	ft. in.		
Boulder clay	7	.....	.....
Silty white and red variegated clay with a few pebbles	1	.....	.....
Red and brown variegated clay	1 3		
Grey-white clay	9		
Red and brown variegated clay	3 6	No. 14	31–32
Grey-white clay	6		
Water-level.			
Red and brown variegated clay (2-inch band of white clay at 3 feet)	5	No. 15	31
Red and some brown clay	6 6	No. 16	32
White-grey clay	3	No. 17	34–35
Red, grey, and brown clay	4	No. 18	32
Hole bottomed in clay.			
Total thickness of refractory clay	24 6		

Clay and silica sand outcrop almost continuously either above or just below water-level between exposures Nos. 1 and 2; between exposures Nos. 2 and 3, no clay or sand was observed.

Exposure No. 4.—On the right bank, 1,415 feet downstream from exposure No. 3, silica sand, poor in colour and with a low kaolin content, outcrops above water-level for 200 feet before it is concealed with debris. The contact between the silica sand and boulder clay, at the highest point, is 9 feet above water-level. Several attempts were made to auger the sand below water-level, but without success. A pit exposed the following section:—

	Thickness, ft. in.
Boulder clay	6
Rusty cream silica sand, with some kaolin	3 6
Badly iron-stained silica sand, with some kaolin	5 6
Water-level.	
White silica sand and kaolin	1
Hole abandoned.	

Exposure No. 5.—On the right bank, 2,590 feet downstream from exposure No. 3, or 1,175 feet from exposure No. 4, white-grey, red, and brown variegated clay outcrop above water-level for 120 feet. The clay, which rises 6 inches above water-level, is overlain by 5 feet of badly iron-stained silica sand with a low kaolin content. The exposure is directly opposite a similar showing on the left bank, and is probably an extension of the same body. Auger hole No. 1, located near the centre of the exposure, gave the following section:—

	Thickness	Sample No.	Fusion cone
	ft. in.		
Water-level.			
Pink-red clay	3	.....	.....
Grey-white clay (2-inch red and brown clay seam at 1 foot 6 inches)	2	No. 19	33–34
Red, grey, and brown clay	5	No. 20	32–33
White-grey clay	1	No. 21	33–34
Grey-white and a little red clay (not sampled, same as No. 21)	1	.....	.....
Brown, red, and grey clay	3	.....	.....
Hole bottomed in clay.			
Total thickness of clay	9 6		

Auger hole No. 2, 50 feet downstream from auger hole No. 1, gave the following section:—

	Thickness	Sample No.	Fusion cone
	ft. in.		
Whitish grey variegated clay	6	.....	.....
Water-level.			
White and brown variegated clay	2	.....	.....
Red and grey variegated clay	2	.....	.....
Light-grey (micaceous) clay	1 6	.....	.....
Grey and red variegated clay	4 6	.....	.....
Pinkish-red clay	3	.....	.....
Green-brown and red variegated clay	1 6	.....	.....
Reddish-brown clay	1	.....	.....
Grey micaceous clay, with a little sand	1 6	.....	.....
Whitish-grey clay	2 6	No. 22	33
Grey micaceous clay	3	No. 23	32
Silica sand, with some kaolin at 23 feet.			
Total thickness of clay	23		

Several attempts were made to collect a sample of the silica sand at 23 feet, but without success. This was the maximum depth to which the auger could be used.

Exposure No. 6.—On the right bank, 3,200 feet downstream from exposure No. 3, red-grey variegated and white-grey clay outcrop at or just above water-level for a distance of 60 feet. The river banks at this exposure are fairly low for 100 feet or so back from the river. The log of the auger hole is as follows:—

	Thickness	Sample No.	Fusion cone
	ft. in.		
Fairly white clay (large sample taken)	1	No. 37	33–34
Water-level.			
Red, grey, and brown clay	2	.....	.....
White-grey clay	1 6	No. 24[1]	33–34
		No. 25[1]	34–35
White silica sand, with some kaolin	3	.....	.....
Grey-white and a little red clay	1 6	.....	.....
Grey and red clay	6	.....	.....
Grey-white clay	6	.....	.....
Hole bottomed in grey clay.			
Total thickness of clay	7 3		

[1]Taken from river bed.

It was impossible to continue the auger hole below 7 feet 3 inches on account of water and sand coming in at a 3-inch sand seam.

It was from this exposure that fusion tests of the grey-white or white clay gave fusion cones running between 34 and 35. Unfortunately, the seams of white clay are thin and patchy, which would make the recovery of it very difficult and expensive. At this stage, it is quite safe to say that a great deal of well-directed drilling would be necessary before any definite conclusions could be made as to the quantity of white clay present.

Exposure No. 7.—On the left bank opposite exposure No. 6, red, brown, and grey clays are exposed either above or below water-level for 500 feet. At this exposure, the dark-grey and black plastic clays with some lignite are found overlying the light-coloured red and grey variegated clays. The contact and attitude of the dark- and light-coloured clays could not be determined, since they were well below water-level. However, there seems to be little doubt that the dark clays have slumped from their original position, since in every case the bedding was tilted and disturbed. The log of auger hole No. 1, located at the centre of the exposure, is as follows:—

	Thickness	Sample No.	Fusion cone
	ft. in.		
Black-grey plastic clay	2	No. 34	32–33
Water-level.			
Black plastic clay and lignite (about 40 per cent.)	2	.....	.....
Lignite and black clay mixed	2 6	.....	.....
Light-grey plastic clay	1	.....	.....
Total thickness of clay	7 6		

Instead of continuing the auger hole to depth, another hole was located in light-grey clay, 10 feet upsteam. The log of auger hole No. 2 is as follows:—

	Thickness	Sample No.	Fusion cone
	ft. in.		
Light-grey clay	5	No. 32	32
Light-grey clay	2 6	} No. 33	33–34
Grey and brown clay	3		
Red and grey clay	2	.....	.....
Hole bottomed in red and grey variegated clay.			
Total thickness of clay	12 6		

The log of auger hole No. 3, located 150 feet upstream from auger hole No. 2, is as follows:—

	Thickness, ft. in.
Dirty grey clay	1
Grey-black plastic clay	1
Black micaceous clay, with some sand	2
Dirty grey micaceous clay	1 6
Grey clayey sand, with some mica	1
Total thickness of clay	6 6

The auger hole was abandoned on account of water and caving.

Exposure No. 8.—On the left bank, 300 feet upstream from exposure No. 7, grey-white and variegated red to brown refractory clay, extending 4 feet above water-level, is exposed for 220 feet. The log of auger hole No. 1, located at the downstream end of the exposure, is as follows:—

	Thickness	Sample No.	Fusion cone
	ft. in.		
Light grey-brown clay	2 6	No. 26	32–33
Grey-white clay	1		
Water-level.			
Red, grey, and brown clay	4 6	No. 27	31
Light-grey micaceous sandy clay, with some brown clay	2 6	No. 28	32
Red and grey clay	5	No. 29	31
Red, brown, and mauve clay	1 6	No. 30	30
Red, grey, and brown clay (some sand?)	1 6	No. 31	31–32
Hole bottomed in grey and brown clay.			
Total thickness of clay	18 6		

Auger hole No. 2, 100 feet upstream from auger hole No. 1, gave the following log:—

	Thickness, ft. in.
Grey-white, red, and brown clay	2
Grey and white clay	6
Red and grey clay	1 6
Water-level.	
Red and grey clay	2 6
Brown, grey, and green clay, with considerable mica	1 6
Red and grey clay (1-inch sand seam)	3
Red and brownish-green clay	5
Light grey-white clay, lower foot rather sandy	2
Red and grey, and brown clay	1
Mauve, red, and brown clay	2
Hole bottomed in red and brown clay.	
Total thickness of clay	21

Exposures Nos. 9 and 10.—These exposures are on the left bank directly opposite exposure No. 4 on the right bank. Exposure No. 9 is a small showing of red and grey clay in the river bed, and exposure No. 10 is a grey clay. Neither showing is very extensive. Pits and auger holes failed to give good sections, since water and caving would not permit a great deal of work.

Exposures of grey clay and silica sand with a little kaolin were traced either just above or below water-level upstream from exposure No. 10 to a point opposite exposure No. 1 on the right bank. No sections were obtained, since it was impossible to sink auger holes or test pits in the silica sand.

Location C

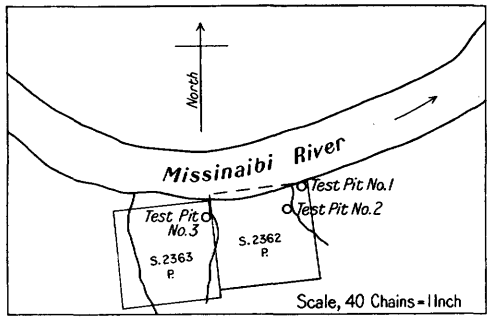
At this location, which is a quarter of a mile downstream from Soweska river, extensive beds of silica sand outcrop along the Missinaibi and the small streams flowing into it. They appear to be widespread and in many places quite thick, the silica sand at one exposure extending 25 feet above water-level. Unfortunately, in the four exposures that were opened up by pit-sinking or trenching, the sands were low in kaolin and badly iron-stained. For the present, at least, this deposit appears to be uneconomic, and only one exposure will be described.

Exposure No. 1.—On the left bank of the Missinaibi, 1,400 feet downstream from Soweska river, grey-white silica sand with a thin band or lens of grey-brown plastic clay outcrops above water-level for 250 feet. The following section was exposed by a test pit:—

	Thickness	Sample No.	Fusion cone
	ft. in.		
Glacial till	7	.....	.....
Silica sand, badly iron-stained	8	.....	.....
Grey-brown plastic clay	1 3	} No. 2	33
Cream and grey-white silica sand, with some kaolin	4		
Water-level.			
Hole bottomed in silica sand.			

The bank at this exposure is terraced and quite low near the shore line, but rises steeply to 60 or 70 feet a short distance from the river.

Very thin (an eighth to a quarter of an inch) lenses of grey-white clay were observed in the silica sand just above water-level. This undoubtedly accounts



Plan showing Tees-Curran claims and location of test pits Nos. 1, 2, and 3, Location D, Missinaibi river.

for the very low kaolin content in the upper part of the sand beds, since the kaolin would naturally filter downward and become concentrated under the action of water.

Location D

On the right bank of the Missinaibi, about five miles above the Wabiskagami river, light-coloured refractory clays and silica sand outcrop above water-level for a distance of 2,000 feet. Although a very careful examination was made of the opposite bank, no outcrops of silica sand or refractory clay were uncovered. Silica sand of a good colour but low kaolin content underlies the clay seam, and in one instance overlies it. Up to the present time, the deposits found at this location rise higher above sea or river water-level than at any other location in the Moose River basin. At one exposure, the silica sand is between 55 and 65 feet above summer water-level, while at another the bottom of a 9-foot clay seam is about 27 feet above.

The clay and silica sand occurrences at this location are of the light-coloured, mottled red and grey type. The clay seam appears to be fairly continuous and extensive, flat-lying and well above water-level. Although the thickness of the

seam is uncertain, it appears to range from 3½ to 9 feet. No extensive beds or seams of white refractory clay were uncovered, although a very careful search was made. Several small lenses or patches of this clay were found in the bed of the river at indentations along the shore line. The presence of the white clay is probably due to the river washing the kaolin out of the silica sand and carrying it down to quiet water, where it settles and becomes concentrated. The claims are held by W. Tees-Curran, of Montreal.

Test Pit No. 1 (Claim S. 2,362).—On the right bank of the Missinaibi at the extreme downstream end of the deposit, red and grey mottled refractory clays and silica sand extend 18 feet above water-level. The total length of this exposure was not determined, owing to sloughing of the banks. The section from the top of the bank to water-level is as follows:—

	Thickness	Sample No.	Fusion cone
	ft. in.		
TEST PIT:			
Glacial till	5	.....	.....
Red and grey-white clay	1 6	No. 3	29–30
Sandy red and grey clay	1 6		
Light-grey sandy clay	6	.....	.....
Cream-white silica sand and kaolin	2 3	No. 4	
AUGER HOLE:			
Cream-white silica sand, iron-stained	4	.....	.....
Fine white silica sand and kaolin	2 6	No. 5	
White silica sand and kaolin	2 6		
Water-level.		No. 6	.....
White silica sand, with some kaolin and iron-stains	2		
White clay from river bed	3 6	No. 8	32
Hole bottomed in silica sand.			

Test Pit No. 2 (Claim S. 2,362).—This pit is located on the left bank of a little stream that flows into the Missinaibi, a few hundred feet above its mouth. Light-coloured clays and silica sand outcrop for 200 feet. The contact between the cream silica sand and glacial till is approximately 40 feet above the water-level of the Missinaibi. The section opened up is as follows:—

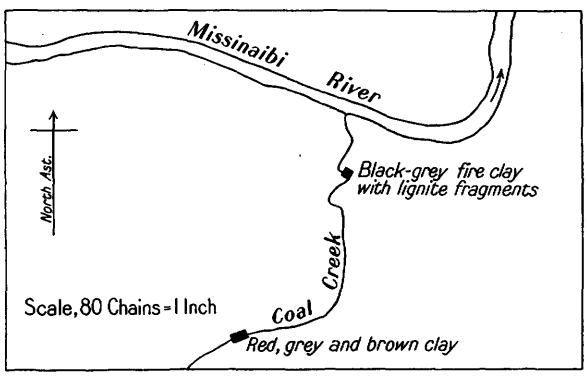
	Thickness	Sample No.	Fusion cone
	ft. in.		
Glacial till	2	.....	.....
Cream silica sand and kaolin	4	.....	.....
Brownish-cream clay	10	.....	.....
Red and cream mottled clay	2 6	.....	.....
Light grey sandy clay	2 2	No. 7[1]	29–30
Red and grey mottled clay	3	.....	.....
Grey and cream clay	6	.....	.....
Hard grey cement-like silica sand and some impure kaolin	2	.....	.....
Fairly white silica sand and kaolin	2	.....	.....
Fairly white silica sand and kaolin, with iron discoloration	3	.....	.....
Concealed, possibly silica sand.			
Thickness of clay	9		

[1]Best 14 inches.

Test Pit No. 3 (Claim S. 2,363).—Test pit No. 3 really consists of a series of pits that were put down on the face of a silica sand exposure along a small stream at the boundary lines between claims Nos. 2,363 and 2,362. In all the pits, silica sand of a fairly good colour, but low kaolin content were encountered. It is here that the contact between the glacial till and the silica sand or refractory clay is some 58 or 60 feet above water-level. From 1 to 2 feet of fire clay with pebbles overlie the sand. On the opposite bank of this stream, R. J. Montgomery and R. J. Watson reported 2½ feet of fire clay overlying the silica sand. However, since their visit to the property in the summer of 1926, the clay has been completely hidden by large blocks of glacial till.

Location E

On Coal creek, a small tributary of the Missinaibi river, about 8½ miles downstream from the pre-Cambrian contact, there are two pre-glacial clay exposures. The first exposure is approximately 2,000 feet upstream from the



Plan showing clay occurrences on Coal creek, Location E, Missinaibi river.

mouth, and the second, 1½ miles. At the first exposure, the water was too high to permit the sinking of test pits or auger holes. However, black-grey clay with lignite fragments was traced for a short distance in the bed of the river. At the second exposure, red, brown, and grey plastic clays extend a few feet above water-level. Auger holes were sunk, but very little information was gathered from them, since hard obstructions were encountered at a shallow depth in every hole. The clay occurrences are quite small and inaccessible, and do not appear to warrant a great deal of work or consideration.[1]

Location F

This location is on the right bank, 600 feet below the little rapids, or two miles below the pre-Cambrian contact. There are two small exposures of red and grey mottled plastic clay, extending 2½ and 2 feet, respectively, above summer water-level. The most westerly occurrence is along the foot of the pegmatite dike that forms the bank of the river at this point. At the easterly exposure of clay, the dike is some distance away from the river.

[1]For a description of these occurrences, see the report by R. J. Montgomery and R. J. Watson, Ont. Dept. Mines, Vol. XXXVII, pt. 6, 1928.

The age of the clay is uncertain, but the low fusion cones (cones 8 to 12) and the nearness of the pre-Cambrian contact would seem to place them either in the Devonian or the Lower Cretaceous. However, more work will be necessary before conclusions can be drawn with any degree of certainty. In any case, the deposit is rather inaccessible to be considered economic at the present time.

Exposure No. 1.—Approximately 600 feet below the right bank of the little rapids, red and grey mottled clay is exposed above water-level for a length of 20 feet. An auger hole gave the following section:—

	Thickness	Sample No.	Fusion cone
	ft. in.		
Red and grey mottled clay	2 6	.....	.....
Water-level.			
Red, grey, and brown clay	4	No. 9[1]	11–12
		No. 12[2]	9
Red, brown, and grey clay	5		
Grey-white clay	6	No. 10	8
Red, brown, and grey clay	2		
Hole bottomed in clay.			
Total thickness of clay	14		

[1]Lower 2 inches.
[2]From 1 foot 8 inches to 2 feet.

Exposure No. 2.—Three hundred feet above exposure No. 1, another small exposure of red and grey mottled clay extends 2 feet above water-level. The outcropping is small and directly at the foot of a large pegmatite dike that rises from 80 to 100 feet above water-level. One auger hole was sunk to 11 feet, giving a section as follows:—

	Thickness	Sample No.	Fusion cone
	ft.		
Red and grey mottled clay	1		
Water-level.			
Red, brown, and grey mottled clay	2	No. 11	16–17
Red and grey mottled clay	8		
Hole bottomed in clay.			
Total thickness of clay	11		

Occurrences on the Tributaries of the Missinaibi

Opazatika River

This river was covered on foot for 3 miles above the mouth, and then by canoe as far as Friday creek, 15 miles upstream. No exposures of pre-glacial clay or sand were observed, although the water level of the river was extremely low. The only occurrences of geological interest are the interglacial clay and peat beds exposed along the river bank just above water-level.

Soweska River

A very careful examination was made of the shores of this stream for 5 miles above the mouth. Interglacial peat and peaty clay beds, some 3½ miles upstream,

are exposed along the river bank for a distance of 2,500 feet. The thickness of the peat beds varies from 4½ to 5½ feet.

Little Soweska River

Silica sand with a little kaolin outcrops at two points along this stream. The sand, however, is very badly iron-stained and of little economic importance. For the position of these outcrops, see map on page 89. The stream was covered on foot for 2 miles upstream.

Wabiskagami River

No exposures of pre-glacial clay or sand were observed in the 5 miles covered by canoe. The red and grey mottled refractory clay occurrences about 6 miles above the mouth were not examined owing to their inaccessibility. A description of these clays has been given by R. J. Montgomery and R. J. Watson.[1]

Conclusions

It may be safely stated that the preliminary survey during the summer of 1932 definitely indicated two very promising deposits of refractory clay. The outstanding features of these occurrences are the uniformly high pyrometric cone equivalents of the clays, and the good thickness and length of the exposures. Although no definite estimate of the tonnages at the various deposits can be given, the possibility of blocking out commercial quantities are good. Another favourable feature is the moderate thickness of overburden as compared with other clay deposits in the Moose River basin.

Pits and auger holes at the Ruby-Sheppard claims (Location B) penetrated up to 24½ feet of very refractory clay (cones 30 to 25) and bottomed in it. In fact nearly every auger hole was in clay when augering operations were suspended. The benches or terraces along the river bank at these claims afford an excellent opportunity for a small-scale stripping operation. The clay exposures are numerous and extensive.

The refractory clay occurrences at the Tees-Curran claims (Location D) are fairly extensive but not very thick, the maximum thickness being 9 feet. The fusion cones of the clay run from 29 to 32. The one very favourable feature at this deposit is that the bottom of the clay seam is well above river water-level and lends itself to easy and cheap recovery.

For the present it seems quite safe to say that the successful development of these deposits will depend on the possible uses for this particular type of refractory clay, and the solving of the problem of transportation, factors which as yet have received only a limited consideration.

The primary objective of the survey was to ascertain whether china clay deposits with commercial possibilities occur on the Missinaibi or its tributaries. In brief, the deposits located were of the red and grey mottled refractory clay type with occasional seams or lenses of white refractory clays. These lenses or seams of white clay are thin and irregular and, at the best, could only be worked in conjunction with the red and grey mottled clays.

[1]Op. cit.

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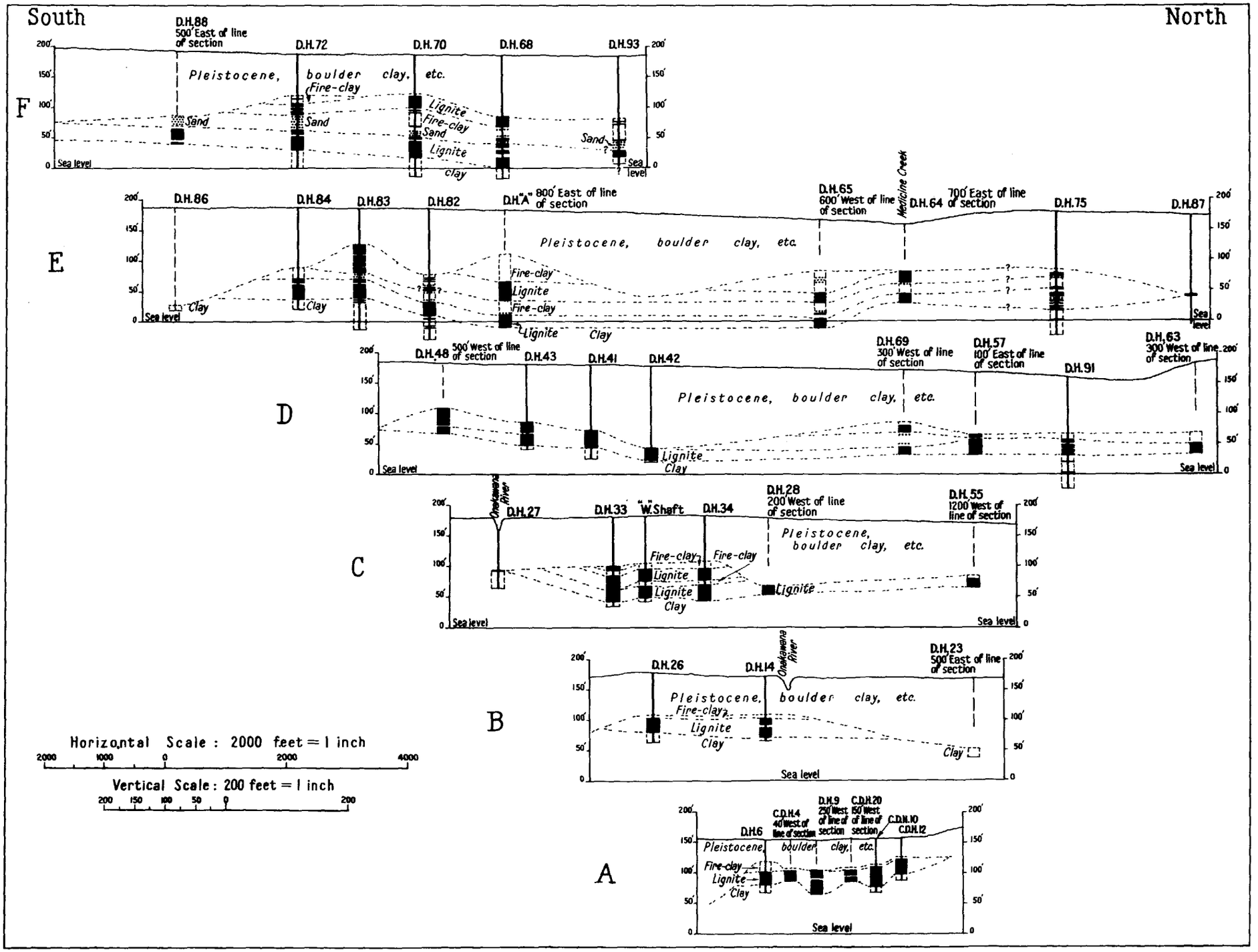


Fig. 6—Geological sections from south to north through the Onakawana lignite field (see key plan, Fig. 4).

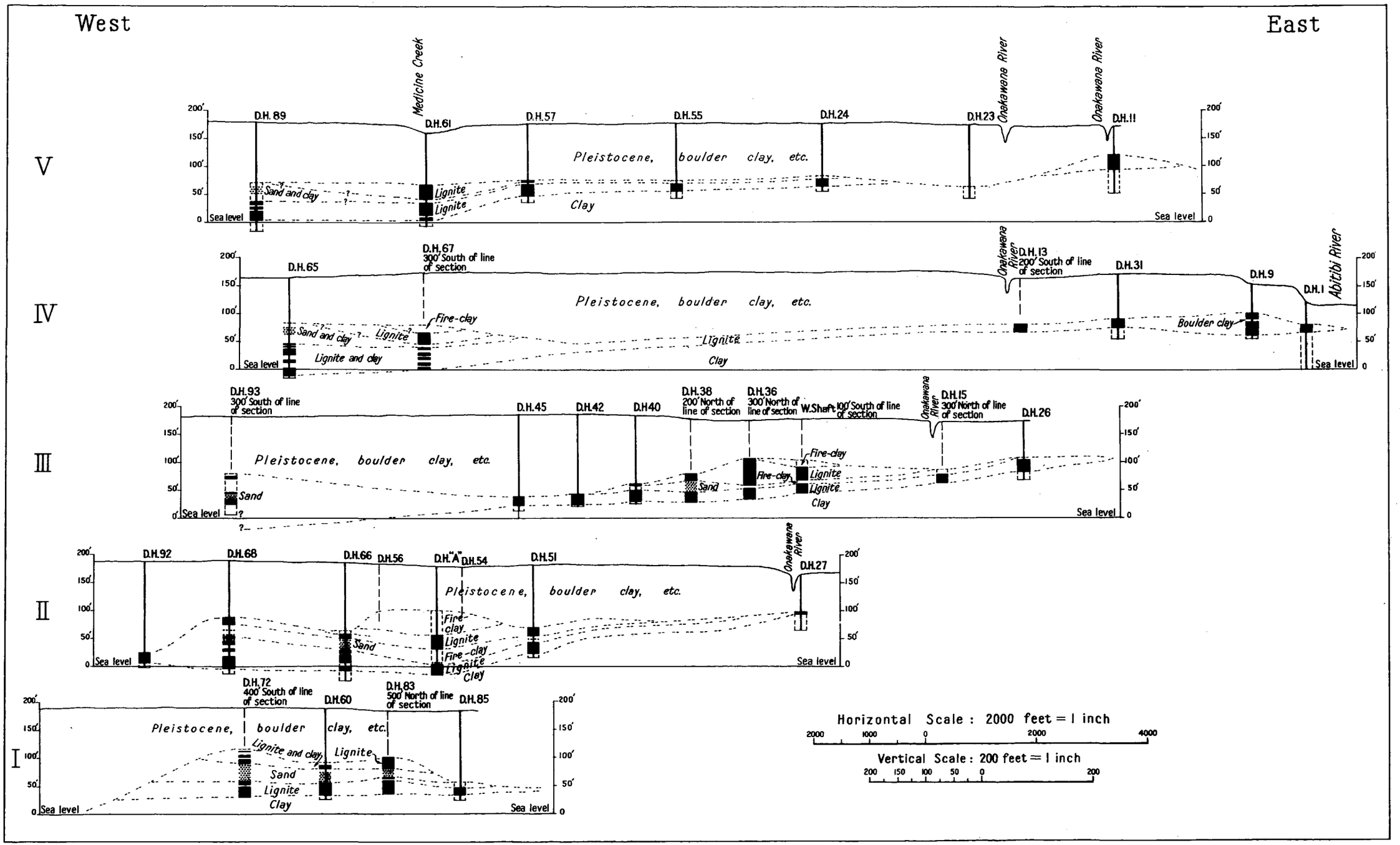
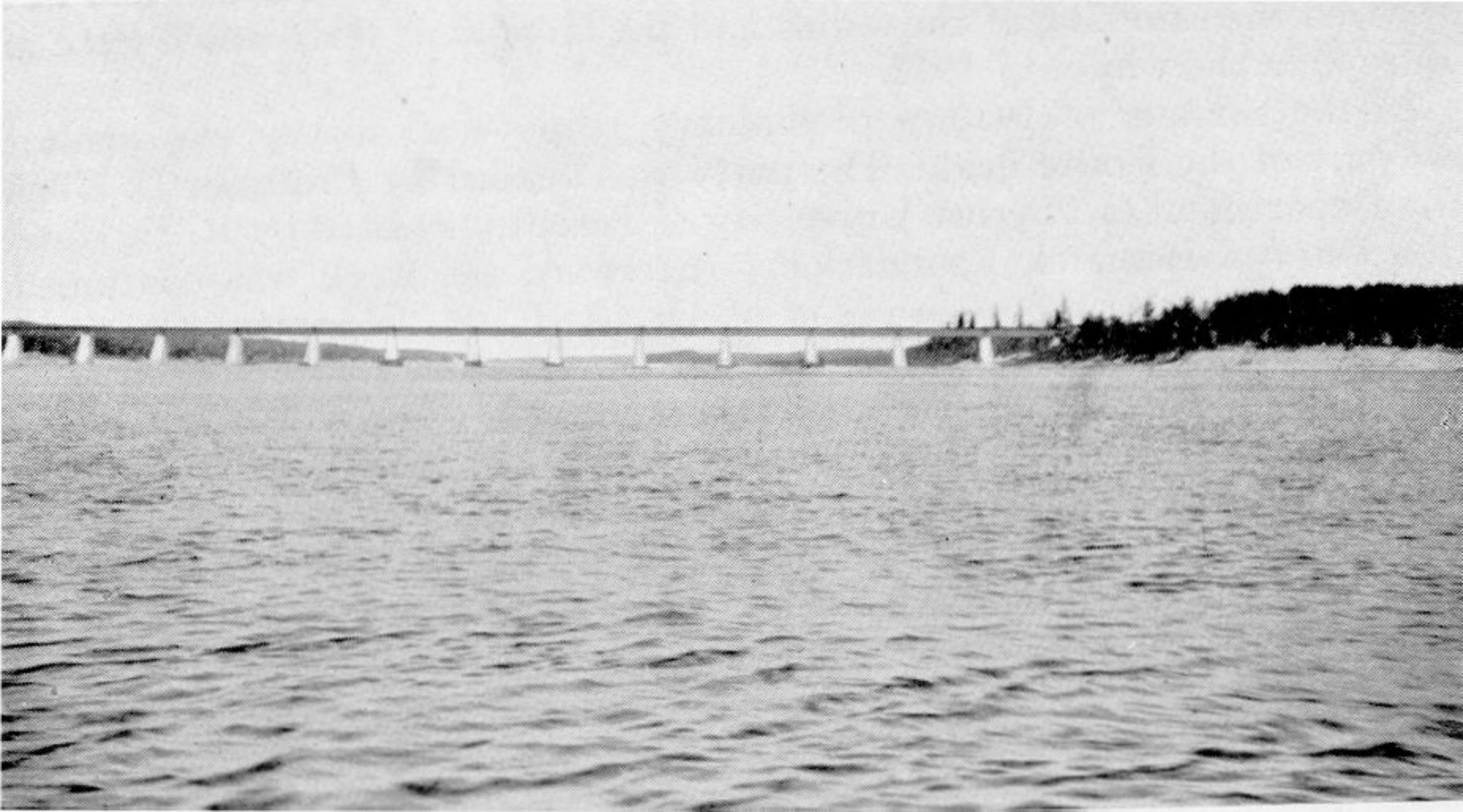


Fig. 7—Geological sections from west to east through the Onakawana lignite field (see key plan, Fig. 4).









PROVINCE OF ONTARIO
DEPARTMENT OF MINES

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

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COLOURED GEOLOGICAL MAPS

(In pocket at back of report)

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Map No. 42*c*—Manitou-Stormy Lakes Area, District of Kenora, Ontario. Scale, 1 mile to the inch.

Courtesy Royal Canadian Air Force



Aerial photograph of Upper Manitou lake looking northeastward across the lake from the southwestern corner.

Geology of the Manitou-Stormy Lakes Area

By Jas. E. Thomson

INTRODUCTION

About thirty years ago the Lake of the Woods region became the scene of considerable gold-mining activity. During the same period the Manitou Lakes area had a similar "rush," and several gold mines were opened. The majority of these never reached the production stage, but a small amount of gold was recovered from a few properties. Around 1912 practically all mining in the area ceased. Since that time sporadic attempts have been made to reopen a few of the old mines but, so far, without success. The failure of these early mining ventures somewhat curbed prospecting activity in the area, although each year

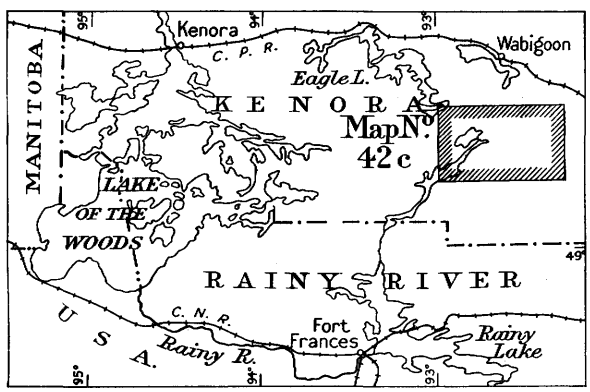


Fig. 1—Key map showing location of the Manitou-Stormy Lakes area. Scale, 50 miles to 1 inch.

a few prospectors have returned to the area, generally to do development work on old mining locations.

The recent intensive search for gold deposits in the older regions located within a short distance of the railways makes areas such as this assume a new importance. During the summer of 1932, the writer was instructed to make a geological survey of a considerable part of the Manitou Lakes area in the hope of obtaining new geological information that would be of assistance in further prospecting of the country. Favourable conditions for the occurrence of gold deposits were found, the geology, in general, being similar to that in the well-known gold camps of Northern Ontario. Gold has been found over a widespread area around the Manitou lakes, but, in recent years, a concentration sufficient to make an ore body of commercial importance has not been found. Despite the long and rather disappointing history of the area, there is reason to believe that an intensive search may yet reward the investigator.

The Manitou Lakes area lies south of Wabigoon, which is a station on the Ignace-Kenora division of the Canadian Pacific railway in the district of Kenora. The area examined during the field season is shown on the geological map (No. 42*c*) that accompanies this report. It is underlain by early pre-Cambrian rocks

and extends from Upper Manitou (also known as Anzhekumming) lake eastward to Kawashegamuk and Stormy lakes and from Minnehaha lake on the north to Lower Manitou, Meggisi, and Wapageisi lakes on the south. This is only a part of the larger belt of similar rocks that extends northward towards Sioux Lookout and southward into the district of Rainy River.

The Dryden sheet (No. 52F) of the National Topographic series, issued by the Topographic Survey of Canada, provides an excellent aerial map of the region. This was used in the preparation of the geological map of the area. A few minor alterations and additions have been made to this topographic map, chiefly in the drainage of small lakes and the location of portages. The area is included in two general geological maps, prepared by McInnes,[1] but apart from reports by Parsons[2] and Bruce[3] on some of the mining locations, there has been no previous detailed investigation of the geology.

Acknowledgments

The writer and his party wish to express their appreciation of the many courtesies extended during the summer by various individuals. The writer is indebted to Chas. W. Merrill, of Wabigoon, for transportation of supplies and assistance in the location of abandoned mine workings. The kindness and hospitality of Mr. and Mrs. Geo. B. Scattergood at "Camp Find Us," their summer home at Goldrock, added greatly to the pleasure of the field season.

G. S. MacKenzie, F. H. Burnaby, and Bruce Russell rendered able assistance in the field. Mr. MacKenzie, as senior assistant, did a considerable part of the geological mapping. The party is indebted to W. J. Russell, professor of the University of Western Ontario, and Bruce Russell for the use of their outboard motor during the summer.

Assays and chemical analyses of samples were made by the staff of the Provincial Assay Office.

Access

The Manitou-Stormy Lakes area may be easily reached from either Wabigoon or Fort Frances. During the summer months Chas. Merrill operates a transport service, generally bi-weekly, from Wabigoon to Goldrock. Goldrock is located at the northern extremity of Upper Manitou lake and was a small village during the days when the gold mines in the vicinity were operating. A 7-mile government road extends from Goldrock to Minnehaha lake. In the summer Mr. Merrill operates a 1½-ton truck on this road and runs a large motor boat from Minnehaha lake to Wabigoon.

The area is covered by a myriad of lakes, so that all parts may be reached by convenient canoe routes. From Goldrock motor boats can run southward through the various lakes and straits to the dam located on the Manitou river above Rainy lake. At the outlet of Upper Manitou lake and above Mr. Watson's farm there are narrows that offer some difficulty to boats with a draught of more than about 2 feet of water.

Two canoe routes extend eastward from the Manitou lakes. The northerly route passes through Boyer, Aiabewatik, Nozheiatik, and Stormy lakes to Kawashegamuk lake. The southerly route is from Manitou straits through

[1]Wm. McInnes, Manitou Lake Sheet, Geol. Surv. Can., Map No. 720, 1902; Ignace Sheet, Geol. Surv. Can., Map No. 663, 1906.

[2]A. L. Parsons, Gold Fields of Lake of the Woods, Manitou and Dryden, Ont. Bur. Mines, Vol. XX, pt. 1, 1911; Vol. XXI, pt. 1, 1912.

[3]E. L. Bruce, Gold Deposits of Kenora and Rainy River Districts, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925.

Cane and Scattergood lakes to Meggisi lake. A fairly good canoe route extends from Boyer lake south to Washeibemaga lake and through Sagenak and Kawijekiwa lakes to Stormy lake. Meggisi lake may also be reached from Washeibemaga lake by way of Kennewapekko lake and from Eagle Rock lake on the south.

Previous Geological Work

Geologists and inspectors of the Ontario Bureau of Mines made short visits at the various mines and prospects of the Manitou Lakes area in the days when mining operations were being carried on. Coleman and Miller have described some of the geological features in the vicinity of mining locations; and Bow, Carter, and Corkill, during their trips of mining inspection, have discussed the development of properties. As previously mentioned, general geological maps of the area have been made by McInnes,[1] and were published by the Geological Survey of Canada in 1902 and 1906. In 1911, Parsons described the gold mines around Goldrock and made a geological map of a small area in that neighbourhood. He revisited the area in 1912. In 1925, Bruce reported on the gold deposits of Kenora and Rainy River districts. He included in this survey a detailed examination of the Laurentian, Big Master, and Sakoose mines.

The following is a selected bibliography of literature on the area:—

A. Blue, Ont. Bur. Mines, Vol. V, 1895, p. 163.

Jas. A. Bow, Ont. Bur. Mines, Vol. VII, pt. 1, 1897, pp. 75-78; Vol. VIII, pt. 1, 1899, pp. 72-76; Vol. IX, 1900, pp. 61-64.

E. L. Bruce, Gold Deposits of Kenora and Rainy River Districts, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, pp. 34-39.

W. E. H. Carter, Ont. Bur. Mines, Vol. X, 1901, pp. 97-102; Vol. XI, 1902, pp. 244-249, 255; Vol. XIII, pt. 1, 1904, pp. 66-70; Vol. XIV, pt. 1, 1905, pp. 51-54.

A. P. Coleman, Ont. Bur. Mines, Vol. IV, 1894, pp. 62-67; Vol. VI, 1896, pp. 83-87; Vol. VII, pt. 1, 1897, pp. 121-125.

E. T. Corkill, Ont. Bur. Mines, Vol. XV, pt. 1, 1906, pp. 50-53; Vol. XVI, pt. 1, 1907, pp. 57, 58.

Wm. McInnis, Geol. Surv. Can., Vol. X, 1897, pp. 42, 43.

W. G. Miller, Ont. Bur. Mines, Vol. XII, 1903, pp. 91, 92.

A. L. Parsons, Gold Fields of Lake of the Woods, Manitou, and Dryden, Ont. Bur. Mines, Vol. XX, pt. 1, 1911, pp. 178-188; Vol. XXI, pt. 1, 1912, pp. 194-198.

History and Development

It is impossible to state when gold was first found in the Manitou Lakes area. In 1894, after Coleman's first visit to the area, he wrote:—

> Up to the present Manitou lake has yielded only specimens, some of them exceedingly fine, however. There is no mine and no stamp mill on its shores, and the deepest exploration at the time of our examination did not go down more than 25 feet.[2]

During 1895 and 1896, there were glowing accounts of gold discoveries in the area, and in 1896 a small mill was constructed near the present location of the Gold Rock mine to handle job lots of ore from nearby properties. In 1897 communication was aided by the construction of a government road from Goldrock to Minnehaha lake. A dam was also built at this time on the Manitou river to raise the level of Lower Manitou lake, so that boats could navigate the full length of the chain of lakes. Then followed a great mining "boom." Between 1895 and 1912, reports of the Ontario Bureau of Mines show that at least 20 mines were opened up around the Manitou lakes, and other prospects are referred

[1] Wm. McInnes, op. cit.
[2] A. P. Coleman, Ont. Bur. Mines, Vol. IV, 1894, p. 66.

to. In many cases these so-called mines would be more properly termed prospects, as only a small prospect shaft was sunk and then the property was abandoned. However, complete surface equipment, including a mill, was generally erected at each mine. By 1900, Bow reported that mining development was slow but stamp mills were coming into the area, which was believed to be an encouraging sign.

About this time there was some prospecting activity in the area northeast of Kawashegamuk lake. This became known as the "New Klondike" area. Interest was chiefly centred around a property that later was developed into the Sakoose mine. In 1906, there was a revival of interest in the Manitou country by the discovery of very spectacular gold ore on the first level of the Laurentian mine. However, the ore body proved to be small. By 1912, mining in the area had practically ceased. During the entire period only three mines—the Laurentian, Big Master, and Sakoose—ever milled any appreciable amount of ore. The total gold production from the Laurentian mine is recorded at about $141,000, although it is reported that much gold was stolen. The production from other properties is not known.

A few of the more promising mining locations have been re-examined. In 1913 and in 1916, the Laurentian was examined, but no work was done. The Big Master was also investigated in 1916. During 1928 and 1929, the Gold Rock mine was opened on an old mining location at the southwest end of Upper Manitou lake. No work has been done since 1929. The Sakoose mine was sampled in 1931, and a small amount of diamond-drilling was done.

Systematic exploration of claims on Manitou island and around the northern part of Lower Manitou lake has been carried on in recent years.

Topography and Drainage

The Manitou-Stormy Lakes area shows the typical topographic features of the pre-Cambrian shield. It is essentially a nearly level peneplain, although low rounded hills in some parts present a rather rugged appearance. The relief is probably not more than 200 feet at any point. From the height-of-land that runs across the northern part of the area a very gentle slope extends southward. In the extreme northern part of the map-sheet, glacial lake deposits form a thin veneer over a small part of the country. These form the southern margin of the clay belt that is found around Wabigoon and Dryden. The remaining part of the area is very largely rock outcrop. The rocky shore line of almost every lake adds to the natural beauty of the country. Areas of swamp and muskeg are rare. Underbrush is rather sparsely distributed except in a few areas of brulé, where walking is impeded by small thickly interwoven jackpines.

The most conspicuous feature of the topography is the abundance of lakes. Probably one-quarter to one-third of the area is covered by water. The shape and general pattern of these lakes have been largely determined by the character of the bed rock. In those parts of the area where the underlying rock is schistose greenstone or sediments, the general elongation of the bodies of water is either parallel to the regional schistosity or controlled by the structure of the sediments. For example, the general northeast-southwest trend of Upper and Lower Manitou and neighbouring lakes is approximately parallel to the strike of the rock cleavage. Mosher bay presents a distinct departure from this general pattern but has developed along the contact of a belt of steeply folded sedimentary rocks. Faulting has undoubtedly been responsible for the shape and location of certain lakes. A fault of considerable magnitude extends through the Manitou straits

and northward to Kabagukski lake. It may possibly continue southward along the eastern shore of Lower Manitou lake. A zone of soft fissile schists was developed along the fault. These were rapidly eroded in comparison with the surrounding massive rocks, and lake basins were formed in the resulting depressions when the post-glacial drainage system was established. The general trend of topographic features in the upper part of Lower Manitou lake is well brought out in aerial photographs.

In the eastern part of the area, Kawashegamuk, Stormy, and other lakes lie parallel to the underlying rock structures. Where the bed rock is hard massive greenstone or granite the lakes are irregular in outline. Boyer, Aiabewatik, Meggisi, and Wapageisi lakes are examples.

The main drainage systems are largely through lakes connected by short streams or straits. North of the height-of-land, the lakes from Aiabewatik to Minnehaha flow into Dinorwic lake and thence to the Wabigoon river. East of the divide, the drainage is through Stormy and Kawashegamuk lakes to Dinorwic lake. South of the height-of-land there are three drainage basins, which empty into Rainy lake. The most easterly drains by way of the Turtle river; the central, of which Meggisi lake is part, is by way of Kaopskikamak lake into Redgut bay; and the westerly is through the Manitou river.

Natural Resources

Timber

Much of the timber within the area is second growth and of little economic importance. The forest trees are principally spruce, balsam, poplar, birch, cedar, red and white pine, and jackpine. Old saw-mills and lumber camps at various places throughout the country indicate considerable lumbering activity in the past. A few good stands of red and white pine may still be seen, but they are of small extent and in the more inaccessible parts of the country. Many large pines were noticed north and east of Wapageisi lake. A small ground fire swept through part of this area in 1932.

Brulé of several different ages is found, but the extent of recently burnt-over country is not great, the largest areas being near Scattergood lake and from Wapageisi lake eastward to the limit of the map area.

Game and Fish

The area abounds with game. Deer, moose, bear, porcupines, wolves, weasel, and skunk are very plentiful. Partridge are seen everywhere, and ducks are abundant in the summer and fall on some of the smaller lakes.

All the larger lakes contain lake trout, whitefish, and pike. Black bass are caught in Johnar lake. Brown trout have been placed in Sasakwei lake. An occasional maskinonge is caught in the Manitou lakes. Commercial fishing is carried on in Upper Manitou, Lower Manitou, and Boyer lakes. In the past, Stormy and Kawashegamuk lakes have also been fished commercially.

Agriculture

There is very little of the area suitable for farm land, but small patches of clay soil north of Kawashegamuk lake could be so utilized if necessary. Excellent vegetables are grown in gardens at Goldrock and at Mr. Watson's farm on the Manitou straits.

Tourist Camps

Every summer, tourists make canoe trips through the Manitou lakes, which are on a canoe route from Rainy lake north to the C.P.R. and on to the C.N.R. While the whole region contains delightful scenery and abundance of game and fish, the natural beauty and accessibility of the Manitou lakes renders them particularly attractive to lovers of the outdoors. Tourist camps are located on the north end of Rainy lake within easy reach of Lower Manitou lake.

GENERAL GEOLOGY

The consolidated rocks of the area are almost entirely of early pre-Cambrian (Archean) age. They present an interesting diversity of types. In some localities such a variation and intermingling of rocks is found within short distances that it is difficult to represent them on a geological map. On the whole, there is a certain similarity between the succession of rocks in the Manitou-Stormy Lakes area and that in the Rainy Lake area to the south, which has been described by Lawson.[1] The greater part of the map area is underlain by Keewatin lavas, pyroclastics, and associated sediments. Near the western margin of the greenstones a complex of gneisses and sediments somewhat resembles the Coutchiching rocks. A belt of sedimentary rocks, lying stratigraphically above the Keewatin series, is of Timiskaming age. While the greater part of the granite and associated porphyries belongs to the Algoman period of plutonic intrusion, certain small areas of the earlier Laurentian granite are found.

The various formations may be classified as follows, the oldest rocks being placed at the bottom:—

QUATERNARY	
PLEISTOCENE and RECENT:	Stratified clays, boulder clay, sand, gravel, peat.
	Great uniformity
PRE-CAMBRIAN	
KEWEENAWAN(?):	Diabase.
	Intrusive contact
ALGOMAN:	Quartz and feldspar porphyry; aplite. Hornblende and biotite granite and gneiss.
	Intrusive contact
PRE-ALGOMAN:	Gabbro, diorite, quartz diorite, lamprophyre.
	Intrusive contact
TIMISKAMING:	Manitou Series: Conglomerate, arkose, quartzite and slate, with some associated agglomerate and tuff.
	Unconformity
LAURENTIAN:	Altered granite and gneiss, granodiorite, quartz monzonite, sericite schist.

[1]A. C. Lawson, The Archæan Geology of Rainy Lake Re-Studied, Geol. Surv. Can., Mem. 40, 1913.

Intrusive contact

KEEWATIN:
- Clastic sediments, chiefly arkose and quartzite, interbedded with lava flows.
- Agglomerate and tuff with occasional interbedded lava flows.
- Acid volcanics: Rhyolite, trachyte, felsite.
- Basic volcanics:
  - Massive andesite, basalt, and pillow lava.
  - Feldspar basalt porphyry.
  - Chlorite and hornblende schist.
- Complex of gneisses, sometimes garnetiferous; impure quartzite; chlorite schist. (This may be Coutchiching in age.)

Keewatin

Complex of Gneiss, Quartzite, and Schist

West of Upper and Lower Manitou lakes, there are three belts of much altered gneisses, quartzites, and schists, which lie between the Keewatin green-



Banded gneisses on the east side of Olsen bay, Lower Manitou lake. These gneisses may be Coutchiching in age.

stones and the granite. Hornblende syenite and other differentiates of the granite have been injected into these metamorphosed rocks, making a sort of transition complex. However, in Olsen bay of Lower Manitou lake, the gneisses have a distinct sedimentary character. In places a lamination resembling bedding may be seen in these rocks, and they have the appearance of an impure quartzite. Certain horizons of the gneiss are highly garnetiferous, others contain narrow bands of chlorite schist. Near the greenstone the beds dip at angles of 20° to 35° S.E., which would carry them under the Keewatin rocks. On the west side of the bay erosion remnants of gently dipping gneisses lie on the massive granites. The contact between the two is sharply defined.

Thin sections of the gneisses from the vicinity of Olsen bay show a mosaic of quartz, biotite, and epidote, with lesser amounts of hornblende, garnet, zoisite, magnetite, orthoclase, and plagioclase. The feldspar is generally decomposed. The lamination of the rock appears to be due to the disposition of the quartz, biotite, and epidote in bands. Some of these gneisses correspond

in mineralogical composition to the "Coutchiching mica schists" described by Lawson.[1]

A chemical analysis of a typical gneiss from Olsen bay shows the following composition:—

	Per cent.
SiO_2	63.17
TiO_2	1.01
Al_2O_3	17.38
Fe_2O_3	1.03
FeO	4.86
CaO	5.42
MgO	1.57
Na_2O	3.09
K_2O	1.20
H_2O	1.04
CO_2	.29
P_2O_5	.12
S	nil
Total	100.18
Specific gravity	2.811

The ratio of magnesia to lime and of potash to soda in this sample is in accordance with the general characteristics of igneous rather than sedimentary gneisses.

Both structurally and lithologically this complex, especially that portion near Olsen bay, somewhat resembles the Coutchiching rocks on Rainy lake. Owing to the fact that the writer spent only a couple of days at the end of the field season in examining the Olsen bay section, it is not possible to make too conclusive statements, but further examination of this and the country to the south of the map area might disclose a pre-Keewatin series. McInnes[2] shows that this belt extends to the southwest for several miles.

Basic Volcanics

The greater part of the Keewatin series consists of lavas ranging from andesite to basalt in composition. They generally extend in monotonous continuity for long distances, but in certain sections are interbedded with agglomerate and tuff. Pillow structures are found, but they are not sufficiently numerous or well preserved to afford a key to the structure of the lava flows. The pillows often contain amygdules near the periphery. The lavas are ordinarily fine-grained, and are metamorphosed to the typical dark-greenish coloured rocks which may be appropriately termed "greenstones" in the field. In certain places they assume a coarse-grained texture and resemble a gabbro in appearance. Close examination of such exposures will often show that the gabbroic phase may grade into a lava containing flow structure, amygdules, or pillows. Undoubtedly the coarse-grained material represents the central zone of a lava flow where cooling proceeded slowly and crystals were allowed to grow. Where isolated outcrops of this gabbro-like rock are found, it is often impossible to determine whether they are part of a lava flow or the pre-Algoman intrusive gabbro.

Porphyritic lava flows are of common occurrence, and since they somewhat resemble porphyritic intrusives their distinction is important. Phenocrysts of feldspar, often assuming crystal outlines and up to an inch in diameter, occur across widths of from 4 to 150 feet in the lava matrix. The bands are quite

[1]A. C. Lawson, op. cit., pp. 28-33.
[2]Wm. McInnes, Manitou Lake Sheet, Geol. Surv. Can., Map No. 720, 1902.

persistent along the strike. They evidently represent a horizon in a flow, as the zone of phenocrysts gradually fades out on either side into lava. Sometimes pillows may be found in the lava within a few feet on either side of a porphyritic band. Hurst[1] has described a rock of similar appearance which occurs in the Sioux Lookout area as a feldspar basalt porphyry, or "leopard rock." This name has been adopted here, although it is probable that the lava matrix is sometimes andesitic in composition.

Locally the lavas have been sheared to form chlorite and hornblende schists. These are found near granite and porphyry contacts, although occasionally this marginal phase of the greenstones is recrystallized to a dark-coloured, medium-grained amphibolite.



Exposure of agglomerate at Goldrock.

Acid Volcanics

These are very sparsely distributed, being found only in the vicinity of Uphill lake. Here the rocks vary from rhyolite to trachyte in composition. Near the granite they have a felsitic appearance.

Agglomerate and Tuff

Bands of fragmental rocks are associated with the lavas in several parts of the area. They are particularly abundant in the vicinity of Upper and Lower Manitou lakes. Fragments of light-coloured material, sometimes porphyritic, occur in a dark-green matrix. The fragments are occasionally angular in shape but more often are elongated parallel to the schistosity. The matrix is largely altered to chlorite schist, but there is ample evidence that it was once of a tuffaceous nature. Bedding is often observed in the tuffs, and occasionally cross-bedding is found. The beds pass gradually above and below into a tuff breccia or agglomerate. In some cases beds of slate and fine-grained quartzite are interbedded with the agglomerate. A fine example of this may be seen along the Manitou straits immediately west of the northern part of Beaverhead

[1]M. E. Hurst, Geology of the Sioux Lookout Area, Ont. Dept. Mines, Vol. XLI, pt. 6, 1932.

island. The fragments that make up the agglomerate are generally of an acid nature. Microscopic examination shows them to be rhyolite and felsite. The fragments have a maximum dimension of 2 feet and range from this size to minute particles. In some places the agglomeratic fragments are rounded and evidently water-worn. On the first island south of Goldrock, in Trafalgar bay, a narrow horizon of conglomerate occurs in the agglomerate and tuff. This conglomerate contains a few well-rounded pebbles of granite.

The bands of agglomerate and tuff are intimately associated with lava flows. This relationship is well demonstrated at many locations around Upper Manitou lake. Narrow bands of agglomerate and tuff occur in the lavas, and in places an alteration of flows and fragmental material is found across a considerable section normal to the strike of the formation. The contact between



Agglomerate and bedded tuff as exposed on an island in Upper Manitou lake.

individual lava flows and bands of pyroclastics is very well defined. The larger areas of the fragmental rocks associated with the lavas are outlined on the accompanying geological map, but the boundaries between these and the areas underlain by lavas alone must be considered rather arbitrary.

The fragmental-appearing rocks at Goldrock have been interpreted in various ways. McInnes[1] mapped them as greywackés, volcanic tuffs, and agglomerates, but Parsons[2] states that the so-called agglomerate is really a brecciated portion of a quartz porphyry. Bruce[3] was inclined to accept this explanation. The writer's views are in accordance with the earlier interpretation of McInnes. The above-mentioned evidence seems to clearly indicate a certain amount of water-sorting of volcanic *ejectamenta*. It is apparent that volcanic fragmental material, including much ash, was thrown off by explosions from the same sources that produced the lavas. At certain times the fine ash was sorted by erosional agencies. Not only are the agglomerate and tuff associated with the lavas, but they are found to a lesser extent with the sediments of the Manitou series, as will be pointed out later.

[1]Wm. McInnes, op. cit.
[2]A. L. Parsons, Ont. Bur. of Mines, Vol. XX, pt. 1, 1911, p. 180.
[2]E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, p. 34.

Clastic Sediments

Narrow bands of bedded greywacké, quartzite, arkose, and a small amount of conglomerate are found in the greenstones at a rather distinct horizon, which is stratigraphically not far below the sediments of the Manitou series. Many of the bands are too narrow to be shown on a geological map. The largest number of these isolated occurrences are found around Glass bay, Lower Manitou lake. Here several parallel bands of arkose, quartzite, and greywacké are interbedded with the lavas. The sediments occur in bands from less than 10 feet to over 600 feet in width. They have distinct bedding planes, which dip at very steep angles both to the northwest and southeast. Often the beds dip vertically. Plotting of the strikes of the bedding shows that in some parts of the bay these sediments have been faulted considerably. On the northeast shore of Stormy lake and the adjacent shore of Kawashegamuk lake similar bands are found, but here the beds dip at angles of 65 to 80 degrees towards the main sedimentary series.

It is possible that these narrow bands are remnants of the main body of the Manitou series that have been so deeply infolded as to escape erosion. This seems the more logical assumption in the case of the isolated area of sediments east of Cane lake, which is much larger than the others and which contains conglomerate similar to that of the Manitou series. However, the majority of the bands are more probably independent horizons of sediments in the Keewatin series. Their relationship to the lavas would suggest that they were deposited during relatively short-termed, intermittent periods of sedimentation towards the end of Keewatin time, when volcanic extrusions were less frequent in occurrence. The variable thickness, lens-like shape, and clastic nature of the material indicate terrestrial conditions of deposition as flood-plain or deltaic deposits. Bruce[1] has suggested this mode of origin to explain the intimate association of early pre-Cambrian sediments and lavas.

Structure of the Keewatin

The structure of the Keewatin rocks may be vaguely inferred in certain places from fragmentary evidence. As previously stated, the pillow lavas are not sufficiently well developed or widespread in occurrence to furnish a key to the major structural features. However, the bands of agglomerate and bedded tuff provide some information. Inasmuch as the pyroclastics are interbedded with the lavas, the trend of these bands of agglomerate and tuff is approximately the strike of the formation. Thus, the general strike of the lava flows and intercalated volcanic sediments on Upper and Lower Manitou lakes is roughly northeast and southwest, or approximately parallel to the western granite contact. In the tuffaceous horizons the dip of the bedding along this section is 70° to 85° S.E. Moreover, in the neighbourhood of the granite contact, the bedding of the sedimentary gneisses dips at angles of 20° to 35° S.E. This would indicate that the part of these two lakes west of the fault is on the western limb of a syncline, the axis of which trends roughly northeast-southwest.

In other parts of the Keewatin series, little of the structure can be determined.

Laurentian

Small areas of acid plutonic rocks that were intruded at an earlier period than the main mass of granite occur on Upper and Lower Manitou lakes. They

[1]E. L. Bruce, Bull. Geol. Soc. Amer., Vol. 38, 1927, pp. 778-781.

are of a medium- to fine-grained texture and have a grey or greenish-grey colour. The rock is generally an altered granite or granite gneiss, but more basic phases are also found. Granodiorite occurs on Frenchmen island and on some of the other islands in Upper Manitou lake. On Manitou island there is an area of acidic rock that is largely sericite schist. The less altered part of this material, which may be seen in the pits on the sulphide showing owned by Frank Gaffney, is a quartz monzonite. It is a dark-green, medium-grained rock and contains distinct phenocrysts of quartz.

Microscopic Characteristics

Thin sections show the granite gneiss to be composed largely of quartz, orthoclase, andesine, and dark minerals that have become decomposed. There is considerable evidence that hot solutions have circulated throughout the rock. These have altered the primary constituents, producing a large amount of epidote, zoisite, chlorite, pyrite, and carbonate veinlets. The feldspars are sericitized.

The granodiorite contains a mosaic of quartz, orthoclase, andesine, augite, biotite, and hornblende. Secondary minerals are chlorite, epidote, and carbonate in veinlets and stringers. The constituent minerals are granulated along certain crushed zones in the sections.

The quartz monzonite differs from the granodiorite mainly in having a larger content of alkali feldspar, the orthoclase being equal in amount to plagioclase. Thus the rock comes within the limits of quartz monzonite as defined by Lindgren.[1]

A chemical analysis of the Laurentian granite is given below. For purposes of comparison, an analysis of the typical Algoman granite of the area was also obtained. The higher content of water and carbon dioxide in the older granite is due to the above-mentioned alteration effects.

Analyses of Granites

	No. 1	No. 2
	per cent.	per cent.
SiO_2	63.07	66.95
TiO_2	1.04	.39
Al_2O_3	16.26	16.53
Fe_2O_3	1.39	1.60
FeO	4.63	1.17
CaO	2.94	2.83
MgO	1.50	1.36
Na_2O	4.59	5.12
K_2O	.91	2.95
H_2O	2.08	.48
CO_2	1.43	.33
P_2O_5	.24	.10
MnO	.....	.08
S	.04	.01
Total	100.12	99.90
Specific gravity	2.757	2.703

Sample No. 1.—Altered Laurentian granite from an island in the northern part of Upper Manitou lake. Analysed at the Provincial Assay Office.

Sample No. 2.—Pink hornblende granite of Algoman age, Uphill lake. Analysed at the Provincial Assay Office.

[1]W. Lindgren, Amer. Jour. Sci., Vol. IX, 1900, p. 269.

Field Relationships and Correlation

It is difficult to show that all the dikelike masses in Upper Manitou lake that have been mapped as earlier granite are Laurentian rather than Algoman in age. Some of these are included with the earlier granite on account of a lithological similarity to other areas where the evidence is more definite. The reasons for delineating the Laurentian granite from the later Algoman granite that intrudes the Manitou series are as follows:—

1. The Laurentian rocks are schistose, the schistosity being parallel to that of the Keewatin greenstones. It is, therefore, apparent that the intense folding, which preceded or was contemporaneous with the intrusion of the Algoman granite, deformed Keewatin and Laurentian rocks alike. The Laurentian granites are definitely intrusive into the greenstones. This relationship may be observed on several islands in Upper Manitou lake. Xenoliths of agglomerate are found as inclusions in the granite on the island immediately south of Frenchmen island.

2. The sheared granitic rocks are intersected by massive quartz porphyry dikes. The porphyry dikes are intrusive into the Manitou series of sediments, and they present every evidence of being genetically related to the Algoman granite.

3. Quartz veins intersect the Laurentian granitic intrusives. Throughout the area these veins show a close genetic relationship to the Algoman rocks.

4. Microscopic examination shows the older granites to have suffered considerable alteration by circulating hydrothermal solutions. These probably came from the magma which produced the Algoman rocks.

5. Both in field relationships and in microscopic characteristics these rocks have a certain similarity to the Laurentian granites on Rainy lake.[1]

Manitou Series

This is a well-defined band of sedimentary rocks which has been given the specific name of Manitou series. The belt averages about 2 miles in width and is divided into two parts, which are on the same strike but separated by a mass of intrusive granite. Each of the two bands has been traced about 14 miles. The sediments extend as an arcuate band from the north end of Lower Manitou lake to a point near Rattlesnake lake, where they are nosed out by the granite. They are found again on Washeibemaga lake and were traced eastward along the southern part of Stormy lake to its southeastern extremity.

The sedimentary series is composed of boulder and pebble conglomerate, arkose, quartzite, slate, and a certain amount of agglomerate and tuff. No lavas were found within the boundaries of the series.

Conglomerate is of very widespread occurrence and probably is the commonest of all the members. As one crosses the strike of the formation, conglomerate is often found over a width of half a mile. Near Mosher bay, where the most detailed study was made, the conglomerate seems to be largely confined to the southern side of the series, and arkose, quartzite, and slate lie stratigraphically above it. However, in some localities, e.g. on the northeast shore of Stormy lake, arkose and quartzite are found at the base of the series. Beds of conglomerate and arkose are often interbedded. A splendid example of this may be seen on the east side of Manitou straits about a mile south of the portage to Cane lake. Thirty-four alternating beds of arkose and conglomerate, all over 6 inches in width, were counted across a distance of 100 feet normal to the strike

[1]A. C. Lawson, *op. cit.*, pp. 51-59.

of the beds. There were also innumerable beds of conglomerate one-quarter to one inch in thickness. The beds maintain their uniformity of width along the strike. The maximum thickness of a bed of conglomerate was 5 feet. The boulders lie with their long axes parallel to the strike of the beds, although some of the larger granite boulders are well rounded. Boulders were observed here up to 8 inches in diameter, the average being between 1 and 4 inches.

Pebble counts at different locations in the area, including the above-mentioned spot, show the conglomerate to be composed of pebbles in the following proportions:—

Composition of pebbles	Mosher bay, immediately north of creek from Uphill lake, 106 pebbles counted in 6 sq. ft.	East shore of Manitou straits S. of portage to Cane lake, 188 pebbles counted in 8 sq. ft.	Lake east of Kawijekiwa lake, 186 pebbles counted in 8 sq. ft.
	per cent.	per cent.	per cent.
Greenstone	7	44	65
Granite	43	16	10
Porphyry		4	6
Quartz	14	18	7
Chert	32	7	8
Jasper	4	.....	.....
Banded iron formation	.....	2	1
Slate or schist	.....	9	3

The pebbles always show a considerable degree of rounding. Occasionally granite boulders are found over a foot in diameter; and boulders of banded iron formation 6 inches in diameter were seen. Boulders 2½ to 3 feet in diameter occur on the lake immediately southeast of the central part of Washeibegama lake.

The matrix of the conglomerate is arkose, consisting of small fragments of quartz, chert, oligoclase, and orthoclase embedded in a groundmass of sericite, chlorite, limonite, and silica. Carbonate and pyrite are seen in thin sections and are secondary.

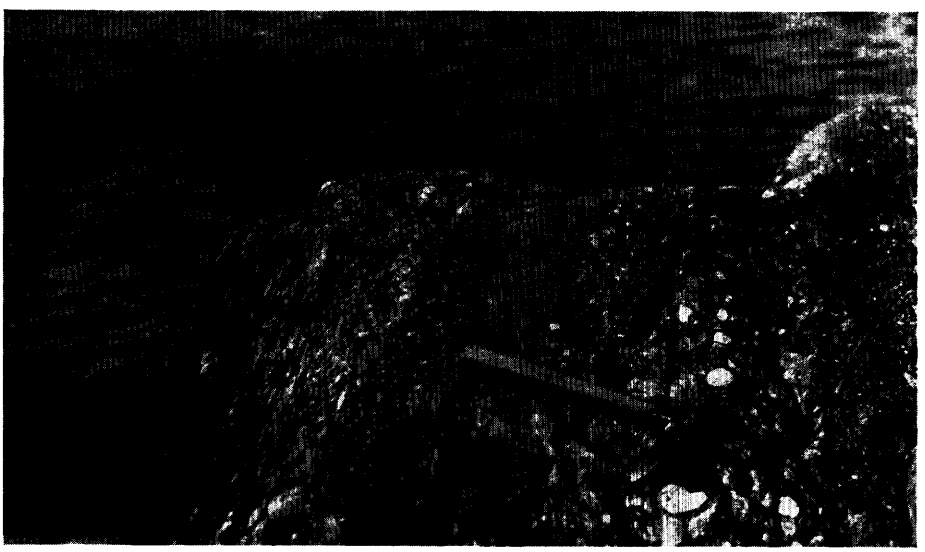
A thin section of a well-rounded grey granite pebble obtained from the conglomerate south of Mosher bay showed the rock to be a normal hornblende granite, composed of quartz, orthoclase, oligoclase, and hornblende, with a little garnet, apatite, and biotite. A remarkable feature is the freshness of the constituent minerals, which are not as greatly altered as some of those in the Algoman granites. Evidently the surface of the pebble was disintegrated by mechanical processes, such as abrasion, to a much greater extent than it was decomposed by chemical agencies.

Agglomerate and tuff are associated with the conglomerate in certain parts of the area. The best examples of this are found north of Uphill lake, on Washeibegama lake, and south of Snake bay of Stormy lake. Half a mile east of the portage from Uphill lake to Mosher bay, conglomerate may be seen along the shore of the bay. It grades into agglomerate to the east. The conglomerate contains well-rounded pebbles of jasper, chert, quartz, and granite. The agglomerate is composed of elongated fragments of light-coloured porphyritic material in a tuffaceous matrix. This pyroclastic rock contains an occasional well-rounded pebble of jasper and chert. Interbedded with the agglomerate is a band of slate, 2 feet wide, showing distinct bedding and having a sharp contact on either side with the agglomerate. On the south side of Washeibemaga lake

the same features may be observed. Here it often happens that the fragments in the rock are entirely light-coloured agglomeratic material that has been somewhat rounded, so that it is almost impossible to differentiate the pyroclastic from the clastic rock.

The association of volcanic sediments with the conglomerate would indicate that volcanic activity continued in the region after the commencement of deposition of the conglomerate. Volcanic ash and larger fragments were then intermingled with the sedimentary material derived from the erosion of a terrain of greenstones, iron formation, and granite.

The best exposures of arkose, quartzite, and slate are found in Mosher bay and Manitou straits. The arkose and quartzite weather to a light-grey colour, and distinct grains of quartz and feldspar may be seen with the naked eye. Microscopic examination shows most of these sediments to be arkose. At several



Conglomerate and arkose of the Manitou series, south end of Beaverhead island, Lower Manitou lake.

points in Mosher bay, beds 5 to 6 inches in thickness exhibit a perfect gradation from arkose at the base of the bed to slate at the top. The gradation may sometimes be seen across a dozen or more successive beds. Well-bedded slates, relatively free from coarser-grained clastic phases, also occur in this locality.

Near Washeibemaga and Sagenak lakes a massive grey arkose is found. Quartz grains of such size are present that it is often difficult to distinguish hand specimens of this rock from massive grey quartz porphyry, which also occurs in the same locality. However, a little careful searching will generally reveal bedding or conglomeratic horizons in the arkose.

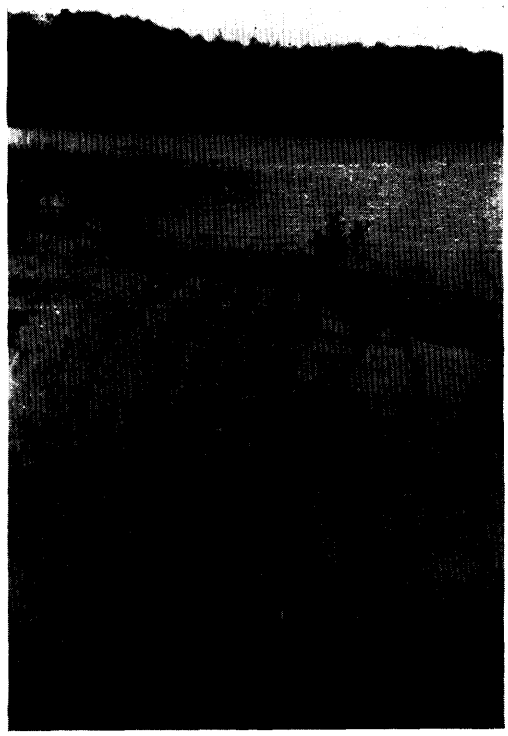
Thin sections of arkose from various parts of the area reveal a general similarity of mineral composition. Clastic grains of quartz, plagioclase, orthoclase, and occasionally titanite and apatite, are embedded in a matrix of chlorite, sericite, quartz, carbonate, kaolin, and iron oxide. In some cases almost half the grains are feldspar. The grains show evidence of considerable abrasion and are sometimes well-rounded but more often subangular. Only one section showed sufficient evidence of clastic ferromagnesian minerals to be called a

greywacké. The general absence of these minerals is remarkable, considering the fact that the sediments were derived from a terrain of basic igneous rocks. Only one section was sufficiently devoid of feldspar to be called a quartzite.

STRUCTURE OF THE MANITOU SERIES

Western Belt

Folding.—The most detailed study of the structure of the sediments was made in the vicinity of Mosher bay. Here the beds are well exposed, and the



Bedded sediments on a small island south of the entrance to Mosher bay, Upper Manitou lake. Note the gradation in grain from light-coloured arkose to darker slate, indicating that the tops of the beds are to the right. A fault with a small horizontal displacement occurs near the hammer.

minor structural features are fairly well preserved. The tops of beds may be determined by (1) the gradation in size of the original grains across individual beds, (2) cross-bedding, and (3) the relationship of regional cleavage to the bedding in vertical section. Gradation in grain size from coarse on the bottom side of the bed to fine on the top is perfectly exhibited along the shore of Mosher bay in beds of arkose which grade upwards into slaty material. It has been pointed out that variation in the size of grains is not always a safe criterion for the determination of the tops of beds and that sometimes it gives diametrically opposite results from those obtained by other more reliable methods.[1] As shown on the

[1]H. C. Cooke, Trans. Roy. Soc. Can., Vol. XXV, Sect. IV, 1931, pp. 71-74.

accompanying sketch map (Fig. 2), which shows some details of the structure, there is a general, but not complete, agreement between all methods of determining tops of beds near Mosher bay. Difficulty is often encountered in proving the tops of beds by the relationship of cleavage to bedding, owing to the fact that they differ only a few degrees in dip. Cross-bedding is rarely seen.

Near Mosher bay the sediments appear to occur in a closely folded syncline, the axis of which strikes about N. 70° E. and pitches to the southwest. On the south limb the tops of the beds are to the north, and the dip is to the north at a steep angle. Occasionally the beds are slightly overturned to the south.



Sediments of the Manitou series occurring near the fault on the south end of Beaverhead island, Lower Manitou lake. The lighter-coloured material is arkose; the darker is slate. Distortion of the beds is due to faulting movements.

The north limb of the syncline has been partly removed by faulting. The one exposure of slate on the northeast shore of Mosher bay dips to the south. In the southern part of Manitou straits near the fault contact, the beds dip steeply to the southeast, suggesting that this may be part of the northwest limb of the syncline. A more detailed examination might show that this is not a simple synclinal fold but rather a series of close folds, the axial planes of which are not far apart.

Faulting.—The contact between the sediments and greenstones on the northwest side follows a zone of highly sheared, fissile chlorite and sericite schists. This sheared zone is about 200 feet wide and was traced from the south end of Beaverhead island northeast to Mosher bay and thence to Kabagukski lake.

Near Mosher bay the schists have a vertical dip, but in Manitou straits the dips are from 70° to 85° S.E. Near the contact the sedimentary beds are truncated by this sheared zone at an angle of about 15 degrees in Mosher bay and 25 degrees on Beaverhead island. This structure can only be explained by a fault of considerable magnitude. In Mosher bay there is concrete evidence of great disturbance in the sedimentary beds near the faulted contact. Drag folds are developed in the arkosic and slaty beds, and small minor faults may be observed in several places. The distortion of hard, competent arkose, which is interbedded with the softer less competent slates, has produced a breccia in places. This consists of irregularly shaped masses of arkose, which yielded by fracturing, surrounded by slaty material, which flowed around the more massive rock. On the south end of Beaverhead island the beds near the fault are also distorted but not to the extent of those in Mosher bay.

No gouge or breccia was noted along the fault zone. This may have been obliterated by continued shearing, or it may be that the shearing now exposed took place at considerable depth and over a long period of time. Instead of a well-defined fracture the fault is more of a shear, probably with a large horizontal component. In this respect it resembles a fault described by Hawley[1] in the Sapawe Lake area.

A branch fault appears to extend from the north side of Mosher bay southwest to the east end of Uphill lake. Evidence for this is the occurrence of an outcrop of quartzite on the shore in the northwest corner of Mosher bay, the southerly extension of conglomerate to the shore of Uphill lake, and the offset of a prominent band of conglomerate in the small bay to the south of Mosher bay. A second fault, approximately parallel to the first, probably extends southwest from the entrance to Mosher bay. On the west side of the small island and on the adjoining mainland small faults are seen, which strike N. 45° E. In the depth of the bay to the south a highly sheared zone with small drag folds is found. It is also to be noted that west of this supposed fault the tops of the beds face south, whereas to the east they face north. Perfect gradation in grain on the small island indicates that the beds face to the north; while on the mainland immediately to the west, and almost directly along the strike, gradation in grain, equally well displayed, shows the tops on the south.

The dip of the highly schistose zone along the contact of greenstone and sediments should approximate the dip of the fault. In the northern part this is essentially vertical, but along the Manitou straits the dip is 70° to 85° S.E. Since the sediments do not occur on the northwest, that side must have been raised, and the fault is thus of the normal type.

The direction of the fault movement cannot be definitely stated, but the data at hand give some suggestions as to the relative direction of horizontal displacement. Since no definite horizons are offset by the fault, the true nature of the major movement can only be inferred from a study of the minor structural features on either side. These are best displayed in the sediments, where minor faults and drag folds are found close to the fault and were evidently produced by faulting movements.

At the entrance to Mosher bay, the flow cleavage in the sediments, which is here more probably related to the major faulting movements than the regional folding, strikes 20 degrees more to the north than the beds. This implies a movement of the northwest side to the northeast. Drag folds in the sediments near the fault in Mosher bay were found to have always the northwest side moved northeast with respect to the southwest side. The same direction of

[1]J. E. Hawley, Ont. Dept. Mines, Vol. XXXVIII, pt. 6, 1929, pp. 16-19.

movement is indicated by drag folds in the chlorite schists of the fault zone near the narrows east of Beaverhead island. The position of the branching faults in Mosher bay implies a similar movement. The accompanying sketch (Fig. 3) shows how these could be formed by the same stresses that produced the major fault. Stresses applied in a northeasterly and southwesterly direction would produce a fracture pattern that would correspond with that made by the faults in Mosher bay.

The age of the faulting may be inferred within certain limits. On the small island south of the entrance to Mosher bay, a narrow lamprophyre dike has been injected along a fault where the horizontal displacement of the beds is

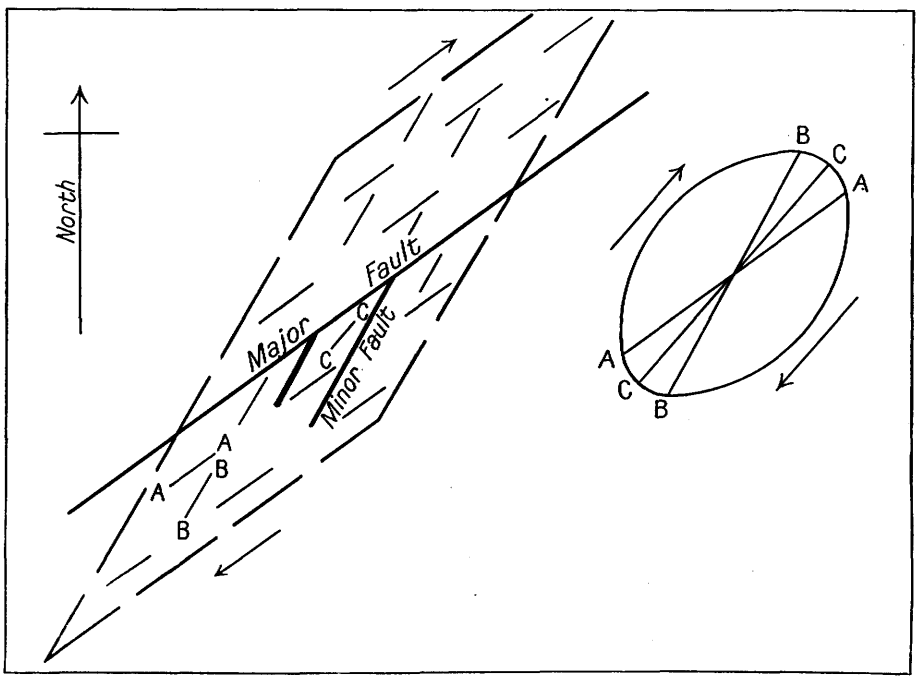


Fig. 3—Diagram showing how mechanics of faulting in Mosher bay may be explained by reference to the strain ellipsoid. The two faults are parallel to the two directions of non-distortion or shear planes (i.e. AA and BB). Schistosity (flow cleavage) would be parallel to the direction of greatest elongation (CC).[1]

only a few feet. The dike was injected along this line of weakness after the faulting took place. The lamprophyre dikes are either part of the pre-Algoman basic intrusion or a phase of the Algoman rocks. Thus the faulting took place at some time prior to the end of the Algoman period and after the folding of the Manitou series. Furthermore, massive sulphides are found along or near the fault zone, which suggests a structural control over their deposition. They were probably introduced along this line of weakness by a solution emanating from the same magma that produced the granites and porphyries. These sulphides also contain traces of gold, which elsewhere throughout the area is genetically related to the Algoman rocks.

Eastern Belt

The structure of the eastern belt of sediments is similar to that of the western section. The rocks are more massive, and bedding is not often found.

[1]C. K. Leith, Structural Geology, Henry Holt and Co., 1927, pp. 44-46.

However, the available information shows that they also occupy a synclinal basin that tends to nose out against the granite east of Washeibemaga lake. This tendency of the sediments to nose out on either side of the granite mass around Rattlesnake lake is strongly suggestive of a once continuous syncline that has been domed up by the intrusion of the granite and subsequently eroded to its present form.

On the north and east sides of Stormy lake the dip of the beds is from 55 to 80 degrees to the south and southwest, indicating that this is the north limb of a syncline. Near the southern contact of the series bedding was rarely found. On the north end of Sagenak lake the beds dip at an angle of 70° N. East of of Washeibemaga lake they are also inclined to the north; but about 2 miles east of Kawijekiwa lake, beds were found to dip southward not far from the contact.

Evidence of an Unconformity

As previously mentioned, it is impossible to determine the attitude of the lava flows with any accuracy, so that no evidence of a structural unconformity between the Keewatin series and Manitou series was obtained in the vicinity of the contact between these two formations. However, in those areas where volcanic sediments are interbedded with the lavas, a rough approximation as to the strike of the flows is possible. A glance at the geological map will show that a band of agglomerate and tuff runs parallel to the elongation of Kawashegamuk lake. If this roughly represents the strike of the lava flows, then there is a distinct angular discordance between the greenstones and the Manitou series. The same relationship may be seen in the vicinity of Upper Manitou lake and Mosher bay. While faulting has occurred here, it could hardly account for the great difference in strike between the sediments in Mosher bay and the bedded tuffs to the west of the fault in Upper Manitou lake.

The nature of the sediments is strongly suggestive of an unconformity. They are undoubtedly of terrestial origin, being probably deposited in shallow lakes or seas. The large amount of conglomerate with its variety of well-rounded pebbles and boulders must have been derived from a great terrain of pronounced relief.

CORRELATION OF THE MANITOU SERIES

The Manitou series corresponds stratigraphically and structurally to the Timiskaming rocks found elsewhere in Northern Ontario and Quebec. The various sediments resemble the Seine series on Rainy lake in many respects. It is possible that the sediments continue south of Manitou lake. An older geological map shows that the same general complex of early pre-Cambrian rocks extends southward for a considerable distance into the Rainy River district.[1]

Pre-Algoman Intrusives

Irregularly-shaped areas of plutonic rocks, varying from intermediate to basic in composition, intersect the Keewatin lavas and the sediments of the Manitou series. They consist of gabbro, diorite, and quartz diorite, all of which are somewhat altered. In many places it is virtually impossible to distinguish these from the coarse-grained phases of the lava flows. However, in certain locations a definite intrusive contact may be seen, and offshoots from the intrusive cut the surrounding rocks. This relationship may be seen on Boyer lake.

[1]A. C. Lawson, Rainy Lake Sheet, Geol. Surv. Can., Vol. III, pt. F, 1887.

It is possible that there are two ages of these basic intrusives in the area, the other being a late phase of Keewatin activity. On one of the larger islands in the northern part of Upper Manitou lake an altered gabbroic rock appears to intrude the agglomerate and tuff and is itself intersected by the Laurentian granite. Unfortunately, this relationship could not be checked by other similar occurrences.

Under the microscope these rocks always exhibit a granitic texture. The feldspars are generally so decomposed that it is impossible to distinguish between gabbro and diorite. The constituent minerals of these rocks are hornblende, biotite, orthoclase, plagioclase, magnetite, and titanite, with secondary epidote, zoisite, chlorite, carbonate, sericite, and leucoxene. Several sections contain primary quartz and may be classified as quartz diorites.

A few lamprophyre dikes that occur in the area may also be included with this group, although their relationship is not definitely known. These dikes are too small to be shown on a geological map. They penetrate the Keewatin greenstones and sediments of the Manitou series, but their relationship to the Algoman granite and porphyries could not be established. Northwest of the map area, near Wabigoon lake, Bruce[1] has found that lamprophyre dikes are earlier in age than the porphyry dikes and granite.

The lamprophyre dikes are dark-coloured, rather fine grained rocks containing a large amount of biotite. A thin section of one of these dikes showed the rock to have the mineral composition of minette. It contained a predominance of anhedral flakes of biotite with lesser amounts of quartz and orthoclase, and a trace of plagioclase.

Algoman

Granites and Gneisses

A considerable area of granite intrudes the sediments of the Manitou series and thus is Algoman in age. The correlation of the remainder of the granite with the Algoman period is chiefly on account of similarity to that part that can be definitely placed. The rock may be generally described as a medium- to coarse-grained granite, generally massive but occasionally gneissoid. The proportion of hornblende to biotite varies with the locality, the hornblende variety being more abundant near the greenstone contacts. The colour is generally pink, but at some distance from the older rocks massive grey granite may be observed along the shore of many lakes.

Microscopic examination shows the rock to be a normal granite with unaltered mineral constituents. Biotite is the predominant dark mineral.

Quartz Porphyry, Feldspar Porphyry, Aplite

Stocks and dikes of porphyry and aplite are of the same general age as the Algoman granite and probably represent a portion of the same magma from which the granites were formed. The quartz porphyry is a massive, greyish-coloured rock that contains distinct phenocrysts of quartz in a fine-grained groundmass. Some dikes near Mosher bay show quartz phenocrysts one-third of an inch in diameter. The quartz porphyry is occasionally sheared, as, for example, the large dike near the upper narrows in Manitou straits. Feldspar porphyry dikes are much less common. A large dike of this porphyry containing crystals of orthoclase one inch in length occurs south of Mosher bay.

[1]E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, pp. 40, 41.

Quartz is often associated with the porphyry dikes as a stockwork of small irregular veinlets filling tension cracks. A few of the dikes also carry a considerable amount of sulphides. Assays of several grab samples of quartz from these dikes and of sulphide-bearing porphyries almost always showed small, non-commercial values in gold. A trace of native gold was actually observed in one porphyry dike. It seems rather obvious that the auriferous quartz veins and mineralized zones must be closely related to these Algoman porphyries and granites.

The aplite dikes are very fine grained, light-coloured, siliceous rocks, with the same general relationships as the porphyries.

Keweenawan(?)

An occasional narrow dike of very fine grained diabase is found. It closely resembles the Keweenawan diabase that is so widespread throughout the Lake Superior region. It was not found to intersect the Algoman granite, so cannot be definitely correlated.

Pleistocene and Recent

As previously stated, the extreme northern portion of the map area contains a few isolated areas of bedded clays, which are part of the extensive clay belt to the north. Throughout the remainder of the area glacial deposits are represented by occasional patches of boulder clay, ground moraine, and low drumloidal hills of drift material. South of Snake bay large greenstone erratics are found in abundance. On the top of some of the ridges erratics 15 feet in diameter may be seen.

Glacial carving is everywhere in evidence. Glacial striae and grooves show the direction of ice movement to have been S. 30° W. to S. 65° W.

ECONOMIC GEOLOGY

Nature of the Gold Deposits

Throughout the Manitou-Stormy Lakes area gold occurs in quartz veins, in massive sulphide bodies, in schists impregnated with sulphides, and in porphyry dikes. Of these the vein type is by far the predominant form of occurrence. Many of the veins closely correspond to the definition of a simple or "true fissure vein," in which the ore occupies a sheet-like space with well-defined walls, often in a massive rock. Composite veins or lodes, consisting of nearly parallel veins, irregularly connected, with schistose country rock intervening, are occasionally found. These usually occur along a fairly well defined sheared zone. The veins are found largely in altered lavas and pyroclastics of the Keewatin series, but have also been discovered in the sediments (e.g. Giant mine), and in acid intrusives (e.g. Manitou island veins in quartz monzonite and veins on Frenchmen island in granodiorite). The vein material consists chiefly of quartz, with or without carbonate. The carbonate is largely ankerite, is sometimes well crystallized, and occurs intimately associated with vein quartz. Secondary quartz and carbonate are found at times in fractures in the primary quartz. Tourmaline is present in many of the veins. Massive veins containing milky-white quartz and devoid of sulphides are generally barren. Pyrite and chalcopyrite are the predominant sulphides in the veins, and pyrrhotite, galena, and sphalerite occur rarely. The sulphides are largely confined to the stringers of schist enclosed along fractures in the quartz and to the schistose wall rock. Native gold is found both in the quartz and schist. Values are erratic, often

being confined to high-grade ore shoots and pockets in otherwise barren or very low grade vein material. The veins are generally small but well defined. They are rarely more than 5 feet wide, generally between 1 and 2 feet.

Small bodies of massive sulphides were observed in a few places. The sulphides are pyrite and pyrrhotite with a little chalcopyrite. Most of the samples of this material taken by the writer carried small amounts of gold (20 to 40 cents per ton). One sample, obtained on the road from the Little Master mine to the government road, assayed $4.20 per ton in gold.

Irregularly shaped zones of more or less disseminated sulphides occur in schists. The largest of these bodies uncovered at present is on Manitou island. Here the mineralization is concentrated in the vicinity of quartz porphyry dikes. Small sulphide zones were noticed in the vicinity of the granite contacts in some parts of the area. Gold values occur in some of these sulphides.

Gold has been found in quartz porphyry dikes but in non-commercial amounts. The gold appears to be confined to irregular networks of quartz stringers in the porphyry. The ore body at the Glass Reef mine was apparently one of these dikes. At one location south of Mosher bay a trace of native gold was noticed in a porphyry dike.

Genesis of the Gold

The gold deposits bear a close relationship to the Algoman granite and porphyry. Prior to, or contemporaneous with, the batholithic invasion the greenstones and sediments were closely folded. As a result of this deformation fracturing, shearing, and faulting took place on a large scale. Along these lines of weakness vein-forming solutions, evidently emanating from the later phases of the granitic magma, were able to penetrate. It appears that after the quartz veins were injected, fractures were formed as the result of stresses developed during consolidation. Hydrothermal solutions penetrated these openings as well as the wall rock, depositing carbonates, sulphides, and gold. These solutions also circulated through favourable structures in the country rock to form the various sulphide masses.

Recommendations to Prospectors

From the above statements, it is evident that the conditions required for the formation of a commercially valuable gold deposit in the region are (1) the existence of a body of rather brittle rock that has been subjected to shearing movements of sufficient magnitude to produce a large shattered zone, and (2) the proximity of granite or porphyry masses from which gold-bearing solutions can emanate in sufficient quantity to fill the fractures.[1] Conditions approaching this theoretically ideal situation occur in certain parts of the Manitou-Stormy Lakes area. Generally speaking, the belt of rocks in the vicinity of Upper and Lower Manitou lakes is considerably sheared; granitic intrusives are often found, and quartz veins are common in occurrence. It is in this area that practically all the old gold mines and more recent prospects are located. Consequently, part of the territory adjacent to these lakes is now staked, and several claims are patented. Farther eastward the rocks are generally massive, and quartz veins and mineralized zones are not so common. Prospecting seems to have been rather limited in amount in this part of the country, and no mining claims are held at present. Around Kawashegamuk lake the rocks are well sheared.

[1]H. C. Cooke and W. A. Johnston, Gold Occurrences of Canada, Geol. Surv. Can., Econ. Geol. Series, No. 10, 1932, p. 14.

Although prospectors may be rewarded by searching in all parts of the greenstone and sediments, those areas near the contact of the Algoman granite and porphyry masses seem to be the more likely locations for gold occurrences.

Description of Properties

Gold has been found on many locations in the Manitou-Stormy Lakes area during the past thirty-five years. Over the period from 1896 to 1912, a number of attempts were made to mine gold, but the great majority of these ventures were failures. As elsewhere in the Lake of the Woods region, there is abundant evidence of wasted efforts and capital in attempts to develop producing mines in the early days. Bruce[1] has discussed the various reasons for the failure of these mines to become more permanent producers. Some were located on veins "too small or too low in gold content" ever to be considered as ore. There was lack of judgment in purchasing unnecessary surface equipment, including a mill, long before the development of the ore body warranted such an expenditure. Other reasons advanced are lack of knowledge concerning the nature and structure of the veins, and inefficient mining and milling methods.

At present very little may be seen at some of the old mines. At certain places the buildings have either been removed or have fallen down, so that it is difficult even to locate the old workings. Sometimes all that may be seen is a shaft, filled with water, and some ore on the mine dump, which covers, or partially covers, the surface exposure of the vein.

The properties are divided into two groups in the following discussion. Those of the first group include the older mines on which no work has been done for many years. Some of these are of little or no economic importance. The second group is composed of mines which have been investigated since they were originally closed down, and the more recent prospects.

OLDER MINES

Detola

The mine is located on the west shore of Kabagukski lake on claim H.P. 411. It was developed during 1910 and 1911. A small mill was constructed and is still located on the property, although it is reported that no ore was ever put through it. The rock in the vicinity of the shaft is massive greenstone, but along the shores of Kabagukski lake there is a highly sheared zone containing chlorite and sericite schist. There is no sign of a vein at the shaft. Parsons[2] reported in 1912 that the shaft was down 230 feet and that 852 feet of drifting had been completed. In the crosscut 436 feet northwest from the shaft, a vein about one foot wide was located, which carried about $12 per ton in gold.

The rock on the dump is largely massive basalt and slaty chlorite schist. The vein material is quartz and a little tourmaline. Small veinlets of carbonate and secondary quartz occupy fractures in the primary quartz. A little sulphide, chiefly fine-grained pyrite, occurs in the quartz and schistose wall rock. A grab sample of the best-looking vein material on the dump assayed $3.20 per ton in gold.

Giant

On claims H.W. 74 and 75, located on the southeastern shore of Mosher bay, development work was done on a vein at intervals between 1897 and 1905.

[1]E. L. Bruce, Ont. Dept. of Mines, Vol. XXXIV, pt. 6, 1925, pp. 1, 2.
[2]A. L. Parsons, Ont. Bur. Mines, Vol. XXI, pt. 1, 1912, p. 195.

The writer did not see the old mine workings. Coleman described the showing in 1897 as follows:[1]—

> On Mosher bay . . . a bedded vein with no regular walls runs near a hilltop with a strike of about 65 degrees. The quartz with some rusty schist, all containing more or less gold, is seven or eight feet wide and retains the same character to the bottom of a pit 24 feet deep sunk upon it. The ore pans well and affords some rich specimens of free gold. Some ore taken by myself assays $6 per ton.

At a later date Carter[2] described a quartz vein which could be traced several hundred feet along the strike of the formation and which averaged about 6 feet in width. A shaft was sunk to a depth of over 200 feet on the property.

Glass Reef

The mine was located on the northeastern shore of Lower Manitou lake near Glass bay (claim H.W. 594). It was worked in 1900, during which year a two months' mill test was made. A shaft was sunk 200 feet, and a considerable amount of drifting and crosscutting was completed. Carter describes the underground development as follows:[3]—

> . . . a faulted and schistose area in a massive dark-green trap dike, the schist carrying lenses of quartz. The shaft was started down on one of these and though it pinched out at about 20 feet depth, sinking continued in the schist, and . . . the dike of trap explored thoroughly both by drifts and crosscuts, but with unsatisfactory results, for throughout all the drifts nothing but scattered lenses and stringers of quartz were found, seldom over a foot and a half wide, short and with no apparent continuity, and in the crosscuts nothing but trap.

There is no surface exposure of the above-mentioned zone, and the timbers cover the rock in the shaft. However, from the nature of the broken rock on the dump it appears that the "dike of trap" is a sheared quartz porphyry containing a considerable amount of quartz in the form of a stockwork of small veinlets. The quartz contains a little tourmaline and carbonate with a trace of pyrite. Near the shaft the country rock is massive greenstone, but a large quartz porphyry dike is exposed to the northeast and the strike would carry it very close to the shaft. A grab sample of quartz and schist selected from the material on the dump was assayed, but contained no gold values.

Last Chance

Some work was done in the early days on claim S. 28 northeast of Goldrock. Coleman[4] discusses the showing as follows:—

> A vein which has been traced for three hundred and fifty yards cuts diagonally across the slaty schist and has at some points a width of three feet, but is quite irregular in this respect. Two pits opened upon it, the deepest only ten feet, show quartz with green and brown streaks and have produced some handsome specimens of gold.

Little Master

This was located on the northwest shore of Kabagukski lake on claim A.L. 206. From 1902 to 1905, three shafts were sunk on the property. In the vicinity of these shafts the rock is massive andesite. Only very small lenses of white quartz and some schistose wall rock may be seen at the workings. A grab sample of the quartz from the large dump on the side of the hill assayed $3.80 per ton in gold.

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[1]A. P. Coleman, Ont. Bur. Mines, Vol. VII, pt. 1, 1897, p. 123.
[2]W. E. H. Carter, Ont. Bur. Mines, Vol. XI, 1902, p. 247.
[3]W. E. H. Carter, Ont. Bur. Mines, Vol. X, 1901, p. 99.
[4]A. P. Coleman, Ont. Bur. Mines, Vol. VI, 1896, p. 86.

Big Dick

This name was applied to a small showing on the north shore of Mosher bay (H.W. 66). Near the shore a quartz vein 10 feet wide has been uncovered on the side of a hill by trenching. The vein strikes N. 30° E. and has a vertical dip. It is not exposed at any other place along the strike. The vein material is quartz containing a little tourmaline and a trace of pyrite and chalcopyrite. The wall rock is highly sheared chlorite schist and is impregnated with fine-grained pyrite. Trending parallel to the vein on the northwest side is a dike of quartz porphyry that contains "eyes" of quartz one-third of an inch in diameter. A sample chipped across 8 feet of the mineralized chlorite schist assayed $1.40 per ton in gold, and a grab sample of the mineralized quartz assayed 20 cents in gold.

Paymaster

On claim H.W. 20, east of Goldrock, a shaft was sunk 325 feet on a lenticular quartz vein, which is 18 inches to 2 feet wide on the surface and cannot be traced any distance along the strike. Carter[1] states that there is another lenticular quartz vein 30 feet away, but the writer did not see it. Corkill[2] has reported the vein to be 11 feet wide on the 200-foot level. A grab sample of the quartz on the dump assayed 20 cents per ton in gold.

Royal Sovereign (Lower Neepawa)

This property is located on the northwest shore of Lower Manitou lake immediately north of Manitou island. Development was commenced in 1897. In 1902, 23 tons of ore were treated in the stamp mill of the Glass Reef mine across the lake. Apparently no work has been done at the property since that time. On the edge of a ridge near the lake shore a shaft was sunk on a quartz vein, and a little drifting was done along the vein. A short tunnel was driven from the base of the ridge to intersect the drift near the shaft.

At the lake shore 6 distinct quartz veins with well-defined walls occur in chlorite schist across a width of about 50 feet. The three larger veins are each about a foot in width. The veins are roughly parallel and strike about N. 70° E.; the dip is from 75° to 80° S.E. The strike would carry them to the shaft on the hill about 50 feet away. The veins on the shore contain white vitreous quartz with a little tourmaline. At the shaft the vein is covered by the dump, but it may be observed in the tunnel. Here, a branching and irregular stockwork of quartz veins up to one foot in width forms a lenticular body about 6 feet in width near the shaft but lensing out almost entirely 20 feet to the northeast. The ore consists of white quartz and tourmaline, considerably fractured and containing numerous ankerite veinlets. A trace of pyrite occurs, chiefly in the chlorite schist. A sample, chipped across a width of 6 feet of the vein in the tunnel near the shaft, assayed 20 cents per ton in gold. A second sample of similar vein material taken from the dump assayed 20 cents per ton in gold.

About 80 feet southwest of the above-mentioned shaft, a second shaft is located. The timbers obscure any sign of a vein, but the ore on the dump is similar to that from the other shaft.

Bow has described the underground development work as follows:[3]—

A seven by nine shaft has been sunk on the hanging wall to a depth of 65 feet. A crosscut has been commenced at the bottom. There is 11½ feet of quartz at the bottom of the shaft

[1]W. E. H. Carter, Ont. Bur. Mines, Vol. XIV, 1905, pt. 1, p. 54.
[2]E. T. Corkill, Ont. Bur. Mines, Vol. XV, pt. 1, 1906, p. 52.
[3]Jas. A. Bow, Ont. Bur. Mines, Vol. VII, pt. 1, 1897, p. 76.

and only the footwall reached. Sixteen feet of vein matter has been exposed at the bottom altogether. At this depth a pay streak in the vein assays from $5 to $140 per ton.

Queen Alexandra

In 1904 a shaft was sunk 85 feet on a quartz vein located on claim H.W. 270 on the eastern shore of Carleton lake. Carter[1] states that 18 tons of ore were treated in a small stamp mill erected on the property, and this produced $16.00 per ton in gold.

Very little can be seen now at the shaft. There is no vein exposed. The rock dump consists of chlorite schist with small lenses of quartz, both of which carry a little pyrite. A grab sample of this material assayed $1.80 per ton in gold. The country rock is schisted andesite cut by granitic dikes.

Victory (Upper Neepawa)

This mine was located on claim McA. 28 about half a mile northwest of Goldrock. It was worked in 1896 and 1897. A shaft was sunk to a depth of 100 feet on a vein, which Coleman[2] describes as follows:—

> . . . a bedded vein in schist about six or eight feet wide, so far as one could tell from the small amount of stripping done, very rich in gold, some brilliant specimens having been obtained here. The dirt overlying the vein pans richly, the gold being very coarse compared with that from some parts of the region.

At present nothing can be seen at the old shaft, but in a pit 25 feet to the west a sheared zone occurs in the massive andesite. This zone is about 5 feet wide and consists of a schisted quartz porphyry containing two quartz veins 6 inches in width. The zone is mineralized with pyrite and chalcopyrite and also considerably carbonated. A grab sample of this material was assayed but carried only a trace of gold.

Volcanic Reef

About the year 1904 a shaft was sunk 130 feet on a narrow quartz vein on claim S. 40, north of Kabagukski lake. The vein strikes N. 45° E., is about one foot wide, and is exposed over a length of 120 feet. The country rock is massive andesite. The vein is composed of sugary white quartz and a little included green schist. A sample chipped across 2 feet of quartz and schistose wall rock assayed 20 cents per ton in gold. The rock on the dump is almost entirely schistose greenstone.

MORE RECENT DEVELOPMENTS

The properties discussed in this group are either old mines which have been re-examined or prospects worked within comparatively recent years. In general, they are of greater economic interest than those previously described.

Manitou Island

The whole of Manitou island, excepting the southwest end, was held at one time by the Anglo-Canadian Explorers, Limited. They did a considerable amount of surface stripping and trenching, uncovering several quartz veins and a zone of sulphides. However, their interest was cancelled in March, 1928, and the claims were restaked for the Manitou Island Syndicate of Kenora. These

[1]W. E. H. Carter, Ont. Bur. Mines, Vol. XIV, pt. 1, 1905, p. 51.
[2]A. P. Coleman, Ont. Bur. Mines, Vol. VI, 1896, p. 85.

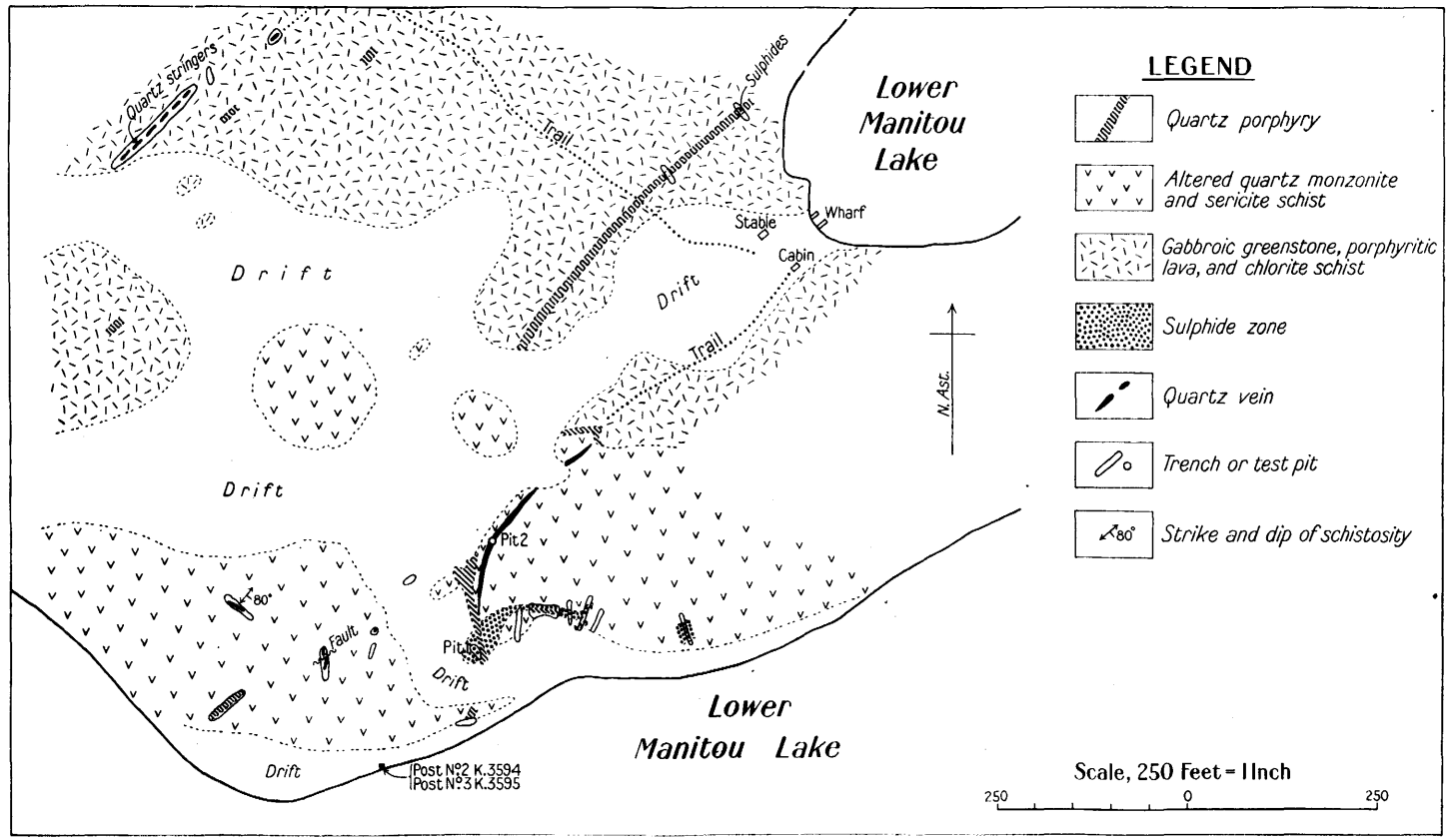


Fig. 4—Geological sketch map showing a part of Manitou island.

were again cancelled in November, 1931, and the northeastern portion of the island has since been restaked by Frank Gaffney, of Kenora, and his associates. The latest stakings include 10 claims (K. 3,594-99 and 3,795-97), one of which covers the old Bee-hive mine.

The most important discoveries on the island are shown on the accompanying sketch map (Fig. 4). The country rock in this vicinity consists of greenstone on the north, which merges into acidic rock toward the south. Immediately east of No. 1 pit this rock is medium-grained and dark-green in colour, and contains prominent "eyes" of quartz. Microscopic examination shows that it is a quartz monzonite. This same type of rock occurs throughout the western end of the workings, but it is often altered to a sericite schist. It is probably an intrusive and resembles the Laurentian rocks. The greenstones, quartz monzonite, and

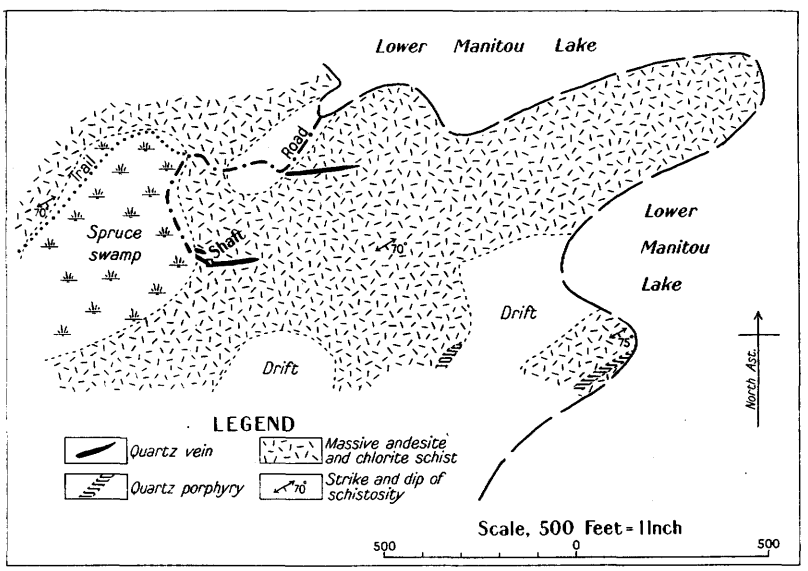


Fig. 5—Geological sketch map of the Bee-hive mine.

sericite schist are all intersected by dikes of quartz porphyry, which sometimes carry a considerable amount of pyrite.

A zone of sulphides, irregular in shape, is revealed in the quartz monzonite by a group of test pits along the side of a ridge near the south shore of the island. The sulphides are pyrite and, to a much lesser extent, chalcopyrite. They are most heavily concentrated near the contact of quartz porphyry dikes. The writer took a chip sample across 12 feet of sulphide material along the northeast face of pit No. 1. This assayed $42.80 per ton in gold. A grab sample of the massive quartz porphyry, which contained a fair percentage of pyrite and some secondary quartz, was also assayed and found to contain $3.30 per ton in gold.

North of the sulphide zone a quartz vein has been uncovered. It is composed of somewhat fractured white quartz, the fractures being filled with carbonate and fine-grained pyrite. The wall rock is carbonated quartz monzonite and is somewhat schistose. The principal vein is about 2 feet wide, but several smaller veins about 6 inches in width run parallel to it. At No. 2 pit the vein system is 6 feet wide. A chip sample across it near this point assayed $1.40 per ton in gold.

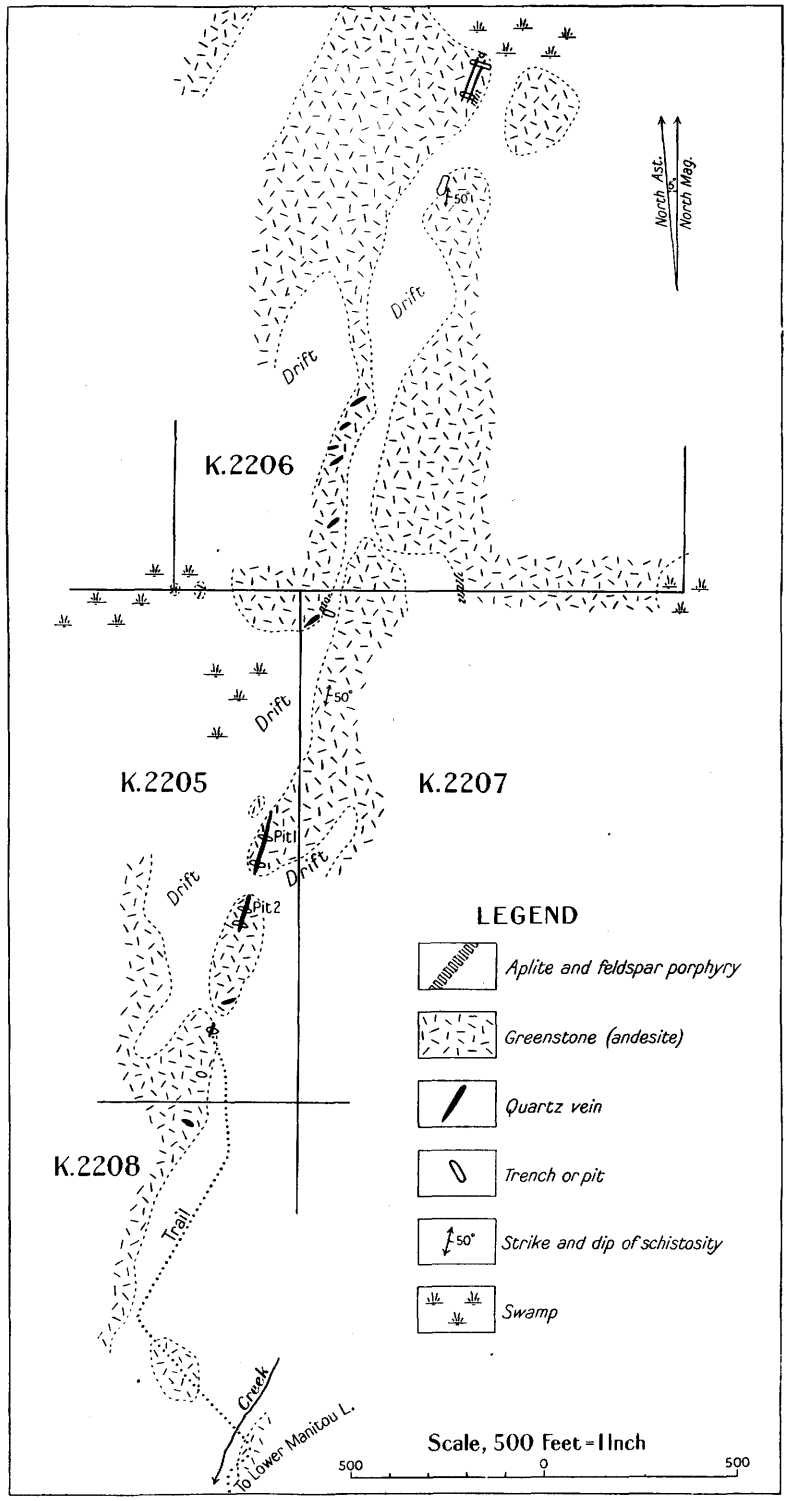


Fig. 6—Geological sketch map of the Dryden–Red Lake Partnership claims.

Near the central part of the island, west of the above-mentioned workings, there are two parallel quartz veins striking N. 65° E. and dipping 60° to 70° S.E. They may be traced 260 feet and 400 feet, respectively, and vary from a few inches to 4 feet in width. The shorter vein is somewhat fractured and contains a trace of sulphides. A sample taken across its widest part assayed 40 cents in gold.

Bee-hive

An old shaft is located on a quartz vein near the north end of Manitou island. This is the location of the Bee-hive mine, which was worked in 1897. The vein may be traced east for 140 feet from the edge of a swamp. The dip is almost vertical. It averages about 3 feet in width, but at the western extremity it splits into two parts and becomes considerably wider. The vein material consists of well-fractured white quartz containing a considerable amount of crystallized pyrite and chalcopyrite in places. Tourmaline occurs in the vein and also veinlets of carbonate. Immediately west of the shaft, the writer found some fine specimens of native gold in the quartz. A few feet west of this spot, a chip sample was taken across 10 feet of well mineralized quartz. When assayed, this was found to contain no gold values. An attempt has been recently made to dewater and retimber the old shaft.

North of the shaft there is another vein which may be traced 180 feet and averages about 3 feet in width. It consists of white quartz with a series of fractures running parallel to the walls. No mineralization was noticed.

Dryden-Red Lake Prospecting Partnership

Four claims (K. 2,205-2,208, inclusive), located north of Lower Manitou lake, are held by this group, for which C. J. Wright, of Dryden, is agent. The main showing on the property is a sheared zone containing quartz veins and chlorite schist. It strikes N. 10° E. to N. 15° E. and dips 45° to 55° E. The sheared zone lies in massive andesite and has a maximum width of 20 feet, averaging 10 to 12 feet. On claim K. 2,205 two prominent quartz veins up to 1 foot in width occur in the sheared zone. Both quartz and schist contain a little pyrite and carbonate. The sheared zone is largely covered by drift, but it has been traced about 300 feet along the strike on claim K. 2,205 and then disappears to the north under overburden. A sample chipped across 8 feet of quartz and schist by the writer in pit No. 2 assayed $1.00 per ton in gold; another sample from pit No. 1, across 4 feet of vein material, assayed $12.80 per ton in gold.

Several lenticular masses of milky-white quartz adjoin the sheared zone. These have an *en échelon* arrangement and probably occupy fractures that were formed as the result of tension stresses at the same time as the main sheared zone. These quartz masses are devoid of mineralization and do not hold much promise of gold values.

Frenchmen Island, Upper Manitou Lake

At least three quartz veins occur on this island, but development work has been confined to a vein that runs in a southeast-northwest direction across the central part of the island (claim P. 150). Test pits have been sunk at intervals along the vein, which may be traced about 525 feet but is rather poorly defined. The strike varies from E. 25° S. to E. 40° S., and the dip is about 70° S.W. The vein lies in granodiorite and varies from 1 to 8 feet in width. It consists of sugary white quartz and contains a little fine-grained pyrite. The wall rock

is sericite schist, which sometimes carries pyrite and chalcopyrite. At its western extremity the vein outcrops on a cliff, and the well-defined sheared zone may be seen in vertical sections. A chip sample was taken across 3 feet of quartz and mineralized schist at this place. This assayed $3.80 per ton in gold.

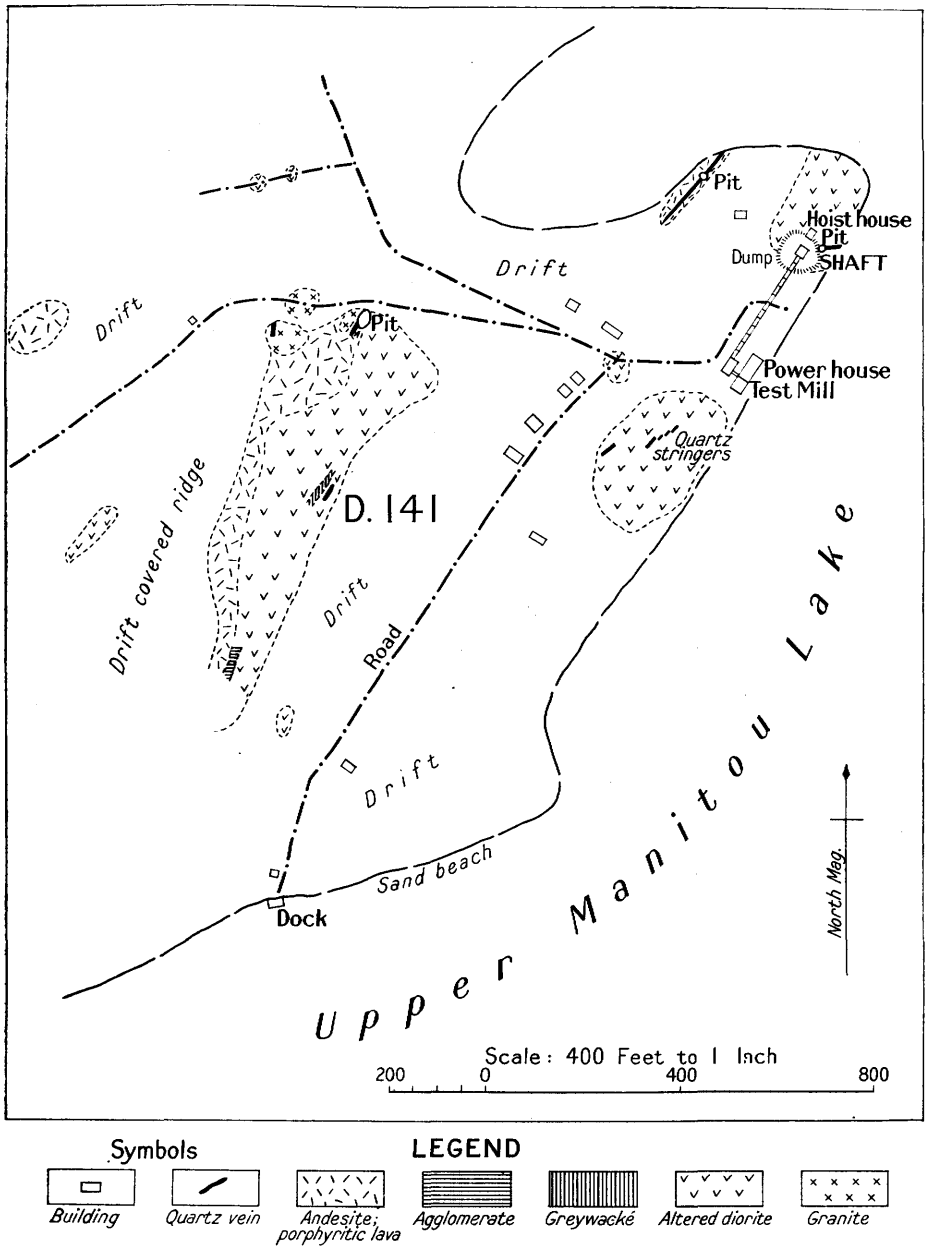


Fig. 7—Geological sketch map of the Gold Rock mine.

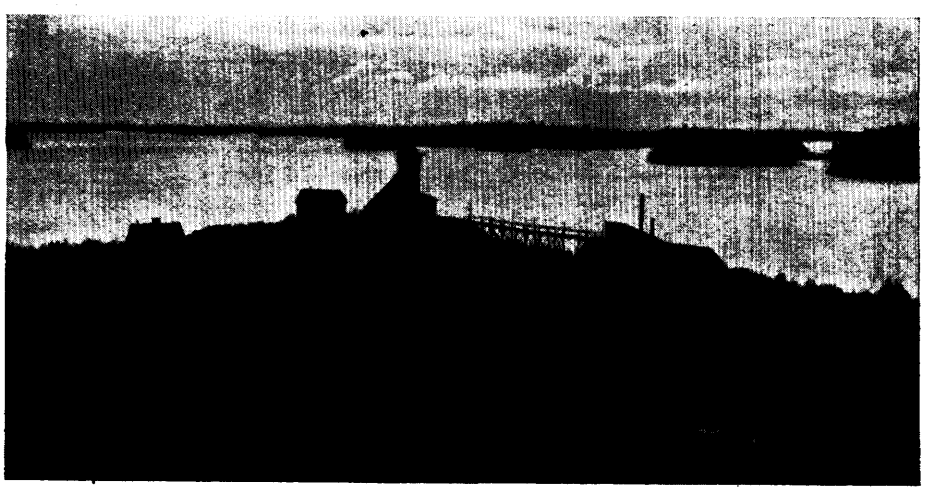
Gold Rock Mines, Limited

This company was organized in 1929 and took over five groups of claims from the Gold Rock Mining Syndicate, Limited. Practically all work was done

on the old Haycock property (claim D. 141) on the west shore of Upper Manitou lake during 1928 and 1929. Camps were erected to accommodate 40 men, and all necessary mine buildings, including a 2-stamp mill, were completed. The old shaft was deepened and a crosscut was driven 170 feet.[1]

The rocks in the vicinity of the mine are chiefly altered quartz diorite with lesser amounts of andesite and agglomerate. It is impossible to state whether the quartz diorite is a coarse-grained phase of a lava or an intrusive. About 400 feet west of the mine buildings there is a small mass of intrusive granite.

At the shaft the vein is covered by the dump and mine timbers, but it is exposed in a pit east of the dump and may be traced a distance of 25 feet to the lake shore. The vein, which is 1½ feet wide, is well defined and consists of white quartz with a little green schist, which carries some pyrite and a trace of chalcopyrite. Native gold was observed in the quartz at the lake shore. A sample chipped across the vein in the pit assayed $2.20 per ton in gold.



Gold Rock mine, Upper Manitou lake.

A second vein occurs 125 feet west of the shaft. This has a general strike of N. 40° E. and dips 65° S.E. The vein ranges from 2 to 8 feet in width and may be traced about 200 feet from the lake shore. It consists of rather sugary quartz and a little included schist, and contains only a trace of sulphides. A representative sample taken across the width of the vein in a test pit gave no gold values. A few other small lenses of quartz occur on the property.

It is apparent that the surface showing did not justify the considerable expenditure on equipment, and there is little reason to believe that this mine could be profitably reopened.

Reliance

This has been formerly known both as the Westerfield mine and the Independence mine. It is located west of Carleton lake on claim K. 3,412 and may be reached by a wagon road from the south end of Upper Manitou lake.

As early as 1899, three shafts were sunk to shallow depths on the vein. During 1900, the main or No. 3 shaft had reached a depth of 85 feet. In 1904, No 2 shaft was down 97 feet, having been sunk that distance on the vein. A

[1]Ont. Dept. Mines, Vol. XXXIX, pt. 1, 1930, p. 97.

drift was also run to the north along the vein. Apparently no work has been done since that time. E. G. Rognon, the owner of the property, has recently fixed up the old road preparatory to further development work at the mine.

A quartz vein, which is not well exposed at the surface, has been traced along a sheared zone by shafts and test pits for a distance of about 800 feet.

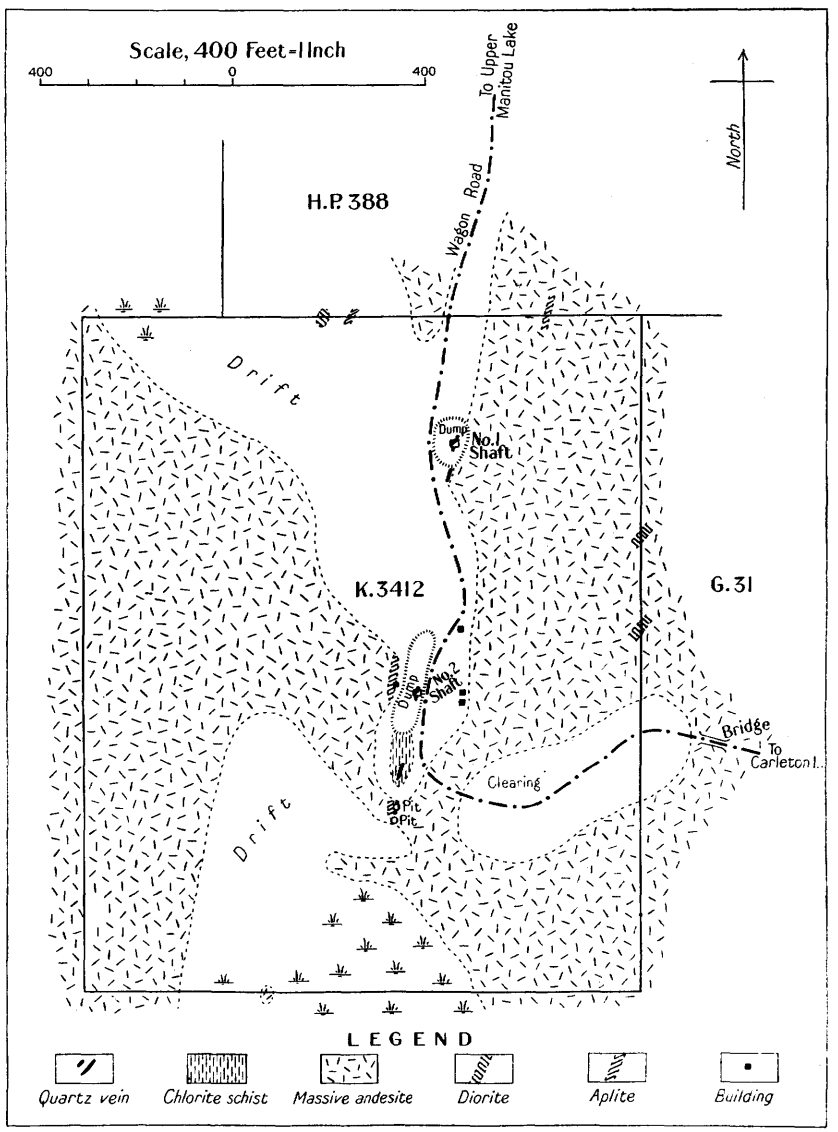


Fig. 8—Geological sketch map of the Reliance mine.

The sheared zone strikes N. 15° E. and dips 60° to 75° S.E. The vein material consists of fractured quartz containing a little tourmaline and schist. The included schist carries pyrite and sometimes traces of pyrrhotite, chalcopyrite, and sphalerite. The wall rock is a carbonated chlorite schist. The width of the vein cannot be ascertained at the two shafts, but in one of the pits there is

mineralized quartz and schist across 6½ feet, the quartz vein being about 2 feet wide. A chip sample, taken across the full mineralized width, did not contain any gold values. A grab sample of the best-looking vein material on the dump at No. 2 shaft also gave a blank, but a similar sample from No. 1 shaft assayed $4.00 per ton in gold.

The claim is largely covered by massive andesite, which is intruded by an occasional aplite dike. A small stock of granite occurs near by on Carleton lake.

Merrill Claims

During the summer of 1932, Charles Merrill, of Wabigoon, restaked the old "Swede Boy" location. This lies about a mile southwest of Upper Manitou lake and may be reached by a trail from the lake.

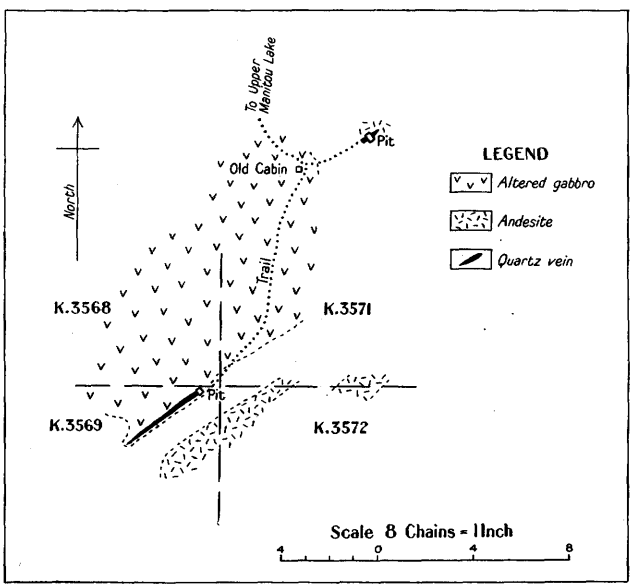


Fig. 9—Geological sketch map of the Merrill claims.

The property was originally staked by three Swedes in 1895. It was claimed that gold occurred in paying quantities in the mud of the swamp near the vein, and a crude attempt was made to establish placer mining, but only a few dollars worth of gold was recovered.[1] The source was probably a milky quartz vein 2½ feet wide, which strikes N. 53° E. and dips 47° S.E. It may be traced about 15 feet along the strike. A shallow test pit has been sunk on the vein. A sample chipped across 4 feet of quartz and schist in the pit gave no gold values.

About 850 feet to the southwest a second quartz vein occurs. It has a strike of N. 55° E. and dips 70° S.E. It may be traced roughly 250 feet and has a width of almost 7 feet in a pit located at the northern limit of its exposure. The vein quartz contains a trace of tourmaline and some green schist in which pyrite and a little chalcopyrite are found. A sample taken across the width of the vein in the pit on assay gave no gold. Native gold is reported to occur in the vein.

[1]A. P. Coleman, Ont. Bur. Mines. Vol. VI, 1896, p. 83.

The vein occurs along the side of a ridge of massive gabbro. To the east the rock is gabbro and basalt occasionally intersected by small dikes of feldspar porphyry or granite.

After the writer's visit to the property, Mr. Merrill uncovered a quartz vein about 250 feet east of No. 3 post of K. 3,571. The vein and associated schist contained some rich specimens of native gold. Mr. Merrill reported the vein to be about 18 inches in width and had traced it 100 feet.

Swede Boys Islands

On the larger of these islands (H.P. 259) an old shaft is located on a quartz vein, which strikes N. 50° E. and dips 75° S.E. The vein is about 2 feet wide and may be traced about 15 feet to the southwest. There are some old pits along the strike to the northeast, but no vein material can be observed. The wall rock of the vein is chlorite schist carrying a little pyrite. Native gold was observed in the schist. A grab sample of the ore on the dump assayed $8.80 per ton in gold.

East of the shaft on the shore of a small bay a stockwork of small quartz stringers and schist occurs across a width of 6 feet and may be traced along the shore a short distance. The quartz and schist carry a little sulphides.

Another old shaft is located on the smaller island (H.P. 260) to the northeast. It was sunk on a small lens of milky-white quartz in massive agglomerate and tuff. The quartz lens is about 2 feet in width and may be traced 30 feet. It contains a trace of pyrite and chalcopyrite. A grab sample of the material on the dump assayed 80 cents in gold.

Watson Claim

This claim (S.V. 343) is located east of Beck lake. A quartz vein occurs immediately south of a small creek. It strikes N. 30° E., dips 75° S.E., and is 5 feet wide. The vein outcrops again about 100 feet southwest of the creek. Here the quartz is 4 feet wide but is white and vitreous. A trace of sulphide, chiefly pyrite, occurs in the schistose wall rock. A sample chipped across 5 feet of quartz and schist contained no gold values. It is reported and evidently quite true that a pocket containing spectacularly rich native gold was found in the quartz vein at the creek. This must have been localized within a small area, as no sign of gold could be seen in the quartz surrounding the small pit from which the high-grade ore was supposed to have been taken. The vein occurs in massive andesite.

Wetelainen Claims

Jonas Wetelainen, of Goldrock, owns claims K. 2,956, K. 2,955, and K. 2,954, all of which adjoin the Watson vein. Several small veins and lenses of quartz occur in massive andesite. The largest of these is found near the southeastern corner of K. 2,955, where there is a vein about 60 feet in length and 1 foot wide. Mr. Wetelainen reported an assay of $3.60 in gold from this location. About the centre of claim K. 2,954 a small pocket of very rich native gold was found in a vein of quartz and mineralized schist. A sample taken by the writer across 6 feet of vein material at the spot from which the gold-bearing samples had been removed assayed $1.40 per ton in gold.

Laurentian

In 1924 Bruce[1] examined the Laurentian, Big Master, and Jubilee mines, and prepared a geological map of these properties. As no work has been done

[1]E. L. Bruce, Gold Deposits of Kenora and Rainy River Districts, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925.

at these mines since that time, the writer did not examine them in detail. Bruce's geological map is reproduced here with a slight modification in the interpretation of one of the rock formations (see Fig. 10). As previously stated, the writer

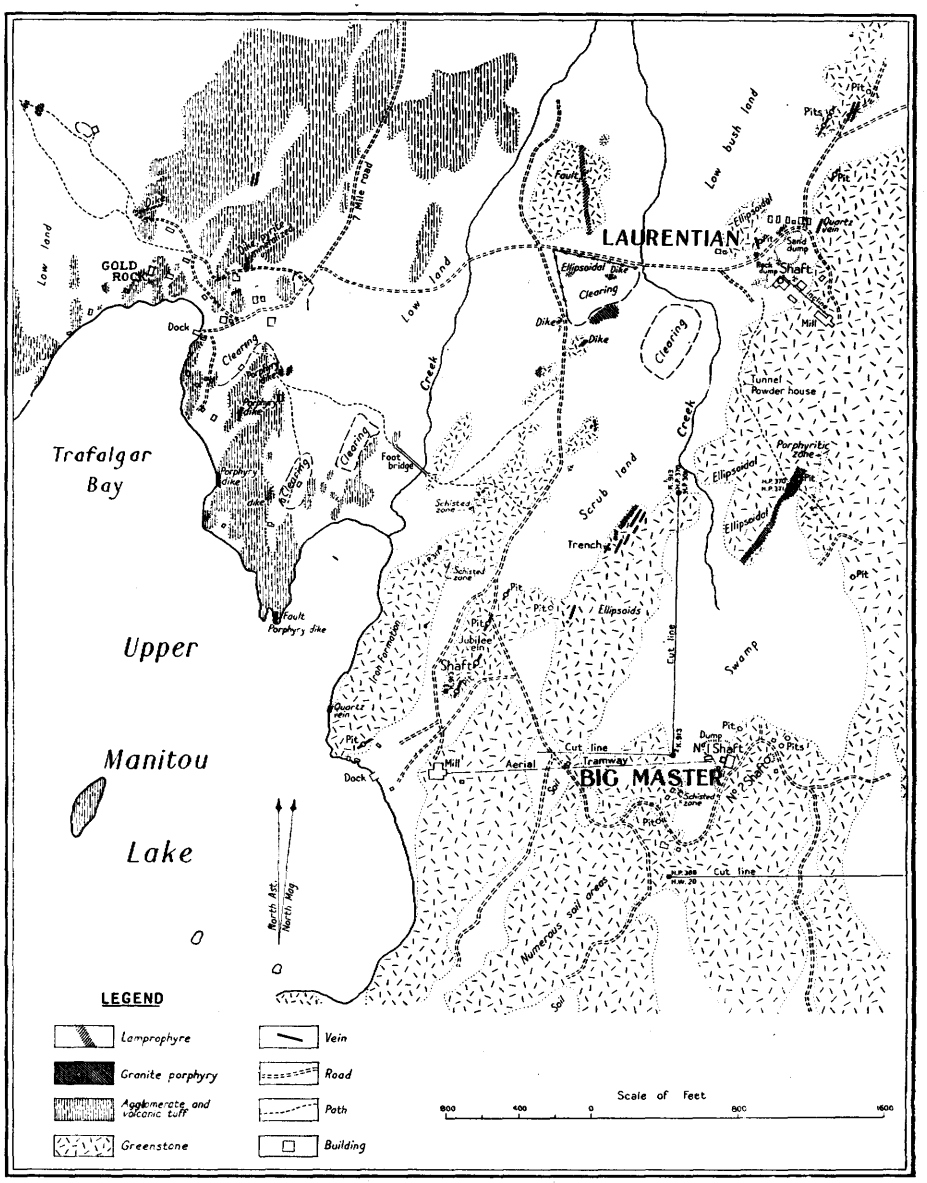


Fig. 10—Geological sketch map of the Laurentian, Big Master, and Jubilee mines (after E. L. Bruce[1]).

regards the fragmental rock near Goldrock as agglomerate and volcanic tuff rather than a brecciated porphyry.

The following information is abstracted from Bruce's report:[2]—

The Laurentian, H.P. 371, which began operations in October, 1903, was rapidly developed, and a 20-stamp mill was installed and put in operation in May, 1906. On the 1st level, rich ore

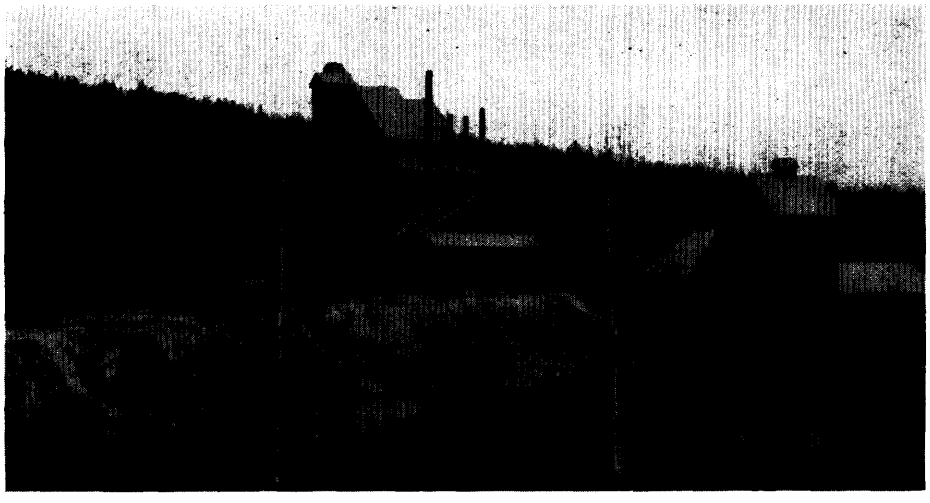
[1]E. L. Bruce, op. cit.
[2]Ibid, pp. 35, 36.

occurred in a narrow vein, in parts of which there was more gold than quartz. Production continued fairly steadily until November, 1909, when the mine went into receivership. In 1911, a little work was done; and in 1913, the Great Golconda Mines Company, Limited, took out and milled some ore from the old workings. The Dominion Reduction Company dewatered and sampled the workings early in 1916, but no work was done and their option was not exercised. . . .

The veins of the Laurentian and Big Master system trend slightly east of north. At the Laurentian shaft, the vein cannot now be seen, but following the road north from the houses a vein is exposed by pits just west of the road, and two small parallel veins lie somewhat to the east. The strike of these veins would carry them near the Laurentian shaft if they continue that far. The vein in the pits consists of two lenses of quartz, the eastern one ten inches wide and the western four inches wide, separated by three feet of rather rusty chloritic schist. A second pit 200 feet to the north exposes 80 inches of solid quartz. A sample taken across the face of this pit gave no gold and only a trace of silver.

Published descriptions of the underground workings state that the ore occurred as exceedingly rich stringers of quartz in zones of schistose rock.

"The ore body consists of bands of quartz varying from a mere trace up to several inches in width. . . . Occasionally schistose bands are found which, when quartz is present in thin



Laurentian mine, Goldrock.

stringers, may be regarded as ore bodies. The width of the principal vein is as much as forty feet, but will probably not average more than twenty feet."[1]

The total amount of quartz seems to have been very small. It is reported and is apparently true that much gold was stolen. The production is reported as follows:—

PRODUCTION OF GOLD FROM THE LAURENTIAN MINE

1906	$26,325.00
1907	50,470.75
1908	32,248.75
1909	32,104.61
Total	$141,139.11

Little quartz remains on the dump, and apparently all that was of any value has been put through the mill since. A sample left in the bins carried only a trace of gold. The tailings from the milling are rather coarse, and high losses would be expected. A sample from the surface of the dump gave only eighty cents per ton, but the lower part may be somewhat richer.

Big Master

The following is taken from Bruce's[2] description of the property:—

The Big Master mine consists of claims H.P. 366, 367, 368, 369, and 373. No mention of it is made in government reports previous to 1900, when it is stated mining operations were

[1] A. L. Parsons, Ont. Bur. Mines, Vol. XX, pt. 1, 1911, p. 182.
[2] E. L. Bruce, op. cit., pp. 35, 37.

suspended to install new machinery, and apparently the mine had then been in operation for some time, as the amount of development described was considerable. After the installation of the plant, which included a 10-stamp mill, operations proceeded steadily with some gold production until 1904. The mine remained closed for over a year and was then again operated from April, 1905, to January, 1906. It was pumped out for examination in 1911. Again in 1916, the Big Master was examined by the Dominion Reduction Company at the same time that that company sampled the Laurentian. . . .

The Big Master vein is covered by the dump at the shaft, but 200 feet northeast is exposed in a pit as several stringers of quartz one to two inches wide, in a rusty zone four to six feet wide which contains some siderite and pyrite. The shaft east of the main shaft was sunk on a rusty zone in schistose ellipsoidal-weathering greenstone. At the shaft south of the road to Goldrock, there is a vein of quartz twenty inches wide, but no sulphides.

The Big Master vein or veins, as they appeared underground, are described in various reports of the Ontario Bureau of Mines.

"The pay shoot, which lies northeast of the shaft, has a length of eighty feet along the vein (2nd level) and an average width of eight feet, both of which dimensions it maintains fairly closely from the surface down. The average value is given as $8.00 per ton. The big or east vein, lying to the southeast of the above, is also reported to have a pay shoot, which is ninety feet long and about five feet wide, lying directly opposite the one mined in the west vein. These pay shoots are well defined from the rest of the vein in that they each consist of a sudden enlargement of the quartz to about double its width elsewhere. It is stated by the manager that the quartz of the west vein carries values pretty well throughout, but that except at the so-called pay shoot, it is too narrow to mine at a profit."[1]

The report for the following year differs materially in the values quoted. The statement is made that the west vein widens from two and a half feet on the surface to nine feet at 285 feet, and that in the vein there is a shoot thirty feet in length on the surface and 156 feet long at a depth of 185 feet, with an average value of $17 per ton. The east vein along the 85-foot level had a width of twelve feet with a shoot of ore 140 feet long, averaging $8.35 per ton.[2]

It may be assumed that the lower value of $8 or thereabouts per ton is more nearly the average value of the ore shoots and that, as stated, only those parts of the vein, where the width increased to four or five feet, could be classed as ore; that is, that where the drift required the removal of wall rock, values were not sufficiently high in the vein to maintain ore grade with the dilution of vein matter with low-grade rock.

Jubilee

The Jubilee mine is located on claim H.P. 301. Bruce describes the vein as follows:[3]—

The Jubilee vein has been opened at a point a short distance north of the Big Master mill and a shaft has been sunk at a point where it is 4 feet in width. Southwestward, the vein is exposed for about 15 feet, and in that distance it narrows to 3 feet. A large proportion of the material is quartz, which is white, vitreous, and with only a small quantity of pyrite in it. The schistose wall rock, however, contains sufficient sulphide to cause it to weather red. Two hundred feet to the northeast, a pit on the same vein shows a sheared zone 8 feet wide, of which one-half is quartz of a white vitreous variety, somewhat iron-stained. The walls of the vein consist of sericite schist, which is impregnated to some degree with pyrite. A sample channelled across the vein, near the shaft where the width is 4 feet, gave an assay of $5 per ton in gold. Another vein or series of veins occurs on the Jubilee property, just east of the Jubilee dike of granite porphyry. The largest of these is a lenticular mass of quartz 2½ feet wide in a band of rusty-weathering schist 4 feet in width.

Sakoose

The Sakoose mine is located 6 miles south of Dyment station on the Canadian Pacific railway on claims H.W. 416 and 475. It was originally known as the Golden Whale mine. The Sakoose was worked from 1899 until 1902. Carter[4] reports that 7,735 tons of ore were mined and milled from the stopes. A spur line was built to the railway, and the ore was shipped to the Keewatin Reduction Works for treatment.

The writer did not visit the property. The following account of the geology, and the geological map (Fig. 11), is taken from Bruce's report:[5]—

[1]W. E. H. Carter, Ont. Bur. Mines, Vol. XIII, pt. 1, 1904, p. 68.
[2]Ibid, Vol. XIV, pt. 1, 1905, p. 54.
[3]E. L. Bruce, op. cit., p. 37.
[4]W. E. H. Carter, Ont. Bur. Mines, Vol. XI, 1902, p. 255.
[5]E. L. Bruce, op. cit., p. 39.

At the shaft, the main vein occurs in the quartz porphyry. Northeastward, the walls are the rocks classed as sediments and silicified greenstones. The wall rock is sheared slightly in places, but the alteration is not extensive. The vein is very irregular in strike and dip and varies in width from a few inches to 5 feet or more. The quartz is an unusual dull blue colour and rather vitreous. Very few other minerals occur in the vein.

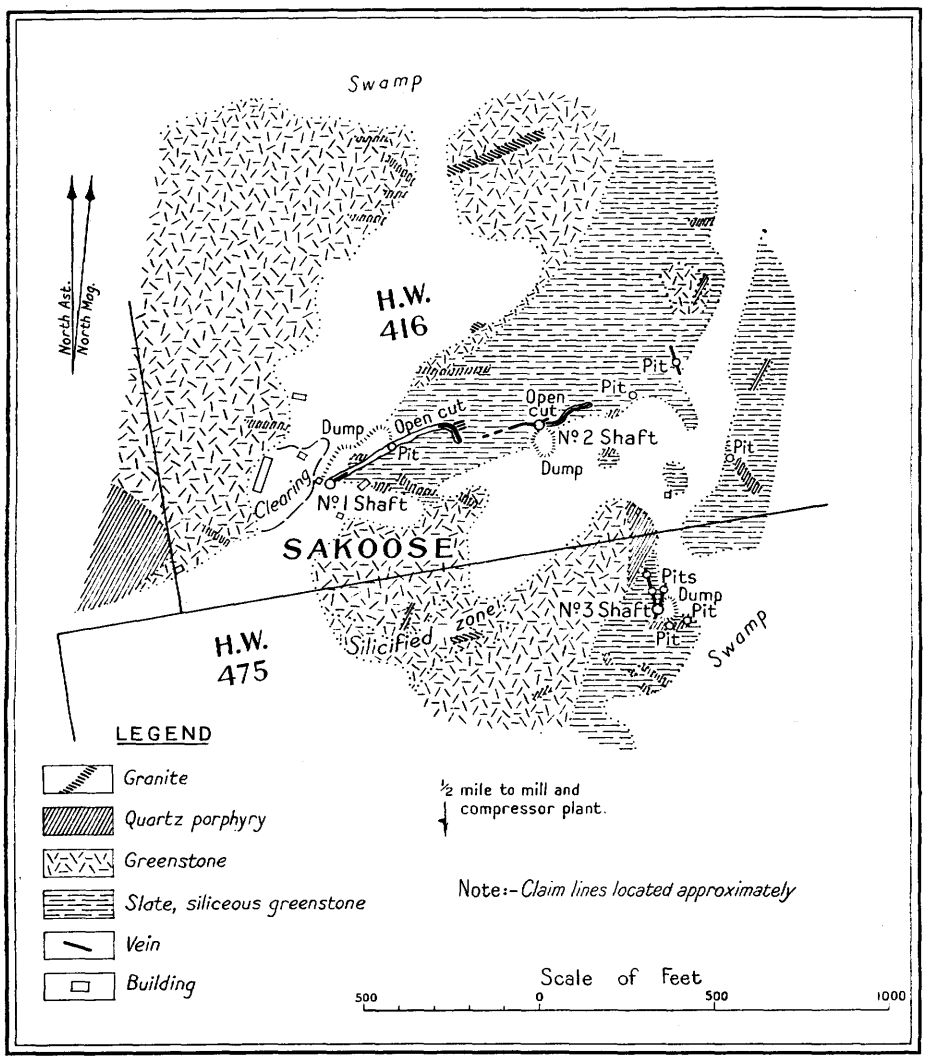


Fig. 11—Geological sketch map of Sakoose mine (after E. L. Bruce[1]).

The mine was examined by Percy E. Hopkins, consulting geologist, in June, 1931, and 500 feet of diamond-drilling was done. Mr. Hopkins has informed the writer that No. 1 shaft averaged $17 per ton in gold across 18 inches to a depth of 120 feet, and sampling of the open cut immediately east of this shaft averaged around $10 per ton in gold. Four short diamond-drill holes were sunk west of the shaft in an endeavour to find the extension of the vein under drift, but it was not located.

[1]E. L. Bruce, op. cit.

Geology of the Kakagi Lake Area

By E. M. Burwash

INTRODUCTION

The region immediately to the east of the Lake of the Woods lies somewhat away from main lines of travel either by rail or water. It is readily accessible, however, from the lake and easily traversed by means of a network of smaller lakes and connecting streams. A railway line that has been projected through has still to be started, but a motor highway is at present under construction along its western margin between Kenora and Fort Frances.

This area attracted prospectors and lumbermen during the last decade of the last century with the result that extensive logging operations were carried out

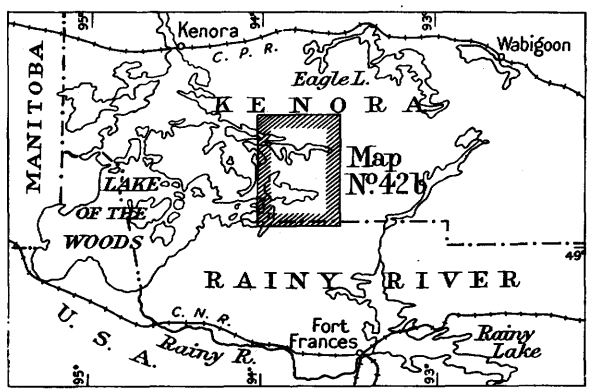


Fig. 1—Key map showing location of the Kakagi Lake area. Scale, 50 miles to the inch.

and numerous mineral claims staked for gold. One property only, the Regina, situated on Regina bay of the Lake of the Woods, continued in operation for more than a short period. The shaft reached a depth of over 500 feet with nine levels, and the ore was treated by stamping, amalgamation, and cyaniding. Work had practically ceased in 1906, after the mine had been operated for about twelve years. The operation of the other properties in the area to the east of the lake was in nearly all cases commenced later than the Regina, and all were abandoned by 1903.

There were some rich openings, but no very satisfactory developments appear to have resulted. A shaft was sunk in one case, the Virginia mine, to a depth of 200 feet, and it was hoped that further development would produce a working mine, but the work was discontinued. Several attempts to resume operation of the Regina have been made since then. After a change of ownership in recent years it was renamed the Horseshoe mine, and as late as 1931 was dewatered for examination by engineers representing several financial interests. More extended studies of the geology of these and other properties will be found in the section on "Economic Geology."

In view of the improvement of mining and metallurgical methods since work was practically abandoned in this region,[1] the present advantageous conditions for gold mining, and the advance in knowledge of the geology of the gold deposits of the pre-Cambrian that has been made during the same interval, the Department of Mines of Ontario undertook a resurvey of the geology of the area concerned in 1930 and commissioned the present writer to perform the work. The field work was continued during the summers of 1930 and 1931 and has resulted in the mapping of an area approximately 20 by 30 miles on a larger scale (one mile to the inch) than that of the existing maps, and in more detail. Previous maps include the Manitou Lake sheet[2] of McInnes, published in 1902, on a scale of 4 miles to the inch. A small part of the area is covered by A. C. Lawson's map, issued in 1885[3] and republished for the Sixth Report of the Ontario Bureau of Mines in 1897, on a scale of 2 miles to the inch. The map of the southeastern part of the Rainy River district,[4] published by the Ontario Bureau of Mines in 1895, on a scale of 2 miles to the inch, which contains work done by Lawson to the southeast of his Lake of the Woods map, covers the southern part of the area.

The present survey was carried out with the object of ascertaining more accurately modes of mineral occurrence and the probability of their successful exploitation, so far as geological data will accomplish these ends. The larger scale of the map accompanying this report, No. 42*b*, has permitted a much greater degree of differentiation of the various rock formations, and particularly of the lavas, pyroclastics, and sediments, as well as more extensive tracing of boundaries, particularly of igneous contacts. Special attention was paid to the granites and other igneous masses that might be metallogenetic. Some study was also given to the apparent stages in the process of mineralization.

General Description of the Map Area

The mapped area extends from the southern part of Dryberry and Populus lakes on the north to the boundary between the districts of Kenora and Rainy River on the south. Its eastern limit passes through Atikwa, Rowan, and Pipestone lakes, at approximately longitude 93° 33′ W. The western margin crosses Lobstick, Regina, Snake, and Sabaskong bays of the Lake of the Woods at about longitude 94° W. The map-sheet lies directly east of Aulneau peninsula, or Grande Presqu'île, which separates the northern and southern expansions of the Lake of the Woods.

On the north side of the peninsula, access to the field is most easily obtained by launch from Kenora to Whitefish bay, which lies between the east side of the lake and the northeast coast of the oval peninsula,[5] separating the peninsula almost completely from the mainland. This route leads most directly to the northern part of the area. The distance by launch from Kenora to Whitefish rapids is about 45 miles. The southern part is more easily reached from Sabaskong bay, which is on the south side of the peninsula and leads by way of Crow portage to Kakagi and its connecting lakes. Access to Nestor falls in Sabaskong bay is gained from Fort Frances by the completed part of the Kenora–Fort Frances highway. The distance is about 75 miles.

[1]E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925; republished as Bull. No. 85 in 1932. For a general summary of the geological and economic factors, see pages 1 to 3; for a description of the Regina mine, pages 10 to 13.

[2]Geol. Surv. Can., Map No. 720, 1902.

[3]Ibid, Vol. I, pt. CC, 1885.

[4]Ont. Bur. Mines, Vol. IV, 1894.

[5]For a full description of the topography of the Lake of the Woods, *see* A. C. Lawson, Geol. Surv. Can., Vol. I, pt. CC, 1885.

Population and Industries

Apart from a few white men engaged in trading, prospecting, and the care of tourist camps or mines, there is no permanent population in the area except the Indians who live at Whitefish rapids, Crow portage, and Kakabikitchiwan lake. In whole or in part five Indian reserves are included in the map-sheet, but the total number of persons who live on them is not large. When lumbering operations are in progress there may be over 1,000 men employed. Several crews of the Keewatin Lumber Company were engaged in bringing out pulpwood in 1930, but none in 1931. A few fishermen operate on the lake in the summer, and there are also a number of tourists and the officers of the Ontario Forestry Service. Summer travel in the region is prohibited except by special permit, owing to the value of the timber, which has grown for more than thirty years without serious fires.

Acknowledgments

During the field work in the summers of 1930 and 1931, friendly assistance was extended to the field parties by several persons in many ways. At Kenora, J. D. C. Smith, the mining recorder, the officers of the Department of Northern Development, and Lt.-Col. A. T. Fife are especially mentioned as having afforded indispensable help. The men in charge at the Horseshoe mine and at the Keewatin Lumber Company's depot at Whitefish rapids rendered the party services which saved much time and effort in carrying out the work. At Fort Frances, in 1931, we were also indebted to the Northern Development Department, which afforded us transportation to Nestor falls and saw to forwarding mail and supplies. Owners and caretakers of tourist cottages and of the hotel at Nestor falls also tendered us the use of facilities that saved much otherwise necessary travel.

The writer wishes especially to acknowledge the services of the six assistants who during two seasons were connected with the work. The competent help of W. D. Harding and C. B. Morgan added much to the extent of territory that could be covered. The junior assistants, Messrs. R. A. Young and Walter Sutton in 1930, and C. M. Stanbury and R. J. Beggs in 1931, contributed their full quota to the results by patient and often strenuous work and by the able performance of the technical duties assigned to them.

Climate

The following figures, taken from a publication by the Meteorological Service of the Department of Marine of Canada, indicate sufficiently the range of temperatures and the rain and snowfall of this area:—

TEMPERATURE (AS AT KENORA)—DEGREES F.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Mean maximum	7	12	26	45	59	72	75	72	63	48	28	15	44
Mean minimum	−12	−12	2	26	37	50	54	50	42	32	14	0	24
Mean.....	−2	0	14	36	48	61	64	61	52	40	21	8	34
Mean ranges...	19	24	24	23	22	22	21	22	21	16	14	15	87

Absolute range maximum recorded 99°.
Minimum recorded −45°.
Absolute range 144°.

PRECIPITATION (AT KENORA)—INCHES

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Rain	.....	.....	0.33	0.96	2.6	3.23	4.86	3.5	3.09	2.04	0.4	0.1	21.12
Snow	10.2	8.2	7.7	3.8	.8	.....	.....	.....	.5	4	7.8	10.2	53.2
Total (as rain)	1.02	.83	1.1	1.34	2.68	3.23	4.86	3.6	3.14	2.44	1.18	1.12	26.44

The climate may be fairly described as an extreme interior continental climate and rather dry. The ice in the Lake of the Woods, according to reliable local information, forms on an average about the middle of November and breaks about the middle of May, which gives clear navigation for six months and ice conditions for an equal length of time. The period during which the ice is safe for travel must be somewhat shorter.

Though the annual precipitation is not high, the summer maximum of precipitation (July, 4.86 inches) renders the climate very good for crops that do not mature too early, and especially for roots.

Flora

The following lists of trees, shrubs, and other plants, while by no means exhaustive, cover those which are commonly encountered.

Forest Trees (common)

White pine (*Pinus strobus*)
Red pine (*Pinus resinosa*)
Grey, northern scrub, or jack pine (*Pinus banksiana*)
Black spruce (*Picea nigra*)
Balsam (*Abies balsamea*)
Tamarac (*Larix americana*)
White cedar (*Thuja occidentalis*)
Juniper (*Juniperus communis*)
American aspen or white poplar (*Populus tremuloides*)
Balm of Gilead or balsam poplar (*Populus balsamifera*)
Large-toothed aspen or poplar (*Populus grandidentata*)
Alder (*Alnus incana*)
Elm (*Ulmus americana*)
White birch (*Betula alba*, var. *papyrifera*)
Maple (*Acer spicatum*)
Ash (*Fraxinus sambucifolia*)
Oak (*Quercus*, probably *macrocarpa*)
Willow (two or three species)

Herbaceous Plants

Wild strawberry in clearings (*Fragaria virginiana*)
Giant water-grass or reed grass (*Phragmites communis*)
Wild rice (*Zizania aquatica*)
Cat-tail flags (*Typha latifolia*)
Reed meadow grass (*Glyceria grandis*?)
Horsetail (*Equisetum arvense*?)
Yellow water-lily or pond-lily (*Nuphar advena*)
White water-lily (*Nymphaea odorata*)
Lesser water-lily (*Nymphaea odorato*, var. *minor*)

Owing to the use of horses and other activities connected with mining and lumbering there are also a great many introduced plants, which thrive without cultivation, including:—

Timothy grass (*Phleum pratense*)
Red top grass (*Agrostis alba*)
White clover (*Trifolium repens*)
Red clover (*Trifolium pratense*)

Shrubs

Saskatoon (*Vaccinium corymbosum*)
Blueberry (*Vaccinium canadense*)
Cranberry (*Oxycoccus vulgaris*)
Labrador tea (*Ledum latifolium*)
Swamp laurel (*Kalmia glauca*)
Meadow-sweet (*Spiraea salicifolia*)
Black currants (*Ribes floridum*)
Gooseberry (*Ribes oxyacanthoides*)
Red raspberry (*Rubus strigosus*)
Cloudberry (*Rubus chamaemorus*)

Mosses

The muskegs here, as elsewhere, and the damp wooded lowlands have a great variety of mosses, including especially *sphagnum* and other swamp plants, and in the woods, liverworts, club-mosses, and the very prevalent soft moss of the shady woods, commonly used for chinking log-houses. On the more exposed rocky surfaces, the so-called reindeer mosses or lichens are also common.

Fauna

This area has been of importance for its fish and game and, owing to the restriction of travel, is at present well stocked with many of the larger game animals.

Fish

Lake trout (*Cristivomer namaycush*)
Whitefish (*Coregonus clupeaformis*)
Pike (*Esox lucius*)
Maskinonge (*Lucius masquinongy*)
Pickerel or doré (*Stizostedion vitreum*)
Perch (*Perca flavescens*)
Sunfish (*Eupomotis gibbosus*)
Black bass (probably *Micropterus dolomieu*)
Sturgeon (*Acipenser rubicundus*)

Reptiles

Snapping turtle (*Chelyndra serpentina*), very large specimens and apparently quite common.
Common striped snakes.

Birds

The following, with several species of plover that were not identified, were the common water birds of the lakes and rivers. They all nest in this locality. The more sought-after game, ducks, were notable by their absence.

Loon (*Gavia imber*)
Herring gull (*Larus argentatus*)
Common tern (*Sterna hirundo*)
Sawbill duck (*Merganser americanus*)
Great blue heron (*Ardea herodias herodias*)

Of the larger members of the carnivorous and other land birds, the more commonly seen were:—

Crow (*Corvus brachyrhynchos brachyrhynchos*)
Red-winged blackbird (*Agelaius phoeniceus phoeniceus*)
Osprey (*Pandion haliaetus carolinensis*)
Great horned owl (*Bubo virginianus virginianus*)
Ruffed grouse (*Bonasa umbellus umbellus*)

Large numbers of birds, assumed to be warblers, chickadees, nuthatches, and smaller woodpeckers, are found in the woods and along the shores, but

attention could not be given to accurate determination. The Canada jay (*Perisoreus canadensis canadensis*) is of course common.

Mammals

The following mammals were observed as among those common in the region:—

CERVIDAE

Moose (*Alces americanus*)—quite numerous and as observed appear more strongly marked, with black back and sides, brown head, and pale grey legs, than those seen by the water elsewhere.
Red deer (*Odocoileus virginianus*, var. *borealis*)—very common in this protected area, where little travel is allowed.

RODENTIA

Porcupine (*Erethizon dorsalis*)—extremely common.
Beaver (*Castor canadensis*)—not many remain.
Varying hare (*Lepus americanus*)—fairly abundant.
Red squirrel (*Sciurus hudsonicus*)
Chipmunk (*Tamias striatus*)
Muskrat (*Fiber zibethicus*)
Long-tailed jumping mouse (*Zapus hudsonicus*)
Short-tailed mouse or field mole (*Microtus pennsylvanicus*)

URSIDAE

Black bear (*Ursus americanus*)

MUSTELIDAE

Mink (*Lutreola vison*)
Wolverine (*Gulo luscus*)—one appeared to be present on Kakagi lake, but was not seen.

GENERAL GEOLOGY

Table of Formations

QUATERNARY	
RECENT:	Beach and marsh deposits.
PLEISTOCENE:	Lacustrine—sands and gravels, clays. Glacial—outwash(?); till.
	Great erosional unconformity
PRE-CAMBRIAN	
KEWEENAWAN(?):	Late dioritic dikes.
	Intrusive unconformity
ALGOMAN(?):	Quartz and rhyolite porphyry. Younger granite: Hornblende-muscovite granite. Titaniferous hornblende-biotite granite.
	Intrusive unconformity
HAILEYBURIAN(?):	Lamprophyre dikes. Diorite, amphibolite, and peridotite.
	Intrusive unconformity (?)
LAURENTIAN(?):	Younger biotite gneiss. *Intrusive unconformity* Older hornblende-biotite gneiss.

KEEWATIN:	Fragmental lavas, mainly andesitic. Banded ash and breccia. Flows, andesitic for the most part with some interbedded rhyolite (pillow, amygdaloidal, coarse porphyritic, and massive structures), also schists of corresponding composition.
COUTCHICHING(?):	Gneisses, sericite and sericite-chlorite schists, interpreted as mainly bedded pyroclastics, with some possible sediments. Rhyolite at Berry lake.

Coutchiching(?)

Warclub Lake Series

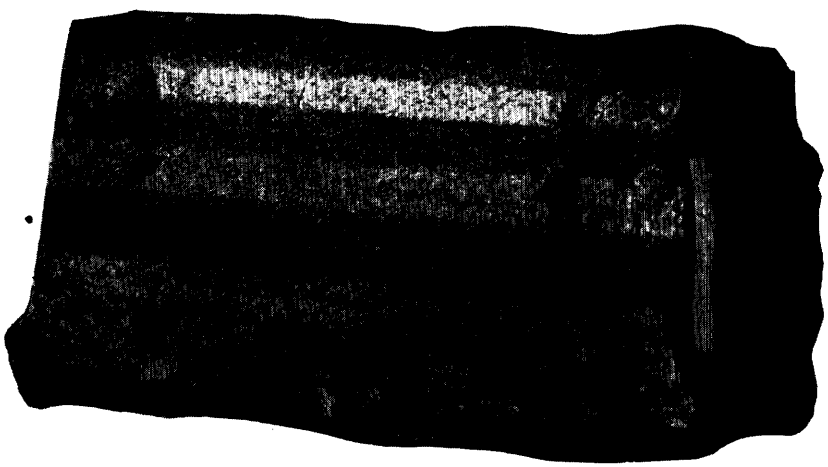
There is a band of schisted and partly fragmental clastic rock in the neighbourhood of Warclub lake and extending thence southwestward beyond Dirtywater (Weenagami) lake, where it divides into two branches, which pass north and south of the Kishquabik granite stock. The southern arm extends to the head of Lobstick bay, where it fingers out to the west, apparently passing under the greenstones. The northern branch, after curving around the north and northwest margin of the granite area, continues west of Berry lake toward Long bay of the Lake of the Woods. This is the upper member of the Keewatin as described by Lawson under the heading of "hydromicaceous schist and nacreous schists with some associated chloritic and micaceous schists and including areas of altered quartz porphyry." An examination of these rocks was made in the summer of 1930 around Warclub lake, where they had been mapped by McInnes in his map published in 1902.[1] They are also exposed on Lobstick bay and on Berry lake and the smaller lakes lying east of it.

Under the microscope the rocks reveal a sedimentary origin for the most part; some are evidently the clastic remains of andesites and rhyolites, now presenting an arkosic character. In some cases a finely granulated mass contains larger fragments of the original rocks now rendered lenticular by shearing. There are also shreds of mica, both biotite and muscovite, generally arranged in parallel. In other cases, hornblende or epidote also occur. These gneissoid arkoses contain fragmental quartz and orthoclase or oligoclase feldspar if rhyolitic in origin. In other cases an andesitic origin is indicated by the presence of more hornblende and andesine feldspar with less fragmental quartz. Both andesine and orthoclase are sometimes present. Secondary quartz pavement is usually present in either case. In other cases, the quartz predominates to such an extent that quartzite seems a more proper designation, and this would appear to indicate a sorting of the material as derived from the original lavas by weathering and water transportation, rather than deposition in the form of volcanic ash. The term "greywacké" would also appear to be more suitable in some cases. Conglomerates are present to some extent. Banded rock, much resembling iron formation, was also noted.

Some mica schists of a steel-grey colour and semi-metallic lustre found on Warclub lake and also in the area around Stephen lake appear to consist largely of sericite with hornblende and grains of iron ore and quartz. The sericite here is probably hydrous, and the hornblende apparently represents more or less calcareous and magnesian content in an otherwise argillaceous sediment. In other cases the schists are more properly described as hornblende schists. A biotite-muscovite schist with garnets and some angular grains of original quartz represents a much altered sandy shale.

[1]Manitou Lake Sheet, Map No. 720, Geol. Surv. Can., 1902.

The origin of these rocks is somewhat in doubt. Two possible hypotheses present themselves: (1) They may be mainly volcanic ash with a few interstratified sedimentaries derived from weathering; (2) they might be explained as disintegrated lavas derived from steep slopes and deposited near the source of the material without time for much weathering during transportation. In either case they are intimately associated with the Keewatin eruptives. In the case of disintegration by weathering, they must be considered as subsequent in time to the Keewatin, representing at least a long interval in the volcanic activity. The first of the two alternatives above given must, therefore, be considered the more probable. In addition to this, they lie below the Keewatin as elsewhere described in this paper, or at least below most of it. They were placed at the top of the Keewatin series of Lawson's Lake of the Woods map, but have been coloured as Coutchiching in a recent map issued by the Geological Survey of Canada.[1]



Specimen (natural size) of banded sediment of Upper Keewatin age (probably volcanic), from the portage between two small lakes, 1½ miles south of Warclub lake.

The latter conclusion the writer believes to be more nearly correct for the following reasons: The structure occurs here as the outer member of a synclinal trough, which is formed by the doming-up of the Keewatin over a granite boss. That the lavas dip away from the Kishquabik granite is demonstrated on the shores of Lobstick bay by the position of the ellipsoid structure. These possibly Coutchiching sediments are, therefore, below the lower member of the Keewatin as described in this report. The Kishquabik granite has been regarded as Laurentian because it displays a gneissic structure and also because of the doming-up of the Keewatin over it. In this it differs entirely from the later granitic intrusions, which have penetrated through the synclines previously formed by this doming process. There are two distinct methods of granitic intrusion here indicated. The "doming-up" method can only occur by a decrease in the area of the domed-up terrain, that is during a period of lateral compression and consequent orogenic movement. On the other hand the large domes could not have been formed without interior support. It must, therefore, be assumed that the intrusion and the horizontal orogenic compression were simultaneous, each supplementing the other in the production of the domed and intruded

[1]T. L. Tanton, Kenora Sheet, Map No. 266A, Geol. Surv. Can., 1933.

structure. In the case of the later granites there was no orogenic movement, at least affecting the lower Keewatin, through which the granites eroded their way by stoping or other assimilative action. The Kishquabik granite boss, therefore, undoubtedly belongs to the older period. This is supported by the fact that we

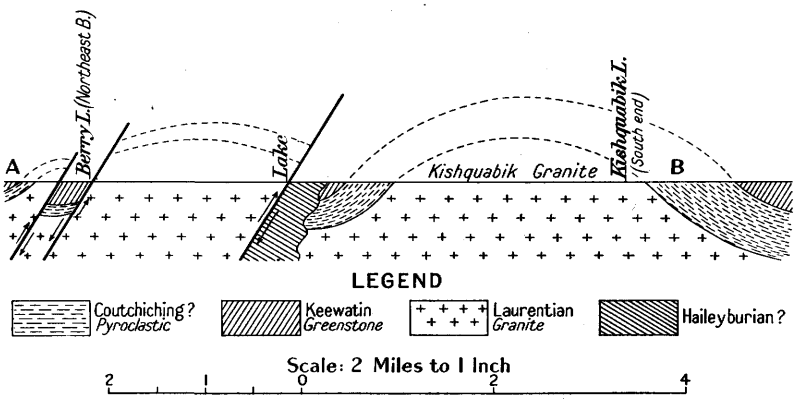


Fig. 2—Section on line A-B (see map No. 42*b* in pocket at back of report), northwest-southeast across Berry lake and the Kishquabik (Laurentian?) granites. The Coutchiching appears doubtful for reasons mentioned in the text.

find the supposed sediments in the same relation to the Dryberry lake Laurentian gneisses.

Another consideration that must be taken into account here is that at the southwest end of the Kishquabik granite oval a rhyolitic formation appears from beneath the banded sediments. The conclusion must be, therefore, that these banded, and in part sedimentary, rocks constitute a pyroclastic member

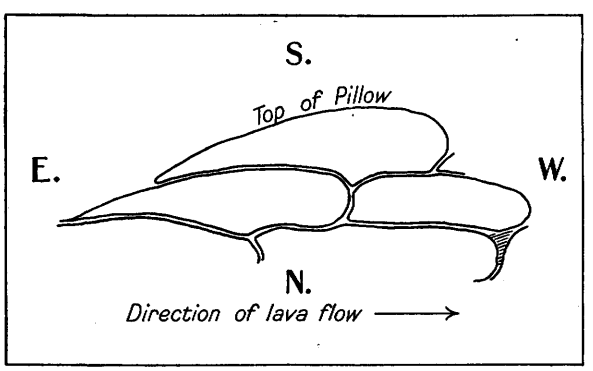


Fig. 3—Horizontal section of closely folded lava showing direction of the upper part of the flow (south) and direction in which the liquid lava flowed (west). The length ranges from two to four feet.

of the lower Keewatin rather than a distinct or in any way unconformable sedimentary terrain of the usual terrigenous character.

Keewatin

The greater part of the oldest rocks present in the area belong to the volcanic formation, to which in this very region the name Keewatin was originally assigned

by Lawson.[1] Wherever it occurs it is typically a lava formation, generally closely folded and much affected by both regional and contact metamorphism. It is throughout the province of Ontario somewhat uniform in character, basaltic or andesitic in composition, the basic lavas often interbedded with thinner and less numerous acidic flows. There are also often small amounts of interbedded sediments, including iron formation, conglomerates, and finer schisted sediments. The ellipsoidal or "pillow"[2] structure is very commonly present in the lavas,

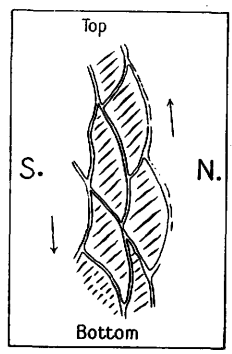


Fig. 4—Vertical section showing fracture cleavage in ellipsoidal lava. The ellipsoids are exposed in an eastward-facing cliff on the north side of Snake bay. The fracture cleavage in the ellipsoids indicates a position on the south side of a syncline with an east-west strike and a dip of more than 80 degrees.

and in several localities the presence of fragmental or scoriaceous tops also aids in distinguishing the structural relations, by determining the upper surfaces of the flows and consequently the direction in which they have been tilted in folding. Amygdaloids are also common.

LOWER (or Middle) KEEWATIN

Flows

In the map area now under discussion, which lies immediately to the east of that depicted in Lawson's map of the northern part of the Lake of the Woods, all of these characteristic features are present. For purposes of structural determination, the ellipsoidal and fragmental structures were both found of competent value. Detailed structural mapping was not attempted, but the larger outlines of structure were readily discernible throughout the field, especially by the quite distinguishable character of the upper and lower surfaces of the "ellipsoids" or "gouts," the lower parts of which are fitted into the irregularities of the surface on which the gout came to rest, the upper parts curved by the surface tension of the viscous liquid and often noticeably more scoriaceous than the lower parts. In some cases scoriaceous or amygdaloidal upper surfaces of flows were also found of determinative value. In other cases thick flows or sills contain large phenocrysts

[1]A. C. Lawson, Geol. Surv. Can., Vol. I, pt. CC, 1885, pp. 10-15.

[2]Due to a succession of gouts flowing one over the other, perhaps better called "gout structure."

of feldspar,[1] which have settled toward the lower surface of the flow by gravity, so that the lower part becomes a strongly marked porphyrite while the upper is almost or quite free from phenocrysts.



Porphyrite in contact with pillow lava on road from Emm bay to Bag lake. Above is massive spessartite, with large phenocrysts sunk nearly to the bottom of the flow, where they were stopped by the solidified lower surface before reaching the pillow lava.

Composition.—All of the above types of structure belong to the lavas of the basal part of the Keewatin as developed in the Lake of the Woods area. In the map-sheet here described they are mainly of an andesitic type with few recognized basalts. Macroscopically they are of several varieties: (1) very fine grained black



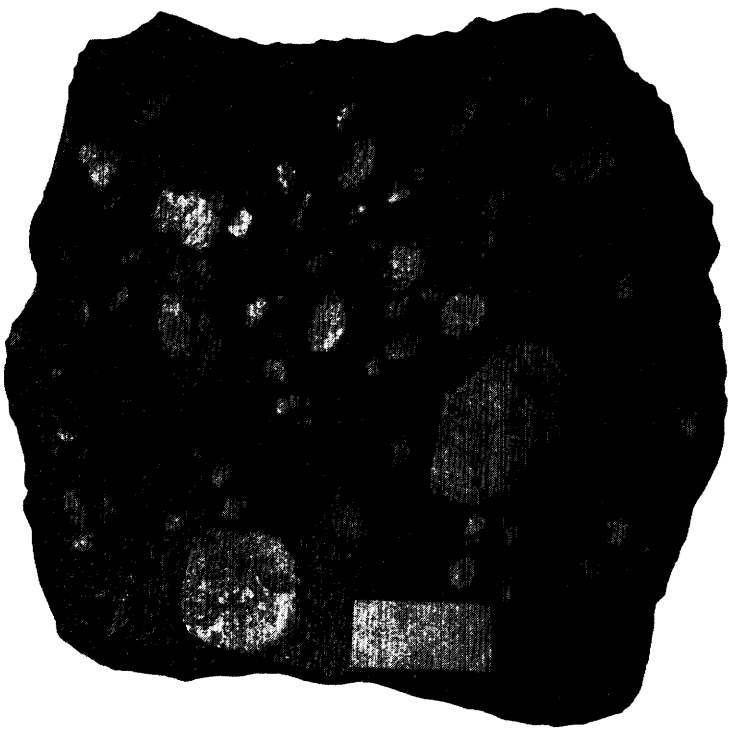
Photomicrograph of andesite porphyry (groundmass only, phenocrysts not shown). The groundmass is a felt of andesine (A) and hornblende laths with dark interstitial material (×31).

lavas; (2) lighter grey lavas, somewhat less fine grained; and (3) "spotted" lavas having a grey to yellowish groundmass dotted with small roundish aggregates of hornblende and biotite. These often contain large phenocrysts of more or less

[1]A. P. Coleman, Ont. Bur. Mines, Vol. VI, p. 102, paragraph on Snake bay, and illustrations A and C.

altered feldspar, which in many cases have caused a differentiation in the thick flows by settling toward the bottom, as above described. These lavas are therefore lamprophyric in type.

All of these lavas are andesitic, the feldspars working out consistently as andesine, except in a very few instances where labradorite was observed. In some cases where the feldspar is andesite, a considerable amount of pyroxene is present in addition to the usual green hornblende. Specimens studied under the microscope were found to fall under the following classifications: doubtful hornblende trachyte; andesite ("light-grey lava"); andesite porphyry; quartz andesite;



Specimen (three-quarters natural size) of spessartite porphyrite (Lower Keewatin). The phenocrysts of feldspar (possibly orthoclase) are, in the main, much altered. The groundmass is feldspar with small round aggregates of hornblende and some biotite.

ophitic quartz andesite; coarse porphyrite, with a groundmass of quartz lamprophyre (spessartite) and large phenocrysts of orthoclase; andesite porphyry, with phenocrysts of both orthoclase and plagioclase; hornblende-andesine lamprophyre (spessartite), with phenocrysts of hornblende and andesine; basaltic porphyry; hornblende diabase; and quartz-hornblende basalt. There are many schistose types representing various members of this series.

The more acid flows were found to include rhyolite, binary rhyolite, and sheared forms including sericite and sericite-chlorite schist.

UPPER KEEWATIN

Apparently overlying the mainly andesitic and rhyolitic lava beds that have been described, the andesitic types of which occasionally exhibit flows with zones at their upper surfaces filled with fragments, there is a series of banded or coarser

bedded breccias, lavas, or ash rocks, overlain by an immense extrusion of fragmental lava of massive structure, which shows very little division into subordinate flows and very seldom even a tendency to parallelism in the fragments.

Banded Ash and Breccia

The lower banded rocks are found along the south shore of Kakagi lake immediately in contact with the great fragmental mass that occupies much of the central part of the lake, and they appear to be interbedded with the lower part of it. At the west end of Kakagi lake they appear again exposed along the margin of the fragmental mass; and the largest exposure of all is found surrounding Stephen lake, extending southwestward along Cedartree lake, and thence southeastward, enclosing a large body of the fragmental lava and in a rough way paralleling the outlines of the Stephen lake granite boss.



Photomicrograph of sericite carbonate schist with decomposed feldspar and altered rhyolite porphyry (×31). M = magnetite. F = kaolinized feldspar. C.SS. = chlorite-sericite schist, with fine grains of magnetite between the micaceous layers.

In this area the structural relations have not as yet been sufficiently worked out to give a locally certain result as to the order of the Keewatin sequence. Assuming with Lawson[1] that the Keewatin as a whole has been domed upward by the Laurentian gneisses, the relations of the different parts of the Keewatin in the field would indicate that the greenstones lie more toward the base of the formation and the banded and fragmental elements above. In that case the Stephen lake granite, like that mapped by Lawson at Red Cliff bay, Lake of the Woods, has been intruded into a synclinal part of the formation at a time much later than the original Laurentian folding and intrusion.

Judging by a disconformity of the strikes of the greenstones and the banded elements of the upper Keewatin, it is possible that there is a marked unconformity between the two parts of this formation, which may account for some of the areal and other apparent irregularities of the Keewatin structures as a whole. Some of these may be local distortions due to the intrusion of the later granites,

[1]A. C. Lawson, Geol. Surv. Can., Vol. I, 1885, pt. CC and map.

as might easily be the case at Stephen lake, where the banded elements are partly cut through by the granite but partly appear to conform to its areal outlines. The parts that are cut, however, while tilted nearly vertically, strike almost at right angles to the trend of the adjacent and supposedly subjacent greenstones. It would appear necessary to assume an overthrust folding of the upper member upon the lower to account for this. Here again, however, complete confirmation is lacking.

Composition.—The banded elements in the upper part of the Keewatin are partly fine-grained and thin-bedded, partly of coarser clastic structure and thicker bedding. The fine-grained often exhibit an alternation of colours in the banding, much like typical iron formation. Microscopically, this banded material appears to consist largely of fragmental quartz and feldspar with some scales of mica or hornblende crystals, and also grains of magnetite, as an important constituent. It has, consequently, been taken for a volcanic ash. In many cases the ash is filled with larger fragments of a uniform type corresponding in composition to the finer part. The feldspars observed in the ash are mainly orthoclase, anorthoclase, oligoclase, or andesine, corresponding quite closely to those of the rhyolitic and andesitic lavas of other parts of the formation. The bedding in all observed cases, whether coarse or fine, was very even and gives the impression of having been laid down in water and cemented there, as there are no evidences of the settling, slumping, and erosional disturbances that would follow subaerial deposition.

Fragmental Lavas.

The fragmental lavas may be in part agglomeratic. Where the fragments are in close contact the finer material between weathers out, leaving them standing in relief on the exposed rock surface. In the greater part of the formation, however, the fragments are not in contact and the material between is of the same character and erosional resistance as the fragments themselves, that is the fragments are disseminated through extremely massive flows of much the same character as themselves. In some cases they are more or less rounded; in most cases, sharply angular. The rounding presumably indicates a fluidal movement of the whole and consequent rotation of the fragments in the liquid. In other cases, especially where flows have been very thick, such movement has been absent and the included fragments have retained their angularity.

The fragments show differing shades of colour and vary in texture, some being porphyritic, some lamprophyric, and others entirely fine-textured. An examination shows that all are either rhyolitic or andesitic in composition. A microscopic examination of material obtained in the northwestern part of Kakagi lake on an island in Emm bay, gave the following results:—

1. The matrix is of porphyritic texture having lath-shaped feldspar crystals with hornblende inclusions, and also much rarer hornblende crystals enclosed in a glassy matrix, which holds microliths of feldspar and hornblende and small grains of iron ore. This is an andesite porphyry or spessartite.

2. A light-coloured fragment included in this matrix has also a porphyritic texture and a fine-grained groundmass of feldspar and quartz, with iron ore grains and small aggregates of quartz and sericite, in which are lath-shaped phenocrysts of feldspar altered to kaolin and sericite. A rhyolite porphyry is indicated.

3. Another included fragment of darker grey colour has a dark-grey groundmass including phenocrysts of acid plagioclase. This is probably an andesite porphyry.

The prevailing composition of the fragmental masses is, therefore, not different from that of the flows of the lower part of the formation, being mainly andesitic.

Laurentian(?)

The granites here included under the term Laurentian are distinguished from those of later age by their prevailing gneissoid structure. The older may well be partially or wholly hybrid, containing, as it does, many inclusions of the older Keewatin rocks, among them the coarse amphibolites. The common occurrence of anorthoclase is also an evidence of this. That this rock is not to be regarded merely as a marginal hybrid phase of the red biotite gneiss is also proved by its contact relations. If these rocks must be correlated with the granites of the eastern part of Ontario, it would appear that the red granite gneiss might be a folded Algoman. The sequence as a whole, however, does not appear to the writer to favour that view. Both types form part of what was originally described by Lawson as Laurentian, but it would seem that the western part of the province as well as the pre-Cambrian of Manitoba requires a somewhat independent treatment.

A matter which distinguishes these gneisses is the manner in which they have intruded the Keewatin lavas by filling large dome-like anticlinal folds from below, rather than by penetration of the rock.

Rocks belonging to this system, as defined by Lawson in the Lake of the Woods region, occur in four distinct areas within the limits of this field:—

Kakabikitchiwan Lake and Sabaskong Bay

The granites and granitoid gneisses here are a southeasterly extension of those of the Aulneau peninsula or Grande Presqu'île. They are well seen near Nestor falls and on the shores of the adjacent lakes and bays. The boundary line between the districts of Kenora and Rainy River was also examined from Sabaskong bay eastward for five miles. The character of the Laurentian here is that of a complex, some of the younger members of which may belong to a distinctly later period than the older members. The series in order of age is: (1) inclusions of grey gneiss, and amphibolite of Keewatin origin; (2) a pinkish-grey gneiss, which has the composition of granodiorite or syenite; (3) pegmatite and granite dikes cutting the first two members; (4) felsitic or aplitic dikelets of a redder colour, which cut the granite.

At Nestor falls the rock (taken for No. 2 above) is a hornblende-biotite gneiss with some oligoclase in addition to orthoclase and carries the accessories sphene and ilmenite.

On the highway at the outlet of Heronry lake the younger granite (No. 3 above), which is found intruding diorite, syenite, and older mica-gneiss, is a hornblende granite with orthoclase, microcline, and oligoclase feldspars, a little muscovite, and leucoxene.

The general facies of granite assigned to the Laurentian in this area is, therefore, markedly basic and titaniferous.

Atikwa Lake

In this area there are two fairly distinct types of gneissic granitoid rock, one of which is undoubtedly younger than the other, as proved by its intrusive relations. The older member, described by McInnes as "evenly foliated hornblende granite gneiss," is exposed on the eastern part of Populus lake, on the western bay of Atikwa lake, on Denmark lake, and on the northwestern bay of Rowan

lake. It was found by the writer to extend westward to the east shore of Empire lake and southward to the north shore of Isinglass lake. Microscopic sections taken throughout the area gave the following types as undoubtedly belonging to this rock unit: quartz diorite, granodiorite, hornblende-soda granite, hornblende granite, quartz diorite near amphibolite, titaniferous hornblende granite, and diallage syenite. The feldspars noted as present were orthoclase, anorthoclase, oligoclase, andesine, and in one case labradorite. In some cases quartz is reduced to small amounts. Among the accessories apatite is common, ilmenite less so. Near the north shore of Isinglass lake an ophitic diorite was observed. Other outcrops near by are granodiorite and ordinary quartz diorite.

The red granite of Atikwa lake is classed by McInnes and Smith as evenly foliated biotite granite. In relation to the hornblende granite and hornblende granite gneiss it is described in a note in the margin of their map as composing the central part of granite gneiss masses, while the hornblende granite constitutes a marginal phase due presumably either to splitting of the magma or hybridization by the adjoining greenstones of the Keewatin. In some cases, especially to the south and west of Atikwa lake, the areal relations of the two types seem to warrant these conclusions, but in other cases the biotite granite is seen in immediate contact with the Keewatin, and in still others there are large masses of the hornblende granite included in the biotite granite, notably at Wall-eye lake and north of Atikwa lake.[1] These might indeed represent hybridized roof pendants, but there are quite obvious cases observable on Atikwa lake where the hornblende granite is intruded by the biotite granite. It is also quite true, as stated by McInnes, that the difference in character between the two granites as to the relative amounts of hornblende and biotite present is not always easily distinguishable, and the red biotite type is found penetrating the hornblendic type at some distances from the main line of contact between them.

To the writer these two types seen to represent the more intimately mixed grey dioritic and red biotitic types seen at Kakabikitchiwan lake. This conclusion was first reached on examination of the contact between the two gneisses, which is seen on the east side of Shoulder island of Atikwa lake near the south end. As this point is approached from the south, the grey hornblende gneiss is first observed to be cut by numerous dikes of red pegmatite. These cut older dikes of white pegmatite in the hornblende gneiss, and these in turn are younger than certain aplitic dikes which with the white pegmatite are taken to be phases of the hornblende gneiss. The red biotite gneiss also contains inclusions of the older hornblende gneiss, which is coarser in texture than the biotite gneiss at the contact. The biotite gneiss has feldspars of a markedly red colour as compared with the older plutonic. In places along the south shore of the lake the older gneiss has large leafy aggregates of biotite, which weather out, leaving a pitted surface. Hornblende, however, is the predominant ferromagnesian mineral, and biotite is equally predominant in the younger red gneiss. A thin section of the latter contains quartz, micropegmatite, orthoclase, oligoclase, biotite, and a little hornblende.

Dryberry Lake

In this area the rocks are typically non-titaniferous biotite gneisses containing a little hornblende, with some intrusions of the younger titaniferous granites. It is generally gneissoid and laminated but in some parts more massive and often porphyritic. The minerals present include quartz, orthoclase, and biotite in all cases, with rarer occurrences of microcline and of oligoclase when hornblende is

[1]These localities lie outside of the map-sheet. *See* Wm. McInnes, Manitou Lake Sheet, Geol. Surv. Can., Map No. 720, 1902.

also present. There are also dikes of hornblende-biotite-muscovite granitic porphyry, biotite-muscovite granites, and pyritiferous quartz porphyry of later age.

Kishquabik Lake

This oval area lies between Lobstick bay and the southeastern part of Dryberry lake and has been named from one of the two narrow lakes that lie within it. The granite here is distinctly of the older type, defined by McInnes as granitoid gneiss. Rather coarse in texture, it shows a pitted surface due to the weathering out of small aggregates of biotite. The essential minerals are quartz, orthoclase, microcline, and biotite, with occasional oligoclase and hornblende. The accessories are commonly apatite, epidote, magnetite, and, more rarely, ilmenite and sphene.

The Age of Lawson's Laurentian

The Laurentian formation as at first defined in eastern Ontario and the adjacent parts of Quebec by Logan and his successors was taken to be the oldest member of the Archean or older pre-Cambrian rock system.[1] It consisted essentially of banded gneiss and granitoid gneiss, which was supposed to be metasedimentary. The gneiss was overlain by the metasedimentary Grenville series, which was considered, therefore, to be of a later age and was at first known as Middle Laurentian. Lawson, after studying the Lake of the Woods region in 1885, decided that the gneissoid member of the series there present was intrusive in the Keewatin greenstone formation (Lower Huronian of Logan), which had not as yet been identified in eastern Ontario. The Laurentian was, therefore, younger than the Keewatin, which was itself later declared by the same author to be younger than the Coutchiching sediments of Rainy lake.[2]

In 1907, W. G. Miller identified a lava formation, mainly greenstone, in eastern Ontario as Keewatin.[3] This formation underlay the Grenville with apparent conformity, and both were found to be intruded by the Laurentian. The time sequence, therefore, numbered from the oldest to the youngest, became:—

4. Laurentian.
3. Grenville.
2. Keewatin.
1. Coutchiching.

Meanwhile in the Sudbury-Timiskaming region another series of folded sediments had come under observation and were not found anywhere intruded by the gneiss, but were intruded by massive red granite of less metamorphic appearance and of demonstrably later age.[4] This was named the Algoman granite. The sediments were variously known as Sudburian, Temiskamian, or Middle Huronian. The name Timiskaming series, or Timiskamian, now seems to be generally adopted in Ontario. The table of time sequence would then be:—

[1]Sir William Logan, Geol. Surv. Can., 1863, pp. 22 ff.

[2]A. C. Lawson, Geol. Surv. Can., Vol. I, pt. CC, 1885. *See also* Geol. Surv. Can., Vol. III, pt. F, 1887-88, pp. 21, 99.

[3]W. G. Miller and C. W. Knight, Ont. Bur. Mines, Vol. XXII, pt. 2, 1913, pp. 3, 9, 11, 45, etc. *See also* W. G. Miller, Ont. Bur. Mines, Vol. XVI, pt. 1, 1907, p. 221; and M. B. Baker, Ont. Bur. Mines, Vol. XXV, pt. 3, 1916.

[4]A. P. Coleman, Ont. Bur. Mines, Vol. XXIII, 1914, p. 204.

W. G. Miller, Ont. Bur. Mines, Vol. XVI, pt. 1, 1907, p. 201; "The Principles of Classification of the pre-Cambrian Rocks, etc.," Compte Rendu, XIe Congrès Géologique International, pp. 673 ff.

6. Algoman

Intrusive unconformity

5. Timiskamian .

Erosional unconformity

4. Laurentian

Intrusive unconformity

3. Grenville
2. Keewatin
1. Coutchiching

Pre-Algoman (Haileyburian) and post-Algoman (Matachewan) intrusives (dikes) have also been discovered in this region.

Subsequently work was undertaken on the Ontario-Manitoba boundary somewhat north of the Lake of the Woods and in adjacent fields to the east and west of that meridian. This investigation by E. S. Moore[1] and others disclosed a basal greenstone formation overlain by apparently conformable metasedimentaries. Both of these formations are older than any of the granites that intrude them. These in part appear to be three in number instead of two.[2] If, then, these Wanipigow sediments are taken as Grenville in age, it is obvious that the older granites which intrude them and which are sometimes gneissic may be considered as Laurentian. At the Lake of the Woods, however, there are two ages of distinctly gneissic plutonics instead of one, as in the eastern part of the province. The older one is a grey, hornblendic rock, often granodiorite in composition, or slightly more acid. It is found both on the Manitoba boundary and at the Lake of the Woods. It is petrographically much unlike the typical eastern Laurentian, but possibly corresponds to the granodiorite of western Quebec. It is intruded by a biotitic granitoid gneiss, which is petrographically much like the eastern Laurentian. Both of these have been considered as Laurentian by Lawson, McInnes, and Smith in the Lake of the Woods and Manitou Lake areas. A third and generally porphyritic and massive red granite, which is found intruding the folded Keewatin of the Lake of the Woods and Lac Seul regions, might then be regarded as corresponding to the eastern Algoman.

The late W. G. Miller,[3] however, considered the Wanipigow sediments as equivalent to the Timiskaming, which is found similarly folded with the Keewatin in the Porcupine and Kirkland Lake areas. Some evidence of unconformity, however, is here admitted. At Kirkland lake especially, these folded measures have been intruded after folding by a succession of porphyries, the oldest of which is also considerably more basic than the others.[4] Thus a succession of events similar to that found in the western part of the province seems to be established at Kirkland lake, but on a smaller scale. If this criterion be accepted, all the granites, porphyries, or felsites in either region are to be considered as Algoman.

Accordingly, in recent years, many writers who have reported on the western part of Ontario have avoided the use of the name Laurentian and listed all their granitoid intrusions tentatively as Algoman. In the present report the older gneissoid types still retain the name Laurentian, originally assigned to them by Lawson, for the reason that their intrusion seems to have been coincident with the

[1]E. S. Moore, Geol. Surv. Can., Sum. Rept. 1912, p. 262 ff.

[2]E. M. Burwash, Ont. Dept. Mines, Vol. XXIX, pt. 1, 1920, p. 181; Vol. XXXII, pt. 2, 1923, pp. 7, 8, 29.

E. L. Bruce, Ont. Dept. Mines, Vol. XXXI, pt. 8, 1922, p. 36; Vol. XXXIII, pt. 4, 1924, pp. 10, 22, 29 ff.

[3]E. M. Burwash, Ont. Dept. Mines, Vol. XXXII, pt. 2, 1923, pp. 9, 31 (footnote 1).

[4]E. W. Todd, Ont. Dept. Mines, Vol. XXXVII, pt. 2, 1928, p. 25 ff.

original folding of the Keewatin in which they have occupied positions under anticlinal domes, while the later massive granites have cut into the synclinal trough or basins between these domes, at a time subsequent to their formation, in a manner strikingly similar to the intrusion of the granitoid and porphyritic intrusives of the eastern gold ranges.

Haileyburian(?)

Mainly in the Keewatin, but to a slight extent projecting into the older granites here classified as Laurentian, there are a number of large unsheared crystalline bodies, which in the past have been explained as due to the recrystallization of basaltic volcanics under regional metamorphic conditions. They appear to be included under the heading "altered traps" by Lawson. The fact that they are almost exclusively found within the mass of the Keewatin greenstones lends colour to this. The amount of secondary mineralogical alteration that they exhibit is also often quite as great as that of the Keewatin lavas. These features seem to relegate them to an age much nearer that of the Keewatin than the age of the rocks that in this area have been assigned to the Laurentian. More basic rocks, however, are subject to more rapid alteration than acid.

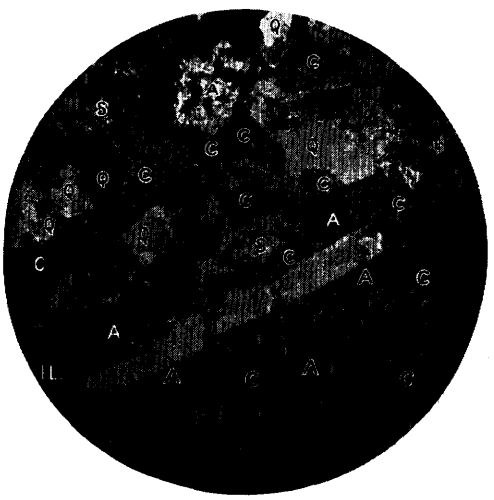
It has, indeed, been clearly shown in modern instances that large accumulations of lava are seldom without intrusive elements of the same rock type and derived from the same magma as the lava, but intruded into it in the form of dikes, sills, or laccoliths, owing to violent action renewed at a time later than that of the first extrusion of the lava. It is even conceivable that an advancing magma might stope its way through its roof and penetrate the lavas already formed from it above the roof by extrusion through vents. Where, therefore, in an altered extrusive series large masses of plutonic aspect are found either apparently conformable or penetrating irregularly through the mass and of the same petrographic type apart from their coarseness of texture, it might be inferred that they belong essentially to the same period of igneous activity to which the intruded lavas are referred.

But while the greenstones are in large part highly schistose, these bodies are massive and often very coarsely so. If they represent altered traps, the only conception one could form of such a metamorphosis would be that it took place after flowage had ceased and represents a purely hydrostatic condition of pressure. In such a condition there would be (1) no deformative movement of the rock, and (2) no circulation of waters. Elimination or introduction of soluble material would be, therefore, hardly conceivable. On the whole, the author believes these coarse-grained masses to be much more ferromagnesian than the surrounding schists, which are higher in quartz, or than the massive fragmentals and rhyolites which they intersect and which are much higher in feldspars. A very unusual kind of elimination would, therefore, be necessary. Not lime or soda, but quartz and alumina, would have to be eliminated. Alternatively, iron and magnesia would have to be introduced, replacing soda and lime. The principal difficulty would be that introduced iron is found usually in the form of a sulphide.

These bodies are, therefore, to be taken as intrusive, and further evidence of this is not lacking, since small apophyses of the amphibolite were found traversing the upper Keewatin fragmental lavas in the northwestern part of Kakagi lake, near the contact of one of the larger amphibolites. In many places, notably on the east shore of the first small lake north of Kakagi lake on the route that leads to Cameron lake, the amphibolite rocks contain numerous inclusions of the fine-grained Keewatin lavas. As to age then, the amphibolite is subsequent to the shearing of the Keewatin, which it is believed took place at the same time as the

intrusion of the Laurentian gneisses. They are, therefore, post-Laurentian. At Stephen lake they appear to be intruded by the Algoman granite. On the south bay of Atikwa lake and on the shores of Denmark lake, which lies immediately to the south, lamprophyric dikes were observed which cut the older phases of the Laurentian and also contain inclusions of it. In the same area also, masses of amphibolite are observed within the older Laurentian. In some cases these were hard to distinguish from inclusions, but in others they were taken without hesitation to be dikes. This would place the lamprophyre and amphibolite in the period that has been assigned to the Haileyburian. They are, therefore, with slight reservation, to be considered as pre-Algoman.

In more detail the principal types of these rocks may be described as follows:—



Photomicrograph of altered ophitic quartz diorite with hornblende, largely chloritized (×26). A = andesine. C = chlorite. Q = quartz. IL = ilmenite. S = saussurite.

Diorite, Amphibolite, and Peridotite

The rocks are of plutonic texture, ranging from medium-grained diorite to very coarse amphibolite and including in some parts minor amounts of peridotite, now largely serpentinized. They are found associated, apparently in an intrusive relation, with great thicknesses of andesitic and occasionally basaltic lavas, interbedded here and there with rhyolitic flows which have shared in the general shearing of the Keewatin formation. The petrographic types of the Keewatin and of these intrusives are therefore parallel, differing mainly in texture. So far, therefore, they fulfil fairly well the conditions required for intrusions contemporary with the Keewatin. There is nothing specific in their forms or relations to the Keewatin that would necessarily indicate a batholithic structure, but their massiveness and more or less lenticular outlines would answer well to the type of the laccolith, and these are often of considerable size.

The main petrographic types may be described more particularly:—

1. A grey diorite or diorite porphyry is well represented along the north shore of Kakagi lake. These rocks have in general a porphyritic texture and correspond in composition to diorite or quartz diorite. This normal diorite has in some cases varied to pyroxene diorite or mica diorite. In one or two places it is of a texture

coarse enough to suggest a pneumatolytic origin and contains large crystals of hornblende and feldspar, and some hornblende spherulites.

2. The amphibolite is sometimes equivalent to quartz diorite, but with the feldspar quartz content much reduced. The hornblende crystals are often large, up to one inch or more in diameter.

3. The peridotites are easily recognized in the field by deep weathering along intersecting joints resulting in a surface divided into small square blocks. The appearance of olivine in increasing amounts, until it forms the major part of these rocks, which are now largely serpentine owing to alteration, was noted on the Ross river below the outlet of Denmark lake and along the south shore of Kakagi lake near its eastern end.



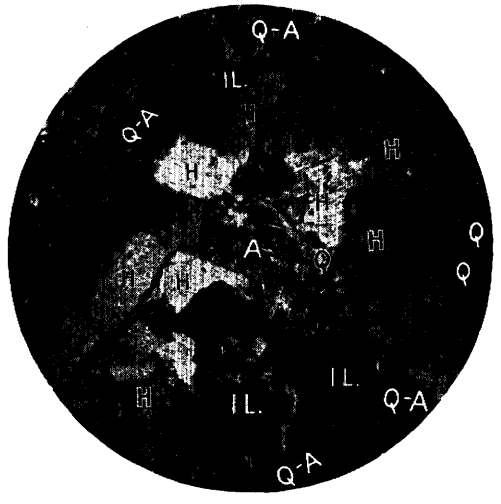
Specimen (seven-eighths natural size) of coarse amphibolite (Haileyburian?) with hornblende masses outlined, from the east side of the outlet bay of the first small lake north of Kakabikitchiwan lake. The crystals in places have a diameter of 1½ inches.

Lamprophyre Dikes

On the north shore of the southwest arm of Rowan lake and elsewhere, rather small dikes of lamprophyre were observed which are characterized by large phenocrysts of biotite. Their position is not far north of the Nolan lake granite, but their only observed relation is that of intrusion into the Keewatin. Their age is, therefore, only determinable as post-Keewatin. Immediately adjacent were intrusions of coarse quartz porphyry, but the two rocks were not observed in contact.

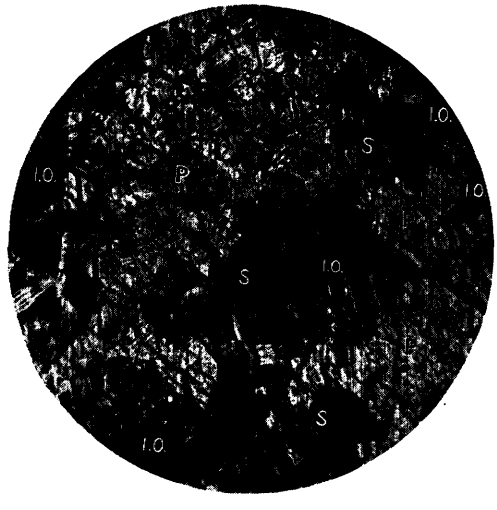
Under the microscope the rock is seen to consist of a groundmass of hornblende and biotite laths embedded in feldspars, which are for the most part striated but undeterminable, probably near andesine. Calcite is present as a decomposition product. The feldspar also contains many needles of apatite and

some of rutile altered to leucoxene. The phenocrysts are well-developed, hexagonal books of biotite associated with some large crystals of hornblende, which



Photomicrograph of amphibolite from the north shore near the east end of Isinglass lake (×30). H=hornblende. Q=quartz. A=actinolite. Q-A=quartz with actinolite. IL=ilmenite.

appears older than the mica. The name hornblende kersantite seems to be fairly descriptive of this rock. The micas exhibit typical dark edges and lighter interiors.



Photomicrograph of peridotite showing a much larger proportion of pyroxene than the average for this rock (×31). P=pyroxene. S=serpentine. I.O.=iron ore, and rutile.

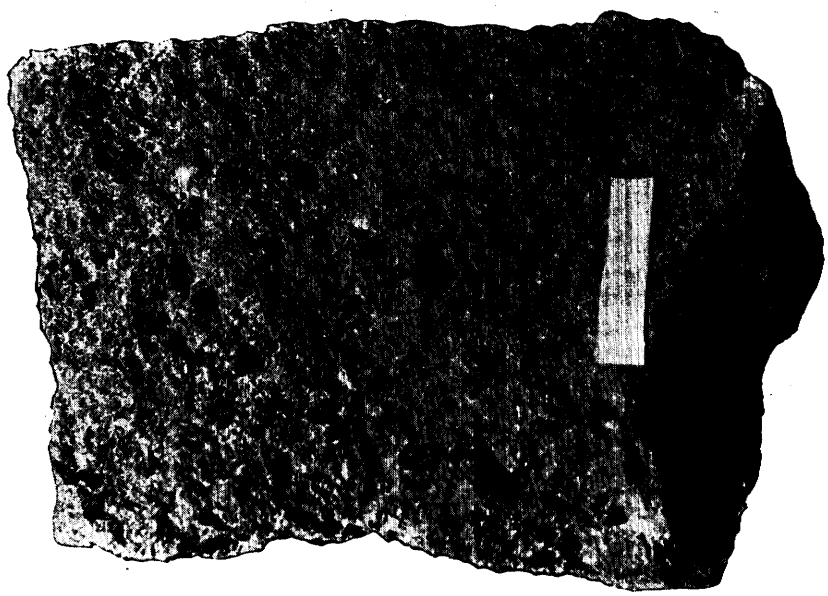
In the absence of more certain determination they are placed with the pre-Algoman on lithological grounds.

Algoman(?)

This division of rocks embraces the unsheared granite bodies of the region, all much less extensive in area than the older granite gneiss and also distinguishable mineralogically and texturally. The unsheared quartz porphyries are distinguished from similar rocks in the Keewatin series by their fresh and massive condition and by intrusive relations. They include small dikes, which traverse the Keewatin areas. These two types of intrusive may be considered separately. Their relation to one another has not been established with certainty.

YOUNGER GRANITE

The younger granite is found in eight localities in this area. In most cases it occurs in rounded bosses of some miles in extent, but in one occurrence, that



Specimen (natural size) of kersantite with dark phenocrysts of hexagonal biotite, north shore of the southwest arm of Rowan lake.

at Isinglass lake, it is represented by a group of dikes. Several of these granite bosses were mapped by Lawson in his map of the northern part of the Lake of the Woods, and recognized as of later origin than the Laurentian gneisses.

A table showing the frequency of occurrence of the mineral constituents of the younger granites will be found on pages 66 and 67.

Titaniferous Hornblende-Biotite Granite

These areas are in most cases hornblende-biotite granites containing oligoclase as well as orthoclase, frequently microcline, occasionally andesine and anorthoclase. Constantly occurring accessories are apatite and ilmenite, and sphene is fairly common. Out of 22 sections, rutile occurs three times, tourmaline once, zircon once, pyroxene once, and magnetite three times. The small area at the northwest bay of Rowan lake differs from the others in the greater predominance of hornblende, while biotite is entirely absent. The commonest secondary minerals noted were kaolin, sericite, chlorite, epidote, and leucoxene. The rutile may also

be, at least in part, secondary; and calcite, hematite, and limonite are occasionally found. The limonite probably represents weathered pyrite.

The areas differ somewhat in certain features and may be described briefly as follows:—

Regina Bay

The granite here is mainly exposed along the south side of the bay and extends only a short distance inland. It may also be seen on nearby islands and on the north shore of the bay. It was mapped by Lawson and recognized by him as distinctly later in age than the Laurentian gneisses. It is in the main massive, but contains certain gneissic zones which strike about S. 50° W. where observed. The general colour is grey, and in composition it is a titaniferous hornblende-biotite granite, which contains oligoclase as well as orthoclase. It is cut by pegmatite dikes, which are largely composed of orthoclase and oligoclase and contain a little magnetite, and also by a porphyritic dike of composition corresponding to hornblende-muscovite granite.

The vein of the Horseshoe (formerly Regina) mine cuts across the contact of this granite with the Keewatin greenstone schists to the south, and has produced gold on both sides of the contact.[1]

Hope Lake

This body of granite lying between William bay and Hope lake differs little from the granite of Regina bay except in the presence of microcline in two sections out of three and of hematite in one. It has been subjected to less regional metamorphism and is accordingly red in colour and displays comparatively few of the minerals that are commonly recognized as secondary. With it may be mentioned a small area that lies on the south side of Caviar lake at the southern end of the narrows that connects two large expansions of the lake. This was noted in the field as a hornblende granite.

The dikes associated with the Hope Lake area vary from a porphyritic type, mineralogically similar to the main body, to a coarse titaniferous hornblende syenite.

Gold-bearing properties that lie immediately adjacent to this granite include the Gold Panner and Virginia mines and a number of claims on the north shore of Caviar lake near the mouth of William bay.

Flora Lake

A considerable body of granite previously unmapped was found to lie west of the canoe route that leads from Caviar lake northeastward. The general type of this area also comes under the classification, hornblende-biotite granite, strongly titaniferous, as evidenced by the presence of both sphene and ilmenite. The feldspars are orthoclase with some perthitic intergrowth of plagioclase, probably oligoclase, and microcline. The ferromagnesian minerals are few even near the margin, except where a hybrid condition appears to exist. Porphyritic structure is also found. On the west side, approaching the margin, the percentage of hornblende and biotite is relatively large, especially the biotite, which displays a gneissic parallelism and occurs in large aggregates. Quartz is small in amount and interstitial in position; the feldspars are microcline and orthoclase. The order of crystallization is biotite (brown), hornblende (green), microcline, perthitic orthoclase, quartz. Accessory apatite and magnetite are present. The feldspars show little alteration. Some epidote and chlorite appear to be due to

[1]See page 75.

the decomposition of hornblende. In a fairly central position in the stock, on the west shore of Isinglass lake, there is a very acid phase which has a little brown biotite, with microcline, orthoclase, plagioclase, and quartz constituting the mass of the rock. Accessory sphene, ilmenite, tourmaline, and apatite occur in small amounts. The name alaskite was used in the field for this phase.

The large group of gold claims that lies along Tillie, Empire, and Kathleen lakes, including the Empire and Nina mines, is parallel and immediately adjacent to the eastern margin of this granite. No staking appears to have been done on any other part of its circumference, and its presence was evidently unknown to McInnes and Smith, of the Geological Survey of Canada, whose map was published in 1902. Many of these old claims have recently been restaked.

Isinglass Lake

Red granites of the younger type are represented in the shores and islands of this lake by dikes, which are for the most part of fine texture. The normal mineral content is quartz, microcline, orthoclase, biotite, hornblende, with accessory zircon and ilmenite altered partly to leucoxene. The dikes for the most part are differentiates, including muscovite, syenite with accessory magnetite and hematite, a fine-grained pneumatolytic phase of felsitic texture, porphyritic biotite syenite, and hornblende granite porphyry. Near the northeast shore of the lake a dike of this granite is exposed on a small island, and a small gold property in the dioritic country rock near by was operated for a short time.

Stephen Lake

This body of granite was mapped by McInnes and Smith from an examination of its outcrops on the shores of Stephen lake. It has since been traced southeast to several small lakes that lie north of Kakagi and Mangus lakes. It is throughout essentially a porphyritic hornblende-biotite granite with notable titanium content. It differs from the other stocks here described mainly in the presence of rutile, which is possibly secondary after titanite. This stock exhibits more alteration than any of the others of the same type, though it is approached in that respect by the Regina bay granite. Pyroxene, andesine, and probably anorthoclase, occur in the contact phases, in some of which also quartz is absent. Microcline was the only distinctive mineral noticed in the central part. The contact phases observed were classed as hornblende-biotite syenite, hornblende syenite, granodiorite, biotite granite, and hornblende-pyroxene granite.

Certain dikes that extend northward from this body reach the north arm of Flint lake. In this vicinity there are two old groups of claims. One of these extends eastward from the southeast arm of Flint lake; the other lies along the north side of the north arm. In the latter group some recent work has been done, and gold values of $10 or more have been reported.

Rowan Lake

A body of red titaniferous granite is in evidence on the northwest bay of Rowan lake, near its outlet. It is porphyritic in part and represented by pegmatitic dikes on Denmark lake, on the river that connects it with Caviar lake, and on a small island near the mouth of the river in the east bay of Caviar lake. It differs from the other younger granites in the absence of biotite, and this may be due to the fact that the exposed parts, mainly dikes, are all of a marginal nature. It is possible that they are an extension of the granite seen on Isinglass lake.

MINERAL CONSTITUENTS OF THE YOUNGER GRANITES

Area and location	Essential Minerals									Accessory Minerals								Secondary Minerals							
	Quartz	Orthoclase	Microcline	Anorthoclase[1]	Oligoclase	Andesine	Muscovite	Biotite	Hornblende	Pyroxene	Apatite	Zircon	Tourmaline	Titanite	Ilmenite	Rutile	Magnetite	Sericite	Kaolin	Calcite	Chlorite	Epidote	Limonite	Hematite	Leucoxene
REGINA BAY:																									
North shore	x	x	...	...	...	...	...	x	x	...	...	...	...	...	...	...	x	x	x	...	x	...	x	...	...
South shore, near fire patrol station	x	x	x	...	...	...	...	x	x	...	...	...	...	x	x	...	...	x	...	...	x	x	...	...	x
North shore, east of narrows to Lobstick bay (rhyolite porphyry shear zones in granite and porphyry)	x	x	...	...	x	...	...	x	...	...	...	...	...	x	x	...	...	...	...	...	...	...	...	...	...
Total	3	3	1	...	1	...	...	3	2	...	...	...	...	2	2	...	1	2	1	...	2	1	1	...	1
HOPE LAKE:																									
William bay, west side, dike	x	x	...	...	...	...	...	x	x	...	...	...	...	x	x	...	...	...	...	...	...	...	...	...	...
Southwest arm south of the bay, east side	x	x	x	...	x	...	...	x	x	...	x	...	...	...	x	...	...	...	...	...	...	...	...	...	...
Southeast arm	x	x	x	...	...	...	...	x	x	...	...	...	...	x	x	...	x	...	...	...	...	...	...	x	...
Total	3	3	2	...	1	...	...	3	3	...	1	...	...	2	3	...	1	...	...	...	...	...	...	1	...
FLORA LAKE:																									
Harding lake, east shore (porphyritic)	x	x	x	...	...	...	...	x	x	...	x	...	...	x	x	...	...	...	...	x	...	...	...	x	x
Harding lake, west shore, near portage to Flora lake	x	x	x	x(?)	...	...	...	x	...	...	x	...	x	x	x	...	...	...	...	...	...	...	...	...	...
Northwest bay of Flora lake	x	x	x	...	...	...	...	x	x	...	x	...	...	...	...	...	x	...	...	...	x	x	...	...	...
Total	3	3	3	1	...	...	...	3	2	...	3	...	1	2	2	...	1	...	...	1	1	1	...	1	1
ISINGLASS LAKE:																									
Trail north to small lake	x	x	x	...	...	...	...	x	x	...	...	x	...	...	x	...	...	...	...	...	...	...	...	...	x
Total	1	1	1	...	...	...	...	1	1	...	...	1	...	...	1	...	...	...	...	...	...	...	...	...	1
STEPHEN LAKE:																									
Distant from margin	x	x	x	x(?)	...	...	...	x	x	...	x	...	...	...	x	x	...	...	...	...	...	...	...	...	...
North shore at Keewatin contact	x	x	...	...	...	...	...	x	...	...	x	...	...	...	x	x	...	x	x	x	x	...	...	...	x
East shore (contact phase)	...	x	...	x(?)	...	...	...	x	x	x	x	...	...	...	x	x	...	x	x	...	x	...	...	...	...

North end of lake north of Mangus lake—marginal phase (hybrid?)	x	x	...	...	...	x	...	...	x	...	x	...	...	...	...	...	...	x	x	...	x	x	...	...	x
Total	3	4	1	2	...	1	...	3	3	1	4	...	...	...	3	3	...	3	3	1	3	1	...	...	2
ROWAN LAKE:																											
Porphyritic dike in amphibolite	x	x	...	...	...	x	...	...	x	...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...
Island on Speight's line (low in ferromagnesian elements)	x	x	x	...	...	...	...	...	x	...	...	...	...	...	x	...	...	...	...	...	...	x	x	...	...
Dike below Ross chute	x	x	...	...	...	...	...	...	x	...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...
Northwest bay, west side	x	x	x	...	...	...	...	...	x	...	...	...	...	x	x	...	...	x	...	...	...	x	...	...	...
Northwest bay, east side (accessory pyrite)	x	x	...	...	x	...	...	...	x	...	x	...	...	x	...	...	...	...	...	...	...	...	...	...	x
Total	5	5	2	...	1	1	...	...	5	...	1	...	...	2	4	...	...	1	...	...	...	2	1	...	1
NOLAN LAKE:																											
Sickle lake on south margin of the granite (porphyritic)	x	x	x	x	...	...	...	x	x	...	x	...	...	...	x	...	...	...	...	...	...	...	...	...	...
South shore of Nolan lake (porphyritic)	x	x	x	x	...	...	...	x	x	...	...	...	...	x	x	...	...	...	...	...	...	...	...	...	...
Small lake east of Nolan lake (porphyritic)	x	x	x	x	...	...	...	x	x	...	x	...	...	...	x	...	...	x	x	...	...	x	...	...	...
Total	3	3	3	3	...	...	...	3	3	...	2	...	...	1	3	...	...	1	1	...	...	1	...	...	...
Grand totals	21	22	13	6	3	2	...	16	19	1	11	1	1	9	18	3	3	7	5	2	6	6	2	2	6

HORNBLENDE-MUSCOVITE GRANITES

WAPUS LAKE:																											
Speight's line, west of the lake, dike in greenstone	x	x	...	...	x	...	x	...	x	...	x	...	...	x	x	...	...	...	...	...	...	...	...	...	...	...	...
REGINA BAY:																											
Dike cutting grey granite (porphyritic)	...	x	...	...	x	...	x	...	x	...	...	...	...	...	x(?)	...	...	...	...	...	...	...	...	...	...	...	...
KAKABIKITCHIWAN LAKE:																											
Cutting diorite, syenite, and older pitted grey gneiss	x	x	x	...	x	...	x	...	x	...	x	...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	x
BETULA-WARCLUB LAKES:																											
Cutting sedimentary (?) gneiss (porphyritic)	x	x	...	...	...	...	x	x	x	...	x	...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...
DENMARK-ATIKWA LAKES:																											
Scott bay, point dividing bay	...	x	...	...	x[2]	...	x	...	x	...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...	...	...
Waterfall lake, dike above falls	...	x	x	...	x	...	x	x	x	x	x	...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...
Tillie lake, northeast shore (porphyritic)	x	x	...	...	x	...	x	...	x	...	x	...	...	...	x	...	x	x	...	...	x	...	...	...	...	...	x
Tillie lake, northwest shore	x	x	...	...	x	...	x	...	x	...	x	...	...	...	...	...	x	x	x	...	x	x	...	...	...	...	...
Total	5	8	2	...	7	...	8	2	8	1	6	...	...	1	5	...	4	2	1	...	2	1	...	...	2

[1]Some albite is probably embedded.
[2]Albite.

Nolan Lake

A large body of red porphyritic granite was found to the south of the southwest bay of Rowan lake. Its southwestern and southern margins lie at no great distance from Otterskin and Brooks lakes. Its surface is considerably above the surrounding country and is dotted by several small lakes, one of which, Nolan lake, marks the west end of the granite and lies more than 100 feet above the present level of Rowan lake. At all points where specimens were taken, the constituent minerals were quartz, orthoclase, microcline, oligoclase(?), biotite, hornblende, apatite, ilmenite, sphene. For the most part little alteration was observed. The porphyritic texture extends consistently through the mass and was observed on both the north and south margins. As no traverse was made across it, any central differentiation remains unknown.

Although this boss was not previously mapped, the Keewatin areas adjacent to it on the west and north were extensively prospected about the beginning of the present century and work was done on a number of properties, especially the Monte Cristo and Sullivan of early discovery, the large veins staked by R. Roy on Shingwak lake, and the system of large veins that can be traced from Cameron lake across Otterskin lake to Brooks lake on the south side of the granite. These veins all carry values in gold. They are of various types, which are described later in the section on "Economic Geology."

Kakabikitchiwan and Heronry Lakes

The younger members of the granitoid complex here, as studied at Nestor falls and on the highway at the outlet of Heronry lake, seem to correspond quite exactly in composition with the other titaniferous hornblende-biotite granites above described, but they have a gneissic structure in some cases like that observable in parts of the Regina bay granite (Sioux Narrows granite of Lawson).

Hornblende-Muscovite Granite

This unusual group of rocks appears to be later in origin than the hornblende-biotite granite. They occur only in dikes cutting the gneisses and granites and possibly represent a late phase of the hornblende-biotite intrusion. They are associated with the various stocks of the later granites throughout the area, possibly as apophyses but certainly as smaller adjacent bodies, and in some cases they penetrate older Algoman granite, as at Regina bay. The dike that crosses the river that connects the eastern bay of Atikwa lake with Waterfall lake just above the fall by which it descends to Waterfall lake consists of quartz, orthoclase, anorthoclase, microcline, muscovite, biotite, and hornblende. Quartz is present in large amounts. Accessories noted are zircon, magnetite, and a little apatite. At the northwest corner of Tillie lake and again on the east side of it, there are outcrops of porphyritic hornblende-muscovite granite containing hornblende in rather small amounts. The feldspars are orthoclase, anorthoclase, and oligoclase near albite. Some of the muscovite is included in the feldspar, and some is younger than the feldspar. The accessories are small amounts of ilmenite and apatite. Quartz occurs in large amounts. On Speight's base line at about 44 chains west from the west shore of Wapus lake, an outcrop of granite with radiating dikes is found which has the following composition: orthoclase, oligoclase, quartz, muscovite, hornblende, apatite, titanite, and ilmenite; and on the north shore of Regina bay a red gneissic porphyritic dike was microscopically determined as a hornblende-muscovite rhyolite porphyry, as described under the heading "Regina Bay" on page 64. The phenocrysts of orthoclase (in Carlsbad twins) and oligoclase

are associated with large plates of muscovite. Crystals and aggregates of green hornblende are found also in a quartz-feldspar-sericite aphanitic groundmass, which carries a little iron ore.

LATER QUARTZ PORPHYRY

Traversing the older formations, including the Keewatin, there are numerous dikes and other bodies of quartz porphyry that have not been sheared. They are obviously in intrusive relation to the altered andesites, lavas, and fragmental volcanics, as well as to the sheared interbedded rhyolites and quartz porphyries of the Keewatin proper. Among the largest of these intrusions is that exposed on the north shore of Peninsula bay, Kakagi lake; it is also well seen on a portage that leads north to a series of small lakes from the northeast corner of the bay. This porphyry forms a large dike which lies parallel to the southwest margin of the Stephen lake granite and distant from it about two miles. The width of the body is over 100 yards and its length something over two miles. Several other dikes of smaller dimensions occur on islands in the northwestern part of Kakagi lake, on Rowan lake, and elsewhere. The large body mentioned contains phenocrysts of striated feldspar, which is not certainly determinable but appeared to be oligoclase in the section examined. There are also rounded grains of quartz and cubes of pyrite. The groundmass consists of similar minerals, very fine grained, with the addition of ilmenite largely altered to leucoxene. The alteration renders its identification difficult.

In some of the smaller dikes the feldspar is andesine; much hornblende is present, sometimes as skeletal growths in the feldspar; and the quartz phenocrysts may exhibit good crystal outlines or be rounded and embayed. Pyrite is generally present in cubes much larger than the grains of the groundmass. The name quartz andesite porphyry seems most nearly to fit the case. In some cases the size of the ferromagnesian minerals would indicate the name quartz lamprophyre porphyry.

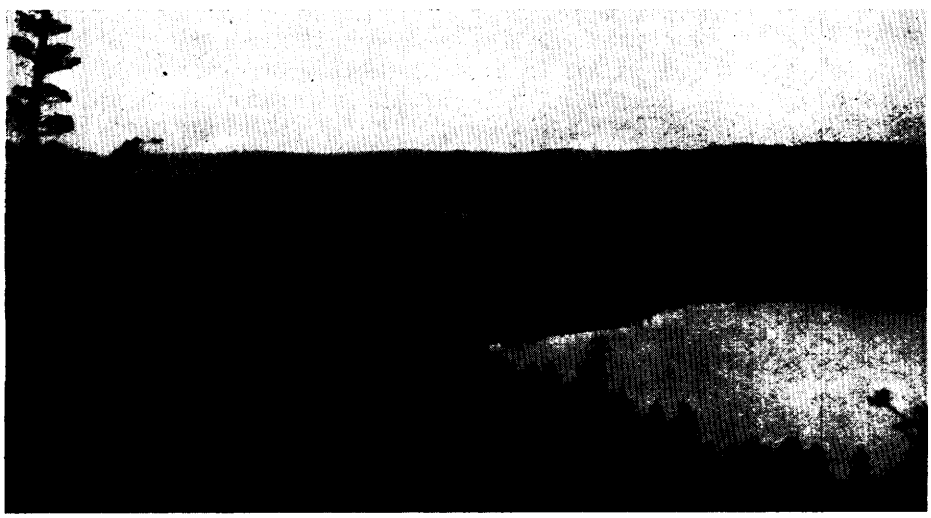
The small island in the southern part of Regina bay, about a mile east of the Forestry station, consists in part at least of unsheared quartz porphyry; a dike here has phenocrysts of quartz in sharp hexagonal outlines, oligoclase near albite, muscovite in large laths, and a little green hornblende barely distinguishable from the groundmass. The name oligoclase-quartz porphyry is suggested. Of the types above described, the last corresponds quite well with the hornblende-muscovite granite that occurs about two miles south near Wapus lake. The quartz porphyry of Peninsula bay resembles in some respects the Stephen lake granite, which lies about two miles to the north. These porphyries may well be related, therefore, to gold occurrences near their boundaries, since these granites are apparently those from which the gold is derived.

On the southwest arm of Hope lake, on a small island which lies to the west of the granite body, there is an occurrence of quartz porphyry in which the groundmass appears macroscopically spotted with green, like a lamprophyre. Under the microscope the groundmass is seen to consist of quartz and feldspar with microlithic ferromagnesian aggregates, probably hornblende. Small iron ore grains also occur. The phenocrysts are quartz and feldspar, the latter non-striated but having an index of refraction greater than Canada balsam, probably oligoclase or andesine.

Several cases were observed where shrinkage cracks in these dikes were filled with quartz. It may well follow that some of the quartz veins distributed throughout the area are derived from these porphyries.

Keweenawan (?)

Traversing other formations, both Keewatin and granite, and following more northerly directions of strike than most of the enclosing rocks, there are certain basic dikes, in some cases of large size. These can be traced for considerable distances, mainly in a northwesterly direction. They are often discontinuous, apparently from faulting. The best examples are to be seen on Sabaskong bay and Kakabikitchiwan lake near Nestor falls and on Lobstick bay extending southward to the northern part of Dogpaw lake. Petrographically, they are ophitic diorites consisting of a felt of rather small laths of striated andesine with interstitial hornblende and some pyroxene. The accessories are ilmenite, magnetite, and quartz. In many instances feldspars are embedded, even in the iron ore. The general appearance of the rock is quite fresh, and the igneous



View of dissected peneplain looking eastward across the Flora lake granite. Taken from the old peneplain level, 160 feet above the lake in the foreground, it shows an even sky-line and the excavation of valleys and lake basins below. Occasional summits, or monadnocks, occur above the old peneplain, and a few rounded descendants or hilltops are seen below it.

structure is well preserved. The late date suggested for these dikes is mainly dependent on these features. They are evidently at least post-Keewatin and post-Laurentian. Their relation to the younger granites or unsheared quartz porphyries was not observed.

Those near Nestor falls appear to lie in the same strike as the basic dikes mapped by Lawson on Whitefish bay.

Physiography

The erosional sculpturing to which these differing rock areas have been subjected gives them at present the aspect of a dissected peneplain. Level-topped ridges are to be seen everywhere north of Kakagi lake in the more resistant rock-types and, at a height of about 200 feet above the lakes, their summits merge into a level sky-line. Here and there a few rounded monadnocks of slightly greater height can be recognized. Below the peneplain surface there are lower hills, for the most part rounded by glaciation, and occasional areas approaching a level condition above the lake surfaces. The lake basins in most cases must be

ascribed to glacial deepening below these levels. In some instances, as in the case of Kakagi lake, they are rock-rimmed basins several hundred feet deep.

The level of the uplifted peneplain is preserved, doubtless with some glacial bevelling, in the tops of ridges in those areas where the rocks are more resistant to erosion. These are mainly the older massive granites, the massive fragmental Keewatin volcanics, and the diorite and amphibolite intrusives. The more gneissic granites are lower in altitude, and the sheared greenstone and rhyolite lavas the lowest of all. The latter occupy a large part of the area.

The larger lakes of the region naturally lie on these lower areas. Berry, Otakus, Dryberry, and Atikwa lakes, however, which lie on the gneiss, are at relatively high altitudes, while the lakes of the schistose areas, including Kakagi, Cedartree, Flint, Stephen, Cameron, Otterskin, Brooks, Isinglass, Shingwak, Dogpaw, Caviar, Denmark, Rowan, and various other lakes are at lower levels, near that of the Lake of the Woods. There is also a decided rise in the lake levels observable as one proceeds eastward from the Lake of the Woods,[1] which is no doubt due to the presence of the large area of batholithic granite between the Kakagi and Manitou Lake areas.

The Kishquabik granite area, which lies north of Lobstick bay (1,060 feet) and rises more than 300 feet above it, has a widely domed upper surface on which a few small lakes and a large area of muskeg are scattered at intervals. The granite is slightly gneissic in structure but not banded. To the north the lower basin of Dryberry lake lies upon more definitely gneissoid rocks. To the east Atikwa lake also lies on a lower gneissic area of less erosional resistance. Between is a large synclinal basin of the Keewatin.

This synclinal basin is intruded by the Flora lake granite, near which there are certain areas of greenstone on the granite contact that rise to the peneplain level and exhibit flat tops. The high area of folded pyroclastics that lies between Cedartree and Stephen lakes also shows flat summits in a marked way. In the region around Kakagi lake, the banded and fragmental volcanics of the upper Keewatin and in part also the amphibolitic and dioritic rocks rise into prominent hills with level summits. Along the south shore of Denmark lake certain rocks of the contact zone between the granite and Keewatin form a series of level-topped ridges.

Where well-defined this topography appears to include four stages: (1) The lowest, and latest, consisting of the basins of lakes and river courses; (2) a lower level of erosion, or low hilly surface, which lies above the lakes, but considerably below the higher peneplain, with which it is connected by many descendant peaks of intermediate heights; (3) the upper planation, represented essentially by flat-topped summits, benches on the sides of monadnocks, and ridges having even crest-lines; (4) occasional summits rising above the peneplain level.

Pleistocene and Recent Deposits

Till

The higher hills and surfaces in general exhibit glacial markings, mainly but not entirely referable to the Labradorean glacier of Wisconsin age. Erratic boulders and till are deposited over these surfaces in varying thicknesses. The boulders are for the most part entirely pre-Cambrian in origin, but a few of limestone were observed on Dogpaw lake. As this area was covered to a considerably greater depth than now by the waters of Lake Agassiz, it is possible

[1]The mean level of the Lake of the Woods is about 1,060 feet. (Low-water level, 1,056 feet; high-water level, 1,062 feet.)

that these boulders should be regarded as transported by floating ice to their present positions from the western shores of the lake. Whether this is true or not, there is a great probability that both the Keewatin and Labradorean ice occupied this area at different times. Heavy deposits of till were observed, especially on the north shores of Rowan lake, where morainic hills occur, and on the hilly country east of Kakagi lake as far as Brooks lake.

Lacustrine Deposits

Overlying the till, from an altitude in the neighbourhood of 1,100 feet and downward, deposits of sand and gravel, which undoubtedly represent the beaches and shallow bays of Lake Agassiz, were frequently found. These were especially noted on the northwest shores of Kakagi lake, in the southwestern parts of Rowan lake, and on the north shores of Cameron lake extending across to Beggs lake. The top of the ridge between Regina and Snake bays has also a considerable

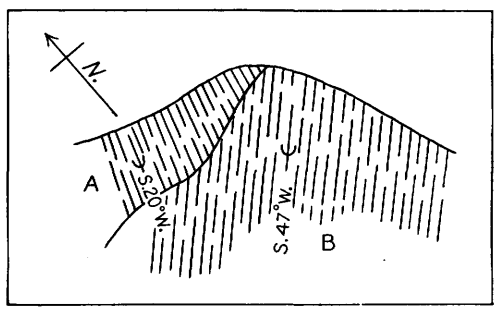


Fig. 5—Faceted rock on an island in Kakagi lake. "A" represents the general direction of the Keewatin glacier movement. "B" may show the Labradorean ice movement, prevailing for the time over the Keewatin; or, more likely, a local change in direction due to nearby vertical rock.

area of sands overlying till. At lower levels sands of considerable extent occur, which may be partly if not entirely referable to rearrangement by the waters at the present level.

Extending southward from the small lake north of Mangus lake another large deposit of sand was observed, and similar deposits form banks along the shores of the lake east of Mangus. These may be in part or altogether outwash plains. No kames or eskers were recognized.

At a lower level a little varved clay was observed on an island in the northwestern part of Dogpaw lake. It was not of great thickness, and the lower part was hidden owing to the raising of the lake level by a dam at its outlet. Most of these deposits of stratified sand, gravel, and clay are no doubt referable to the waters of Lake Agassiz, the surface of which stood at levels that are now somewhat above 1,100 feet in this locality. Above a contour at approximately 1,150 feet, the till is everywhere exposed.

Peat

Deposits of peat have been formed in shallow basins at many levels above the Lake of the Woods (1,060 feet) but, owing to the hilly and deeply dissected nature of the rock surface, are not of very great extent in the area here surveyed. The largest were seen at the southern margin of the field along the boundary

between Kenora and Rainy River districts, where the surface of the country appears to be sinking to lower levels. A muskeg of considerable area also lies on the top of the high plateau of granite to the north of Lobstick bay.

Drift Modification along Lake Shores

The wave action of the present lakes has already produced considerable changes in the terrain along their shore lines. Where rocky surfaces slope steeply at the water level, they have been denuded of whatever cover they had and present rock exposures useful to the geologist and often of large lateral extent. In the case of the more schistose rocks, the combined action of water and frost has undermined cliffs by wedging off slabs of the fissile rock and in some parts has produced benches several feet wide at water level.

Where the gradient of the rocky slopes is gentler and covered by till, the finer parts of the till have been washed out leaving behind a boulder shore line. Where the surface consisted of sand or gravel deposits, these have been washed down and rearranged as sandy or gravelly beaches, bars, and spits at the present water levels. Rocky islets are often connected with the shore by such deposits. In this way sandy flats bordering lakes are being reworked and deposited at slightly lower levels.

Ice has produced considerable effect on the shores of many modern lakes by its expansion forcing gravel or peaty deposits backward from the shore line and piling them in steep banks. This is especially noticeable where the beach faces a fairly large width of lake, presumably because the larger sheet of ice expands to a greater distance up the beach. Conditions of this kind were especially observed on the south shores of Isinglass lake.

Glacial Striae

The following is a list of glacial striae (bearings astronomic-azimuth) noted throughout the area:—

Regina bay, south shore, opposite Indian village		37°
Regina bay, south shore, opposite faceted rock	stoss	37°
	lee	177°
Regina bay, at former Hudson's Bay post		37°
Snake bay, narrows at Camp No. 12		37°
Lobstick bay		27°
Lobstick bay, south shore near east end		42°
Dogpaw lake, island near Speight's line		22°
Denmark lake, west end		25°
Rowan lake, northwest bay, a faceted rock	stoss	62°
	lee	172°
Rowan lake, west shore		29°
Rowan lake, north shore		22°
Rowan lake, north shore, faceted rock	stoss	27°
	lee	177°
Atikwá lake, north end of Shoulder island		22°
Dryberry lake, central part of south bay		37°
Lake northeast of Kenu lake	stoss	29°
	lee	130°
Berry creek, near quartz porphyry contact		29°
Kakagi lake, southwest bay		42°
Kakagi lake, point east of southwest bay, faceted rock	stoss	62°
	lee	57°
Otterskin lake, north shore		22°

The variations in direction appear most marked at those places, such as faceted rock surfaces, where two sets of striae can be read. The bearings at such places on the lee sides of the rocks represent apparently a time when the Keewatin

ice invaded the area, probably before the full development of the Labradorean glacier. The figures representing this condition are, as above noted, 177°, 172°, 130°. In one case observed on the south shore of Kakagi lake, there are two sets (62° and 57°), both relating perhaps to the Patrician glacier of Tyrrell.[1] A list of striae that may represent this phase of glaciation reads 37°, 37°, 37°, 37°, 42°, 62°, 37°, 42°, 62°. A third set, indubitably representing the Labradorean, reads 27°, 22°, 25°, 29°, 22°, 27°, 22°, 29°, 29°, 22°.

In each of these three groups the reader's attention must be attracted by the recurrence of at least two sets of figures exactly repeated. The proper inference would seem to be that the direction of the ice movement throughout the area was extremely uniform at any given time, but shifted from time to time during the advance or retirement of the various ice-sheets.

ECONOMIC GEOLOGY

Gold[2]

Horseshoe (Regina) Mine

This mine, formerly known as the Regina or Black Eagle, was discovered in 1894, began producing in 1895, and was worked continuously until October, 1899. It was again operated for short periods in 1902 and 1905.[3] It has been dewatered for examination on several occasions since then. The last time was in 1931, so far as our information goes. It was one of the large producers of the Lake of the Woods group, at a time when that group constituted the major part of the gold-mining industry of Ontario. At the last dewatering the workings were found to have a depth of over 700 feet. The total production has been variously reported as from $200,000 to $500,000.[4] The number of veins on the property has been stated by Parsons[5] as eight. They vary from a quartz-injected shear zone to a fine fissure type. The vein on which the actual development of the mine was carried out is said to be of the latter type. The strike, which lies between 110° and 130° azimuth, corresponds to that of many shear zones throughout the adjoining country.

The country rock at the mine is greenstone and granite, and the veins cross the contact between these nearly perpendicularly. The greenstone, which forms the main mass of the peninsula between Regina and Snake bays, is part of the southern limb of a synclinal trough folded between the old granite massifs of the Aulneau peninsula to the southwest and of Berry and Kishquabik lakes to the northeast Its structural strike is quite near that of the veins, and is includes sheared bands of rhyolite, which were observed to have similar strikes. Shear zones were also observed in the adjoining granite at a few points east of the mine along the shore of Regina bay. Inasmuch as the granite is subsequent in age to the original folding, it appears that the sheared zones in the greenstone, though nearly parallel to the folding, are much later in age. In addition to the sheared rhyolite bands there are also irregular dikes and larger bodies of unsheared

[1]J. B. Tyrrell, "The Patrician Glacier, South of Hudson Bay," Compte Rendu, XIIe Congrès Géologique International, pp. 523-534; Ont. Bur. Mines, Vol. XXII, pt. 1, 1912, p. 205; E. M. Burwash, Ont. Dept. Mines, Vol. XXXII, 1923, pt. 2, pp. 24-26.

[2]All gold values given in this section of the report are on the standard basis of $20.67 per ounce.

[3]For further information as to the mine in its earlier stages, *see* Ont. Bur. Mines, Vol. V, 1895, p. 180; Vol. VI, 1896, p. 91; Vol. VII, pt. 1, 1897, pp. 41, 114; Vol. XX, pt. 1, 1911, p. 173; Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, p. 10.

[4]Ont. Bur. Mines, Vol. XX, pt. 1, 1911, p. 175.

[5]Ibid.

quartz porphyry, observable especially on the bay where the Whitefish Bay Trading Company's post is situated and also on islands adjoining.

On the north side of Regina bay, opposite the mine, there is a fine-grained porphyritic dike that represents in its composition the hornblende-muscovite granite already described on pages 68 and 69. This dike cuts the Regina bay granite, which is penetrated also by the auriferous veins. The relation between the hornblende-muscovite dike and the intrusive quartz porphyry was not established, but both are younger than the granite, and they may account for two distinct stages of mineralization in the fissures and shear zones of the granite and greenstone. This might be consonant with considerable development of gold-bearing veins in the granite.

The greenstone appears to be in the main andesitic in character and is to a considerable extent of ellipsoidal primary structure, which has helped largely in determining the main foldings of the secondary structures.

The granite has been often described in previous reports[1] and has already been studied in this report.[2] It was determined as titaniferous hornblende-biotite granite. In some phases oligoclase is present, notably in a pegmatite dike on an island to the south of the houses formerly occupied by the Hudson's Bay Company. Out of five specimens examined microscopically, the occurrences of primary minerals are: orthoclase, 4; microcline, 2; oligoclase, 2; quartz, 4; hornblende, 2; biotite, 4; ilmenite, 3; magnetite, 2; titanite, 2. The hornblende-muscovite rock consists of orthoclase, oligoclase, muscovite, and hornblende. It may be taken for a syenitic phase of the granitoid rocks of the same type, the nearest occurrence of which is about four miles to the southeast, near Wapus lake.

The massive quartz porphyry that is also present is presumably younger than the granite, since it does not exhibit shear zones so far as known. It has phenocrysts of quartz, oligoclase, and muscovite in a groundmass of hornblende, feldspar, sericite, and probably quartz. In other parts the quartz porphyry contains notable amounts of pyrite in cubes. Here again the combination of muscovite and hornblende is indicative of a relation to the hornblende-muscovite granites.

The intrusion of the Regina bay granite and of the subsequent porphyries into the Keewatin syncline formed earlier between two masses of older and now gneissic granite appears to be somewhat characteristic of the gold occurrences throughout the region. The synclinal axis appears to pass along the axis of Regina bay and through the northern part of Dogpaw lake to the east, continuing thence toward the northeast. It is marked to the east of Regina bay by an infolded strip of the upper Keewatin fragmental volcanics, which are seen in greater quantity on Kakagi lake, where a large basin-like structure occurs. This syncline is also intruded by the older coarse amphibolite and the younger Stephen lake granite.

Mascotte and Trojan Mines

Other gold properties discovered about the same time as the Regina or slightly before include the Mascotte and the Trojan mines, which are situated about two miles north of South Narrow lake and about a mile from the west end of Kakagi lake. The veins, which were of good size, were in green schists and showed fine gold. A considerable amount of work was done in tunnels and shafts, but apparently the values obtained were not great enough to warrant the

[1]Ont. Bur. Mines, Vol. V, 1895, p. 103; Vol. VI, 1896, p. 91; Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925 (or Bull. No. 85), pp. 10, 11.

[2]See page 64.

expense of erecting a mill. Other properties were actively prospected at Sioux narrows at the entrance to Regina bay.

Virginia Mine

This property, known at the beginning of its history as the Lizzie mine,[1] is situated on Eliza lake, which is the first of a chain of small lakes lying along the route northeast from Caviar (Sturgeon) lake to Eagle lake. Other lakes in succession northward are Waterfall, Muscovite, Tillie, Empire, Kathleen, and Populus. They receive the drainage of Atikwa lake from the east and of a number of smaller lakes to the west in an intrusive granite area named the Flora lake granite. This series of lakes occupies the southeastern edge of a wide synclinal area of Keewatin lavas, pyroclastics, and older sediments, which is infolded between the Atikwa lake gneisses on the southeast and the Kishquabik and Dryberry lake gneisses on the northwest. The central part of this syncline has been intruded by two bodies of massive granite of a later age than the gneisses, called the Hope lake and Flora lake granites. These lie parallel to the axis of the syncline toward its eastern edge. The narrow belt of the Keewatin lying between them and the gneisses to the southeast has apparently received its mineralization from these granite bodies. The Virginia mine lies in the southwestern part of this mineralized zone, opposite the Hope lake granite from which, or from its subordinate dikes, the gold present almost certainly originates. Farther to the northeast, opposite the larger Flora lake area, a series of properties were staked, of which the Nina and Empire appear to have been the most promising.

The mineralization of this zone is mainly but not exclusively found in the more acidic members of the Keewatin, which have been variously described as felsite, rhyolite, or quartz porphyry schists. It is probable that these rocks under shearing forces were fractured to a greater extent than the greenstones and thus presented a better channel for percolating waters and the deposition of quartz. The quartz has again rendered the sericitic schists more brittle, and therefore more receptive of subsequent mineralization following further shearing.

At the Virginia mine there is a wide belt of sheared quartz porphyry on the western side, followed by two minor ones farther southeast, which are separated from the main flow by more basic interbedded lavas. The shaft has been sunk in the main acidic body, whose composition is that of a titaniferous hornblende granite; its texture was originally that of a quartz porphyry. Some of the feldspar phenocrysts are striated and were determined as oligoclase. The sheared condition of this rock has permitted injections of quartz, parallel to the schistosity. The vein on which a shaft was sunk and the greater part of the work done lies parallel to the schistosity and in a direction along which these injections assume larger proportions than usual. Two pits, which lie in a direction roughly 30° S.W. from the shaft at intervals of 450 and 320 feet, appear to represent independent veins at different horizons. The pit nearest to the shaft is sunk in a grey felsitic rock. The strike of the vein exposed in it is from N. 32° E. to N. 37° E. A foot of quartz shows on its southwestern face and about 4 inches on the opposite side. Assays of from 80 cents to $2.00 were reported here. The vein dips about 80° S.E. The larger pit farther southwest is cut in quartz porphyry, which appears sheared on the hanging-wall side and more massive on the footwall. Across a width of about 5 feet there are five or six veins of quartz

[1]For early accounts, *see* Ont. Bur. Mines, Vol. VIII, pt. 1, 1899, p. 59; Vol. IX, 1900, p. 46; Vol. X, 1901, p. 75.

exposed, ranging from an inch to a foot in width. Over this width the rock is said to assay $13.50.

The main shaft follows the dip toward the southeast at a steep angle and could not be descended at the time of our visit on account of the decay of timbers and the presence of water. Assays as high as $20.00 per ton were found here at the surface, and at a few feet depth an extremely rich pocket was encountered which yielded assays of $2,000.00 per ton over 5-foot widths. These values decreased rapidly and practically disappeared at a depth of 30 feet. No report is available of the values in the open cut and drift, which run southwest from the mouth of the shaft a distance of 72 feet into the hillside. The shaft, 6 feet by 8 feet, was sunk approximately 198 feet. At 100 feet the vein had narrowed

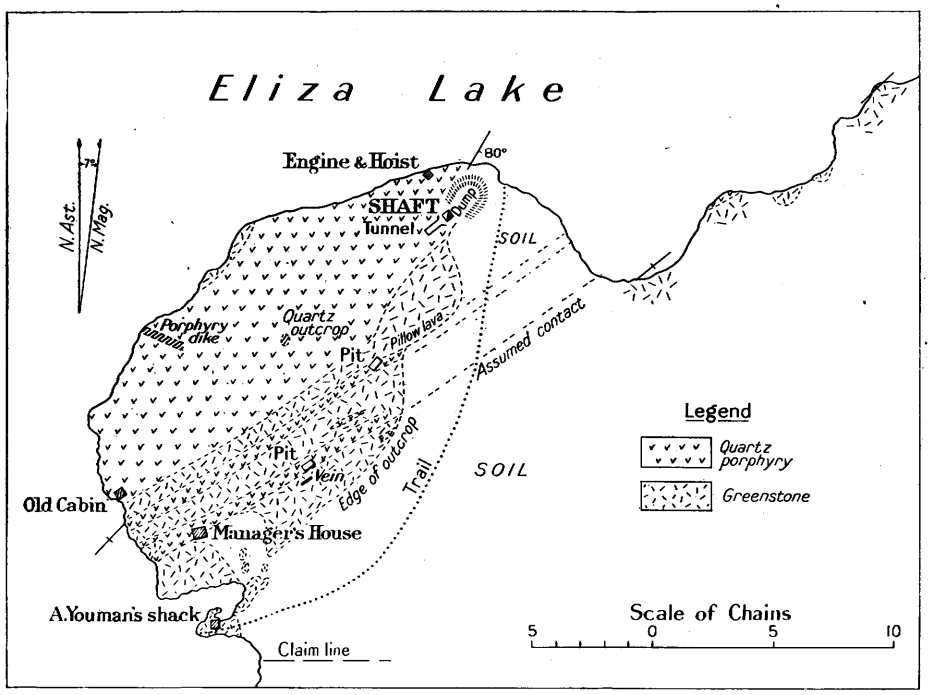


Fig. 6—Plan showing geology at the Virginia mine.

to one foot in width and was practically barren. Here a drift was driven 12 feet northeast, and from the end of it two crosscuts were run One toward the northwest, 102 feet long, ran for about 60 feet through the quartz porphyry schist and for about 40 feet through "grey granite," which from the description given by S. H. Brokunier, the engineer in charge, appears to be an intrusion of diorite or amphibolite of late post-Keewatin age and may be correlative to the Haileyburian of the eastern gold fields. The southeastern crosscut was about 38 feet long and ended at what is described as a hanging wall, probably at the contact of the quartz porphyry with a more basic member of the Keewatin series. This crosscut would require extension for about 360 feet to intersect the horizons of the veins seen in the two southern pits above described. Across the whole width (presumably that of the quartz porphyry), assays showed an average value of $2.00, which was richer in the parts where more quartz was in evidence.

Near the 200-foot level the vein was reported widening and yielding assays as high as $10.00. Assays of quartz samples from the surface of the dump collected by the writer gave a negative result. This probably represents the lower part of the shaft. A thin section shows quartz much stained and shattered and full of minute particles of iron ore. The cracks in the quartz are filled with a ferruginous carbonate with some small crystals that appear to be magnetite. Little or no sulphide and no gold was recognizable in this section. The blue

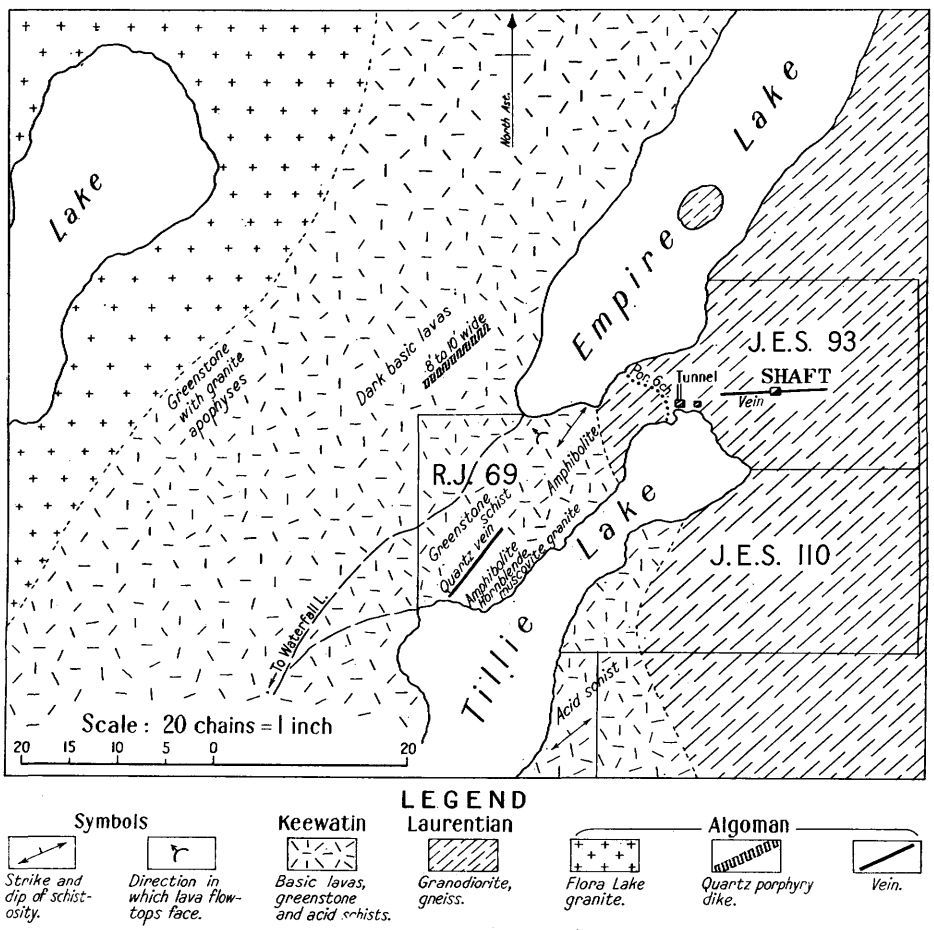


Fig. 7—Plan showing geology at the Nina mine.

colour of the quartz is due to strain, and the darker shades to the presence of finely disseminated iron.

The last work reported was done on this property in 1903. The gold may have been deposited more in the schist than in the quartz. The rich ores formerly obtained here are described as containing spectacular amounts of native gold.

The Virginia mine was reported closed down in the latter part of April, 1900,[1] but was reopened in 1903, as stated above. All the buildings and works are now in a state of complete disrepair.

[1]J. A. Bow, Ont. Bur. Mines, Vol. X, 1901, p. 75.

Mines near the Flora Lake Granite

Claims have been staked almost continuously from the neighbourhood of the Virginia mine as far northeast as Populus lake, and gold in quantities more or less pronounced has no doubt been detected on many of them. Only two properties, however, have been developed sufficiently to indicate a serious belief in their ultimate successful operation, namely the Nina and Empire mines.

Nina Mine.—The Nina is situated at the portage between Tillie lake and Empire lake. It was originally known as the Scovil-Moore property and was operated by the Great Granite Gold Mining and Development Company of Ontario. Reference to it appears in the reports of the Inspector of Mines, the first in 1899. The shaft on the property was then 60 feet deep; and a tunnel of 24 feet had been driven. These are still in evidence but not available for sampling without preliminary work.

The geology, as shown in the accompanying sketch map, Fig. 7, is quite different from that of the other gold properties near by, inasmuch as the shaft is sunk in what appears to be the older type of the Laurentian gneiss. Its final depth when the work was abandoned in July, 1900, was reported as 123 feet. Fifty-six feet of drift had been cut at 73 feet depth, and the tunnel extended to 70 feet. When examined in August, 1930, water in the shaft was within about 40 feet of the surface. The vein dips almost vertically for part of the distance and for the rest slightly toward the north. It is in a sheared zone in the gneiss, which is here considerably mineralized and weathers rusty. The vein consists of several quartz stringers, the widest about 20 inches across and the whole about 4 feet. The quartz has a granulated or "sugary" appearance and seems on the whole not highly mineralized. A picked sample showed a somewhat coarsely granular quartz with muscovite, chalcopyrite, and bornite. It assayed only 40 cents in gold.

On the northwest side of Tillie lake a dike was observed of the hornblende-muscovite granite described elsewhere. This and the occurrence of the vein in granite indicate a similarity between the mineralization here and that at the Horseshoe mine.

Machinery purchased for use at this mine appears never to have been installed, and the work was abandoned in September, 1903.

Empire Mine.—This property lies at the north end of Empire lake and is the most northerly of the properties near the Flora lake granite on which any development work was done. No reports mention this property previous to 1902,[1] when work was first commenced and the name "Violet mine" was used. No subsequent reports are available. When it was visited in 1930, there was found evidence of a considerable clearing, now largely reforested with young poplar, a number of camp buildings beside the lake, and a 5-stamp mill built of logs set farther back at the foot of a slope, on which were two shallow shafts, which had been put down without power machinery. The south shaft, situated about 180 feet north of the mill, was sunk on a rusty sheared zone in greenstone, which has a strike of about S.75° E. The vein-stone as seen on the dump consisted of schist injected with quartz of a fine granular texture. Much pyrite is present but no visible gold. An assay of a fair sample from the dump yielded $6.40 in gold per ton. At the north shaft, which is about 540 feet farther north, the vein is an injected part of a sheared porphyry of more acid appearance and has a strike of N.40° E. The quartz as before has a "sugary" texture and is mineralized with

[1]W. G. Miller, Ont. Bur. Mines, Vol. XII, 1903, p. 96.

pyrrhotite and chalcopyrite in cracks in the quartz or replacing the schisted porphyry. An assay of a fairly mineralized sample yielded $11.60 per ton in gold. Neither of these samples could be taken by channelling across the vein, and it is assumed that samples so made would show considerably lower gold content. The north shaft is 12 and the south shaft about 15 feet in depth. An open cut was made from the latter westward along the vein for a short distance. The mill was operated for a brief period on these surface ores, but it is now in a much dilapidated condition.

It appears that for the most part the mineralization that can be inferred as being derived from the Flora lake granite lies mainly along the eastern margin

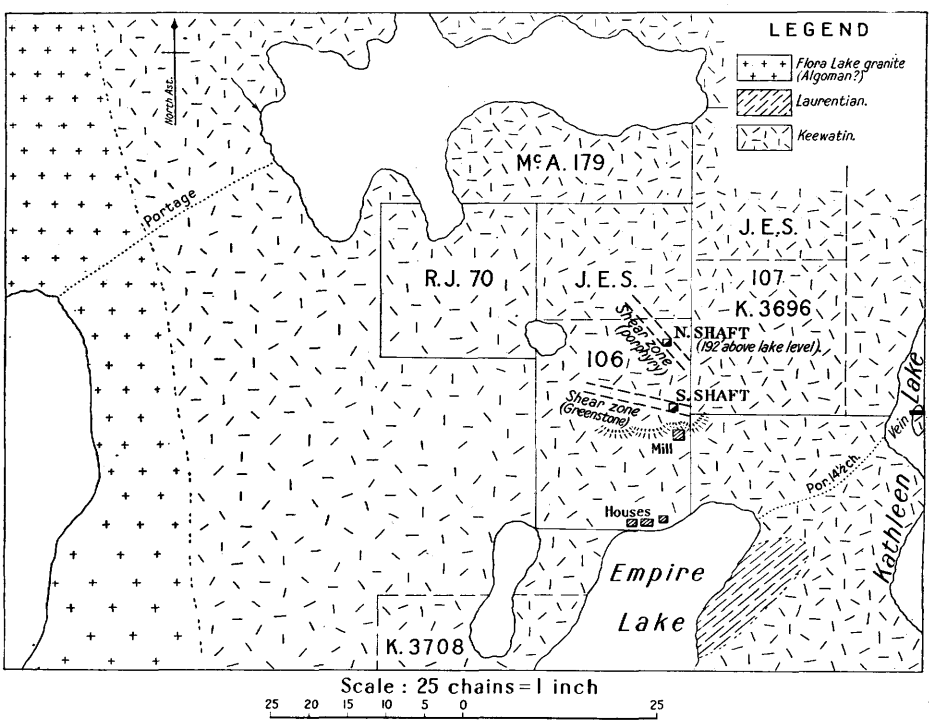


Fig. 8—Plan showing geology at the Empire mine.

of that body. A few claims, however, were staked along a line extending northeastward from the head of Lobstick bay and lie to the west of the granite but at a greater distance and nearer to the Kishquabik gneiss, which is older than the granites to which most of the mineralization is here referred. These claims undoubtedly indicate some appearance of mineralization along this axis, but this was apparently of little importance. A reason for the greater mineralization on the east side of the granite might be found in the fact that that side lies near the edge of the synclinal basin, where certain structural planes that might act as conductors of the mineralizing solutions have there an upward direction.

Gold Panner Mine

This property was opened in 1899 and worked for a short time. It is situated on an island in Caviar (Sturgeon) lake about 4 miles south of the Virginia mine. The island, which contains 22 acres, is traversed by alternating bands of

greenstone and quartz porphyry, which have a strike curving from east by north at the western end to near northeast at the northeastern end of the island. The schistosity is not parallel to the strike of the beds, which would imply that the structure plunges towards the southwest if the schistosity is contemporaneous with the original folding. There are also shear zones which bear N. 25° E., crossing the original schistosity, and the mine appears to be associated with one of these. The gold values are confined, so far as could be judged, to the part of these shear zones that cuts the quartz porphyry in which the shaft was sunk to a reported depth of 100 feet. This would agree with observations of the mineralization of the sheared quartz porphyries or felsites of this region noted on other

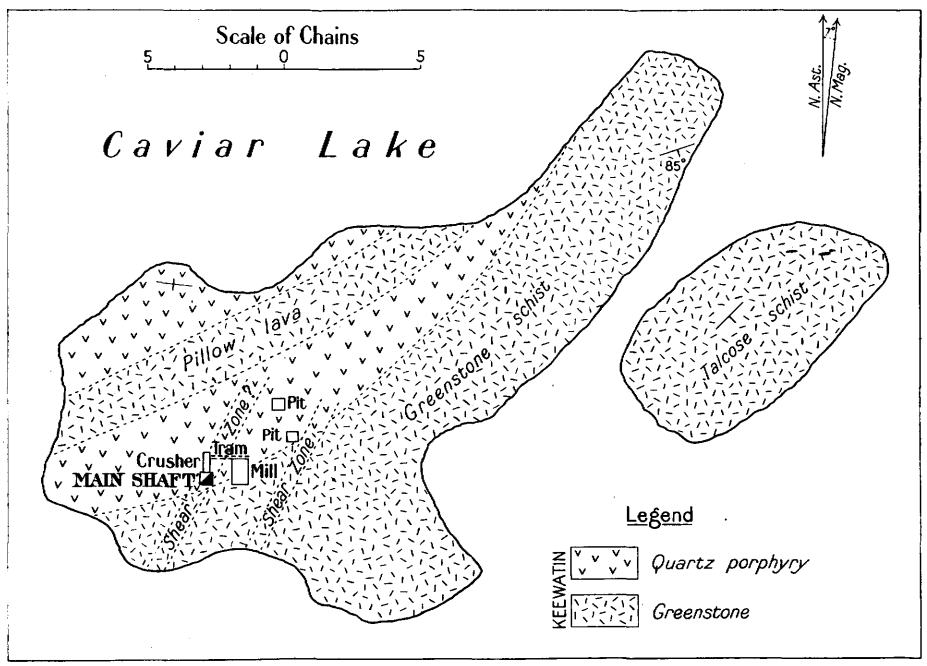


Fig. 9—Plan showing geology at the Gold Panner mine.

properties, inasmuch as the original shearing allowed the injection of quartz in small veinlets along the shear planes, while the later shearing, here seen to be in a transverse direction, probably resulted in a fracture cleavage which admitted the carbonate and gold mineralization. The sulphides are largely pyrite with a little chalcopyrite and molybdenite. The carbonate is ankeritic. Microscopically, the porphyry is seen to consist of orthoclase with some oligoclase or andesine with fractured quartz. Not much ferromagnesian silicate is present, but pyrite crystals and ilmenite grains altered to leucoxene are common. The feldspars are largely altered to sericite and kaolin, and much of the mica is arranged in the plane of shearing.

The well-sheared porphyry is a sericitic schist, but the shearing appears to have been strong only along certain zones of weakness, leaving intervening plates of massive rock. These with the injected quartz formed a brittle mass, which yielded to a later cross-folding shearing by fracture rather than flowage. The idea of cross-folding as the cause of the later shearing would agree with the present plunging attitude of the original structure.

The mine was provided with a crusher and rolls housed with the headframe and connected by a short tram with a 10-stamp mill. A forge, hoist pump, and assay office completed the equipment. Some ore was treated, and it is said that a small amount of gold was produced. Water in the mine caused great difficulty. The vein was reported[1] as 8 feet wide, and rich samples of ore containing native gold were said to be obtained from it. The last work reported on this mine was done in 1903.

The following assays were secured by the writer: (1) Mineralized quartz porphyry somewhat sheared and injected with quartz, which here appears subsequent to the mineralization in cracks penetrating the rock at a different angle, gave $4.20 per ton in gold. (2) Quartz stringers, carrying carbonate, penetrating the mineralized schist gave 40 cents per ton in gold. A complete solution of the mineralization is not indicated in these two samples.

It is not clear from which of the various bodies of intrusive granite in the synclinal basin of Caviar lake the mineralization of the Gold Panner vein has been derived. A small granite outcrop to the east lies in a line between the Hope lake and Stephen lake stocks and suggests that there is a deep-seated connection between these intrusions and the Flora lake granite, which accounts for the similarity of their composition. Two granite bodies that lie to the north and south of Rowan lake are of like composition.

Flint Lake Mine

In the year 1901 the Flint Lake Gold Company, of Philadelphia, in which Thomas A. Edison was said to hold an important if not the principal interest, acquired the claims numbered McA. 285 and McA. 286 from the discoverer.[2] At that date a little surface trenching had been done on the property, which is situated on the northeast shore of Flint lake. It lies about 2¼ miles north of the northeastern end of the Stephens lake granite stock and about 2 miles south-southwest of the small granite area on Caviar lake. A number of dikes of quartz porphyry, probably referable to this granite, are exposed on the south shore of the same bay, and on the islands farther west and north.

The first work on the Flint lake property consisted of two shafts situated 25 chains inland from the north shore of the east bay. These were sunk in 1902. At the same time a plant was erected, which consisted of a 125-horsepower boiler, slide-valve steam engine, Allis-Chalmers Blake crusher (not installed), Krupp ball mill, Fairbanks duplex pump, ore bin, and wooden vats for cyaniding. Other buildings on the property were dining and sleeping camps, blacksmith shop, assay office, and a powder-house situated at a distance from the other works. A graded road about 25 chains in length connected the mine with the mill. As the outcrop stood about 20 feet above a swamp, it was decided to quarry the upper part and mill it as an initial operation. The mill, however, was never used, and the work was abandoned in 1903, probably because the assay values were too low. In this initial work the advantages of cross-trenching seem to have been entirely overlooked, and the plant was prematurely installed.

The ore, as mined at first, was mainly quartz, which occurred in a vein differing slightly in strike from the surrounding schists. The strike of the vein is given as S. 70° E., that of the schist as S. 80° E. The vein also appears to dip toward the southwest, while the planes of schistosity dip north. The vein was, therefore, described as a fissure vein. It undoubtedly contained a good deal of schist mingled with the quartz. The schists contain sericite and chlorite

[1]Ont. Bur. Mines, Vol. IX, 1900, p. 49.
[2]Ibid, Vol. XI, 1902, p. 255.

and represent the more acid types of lava of the area. A selection of ore taken from a pile at the mouth of the tunnel and open cut, which extend west from No. 1 shaft, assayed $3.20 per ton in gold. The ore from the shaft is a white

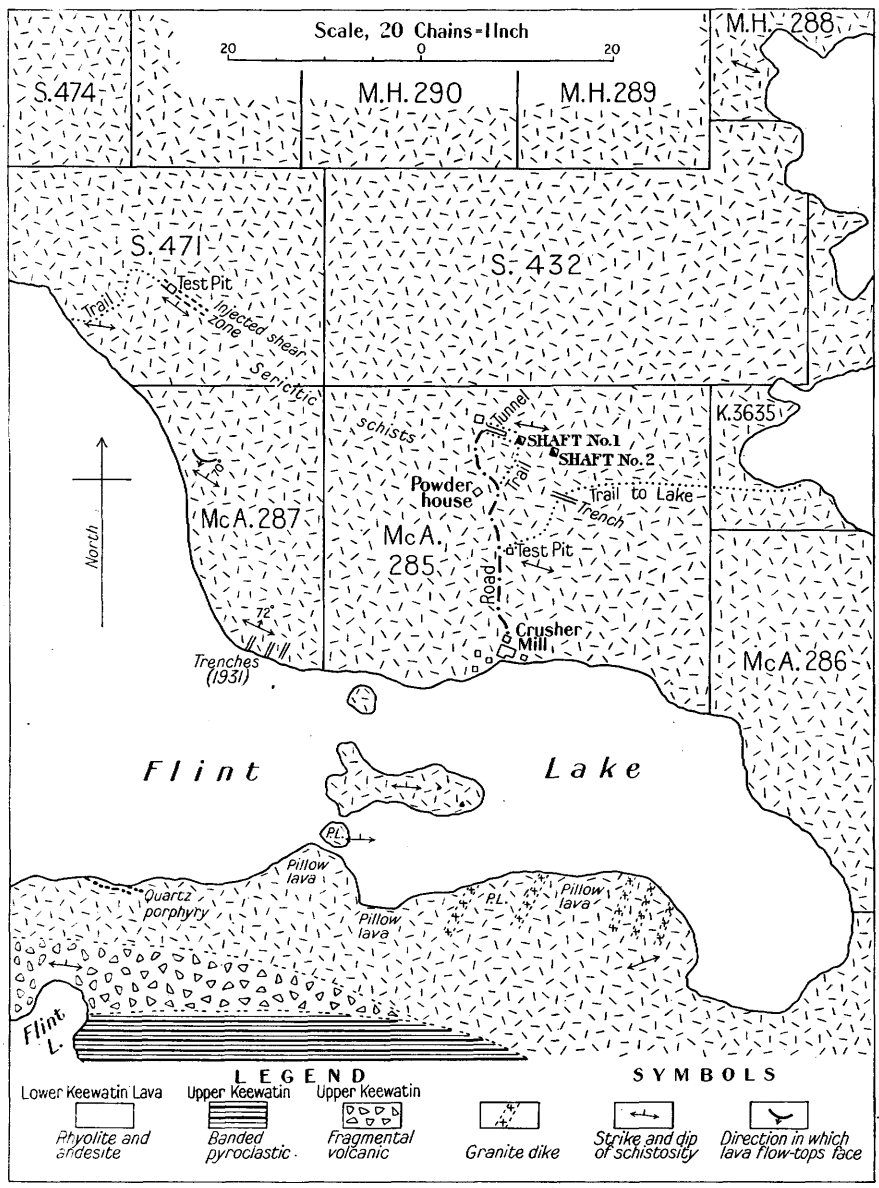


Fig. 10—Plan showing geology at the Flint Lake mine.

glassy quartz with inclusions of sericitic schist and ankeritic carbonate filling cracks. There was no visible gold observed, but a little pyrite was noted. In the original reports,[1] however, fine visible gold is said to occur in the quartz.

[1]Ont. Bur. Mines, Vol. XIII, pt. 1, 1904, pp. 63.

About 35 chains northwest, on claim S. 471, there is a small test pit in chlorite-sericite schist, which is injected with glassy quartz in lenses, sometimes a foot in thickness, carrying pyrite grains. Cracks in the quartz contain veinlets of magnetite and pyrite with a little chalcopyrite. The pyrite is possibly later than the magnetite. A certain amount of carbonate is also present in the schist. It occurs in layers up to an eighth of an inch in thickness interleaved in the schist, but was not noted in the quartz. A sample from this pit yielded $4.40 in gold.

On the second visit to this mine in 1931, it was found that the mine had changed hands and some work had been done, including several trenches cut across a band of the acidic schists 100 feet wide on the south end of this western claim near the lake shore. The work extends about 500 feet along the strike, to which the trenches are transverse. Mr. Findlay McCallum, of Winnipeg, who was in charge of the work, reported that two trenches 100 feet or more apart

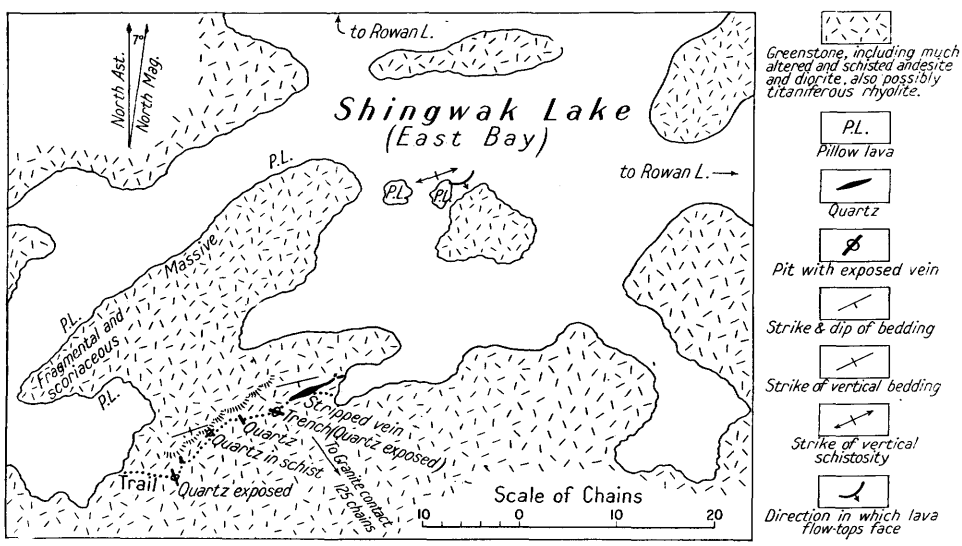


Fig. 11—Plan showing geology on the property of R. Roy.

have yielded values of $10.60 and $8.00 over a width of 5 feet in each case. In the first-mentioned trench there is also another section of several feet that assays $8.00. Here, as elsewhere, the schist is injected with quartz that varies in colour from white to almost black, the dark colour seeming to be due to the presence of finely disseminated magnetite. The veinlets of quartz do not always follow the schistosity, but in some cases break across it. Native gold is visible in the quartz, and other mineralization consists of pyrite and chalcopyrite. The strike of the schistosity here is approximately S. 64° E. (S. 57° E., astr.) and the dip 71° to 74° N.E. It has also horizontal shear zones at intervals. The general structural dip is to the south, which would make it appear that the quartz, in some parts at least, follows fractures parallel to the bedding, while the schistosity traverses the planes of the bedding at an angle inclined opposite to the structural dip. This agrees with the general structural position as indicated by the map, which shows that the beds to the south are of higher horizon and fill a synclinal basin, on the northern edge of which Flint lake is situated.

Roy Claim

At the mouth of the east bay of Shingwak lake on a trail leading across the base of a peninsula that partly closes the entrance, a number of exposures of



Specimen (three-quarters natural size) of carbonated greenstone schists mineralized with pyrite and chalcopyrite and penetrated by gold-bearing quartz veinlets, Roy claim, Shingwak lake. Q = quartz. G = altered greenstone. Ca = ferruginous carbonate. Ch = chalcopyrite. P = pyrite.

quartz are seen in small trenches or pits, and near the east end a wide vein of lenticular form is exposed by stripping for about 250 feet. At its widest part the quartz measures 29 feet, and the average width for the 250 feet was estimated at 8 or 10 feet. This property is known as the Roy mine.

Commencing at the western end, the first vein matter seen is exposed in a pit 6 chains from the landing. The quartz, which has a width of from 4 to 5 feet, represents a vein with a strike of S. 10° E. It is massive and appears to be little mineralized. A few cracks are filled with black magnetite and a little ankerite and pyrite, and the enclosing rock is a chloritic schist. Twenty yards north in the side of a small ridge, a smaller vein is exposed, which has quartz of quite similar appearance and strike in rock of the same type. About 60 yards northeast of the small vein, another exposure of quartz is seen in a schisted rock of lighter colour and more acid type, apparently a sheared porphyry. Ten yards farther on, the trail touches a trench cut in sheared porphyry which has several veins parallel to the schistosity. At the north end of the trench there is a 6-foot vein of quartz, injected by veinlets of ankerite, pyrite, and later small magnetite dikes. This is followed (see Fig. 11) a little farther on by another quartz vein, striking N. 32° E., in a schist that strikes N. 62° E. Farther along the trail the rock changes to greenstone schist again and another quartz outcrop is to be seen. Seventy-six yards farther east a trench 20 feet long across the strike, which is near east-northeast, exposes 15 feet of quartz veins in schist, carrying ankerite; and 29 yards farther in the same direction the stripped part of what may be the same vein was reached. It was uncovered for about 250 feet when the property was visited and showed a maximum width of 29 feet near the central part of the exposure. Offsets branching into the schist on the north side were observed, and in several parts large amounts of fragmentary greenstone were included in the quartz. These fragments shown a certain amount of carbonate replacement.

Mineralization occurs both in the quartz and in the brecciated material. It consists mainly of pyrite and chalcopyrite, and much of it is in cracks subsequent in age to both the quartz and the carbonate. A picked sample gave $1.60 gold and 6.2 per cent. copper. For another sample the result was $4.40 gold and 0.23 per cent. copper, but a channel sample over a part of the vein 6 feet in width yielded only 60 cents in gold. The vein continues some distance farther east on the same strike to the shore of the bay. On about the same strike, mineralization was observed in sheared rhyolitic rocks on the shore of Rowan lake to the north of the bay on which the Sullivan mine is located. The mineralization of the Monte Cristo property appears also to be on a prolongation of the same structural horizon. This belt of mineralization is roughly parallel to the northern edge of the Nolan lake granite. The distance from the granite contact is over 1½ miles at the Roy property and nearly the same at the Monte Cristo.

The Roy–Monte Cristo mineralized zone appears to be at its strongest, as far as quartz is concerned, at the Roy property, where a number of veins differing in strike are seen, representing a very considerable quartz injection in large veins.

Monte Cristo Mine

This prospect consists of a wide band of sheared rhyolitic rock crossing the north end of a peninsula that projects from the south shore of Rowan lake, near the eastern boundary of the mapped area. It lies, as already stated, about 1½ miles north of the northern edge of the Nolan lake granite and is in the immediate vicinity of a number of the unsheared rhyolite porphyry dikes carrying pyrite in cubes, which are taken in this report to be of approximately the same age as the granite. Eight trenches have been cut across the mineralized zone. Six of these were opened in 1900 and sampled by Charles Brent. They were cut at intervals along the strike over a length of about 400 feet. The entire length of the exposure, which crosses the point, is about 600 feet from water to water.

The maximum width of gold-bearing rock was determined by J. G. Cross as being nearly 200 feet, including that exposed on a small island off the point. The most thorough sampling was done by Brent in 1900. Some of his figures for channel samples are shown on the diagram (Fig. 13) of the trenching. He reports that an average of the assays of 54 samples indicated a gold value of $3.72. Of this, $2.55, or about 70 per cent., was recoverable by amalgamation. Later sampling by J. G. Cross in 1931 yielded smaller values on assay, which he

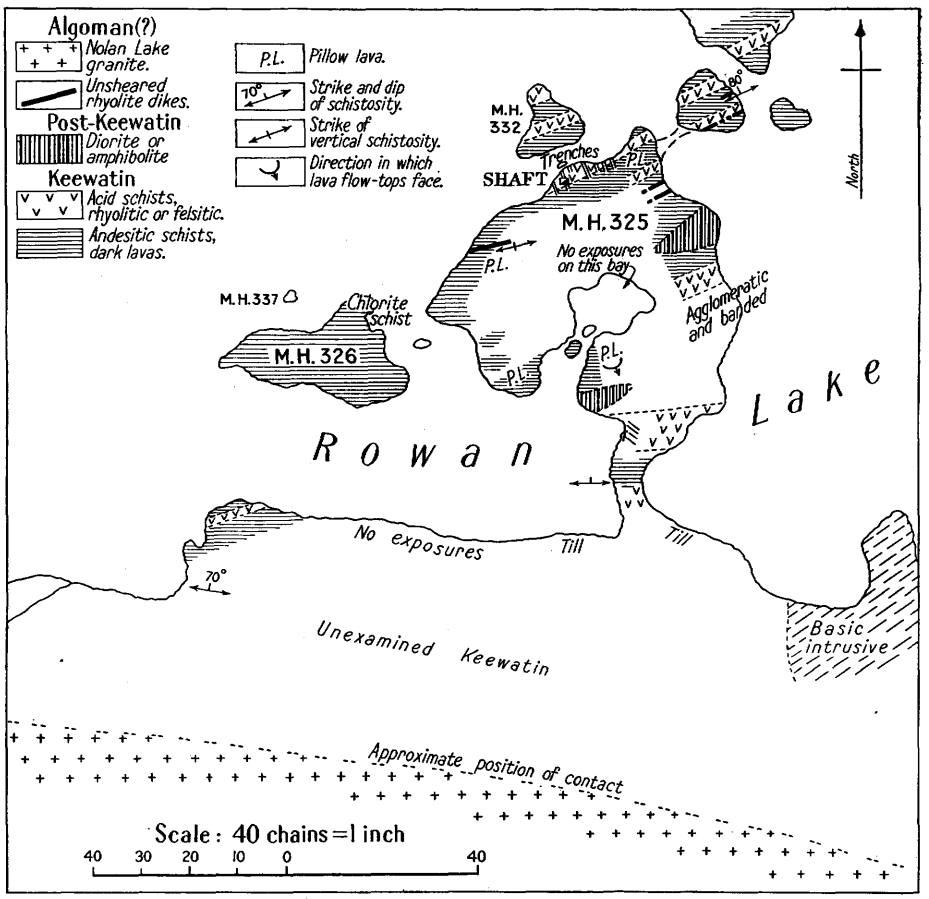


Fig. 12—General plan showing geology at the Monte Cristo mine.

attributed to his not having cleared out the old trenches and to not pulverizing his samples sufficiently.

Here, as in other deposits of the same kind in sheared quartz porphyry or rhyolite porphyry, there is a large body of very low grade average value containing irregularly placed and shaped lenses of higher values. Cross notes that joints may cut off the gold deposition. The schists are crossed in many places by transverse shear zones and presumably joints, having a bearing of about S. 60° E. The strike of the schists is N. 60° to 70° E., and the dip approximately vertical.

As compared with the Virginia and Flint lake deposits, which are similar in being in sheared rhyolitic flows, the Monte Cristo shows less concentration of quartz in large veins, but the wide distribution of low values over considerable

widths is common to all. A study of the mineralization in the rock exposed on the point opposite shows that the sheared porphyry was injected parallel to the schistosity with small veinlets of quartz; crossing this in cracks of a later age are veins of ankerite; pyrite and chalcopyrite, which probably contain the gold, appear to be still later in age. The history that is indicated would, therefore, be: (1) shearing of the Keewatin lavas by folding, producing schistosity in both the greenstone and more acid flows; (2) the quartz injection mainly but not entirely confined to the acid schists, possibly due to their greater solubility, but producing in them a much greater rigidity and brittleness owing to the extensive deposition of quartz; (3) renewed shearing producing a fracture cleavage in the acid zones but not in the greenstones; (4) injection of carbonates into these fractures; (5) subsequent mineralization by solution and replacement of the carbonates.

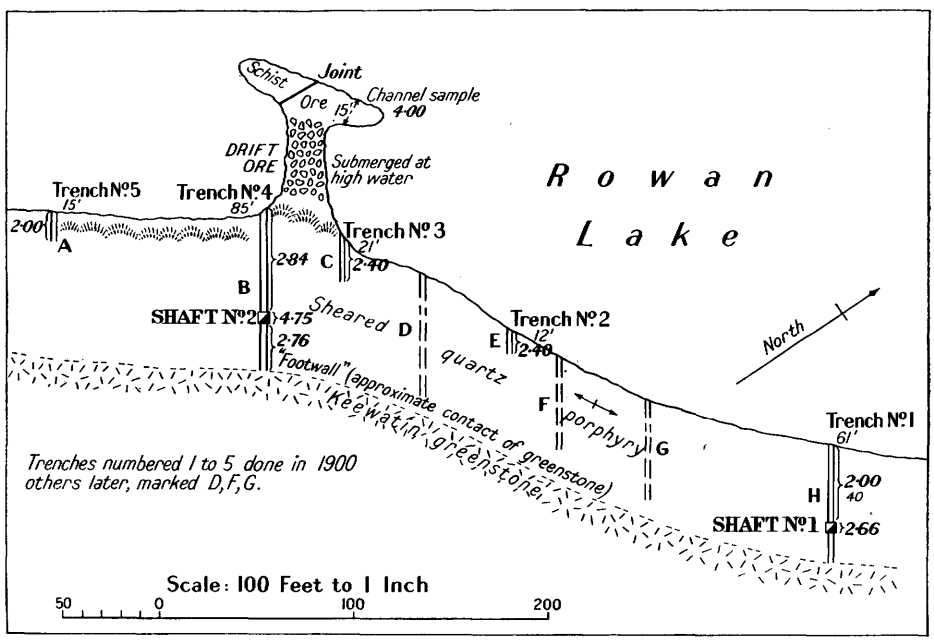


Fig. 13—Detailed sketch of the Monte Cristo mine (after J. G. Cross).

The first folding appears to have been coincident in time with the older granites, provisionally called here Laurentian. The quartz injections may have taken place at a later stage of the same intrusive period when the granites were hardening and could give siliceous solutions into the surrounding formations. If, then, the mineralization by metallic ores is referable to the later granites, it must have occurred at a period very much later than the original quartz intrusion. The intermediate carbonate deposition might be Haileyburian and derived from the diorite-amphibolite intrusions if these are assignable to that age. They are not sheared enough to produce schistosity and, therefore, are younger presumably than the folding of the highly schisted lavas of the lower Keewatin. They are also seen to be intrusive in the massive fragmental upper part of the same formation. The three stages of mineralization here seen might then be accounted for by three different intrusions, of Laurentian, Haileyburian, and Algoman age, respectively. These considerations are, however, advanced only tentatively. It appears certain that the intrusions of the carbonate and later sulphides took

place after a cross-shearing, which could not have been contemporaneous and may have been very long subsequent to that which produced the original schistosity, and also subsequent to the quartz injection that occurred after the

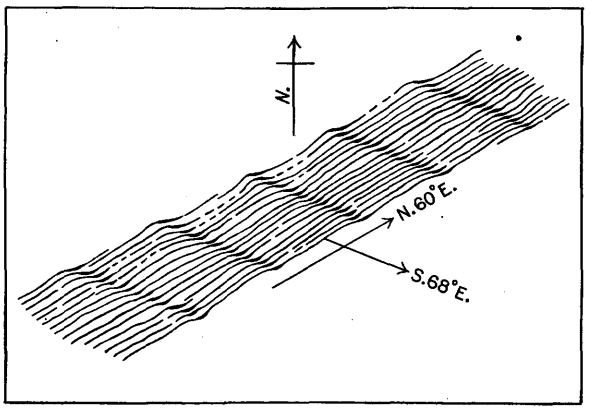
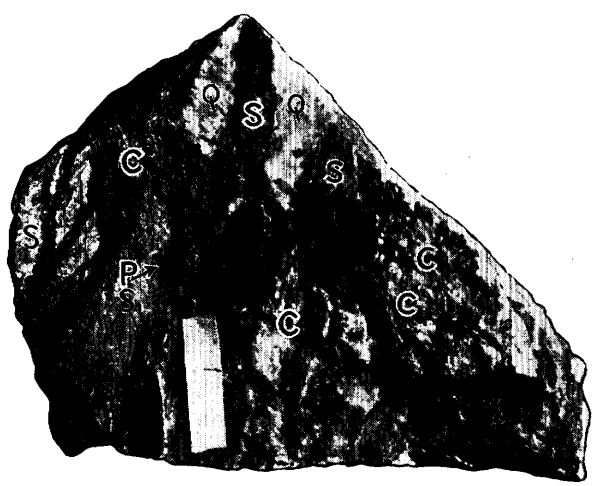


Fig. 14—Rhyolite schist on the Monte Cristo property, Rowan lake. Strike of schistosity, about N. 60° E.; direction of transverse drag folds, S. 68° E.

schistose condition was established. It will be remembered that the gold mineralization appears to be due to cross-shearing in the Gold Panner and Flint Lake properties, both of which are also in sheared zones of rhyolite or quartz porphyry.



Specimen (three-quarters natural size) of gold-bearing injected acid schist, Monte Cristo mine, Rowan lake. Q= quartz injected parallel to the schistosity. S=sericite-chlorite schist. C=ankeritic carbonate later than the quartz, injected transverse to the schist and quartz stringers. P= pyrite in the ankerite or carbonate, which it probably replaces.

Sullivan Mine

This property, at first known as the Reliance mine,[1] is situated at the southwest corner of Rowan lake (then known as Denmark lake), on Timber

[1]Ont. Bur. Mines, Vol. IX, 1900, p. 47.

Berth No. 1, east of Kakagi lake, which had been leased to the Anglo-Canadian Gold Estates, Limited, of England, together with four other blocks, the whole aggregating 117 square miles. The company, which was organized early in 1899, had exclusive prospecting and locating rights in these areas for a limited time. In August of that year, the Reliance property was located in Timber Berth No. 1, and another property, called the Elizabeth, on another area known as Timber Berth No. 61, north of the Seine river. Alan Sullivan, the company's manager, reported on February 13, 1901, that a shaft 94 feet deep had been sunk. At the 60-foot level about 80 feet of drifting had been done, and at the bottom there was a crosscut of 30 feet. The latter was said to be exploratory work due to a dislocation of the vein at that depth. Work was then discontinued pending the arrival of the company's diamond-drill from the Elizabeth mine.[1] As reported by the Inspector of Mines in 1900, the principal shaft had reached a depth of 110 feet. The drill had been used to discover the displaced vein without success.

When visited in the summer of 1931 the buildings were in ruins and the headframe of the shaft had collapsed. As the surrounding surface is largely covered with a deposit of sand and gravel, little could be done in the way of examining the vein. To the west of the shaft an irregular open cut about 45 feet in length had been made, with an offset of 24 feet northward at its western end. The shaft appeared to be only about 25 feet deep and on an incline of about 70° W. Its cross-section was 5 by 8 feet. This shaft, if originally 110 feet deep, may have been filled up with material from the open cut. The dump just west of the shaft would certainly indicate that depth had been reached considerably greater than that now visible.

The vein matter is a sheared porphyry that is practically a sericite schist. The strike is about N. 82° E., and the dip nearly vertical. Trenching had been done in the low ground to the west of the shaft at three or four points widely separated. Little quartz was seen in these trenches and what was visible was in narrow stringers or veinlets. The quartz is very white and glassy. Mineralization consists of cubes of pyrite with some massive pyrite and chalcopyrite. The shaft is situated about 580 feet west of the houses on the shore at the west end of the southwest bay of Rowan lake. Another shaft is said to be 33 feet deep. As no practical samples were obtained, no assays were made. The deposit was described in early reports as having an important gold content, which was not publicly reported in detail. The work was abandoned about 1901.

Mineralized Zones Not Previously Described

Gold occurs at the following points:—

Flora Lake Granite.—On an island near the central part of Kathleen lake a band of sheared quartz porphyry is seen crossing the lake and appears in the north end of a small island, where it is traversed by a quartz vein about 6 feet in width, partly of glassy and partly of a fine granular appearance; its strike is nearly east and west. The glassy part was mineralized with carbonates, pyrite, and sericite. It assayed from 20 to 40 cents.

Isinglass Lake.—On the north shore of Isinglass lake, on claim S. 473, near an outcrop of the felsitic granite that occurs on the claim, there is a mineralized zone in the gneissoid rocks that is sheared, highly oxidized, and mineralized with pyrite and a little chalcopyrite. This zone strikes about S. 64° E., and contains a vein of quartz following the same strike. In appearance the

[1]Ont. Bur. Mines, Vol. X, 1901, pp. 40, 74.

quartz is "sugary" and carries cubes of pyrite, especially in the altered inclusions of the wall rock. An assay from a selected sample yielded 80 cents in gold. A small stamp mill and gasoline engine were at one time erected here. The excavations were rather shallow cuttings on the oxidized zone.

Rowan Lake.—On an island near the north shore of Rowan lake about 4½ miles southeast of the portage from Denmark lake to the north bay of Rowan lake, there is an oxidized zone cutting across the strike of the schists. The general strike is N. 87° E. The lavas are greenstones, ropy or fragmental in the upper part of the flows. They are penetrated along the strike by a rhyolite porphyry dike, which is unsheared. The oxidized zone that is seen on the eastern shore of the island has a strike of S. 28° E. It extends northwestward over a quarter of a mile, crossing a point and the small bay beyond. At the southeast end it contains an irregular body of quartz, distributed in several lenses, which is mineralized with pyrite and possibly a little chalcopyrite. Its mineralization may be traced to an outcrop of granite on a small island half a mile southeast along the strike of the shear zone. This zone was at one time staked and a little work done on it. A sample taken at the time of our visit yielded no values in gold.

South and Southwest of the Nolan Lake Granite.—This area is traversed by a remarkable number of quartz veins, some of them very large, equalling that exposed on the Roy claims northeast of the same granite body.

Several of these veins cut across that point that projects northward in the southeastern part of Cameron lake. They traverse the point in a northwest-southeast direction and cross to a point on Otterskin lake, where their bearing is nearly due east. On the point that divides Otterskin lake into two bays, they are again exposed with a southeasterly strike. The total length of this vein system is about 3 miles. Many of the outcrops studied were of massive quartz, which appears to have undergone no fracturing since it was first deposited and shows no signs of mineralization. These veins are in greenstone lavas. In one case, however, near the northern side of the system, a heavy vein of pyrite traversed by quartz is found running parallel to the schistosity of a sheared rhyolitic flow. The quartz at the first discovery point seems younger than the pyrite, which itself forms a considerable body totalling over 6 feet in width. The vein was also observed on the west shore of Otterskin lake, where the pyrite forms stringers in the rhyolite schist, and not much quartz is visible. At the first point the pyrite assayed 60 cents a ton in gold, but at the Otterskin lake exposure there was no gold content, though a heavily oxidized zone of 10 feet or more in width occurs there. The veins in the eastern part of Otterskin lake appear to be unmineralized.

Following almost on the strike of these veins southeastward, a number of smaller quartz veins in greenstone and sheared porphyry are to be seen on the south bay of Brooks lake and on the point immediately east. Three assays from these veins yielded no gold in two cases, and only 20 cents a ton in the third sample, which was taken from the south bay. The largest vein, which is on the point, had about 2 feet of clear quartz. The strike is S. 63° E., and the wall rock is massive greenstone. The other veins are injected bands of sericite schist with ankerite, apparently older than the quartz, which contains cubes of pyrite.

General Conclusions

It appears in general to be true that the pyrite does not carry much gold, which occurs in promising amounts only where chalcopyrite is present. Judging

by observation duriug the progress of the present work, it would appear that the Empire and Flint Lake mines are those which give visible evidence of possibly profitable results. The very wide dissemination of gold throughout the area seems so far to have raised expectations that have not been realized. The question of exploiting successfully somewhat large and very low grade deposits is that which presents itself most obviously.

The origin of the mineralization has been largely dealt with in passing. Little doubt remains that the later granite bodies, now known to be much more numerous than before, account for the presence of gold with almost entire certainty.

Iron Formation and Ankerite Dikes

A dike of rusty-weathering siliceous carbonate was examined near the southwest end of a bay that forms the most southerly extension of Kakagi lake and opens a few miles east of the Crow portage. From a point on the north shore of the bay near its western extremity a dike of this material, which has a width of 8 or 10 feet in some parts, extends on a bearing of N. 50° W. for a distance of 24 chains to a small lake, underneath which it disappears. It contains no visible sulphides, has a banded structure parallel to its length, and includes fragments of the chloritic schist in which it is bedded parallel to the schistosity. Replacement of the schist by the carbonate on a large scale appears to explain the data observed. On analysis the following composition was revealed:—

	Per cent
Silica	8.10
Alumina	.71
Ferric oxide	.43
Ferrous oxide	8.14
Lime	29.95
Magnesia	12.22
Carbon dioxide	40.71
Sulphur	.06
Water	.15
Total	100.47

This composition corresponds to an ankerite low in iron and high in silica. The silica also is only slightly referable if at all to native quartz. It may be a phase of the iron formation. On the southern and western shores of Schistose lake, iron formation occurs again. At a point in the western end of the lake there are exposures of iron ore with many large fragments of black chert irregularly distributed in it. The fragmentation may be accounted for by the folding to which the bed has been subjected. Another band carrying visible sulphide is exposed on the south side of the point. Its width, though undetermined, exceeds 30 feet, and it appears to be a siderite ore with fragments or bands of white chert and carrying sulphides of iron. Keewatin lavas occur along the south side of the lake, disappearing opposite a point on the north side, where the banded cherts with ore are again encountered. Farther east another band occurs in which the amount of ore is much reduced relatively to the chert. This appears to lie at a lower horizon than the other two exposures.

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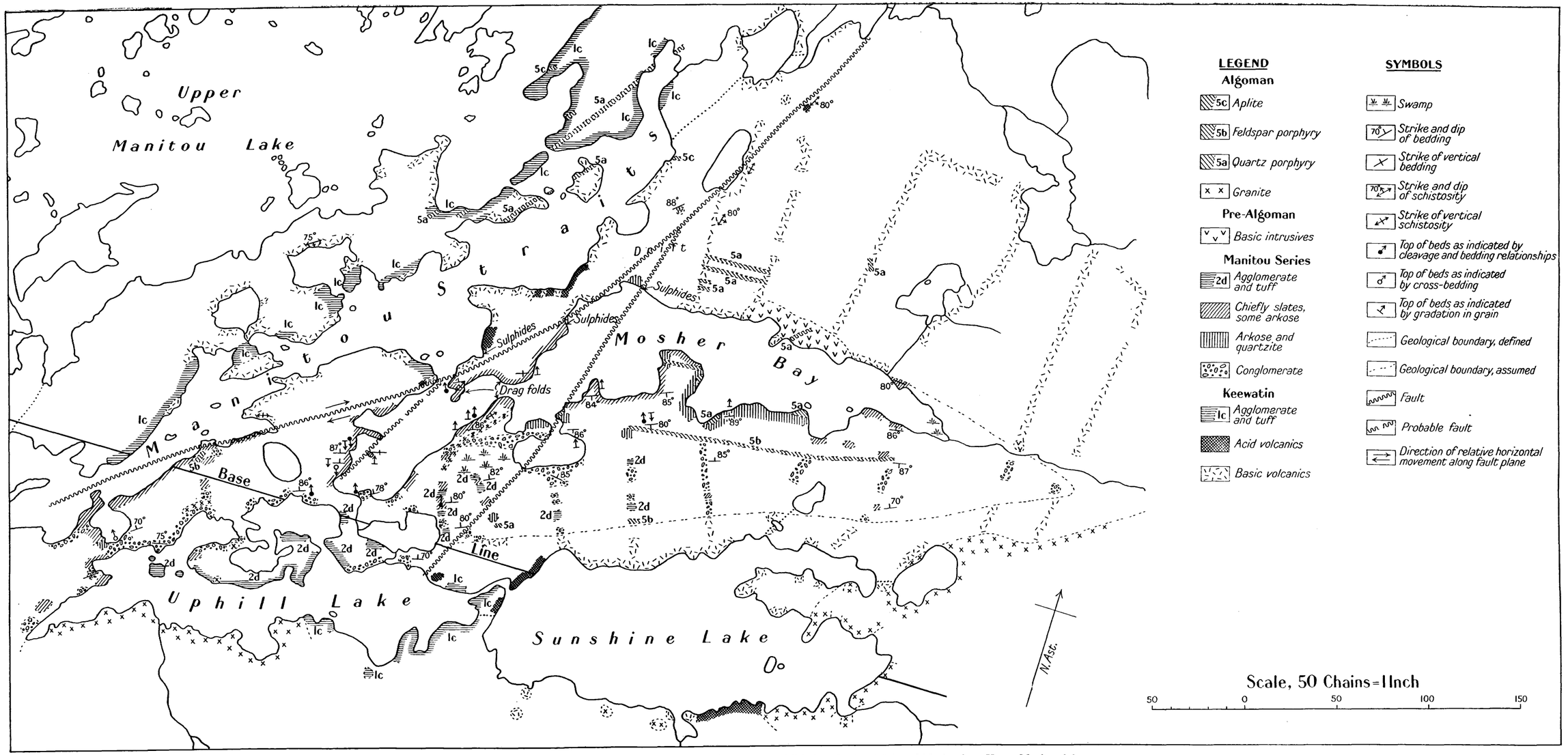
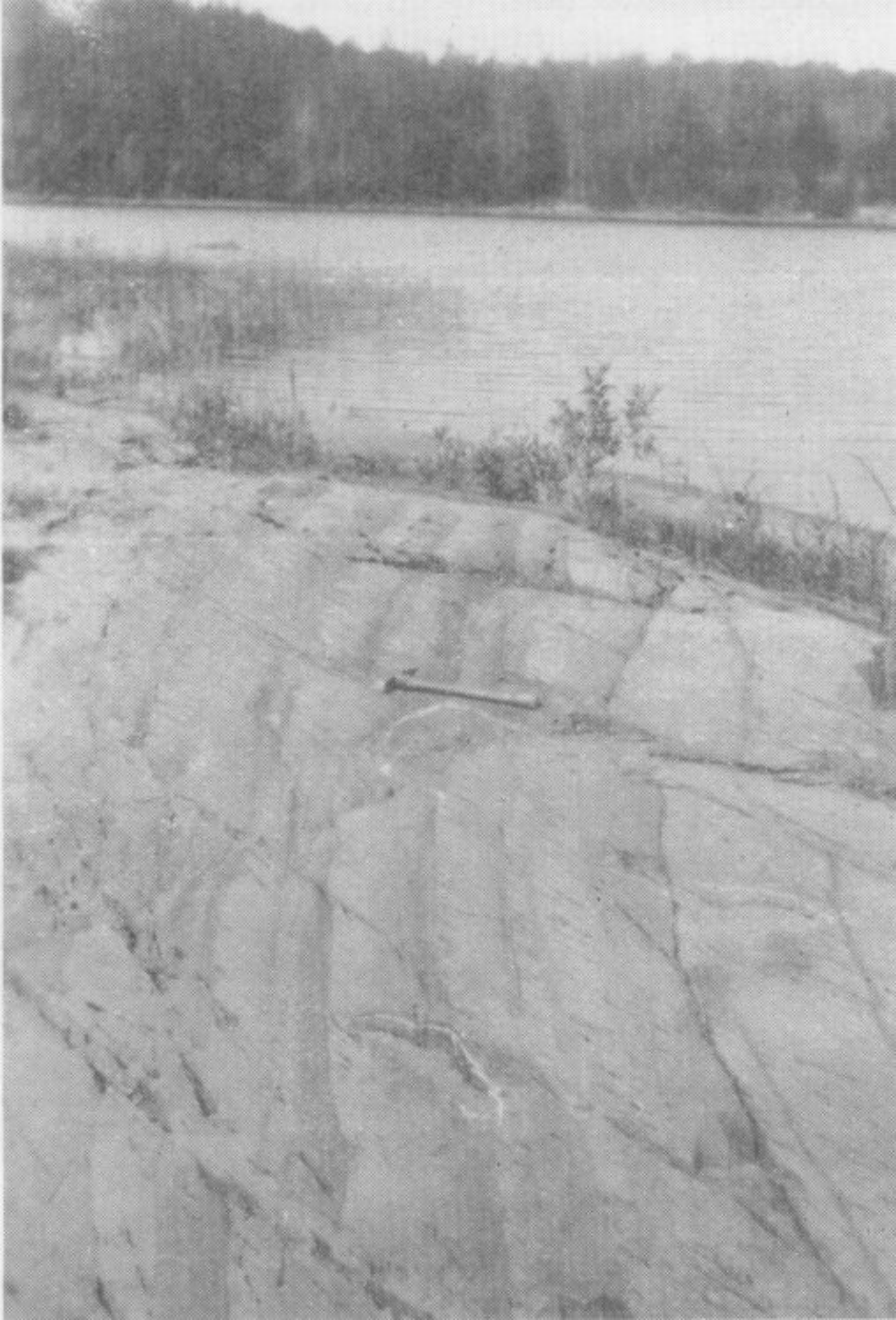


Fig. 2—Geological sketch map showing details of structure and lithology in the vicinity of Mosher bay, Upper Manitou lake.



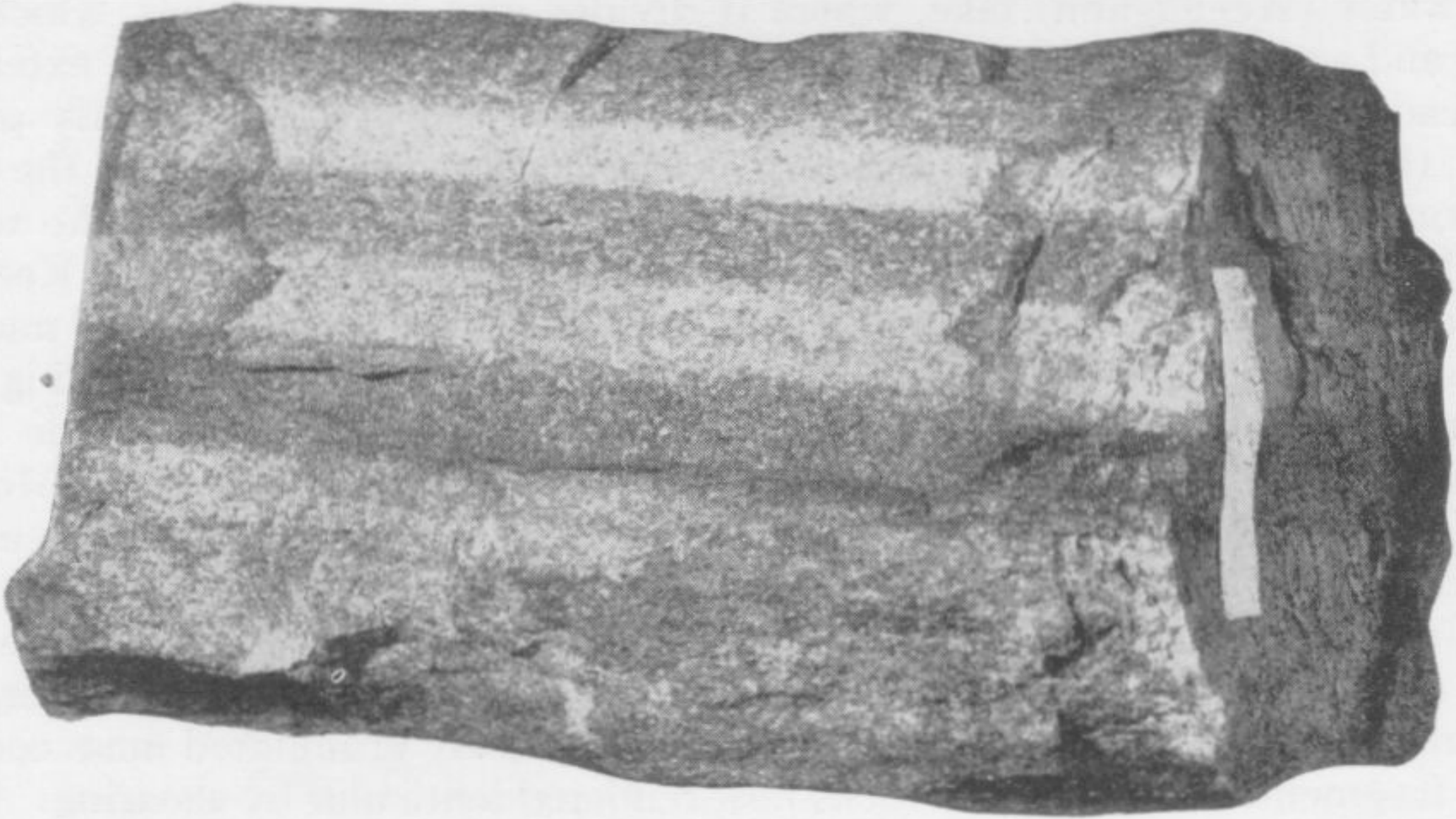


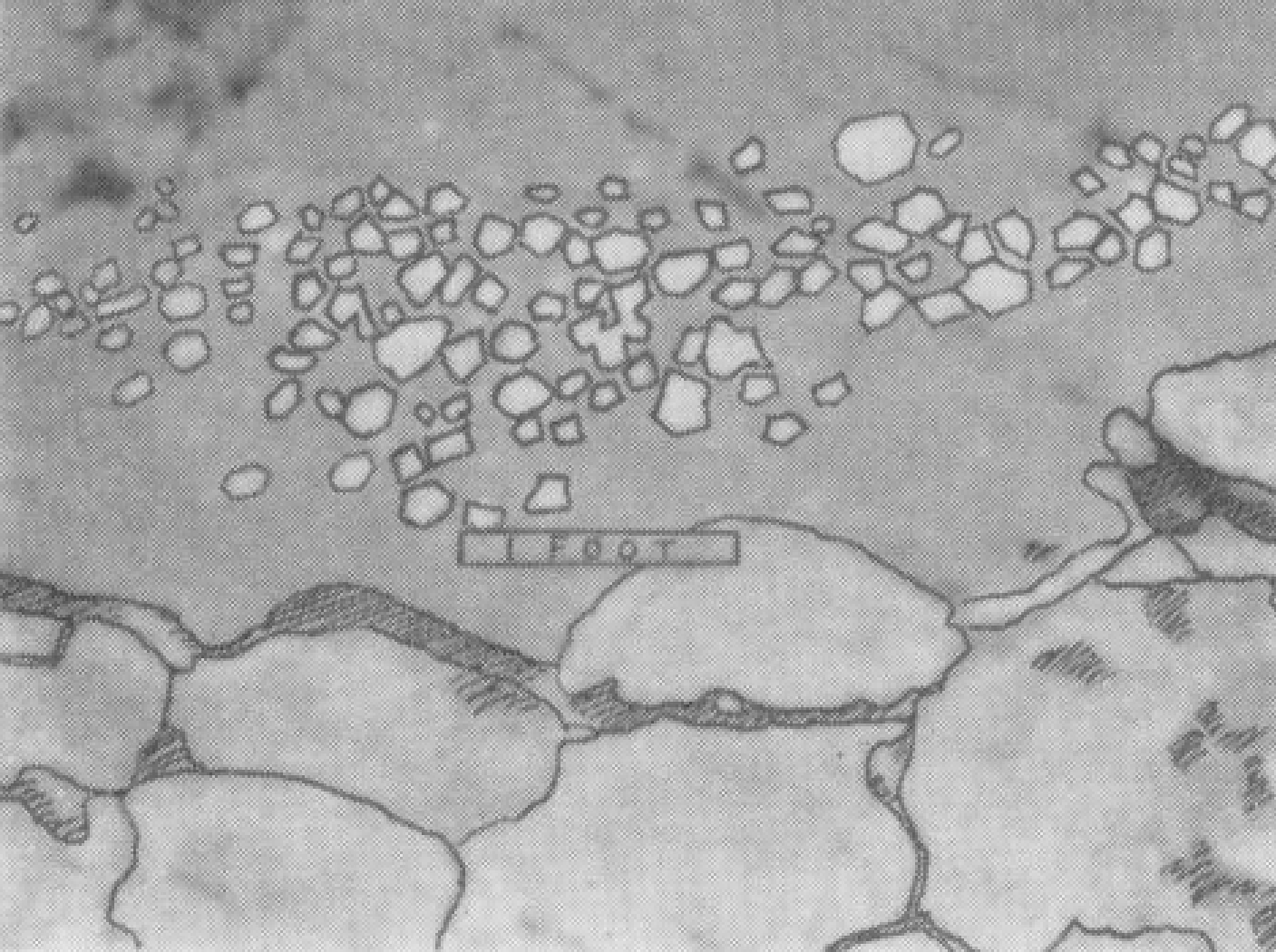




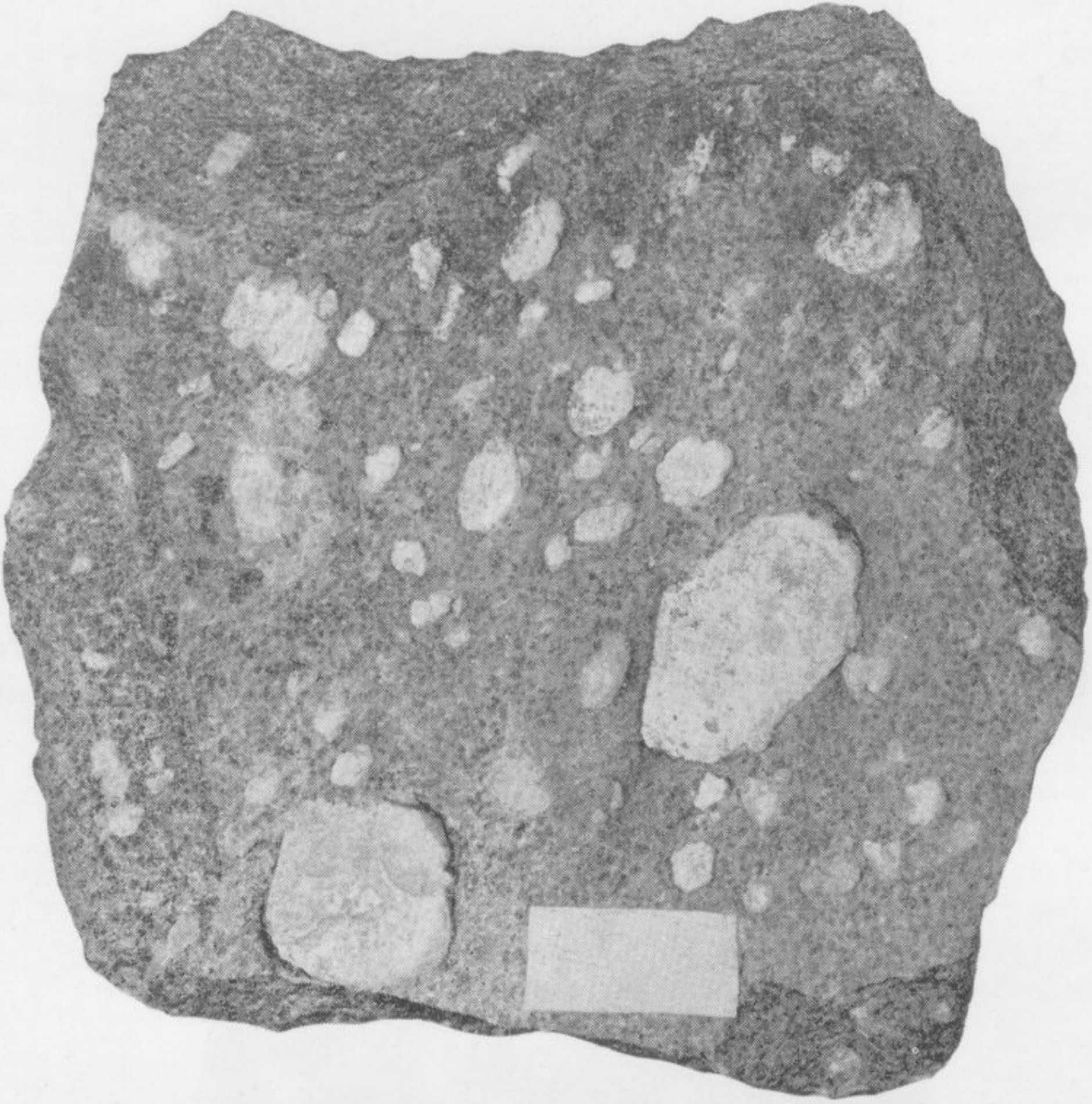


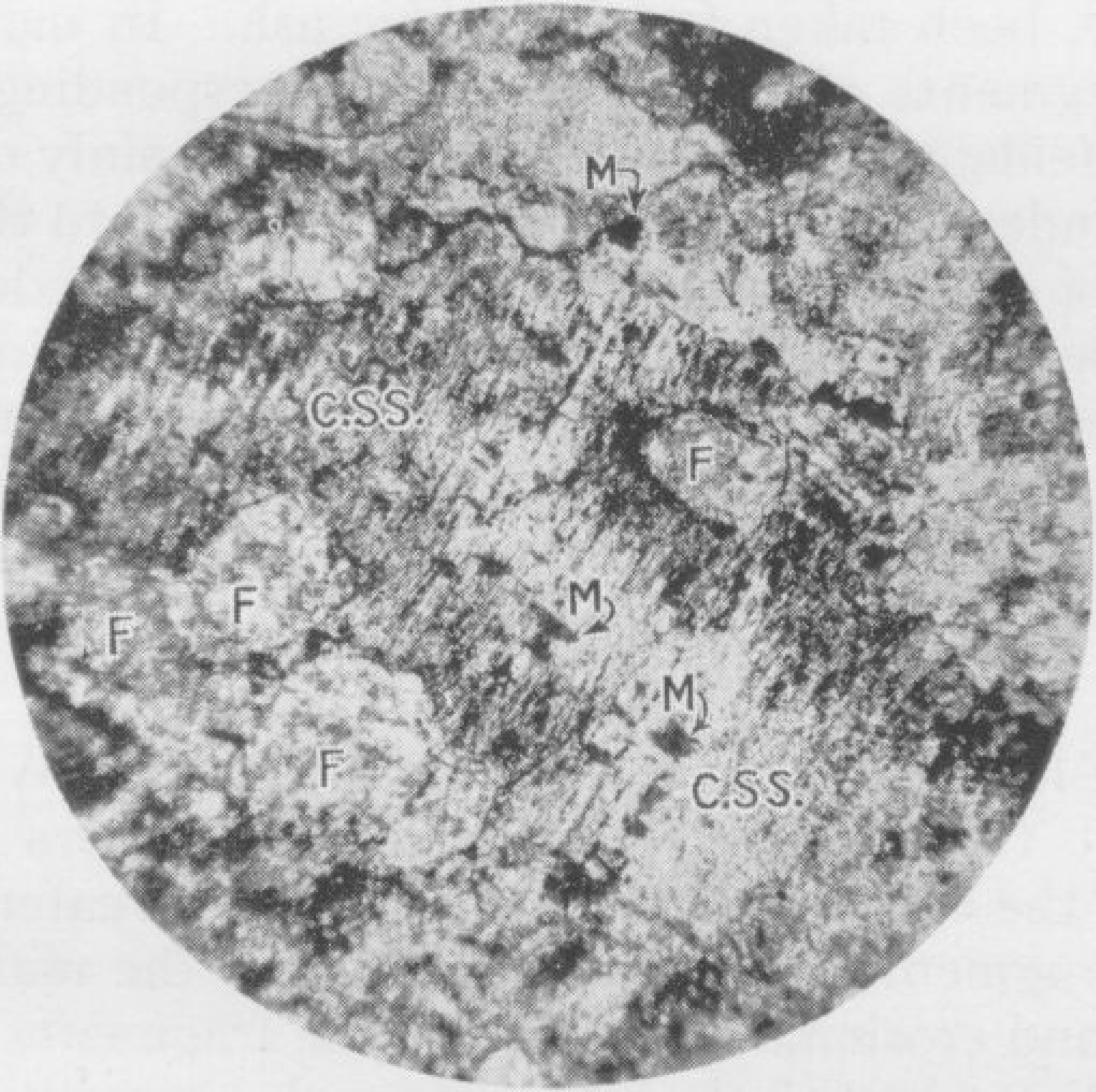


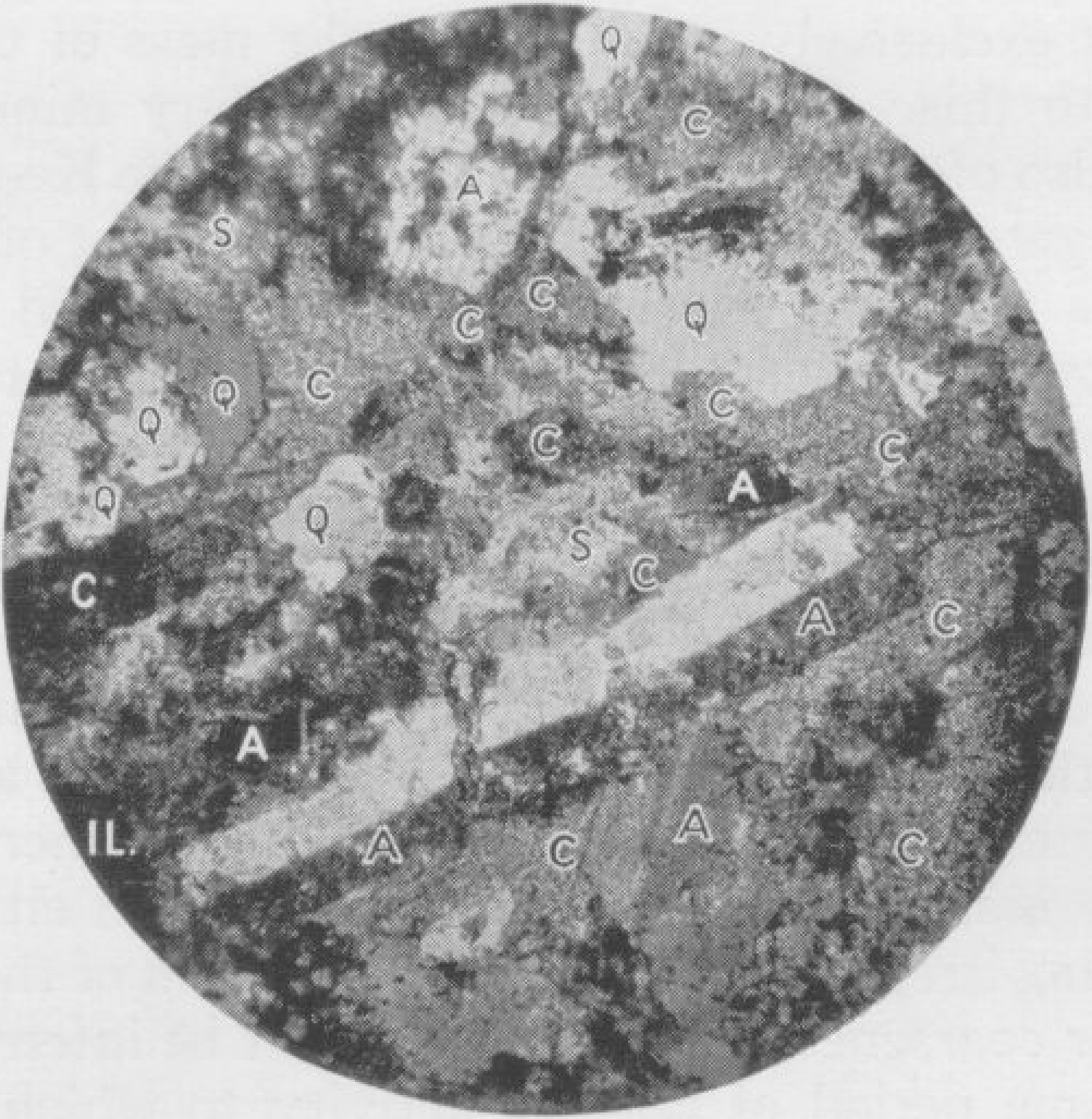



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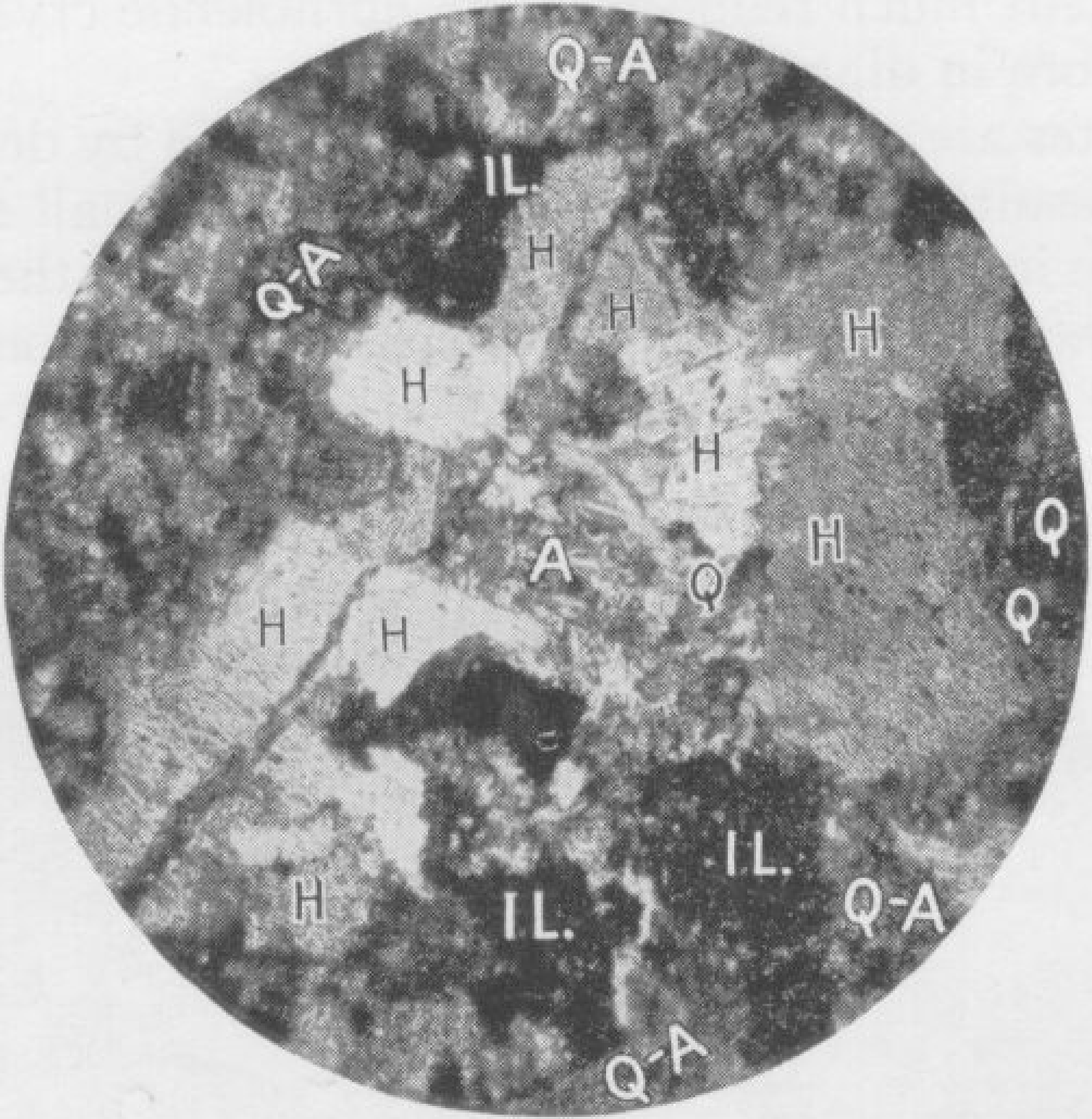

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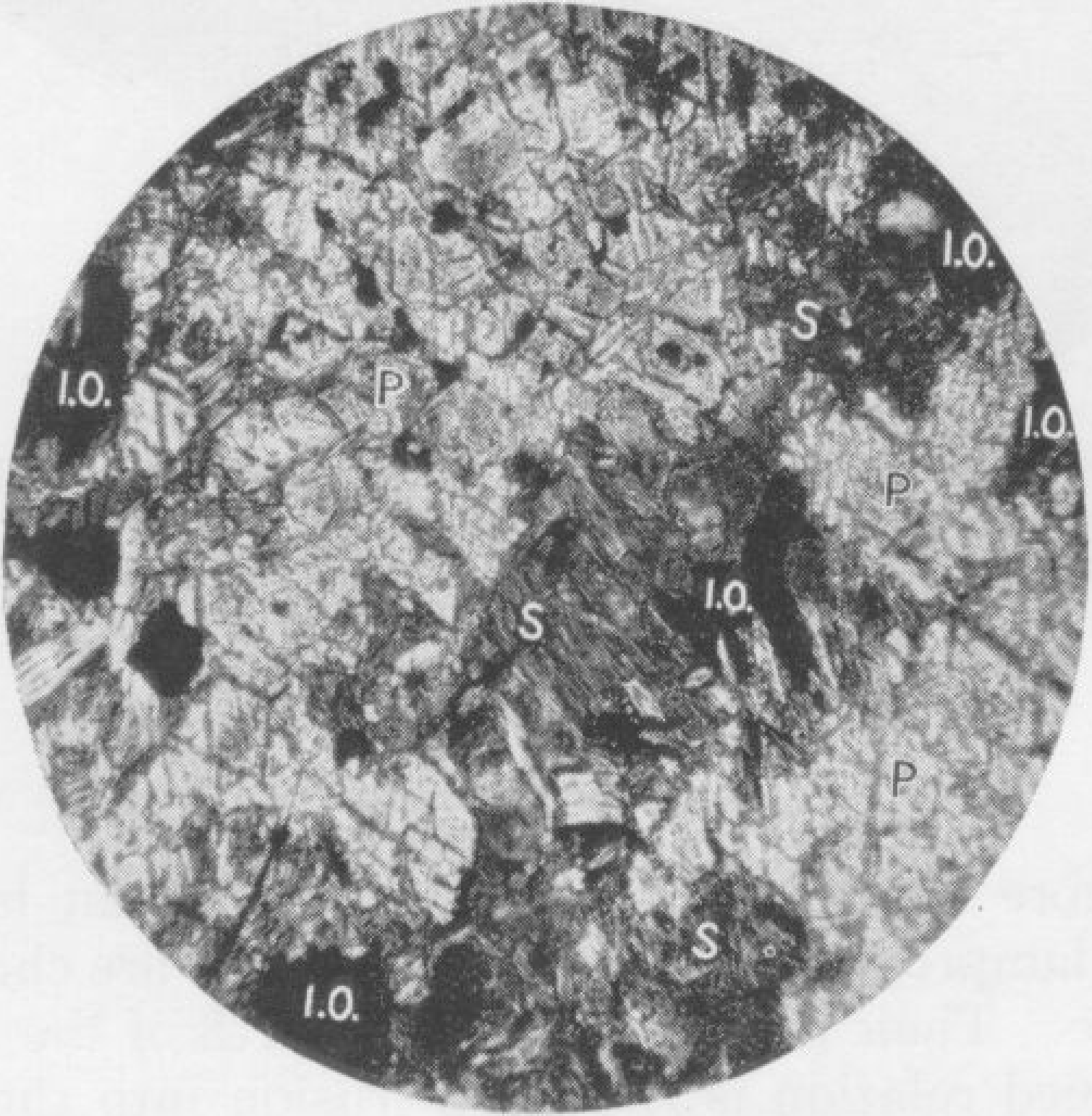


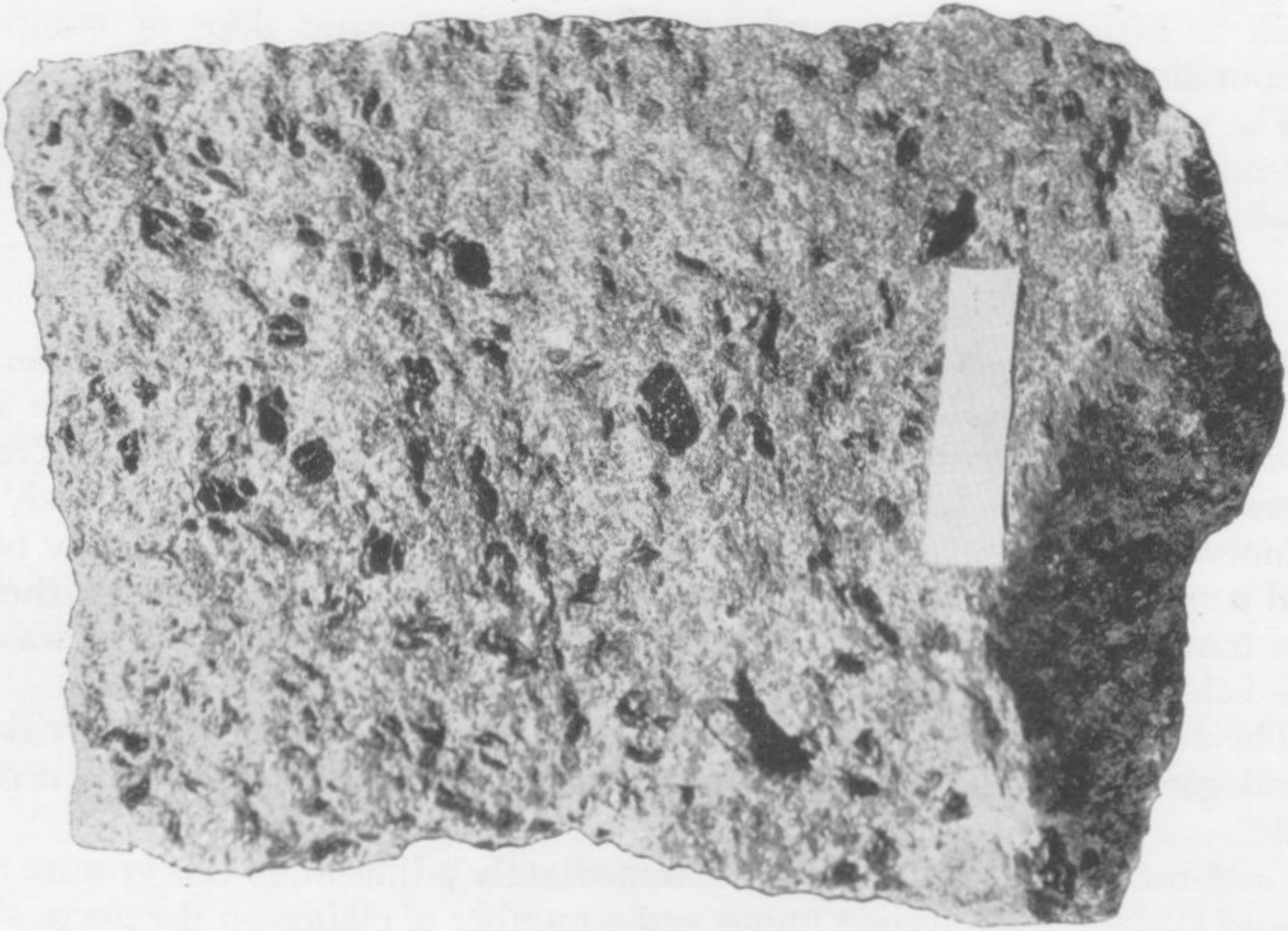

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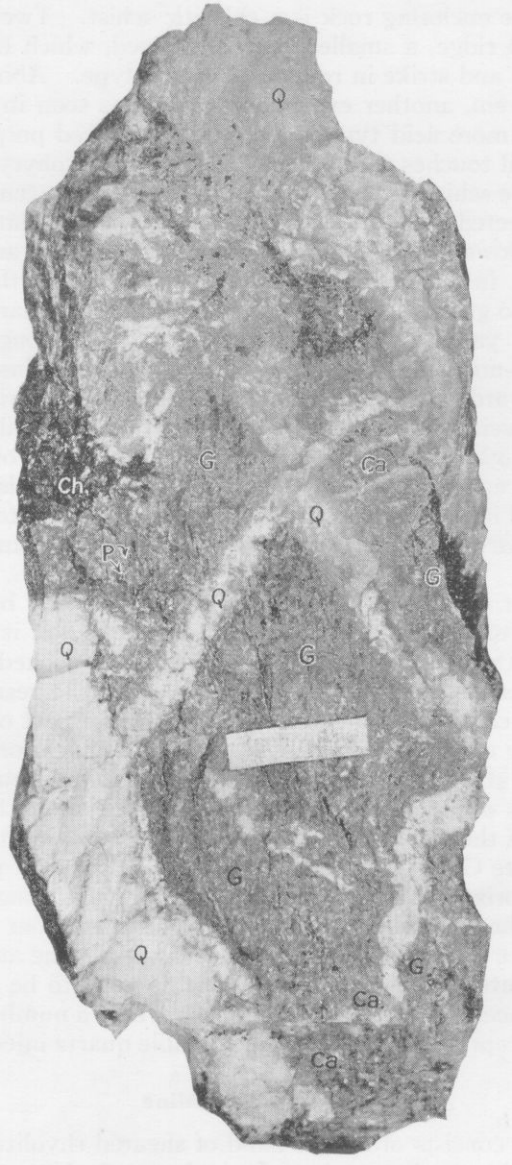

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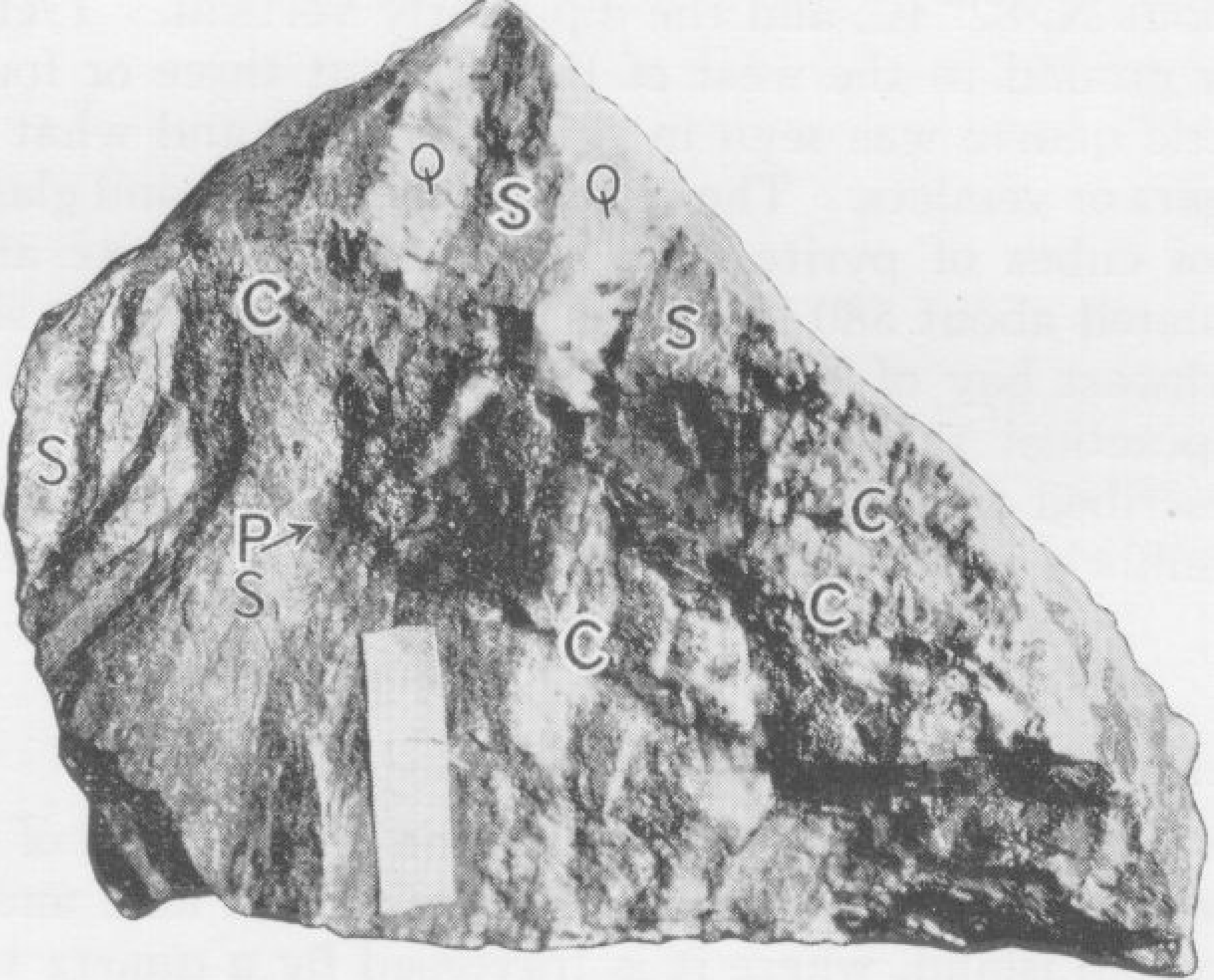

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PROVINCE OF ONTARIO

DEPARTMENT OF MINES

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

FORTY-SECOND ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XLII, PART V, 1933

Natural Gas in 1932, by R. B. Harkness - - - 1-45

Petroleum in 1932, by R. B. Harkness - - - 46-51

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NATURAL GAS IN 1932

By R. B. Harkness

General

Natural gas produced in Ontario in 1932 totalled 7,386,154 M cubic feet, valued at $4,719,297, exceeding the previous year's production by just less than 10,000 M cubic feet, and the amount of imported mixed gas exceeds that of the previous year by almost an equal quantity.

In value of product, natural gas has moved from fifth place to third place, only exceeded in value by gold and nickel. The importance of the natural gas industry in Ontario can better be realized by comparing it with such industries as Portland cement, clay products, and all other non-metallics. The value of natural gas produced now exceeds that of copper and silver.

Table I shows the production by fields, giving a four-year comparison, and shows annual changes and development.

TABLE I—NATURAL GAS PRODUCTION BY FIELDS, 1929–1932

County	Field	1929	1930	1931	1932
		M cu. ft.	M cu. ft.	M cu. ft.	M cu. ft.
Essex	Kingsville	5,780,061	4,999,278	4,376,184	4,506,072
Kent	Tilbury				
	Dover	366,224	459,112	338,422	275,958
Lambton	Dawn	94,027	131,647	130,198	170,671
	Oil Springs				
Middlesex	Crumlin	300	300	300	.....
Elgin	Bayham	46,272	48,018	43,536	45,708
Norfolk	Norfolk	343,765	277,971	312,535	365,638
Lincoln	Lincoln				
Haldimand	Haldimand	1,522,371	1,479,032	1,590,452	1,453,864
Wentworth	Wentworth				
Brant	Onondaga	31,558	58,637	170,521	140,612
Bruce	Amabel	107	858	516	500
Welland	Welland	298,688	408,475	377,566	351,616
Wells in surface drift	Howard and Sarnia	39,814	20,088	19,304	15,515
Private wells	.....	60,000	60,000	60,000	60,000
Total produced		8,583,187	7,943,416	7,419,534	7,386,154
Value		$4,968,133	$5,061,588	$4,635,497	$4,719,297
		M cu. ft.	M cu. ft.	M cu. ft.	M cu. ft.
Imported mixed gas		138,352	144,577	102,141	111,727
Manufactured gas		3,986	3,248	.....	.....
Total distributed		8,725,525	8,091,241	7,521,675	7,497,881

The temperature being mild and consumers practising economy, the production for the years 1931 and 1932 can be considered below normal.

The major distributing and producing companies in the province did no exploratory or development drilling during the year, leaving this field entirely

to the independent producer, in consequence of which thirteen new producing companies entered the field, mainly in Haldimand county. The number of producing wells drilled during the year dropped from 196 in 1931 to 151 in 1932, and the open flow from new wells dropped from 45,123 M cubic feet in 1931 to 8,870 M cubic feet in 1932. There is a decrease of 283,632 in the acreage under lease and $148,855 in the rentals paid.

In spite of the fact that in certain large cities the number of consumers has been greatly reduced, the total number of consumers shows a slight gain, but the quantity used per consumer has declined. There is no doubt that this quantity is below average, for the rates have been slightly reduced. With an average winter and "better times," the average consumption per annum should be in the vicinity of 70 M cubic feet. Omitting the city of Hamilton, this average for the remainder of the province is 65.2 M cubic feet.

TABLE II—DOMESTIC CONSUMPTION OF NATURAL GAS, 1921-1932

Year	No. of pay consumers	Total quantity used	Quantity used per consumer
		M cu. ft.	M cu. ft.
1921	58,609	5,937,316	101.3
1922	63,229	6,028,947	95.3
1923	62,352	6,210,459	99.6
1924	61,100	5,933,595	97.1
1925	62,338	5,300,424	85.6
1926	63,695	5,595,521	87.8
1927	66,818	5,210,315	78
1928	70,259	5,699,553	71.2
1929	80,991	6,336,873	78.2
1930	84,135	6,332,519	75.2
1931	86,050	5,607,744	65.1
1932	86,631	5,409,154	62.4

Gas Wells Drilled in 1932

In northern Raleigh township, Kent county, the Union Gas Company drilled two exploratory wells, one dry and one producer. The Olga Gas and Oil Company extended their operations from their well discovered in the previous year. Bon Jasperson drilled two dry wells in Gosfield South, Essex county, in new territory. This year shows the smallest amount of drilling in Kent county in many years.

In the eastern field, the Dominion Natural Gas Company continued operations in Houghton township, drilling a producing well east of Fairground. This township has had little attention for many years. About fifteen years ago a few wells were drilled with what was then considered too small an open flow to be of commercial importance, but in recent years, with the improved price of gas, such wells are of considerable value. One well has supplied the village of Fairground for many years. Although none of the recent wells drilled has been at all spectacular, the results are encouraging. The old gas area in Haldimand county, which has been producing steadily for thirty-five years, again shows the greatest activity. The Welland field, which was considered fully drilled years ago, had six producing wells in 1931 and 1932, owing to the premium price for gas in that area. None of them was large. Only two producing wells were drilled in Brant county, after an extensive drilling campaign by the Petrol Oil and Gas Company

and the Ajax Oil and Gas Company, on the Six Nations Indian Reserve, during the past five years.

Forty-five drilling rigs were in operation in 1932, and a total of 176,497 feet was drilled in 8,019 working days. Drillers had an investment of $219,600 in drilling rigs, and they employed 138 men, to whom they paid $85,391 in wages.

The following table shows the capital invested, number of men employed, and wages paid in the natural gas industry for the years 1927 to 1932:—

Year	Capital invested in all natural gas operations[1]	No. of men employed	Wages paid
1927	$31,987,879	1,123	$1,148,339
1928	36,601,828	1,209	1,497,999
1929	35,162,736	1,323	1,529,367
1930	36,162,268	1,328	1,545,648
1931	42,921,142	1,241	1,383,286
1932	45,982,719	893	1,059,643

[1]Including drilling, producing, and distributing.

The people of Ontario have, at a low valuation, $7,000,000 invested in service lines, house-piping, ranges, furnace equipment, burners, etc., space heaters, hot plates, and hot water heaters.

Analysis of Gas Consumption

Tables III and IV give the statistics of gas consumed in houses and industries in urban and rural municipalities during the year 1932. By comparing these tables with those published annually since the year 1921, the quantity used at various rates can be observed.

TABLE III—GAS CONSUMPTION IN TOWNS AND CITIES, 1932

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	
Alvinston	690	172	1	11,278	17	525	20	$0.55–.80
Aylmer	1,989	670	....	25,593	.....	.....	16	.90
Bartonville	602	95	....	4,359	.....	.....	19	.60–.75
Belle River	782	163	....	12,252	.....	524	29	.55–.80
Belmont	317	73	....	2,660	.....	.....	9	1.00–1.10
Binbrook	100	18	1	1,034	200	.....	1	.40
Blenheim	1,690	576	3	54,811	402	887	20	.50–.75
Bothwell	646	112	1	9,358	20	.....	14	.55–.80
Brantford	30,724	4,436	11	165,738	1,040	9,836	140	.80
Brigden	433	149	....	11,711	.....	1,920	30	.50–.75
Burlington	3,517	256	....	22,672	.....	.....	48	.75
Cainsville	324	107	....	4,125	.....	.....	4	.80
Caledonia	1,400	521	....	43,893	.....	10,901	7	.60
Canfield	166	60	....	4,791	.....	.....	1	.50–.60
Cayuga	705	216	1	19,971	53	551	6	.60
Chatham	16,223	4,069	3	409,731	4,434	4,007	22	.50–.75
Chippawa	1,073	11	1	415	75	.....	5	.40
Coatsworth	101	25	1	1,824	12	260	4	.40–.65
Comber	506	138	....	14,758	.....	740	19	.50–.75
Cottam	425	87	3	7,665	239	640	35	.55
Courtland	348	51	....	3,476	.....	154	3	.60
Courtright	345	116	1	8,317	88	998	53	.50–.75
Crystal Beach	550	199	....	10,603	.....	.....	1	1.00–1.30
Delhi	1,298	387	....	28,788	.....	282	4	.60
Dorchester	403	112	....	7,201	.....	.....	95	.60–.85
Dresden and Tupperville	1,650	498	2	48,395	148	860	38	.50–.75
Dundas	5,138	1,137	2	58,872	11	2,952	172	.70
Dunnville	3,615	1,039	3	95,385	549	8,705	7	.60
Dutton	761	248	3	21,751	135	1,046	52	.55–.80
Echo Place	732	78	....	2,886	.....	.....	5	.80
Eden	76	29	....	1,449	.....	.....	11	.60
Essex	1,888	466	2	48,267	106	2,856	33	.55–.80
Fairground	75	13	....	611	.....	.....	1	.60
Fenwick	328	97	....	6,424	.....	.....	18	.75
Fingal	169	38	....	2,698	.....	.....	71	.55–.80
Fisherville	162	49	....	4,479	.....	57	2	.50
Florence	184	50	....	3,849	.....	.....	5	.55–.80
Fonthill	862	209	....	5,107	.....	.....	25	.95–1.20
Fort Erie	5,431	1,447	3	65,410	1,513	.....	8	1.00–1.30
Galt	14,036	1,905	1	67,661	242	4,210	147	.80
Grimsby	2,200	186	....	6,078	.....	.....	10	.85
Grimsby Beach		32	....	1,137	.....	.....	11	.85
Hagersville	1,370	397	....	32,627	.....	.....	14	.60
Hamilton	154,701	9,600	3	286,501	552	565,360	47	.75
Hepworth	327	5	2	100	400	.....	1	.75
Hespeler	2,784	86	....	1,519	.....	.....	155	.80
Highgate	338	113	1	9,916	342	.....	32	.50–.75
Ingersoll	5,296	1,021	3	38,793	254	2,076	100	.80
Inwood	250	70	....	4,338	.....	.....	14	.55–.80
Jarvis	504	207	....	17,957	.....	.....	9	.60
Kingsville	2,268	675	1	76,975	216	43	30	.55
Lake Shore	.....	349	....	5,584	.....	.....	16	1.00–1.30
Lambeth	172	101	....	7,091	.....	.....	85	.60–.85
Leamington	5,025	1,402	....	175,206	.....	2,650	20	.55
Lynedoch	175	45	....	3,106	.....	1,223	2	.60
Merlin	189	139	3	13,666	1,992	701	2	.50–.75
Merritton	2,544	414	....	15,003	.....	251	35	.75
Nelles Corners	86	7	....	1,215	.....	.....	1	.50
Niagara Falls	18,508	2,992	....	100,110	.....	15,876	11	1.00–1.30
Oil Springs	433	125	....	7,111	.....	.....	2	.60–.75
Paris	4,330	821	1	34,112	153	1,376	129	.80

TABLE III—GAS CONSUMPTION IN TOWNS AND CITIES, 1932—*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	
Petrolia	2,569	739	1	75,175	365	1,054	60	$0.55–.80
Port Burwell	423	211	....	13,210	.....	.....	3	.60
Port Colborne and Humberstone	8,271	1,729	4	80,294	258	555	5	.70–1.00
Port Dover	1,680	573	....	48,082	.....	318	1	.60
Port Rowan	674	226	....	13,954	.....	.....	1	.60
Preston	6,138	518	1	15,378	88	757	151	.80
Ridgetown	1,942	612	2	58,501	2,024	811	28	.50–.75
Ridgeway	1,096	235	....	12,765	.....	.....	1	1.00–1.30
Rodney	757	241	1	19,633	64	681	40	.55–.80
Ruthven	146	49	....	5,694	.....	.....	25	.55
St. Anns	120	22	....	500	.....	.....	7	.85
St. Catharines	26,192	4,873	1	220,142	420	13,475	35	.75
St. George	507	116	....	3,969	.....	.....	148	.80
St. Williams	270	107	....	5,849	.....	321	1	.60
Sarnia and Pt. Edward	19,012	4,544	1	316,680	1,593	7,990	55	.55–.80
Selkirk	196	128	1	11,165	70	.....	1	.60
Shedden	233	95	....	6,583	.....	504	63	.55–.80
Simcoe	5,397	1,719	4	175,032	718	8,327	20	.60
Smithville	570	181	....	8,196	.....	.....	6	.75
Sombra and Port Lambton	419	145	....	12,104	.....	300	45	.50–.75
Stevensville	418	34	....	1,841	.....	.....	1	1.00–1.30
Straffordville	253	84	....	6,281	.....	639	6	.60
Thamesville	754	204	3	14,536	66	821	13	.55–.80
Thorold	5,068	1,019	....	37,397	.....	309	35	.75
Tilbury	1,996	503	2	45,121	455	1,483	14	.50–.75
Tillsonburg	3,351	1,034	1	78,191	359	1,772	16	.63
Vienna	208	76	1	3,530	97	.....	1	.60–.80
Vittoria	205	82	....	4,341	.....	.....	3	.60
Wallaceburg	4,343	1,155	1	104,629	234	371,367	19	.50–.75
Wallacetown	143	48	1	3,542	20	521	60	.55–.80
Waterdown	924	21	....	298	.....	.....	45	.75
Waterford	1,168	119	....	5,689	.....	187	30	.60–1.48
Welland	10,668	2,664	4	81,764	689	1,190	3	.45–1.30
West Lorne	814	177	3	13,967	233	605	49	.55–.80
Wheatley	724	226	....	18,477	.....	680	12	.50–.65
Windsor (Border Cities)	98,659	13,296	....	1,075,302	.....	177,118	45	.55–.80
Woodstock	10,956	2,126	3	84,964	219	2,789	110	.80
Wyoming	482	115	....	7,932	.....	.....	65	.55–.80
Total	.....	78,955	92	4,849,121	21,165	1,237,041	.....	.....

TABLE IV—GAS CONSUMPTION IN TOWNSHIPS, 1932

County and township	Population	No. of consumers		Quantity consumed, M cu. ft.			Net rate per M. cu. ft.
		Pay	Free	Pay	Free	Industrial	
ESSEX:							
Gosfield, North	2,066	106	2	8,313	244	266	$0.55
Gosfield, South	2,351	362	1	30,437	435	14,502	.50–.55
Maidstone	2,921	72	8	5,537	1,862	623	.55–.80
Mersea	4,446	396	2	35,880	384	20,689	.50–.55
Rochester	2,282	172	6	12,681	1,358	557	.55–.80
Sandwich, East	5,542	10	.....	851	.....	.....	.55–.80
Sandwich, South	2,273	110	.....	9,758	.....	913	.55–.80
Tilbury, North	1,919	22	.....	1,097	.....	93	.50–.75
Tilbury, West	1,489	18	1	995	161	.....	.50–.75
LAMBTON:							
Brooke	2,226	13	.....	436	.....	.....	.55–.80
Dawn	2,191	67	7	4,806	1,044	1,805	.40–.65
Enniskillen	2,547	111	.....	6,909	.....	549	.55–.80
Moore	3,121	292	.....	18,810	.....	756	.50–.75
Plympton	2,671	6	.....	491	.....	.....	.55–.80
Sarnia	3,102	.....	10	.....	2,069	.....	.40
Sombra	2,384	51	.....	3,393	.....	750	.50–.75
KENT:							
Camden	2,027	12	.....	785	.....	.....	.50–.75
Chatham	5,732	82	.....	5,757	.....	832	.50–.75
Dover	4,109	406	1	39,620	142	2,675	.30–.70
Harwich	4,802	421	9	36,402	2,814	.....	.50–.75
Howard	2,649	158	3	14,900	820	.....	.50–.75
Orford	1,796	19	2	1,748	166	.....	.50–.75
Raleigh	3,950	558	25	52,685	5,620	768	.40–.75
Romney	1,391	70	37	5,805	10,566	.....	.40–.65
Tilbury, East	3,262	231	72	19,545	22,233	2,340	.40–.65
Zone	881	12	.....	911	.....	.....	.55–.80
ELGIN:							
Aldborough	2,598	22	1	961	456	.....	.55–.80
Bayham	3,262	76	17	3,569	2,880	471	.60–.80
Dunwich	2,415	51	2	3,816	113	.....	.55–.80
Malahide	2,610	50	2	1,497	282	.....	.60–.80
Southwold	3,594	102	.....	7,202	.....	.....	.55–.80
Middlesex:							
North Dorchester	2,998	16	1	1,040	98	.....	.60–.85
Westminster	6,406	171	.....	19,636	.....	.....	.60–.85
NORFOLK:							
Charlotteville	3,016	15	5	779	1,142	.....	.60
Middleton	2,418	47	2	3,035	364	.....	.60
North Walsingham	1,824	6	2	514	439	.....	.60
South Walsingham	1,502	21	6	1,710	728	.....	.60
Townsend	3,883	30	.....	2,370	.....	.....	.60
Windham	3,331	2	4	183	600	.....	.60
Woodhouse	2,182	163	8	15,676	1,484	.....	.60
BRANT:							
Brantford	7,497	40	.....	1,594	.....	5,973	.80
Burford	3,683	3	.....	164	.....	.....	.80
Onondaga	982	49	11	2,955	1,543	.....	.60–.70
South Dumfries	2,504	13	.....	374	.....	.....	.80
Tuscarora	2,654	6	.....	590	.....	.....	.30–.70
OXFORD:							
East Oxford	1,873	8	.....	439	.....	.....	.80
West Oxford	1,144	56	.....	2,987	.....	.....	.80

TABLE IV—GAS CONSUMPTION IN TOWNSHIPS, 1932—*Continued*

County and township	Population	No. of consumers		Quantity consumed, M cu. ft.			Net rate per M cu. ft.
		Pay	Free	Pay	Free	Industrial	
HALDIMAND:							
Canborough	893	88	46	6,295	8,102	323	$0.60
Dunn	791	119	10	5,808	2,358	.....	.60
Moulton	1,526	158	20	8,346	3,200	.....	.60
North Cayuga	1,310	40	10	3,025	2,084	5	.60
Oneida	1,317	70	15	6,529	2,379	49	.50–.60
Rainham	1,681	164	27	8,181	5,023	1,499	.50–.60
Seneca	1,609	140	35	9,894	5,711	299	.60
Sherbrooke	332	55	10	3,101	1,336	.....	.60
South Cayuga	586	57	16	2,641	2,886	.....	.60
Walpole	3,047	319	61	19,098	10,144	749	.40–.60
LINCOLN:							
Caistor	1,167	117	21	5,089	2,109	147	.50–.60
Gainsborough	2,046	21	.....	490	.....	.....	.75–.85
Grantham	5,007	9	.....	603	.....	.....	.75
Louth	2,829	10	.....	661	.....	.....	.75
WELLAND:							
Bertie	4,050	185	61	10,085	11,762	70	.45–1.30
Crowland	4,921	95	22	3,350	2,806	.....	.75–1.30
Humberstone	2,341	267	33	13,299	5,828	.....	.50–1.30
Pelham	2,603	61	1	4,087	78	.....	.75
Stamford	7,673	89	4	4,856	756	.....	1.00–1.30
Wainfleet	2,625	84	20	4,035	3,807	.....	.50–1.00
Willoughby	882	33	26	1,782	4,940	.....	1.00–1.30
WENTWORTH:							
Ancaster	3,400	94	.....	6,519	.....	.....	.70–.75
Barton	1,641	245	.....	15,596	.....	.....	.70–.75
Binbrook	3,226	70	21	6,306	3,837	790	.60
Glanford	1,273	125	4	11,837	593	542	.60
Saltfleet	4,954	215	.....	8,256	.....	.....	.75
WATERLOO:							
Waterloo	7,556	22	.....	621	.....	.....	.80
Total	.....	7,676	710	560,033	139,786	59,035	.....

SUMMARY

	M cu. ft.
Total distribution to customers	6,866,181
Used by companies for all purposes	40,592
Used by private well-owners	74,000
Leakage in transmission lines	240,509
Leakage in distribution plants	267,439
Leakage in rural lines	9,160
Total amount of gas distributed	7,497,881

Gas Wells and Their Production

In Table V will be found a summary, by townships, of the gas wells of the province, also full details of wells abandoned, new wells drilled, and those in operation; the production of gas, rock pressure, the acreage under lease, and the rentals paid.

TABLE V—GAS WELLS AND THEIR PRODUCTION, 1932

County	Township	No. of wells producing	No. of wells abandoned	Wells drilled[1]			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	Colchester South								1,604	
	Gosfield South	21		2				150	719	$684
	Mersea	3						266		
Kent	Harwich						4,506,072			
	Orford									
	Raleigh	35		1	2	420		550	104,883	
	Romney	145	1		1	93		218		146,459
	Tilbury East	144			2	420		218		
	Chatham								1,580	
	Dover	8	1				275,958	342	7,279	
Lambton	Dawn	19					161,760	610	59,938	
	Euphemia	3						340		
	Enniskillen	4					7,111	700	1,000	
	Moore								4,400	
	Sarnia	13					1,800	70	5,000	
	Sombra			1					1,450	
Middlesex	Ekfrid and others								25,689	88
	Metcalfe								1,186	
	Mosa	3						713	275	
	North Dorchester	3						50		
Elgin	Bayham	35	3				45,708	167		
	Dunwich									
	Malahide	1						190		
Norfolk	Charlotteville	13	2				365,638	243		
	Houghton	7						522		
	Middleton	37		1	2	145		258		
	North Walsingham	9		1				312		
	South Walsingham	13						378		
	Townsend	1						270		
	Windham	8						228		
	Woodhouse	56						248		

Haldimand	Canborough	167	4	3	34	1,024	1,453,864	98	460,351	89,950
	Dunn	31	.....	.....	1	100		270		
	Moulton	115	4	1	16	405		127		
	North Cayuga	153	.....	2	10	659		229		
	Oneida	52	.....	2	12	977		135		
	Rainham	249	1	10	32	2,089		266		
	Seneca	180	5	2	14	601		94		
	Sherbrooke	18	.....	2	1	35		242		
	South Cayuga	55	1	.....	.....	.....		149		
	Walpole	226	4	.....	11	1,581		254		
Wentworth	Binbrook	54	.....	1	4	127		70		
	Glanford	11	.....	.....	.....	.....		57		
Lincoln	Caistor	62	.....	.....	.....	.....		110		
	Gainsborough	5	.....	.....	1	12		100		
Welland	Bertie	90	8	.....	6	122	351,616	125		
	Crowland	48	.....	.....	.....	.....		106		
	Humberstone	66	1	.....	.....	.....		52		
	Wainfleet	29	2	.....	.....	.....		63		
	Willoughby	39	.....	.....	.....	.....		30		
Brant	Onondaga	41	2	.....	2	60	140,612	86	46,630	2,840
	Tuscarora	58	3	2	.....	.....		92		
Bruce	Amabel	2	.....	.....	.....	.....	500	100	50	.....
Peel	Caledon	6	.....	.....	.....	.....	.....	.....	.....	.....
Oxford	Dereham	.....	.....	1	.....	.....	.....	.....	1,148	.....
Surface wells	Harwich	69	.....	.....	.....	.....	14,000[2]	.....	.....	.....
	Howard						1,515[3]	.....	.....	.....
Private wells[4]	.....	300	.....	.....	.....	.....	60,000[5]	.....	.....	.....
Total	.....	2,707	42	32	151	8,870	7,386,154	.....	723,182	240,021

[1]Total footage drilled in 1932 is 176,497.
[2]This gas is not metered and therefore must be estimated. The wells are owned privately, and the gas is used for domestic purposes.
[3]This gas is sold to the Union Gas Company, and was used in Ridgetown.
[4]Principally in Haldimand, Norfolk, and Welland counties.
[5]Estimated.

Work of the Year

Very little new work was done or extensive improvements made in 1932. The policy of the natural gas industry was retrenchment rather than expenditure. Only where new consumers requested gas were extensions made.

The Dominion Natural Gas Company report having carried out routine leakage surveys during the year. They laid three miles of 4-inch line from Burlington to Waterdown and installed a distribution system in the village. This company extended their distribution systems in Preston and Hespeler, which were installed in the previous year.

The Dominion Natural Gas Company also connected the five wells drilled near the village of Fairground, in Houghton township, to the main transmission line to Tillsonburg and Simcoe. These wells are also connected to the Central Pipe Line Company main to Aylmer. This will materially improve the service to these municipalities.

The Union Gas Company put its pipe line from the Haldimand gas field to the city of Hamilton into service, and are now furnishing the United Gas and Fuel Company of Hamilton with natural gas. The latter company has changed over its plant in East Hamilton from manufactured gas to natural gas, and their consumers in that territory are now supplied with natural gas, while those in the remainder of the city are supplied with manufactured gas purchased from the Hamilton By-Product Coke Oven Company. No other important extensions are reported by the Union Gas Company.

Leakage

Tables VI, VII, and VIII show the leakage of gas from pipe lines from the gas field to the consumer, as measured through meters at different points on the pipe lines. This does not include the leakage from field lines in any of the gas fields, nor from the transmission lines from the Haldimand field to Hamilton. It is not practicable to measure this leakage in the field on account of the vast number of separate collecting lines, nor is it practicable in the case of these transmission lines, because gas is being fed into them at so many points. Out of 7,310,000 M cubic feet produced by recognized gas companies, 4,330,000 M cubic feet were measured into pipe lines.

A comparison of leakage in 1931 and 1932 will show 1932 as a favourable year. Leakage has been materially reduced, and many distributing plants are under the standard set as "good operating practice." Leakage surveys are being constantly carried out.

There are 1,500 miles of gas transmission lines and 1,855 miles of gas distribution lines of all sizes in the province.

TABLE VI—LEAKAGE IN DISTRIBUTION PLANTS, 1932

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.	
Belmont	Ontario Salt Co	1.67	4,778	2,660	2,118	334	73	29,013	6
Blenheim	Union Gas Co	12.78	56,174	56,100	74	2,556	576	128	5
Brantford	Brantford Gas Co	92.43	184,208	176,668	7,540	18,486	4,447	1,695	4
Brigden	Union Gas Co	3.88	13,918	13,630	288	776	149	1,933	5
Cainsville	Dominion Natural Gas Co	5.45	8,005	7,011	994	1,090	107	9,289	4
Chatham	Union Gas Co	80.28	427,882	418,172	9,710	16,056	4,053	2,395	6
Corunna	Union Gas Co	5.28	8,811	8,777	34	1,056	249	136	6
Courtright	Union Gas Co	3.83	9,603	9,403	200	766	116	1,724	5
Dorchester	Southern Ontario Gas Co	2.86	9,175	8,241	934	572	112	8,339	4
Dresden	Union Gas Co	8.88	49,716	49,403	313	1,776	494	633	5
Dundas	Dominion Natural Gas Co	12.27	68,673	61,831	6,842	2,454	1,139	6,001	4
Dunnville	Dominion Natural Gas Co	13.62	103,974	96,002	7,972	2,724	1,034	7,709	4
Fenwick	Dominion Natural Gas Co	1.37	7,617	6,828	789	274	97	8,134	4
Fonthill	Fonthill-Ridgeville Gas Co	5.33	6,600	5,107	1,493	1,066	209	7,143	5
Galt	Dominion Natural Gas Co	31.93	76,881	72,078	4,803	6,386	1,906	2,519	4
Hagersville	Dominion Natural Gas Co	7.29	36,513	32,633	3,880	1,458	397	9,773	4
Hamilton	United Gas and Fuel Co	133.50	44,303	33,201	11,102	26,700	1,420	7,818	4
Ingersoll	Dominion Natural Gas Co	22.51	44,212	41,329	2,883	4,502	1,024	2,815	4
Kingsville	Southern Ontario Gas Co	13.18	87,997	81,040	6,957	2,636	665	10,461	4
Leamington	Leamington Corporation	25.47	201,077	177,856	23,221	5,094	1,399	16,598	10
Merlin	Union Gas Co	2.77	16,528	16,358	170	554	139	1,223	6
Mount Hamilton	Dominion Natural Gas Co	23.59	57,672	48,739	8,933	4,718	2,500	3,573	4
Paris	Dominion Natural Gas Co	14.61	39,386	35,899	3,487	2,922	822	4,242	4
Petrolia	Union Gas Co	15.80	82,105	76,593	5,512	3,160	739	7,458	6
Port Burwell	Dominion Natural Gas Co	3.84	10,384	8,018	2,366	768	131	18,061	4
Port Lambton	Union Gas Co	2.02	5,186	5,013	173	404	71	2,436	5
Ridgetown	Union Gas Co	18.02	64,931	61,902	3,029	3,604	612	4,949	5
St. Catharines	Dominion Natural Gas Co	54.42	309,388	294,753	14,635	10,884	4,874	3,002	4
St. George	Dominion Natural Gas Co	2.11	3,865	3,711	154	422	116	1,327	4
Sarnia	Union Gas Co	89.16	363,225	326,263	36,962	17,832	4,544	8,134	5
Shedden-Fingal	Southern Ontario Gas Co	6.11	11,777	9,785	1,992	1,222	132	15,090	4
Simcoe	Dominion Natural Gas Co	29.33	194,470	182,750	11,720	5,866	1,723	6,802	4
South London	Southern Ontario Gas Co	8.34	17,521	16,198	1,323	1,668	171	7,736	4
Straffordville	Dominion Natural Gas Co	1.34	7,081	7,041	40	268	84	476	4

TABLE VI—LEAKAGE IN DISTRIBUTION PLANTS, 1932—*Continued*

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.	
Thorold	Dominion Natural Gas Co.	13.31	46,941	40,661	6,280	2,662	1,018	6,169	4
Tillsonburg	Dominion Natural Gas Co.	23.43	86,508	79,963	6,545	4,686	1,035	6,323	4
Vienna	Dominion Natural Gas Co.	1.04	1,638	965	673	208	20	33,650	4
Wallaceburg	Union Gas Co.	21.05	111,758	107,492	4,266	4,210	1,147	3,719	6
West Hamilton	Southern Ontario Gas Co.	3.81	9,093	7,987	1,106	762	245	4,514	4
Wheatley	Southern Ontario Gas Co.	3.46	21,517	19,157	2,360	692	226	10,442	4
Windsor (Border Cities)	Union Gas Co.	477.36	1,323,092	1,267,420	55,672	95,472	13,296	4,187	4
Woodstock	Dominion Natural Gas Co.	48.32	95,744	87,850	7,894	9,664	2,129	3,707	4
Total		1,347.05	4,329,927	4,062,488	267,439	269,410			

TABLE VII—LEAKAGE IN TRANSMISSION LINES, 1932

Transmission line	Size of pipe line	Equivalent miles of 3-inch 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	134,298	131,691	2,607	25
Gas field to Sarnia and Petrolia	6-, 8-, 10-, 12-inch	380.91	1,632,913	1,598,266	34,647	40–80
Dunnville to St. Catharines	8-inch	57.1	355,223	329,861	25,362	50
Kingsville to Hamilton	8-, 10-, 12-inch	710.5	1,450,734	1,322,765	127,969	75
Gas field to Windsor	8-, 10-, 12-, 18-inch	423.08	1,507,103	1,481,157	25,946	30–80
Gas field to Ridgetown	6-, 8-inch	81.42	220,943	200,465	20,478	25–80
Gas field to Hamilton	8-inch	58.24	53,914	50,414	3,500	30–50
Total			5,355,128	5,114,619	240,509	

TABLE VIII—LEAKAGE ON RURAL LINES, 1932

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.
Dawn	13,400	3,173	3,150	23	508	28	821	8	.....
Dover	102,835	36,842	35,547	1,295	3,895	371	3,490	5	8
Enniskillen	10,156	2,574	2,431	143	385	36	3,972	6	.....
Harwich	101,150	30,739	29,040	1,699	3,831	432	3,933	6	5
Howard	17,681	8,755	8,313	442	670	99	4,464	6	3
Moore	11,195	2,394	2,206	188	424	48	3,917	6	.....
Raleigh	143,492	41,442	39,395	2,047	5,434	408	5,017	6	6
Raleigh (Blake system)	32,314	5,266	3,494	1,772	1,224	80	22,150	4	.....
Rochester	34,400	16,024	15,973	51	1,303	177	288	5	14
Sandwich, East	1,432	825	752	73	54	11	6,636	6	5
Sandwich, South	18,192	7,891	7,626	265	689	75	3,533	6	6
Sombra	1,929	1,100	694	406	73	11	36,909	6	.....
Tilbury, East	62,978	26,653	25,897	756	2,386	205	3,688	6	6
Total	551,154	183,678	174,518	9,160	20,876	1,981	.....	.....	.....

Licenses Issued in 1932

The Natural Gas Conservation Act, R.S.O., 1927, The Well Drillers' Act, R.S.O., 1927, and the Regulations made under these Acts require that the several operations carried out shall be done under license. Tables IX to XIII show a list of those to whom licenses were issued during 1932.

The licenses required under the above Acts are as follows:—

To Lease and Prospect for Natural Gas	$5.00
To Drill or Bore for Natural Gas or Oil	5.00
To Produce Natural Gas	10.00
To Distribute Natural Gas	10.00
To Operate Natural Gas Pipe-Lines	10.00

TABLE IX—OPERATORS LICENSED TO LEASE AND PROSPECT FOR NATURAL GAS, 1932

License No.	Name	Address
550	Acme Gas and Oil Co., Ltd	Toronto, Ont.
527	Ajax Oil and Gas Co., Ltd	Toronto, Ont.
557	Beattie, James A	Glencoe, Ont.
637	Blain, Dr. E. B	Hamilton, Ont.
587	Carrothers, Irwin	Kerwood, Ont.
569	Cyclops Gas Syndicate	Toronto, Ont.
581	Darroch, James	Toronto, Ont.
583	Demaray, Clarence	Kerwood, Ont.
533	Dominion Natural Gas Co., Ltd	Buffalo, N.Y.
648	Dominion Petroleum Co., Ltd	Glencoe, Ont.
536	Erie Gas, Limited	Toronto, Ont.
573	Evans, Louis C	Buffalo, N.Y.
570	Fletcher, E. D	Petrolia, Ont.
532	Freeman, George	Toronto, Ont.
552	Geddes, E. W	Chatham, Ont.
520	Gray, Ira	Merlin, Ont.
543	Haldimand Natural Gas Syndicate	Stevensville, Ont.
568	Harris, Joseph E	Stevensville, Ont.
578	Harrison, Geo. Edward	Toronto, Ont.
555	Henderson, J. E	Chatham, Ont.
546	High Grade Natural Gas Co., Ltd	Chatham, Ont.
545	Highbank Oil, Limited	Chatham, Ont.
566	Holmes, A. B	Toronto, Ont.
529	Homestead Oil and Gas, Limited	Toronto, Ont.
538	Hoover, A. E	Selkirk, Ont.
567	House, Charles C	Stevensville, Ont.
521	Howard, W. C	Leamington, Ont.
530	Hydro-Carbons, Limited	Toronto, Ont.
537	Jasperson, Bon	Kingsville, Ont.
*525	Lambton Trust Co	Sarnia, Ont.
526	Lambton Trust Co	Sarnia, Ont.
580	McCauley, J. H	Cainsville, Ont
577	McChesney, J. G	Selkirk, Ont.
571	McDougall, A. S	Melbourne, Ont.
559	McGill, Joseph	Petrolia, Ont.
547	McKinney, John F	Niagara Falls, N.Y.
535	MacPherson, G. A	Toronto, Ont.
531	Mahaffy, A. M	Toronto, Ont.
544	Medina Natural Gas Co., Ltd	Chatham, Ont.
590	Miller, Robt. F	Selkirk, Ont.
560	Newcastle Oil and Mining Co., Ltd	Toronto, Ont.
563	Pelee Oil and Gas Co., Ltd	Windsor, Ont.
576	Plummer, Lewis E	Toronto, Ont.
*564	Port Colborne–Welland Natural Gas and Oil Co., Ltd	Port Colborne, Ont.
565	Port Colborne–Welland Natural Gas and Oil Co., Ltd	Port Colborne, Ont.

TABLE IX—OPERATORS LICENSED TO LEASE AND PROSPECT FOR NATURAL GAS, 1932—*Continued*

License No.	Name	Address
572	Rawlings, Geo. H	Chatham, Ont.
554	Reaume, Earl	Chatham, Ont.
558	Reichheld, O. E	Fisherville, Ont.
539	Romney Gas and Oil Co., Ltd	London, Ont.
548	Ryan, E. L	Meaford, Ont.
551	Ryder, John W	Toronto, Ont.
*523	St. Clair Natural Gas Co., Ltd	Windsor, Ont.
524	St. Clair Natural Gas Co., Ltd	Windsor, Ont.
553	Scullard, Fred B	Chatham, Ont.
541	Smith, E. W	Toronto, Ont.
549	Smith, Dr. Luke	Chatham, Ont.
540	Smith, Robt. H	Lowbanks, Ont.
534	Southern Ontario Gas Co., Ltd	Buffalo, N.Y.
556	Sydenham Syndicate	Wallaceburg, Ont.
522	Topp, Nathan	Cayuga, Ont.
574	Waller, C. W	Toronto, Ont.
582	Ward, Eugene A	Big Rapids, Mich.
542	Welland County Gas Syndicate	Stevensville, Ont.
561	White, Roy	Tillsonburg, Ont.
528	Willits, D. E	Bothwell, Ont.
562	Willits, G. E	Bothwell, Ont.
575	Winger, Maurice	Hagersville, Ont.
579	Woodhouse, Henry	Toronto, Ont.

*1931.

TABLE X—OPERATORS LICENSED TO DRILL OR BORE FOR NATURAL GAS, 1932

License No.	Name	Address
439	Aloka Oil Co., Ltd	Toronto, Ont.
485	Beecher, L. W	Jarvis, Ont.
432	Culver, W. H., Jr	Dunnville, Ont.
433	Culver, W. H., Jr	Dunnville, Ont.
465	Goit, Lorne R	Dunnville, Ont.
436	Grand River Natural Gas Co., Ltd	Welland, Ont.
449	Hoover and May, Ltd	Selkirk, Ont.
450	Hoover and May, Ltd	Selkirk, Ont.
475	Hoover, A. E	Selkirk, Ont.
459	House, Charles C	Stevensville, Ont.
477	Hussey, W. J	Petrolia, Ont.
*454	Jackson, Percy L	Dunnville, Ont.
*455	Jackson, Percy L	Dunnville, Ont.
456	Jackson, Percy L	Dunnville, Ont.
457	Jackson, Percy L	Dunnville, Ont.
458	Jackson, Percy L	Dunnville, Ont.
438	Jasperson, Bon	Kingsville, Ont.
474	Josh, Thos	Petrolia, Ont.
447	Kells, Ernest	Petrolia, Ont.
466	Kervin and Dawson	Merlin, Ont.
467	Kiser Bros	Chatham, Ont.
468	Kiser Bros	Chatham, Ont.
462	Lymburner Bros. and Webber	Dunnville, Ont.
440	McCutcheon, T. J	Dunnville, Ont.
441	McCutcheon, T. J	Dunnville, Ont.
484	McGaffey, Roy	Bothwell, Ont.
478	McKechnie, Sam	Dunnville, Ont.
479	McKechnie, Sam	Dunnville, Ont.
480	McKechnie, Sam	Dunnville, Ont.
481	McKechnie, Sam	Dunnville, Ont.
452	McLister, J. J	Dunnville, Ont.
476	McRitchie, J. A	Bothwell, Ont.
486	Midwal Oil and Gas Syndicate	Toronto, Ont.
482	Millar, J	Sarnia, Ont.
434	Ontario Counties Gas Co., Ltd	Buffalo, N.Y.
471	Pelee Oil and Gas Co., Ltd	Windsor, Ont.
463	Penn-Ryan Oil and Gas, Ltd	Toronto, Ont.
442	Perkins, J. E	Dunnville, Ont.
487	Petty, J	Toronto, Ont.
*472	Port Colborne–Welland Natural Gas and Oil Co., Ltd	Port Colborne, Ont.
473	Port Colborne–Welland Natural Gas and Oil Co., Ltd	Port Colborne, Ont.
451	Romney Gas and Oil Co., Ltd	London, Ont.
483	Schafer and Benner	Delhi, Ont.
437	Seynuck Valley Oil Co., Ltd	Acton, Ont.
461	Smith, Dr. Luke	Chatham, Ont.
453	Smith, Robt. H	Lowbanks, Ont.
464	Smith's Drilling Co	Windsor, Ont.
445	Smylie, J. W	Toronto, Ont.
443	Stover, F. H., and Son	Chatham, Ont.
444	Stover, F. H., and Son	Chatham, Ont.
448	Sundy, B. K	Tillsonburg, Ont.
435	Willits, D. E	Bothwell, Ont.
469	Willits, D. E	Bothwell, Ont.
470	Willits, D. E	Bothwell, Ont.
446	Wilson, Bert	Sarnia, Ont.

*1931.

TABLE XI—OPERATORS LICENSED TO PRODUCE NATURAL GAS, 1932

License No.	Name	Address
549	Acme Gas and Oil Co., Ltd.	Toronto, Ont.
538	Aikens, W. J.	Vineland, Ont.
*551	Aikens, W. J.	Vineland, Ont.
523	Ajax Oil and Gas Co., Ltd.	Toronto, Ont.
584	Amity Gas and Oil Co., Ltd.	Lowbanks, Ont.
642	Aragain Gold and Natural Gas Syndicate	Toronto, Ont.
*571	Bertie Township Gas and Oil Syndicate.	Selkirk, Ont.
572	Bertie Township Gas and Oil Syndicate.	Selkirk, Ont.
588	Canadian Natural Gas Syndicate.	Simcoe, Ont.
546	Canfield Natural Gas Co., Ltd.	Canfield, Ont.
543	Central Pipe Line Co., Ltd.	Chatham, Ont.
*539	Continental Gas Corporation, Ltd.	Toronto, Ont.
540	Continental Gas Corporation, Ltd.	Toronto, Ont.
522	Culver, W. H., Jr.	Dunnville, Ont.
602	Cyclops Gas Syndicate.	Toronto, Ont.
524	Dominion Natural Gas Co., Ltd.	Buffalo, N.Y.
532	Dunn Natural Gas Co., Ltd.	Dunnville, Ont.
578	Emerson, Harry L.	Dunnville, Ont.
587	Emerald Gas Syndicate.	Toronto, Ont.
529	Erie Gas, Limited	Toronto, Ont.
552	Fisherville Gas Companies.	Fisherville, Ont.
561	Gifford, Arthur, and Son	Cayuga, Ont.
641	Glenney, Daniel.	Dunnville, Ont.
*562	Grand River Gas and Oil Syndicate.	Canfield, Ont.
533	Grand River Gas and Oil Syndicate	Canfield, Ont.
638	Grand River Natural Gas Co., Ltd.	Welland, Ont.
*534	Grimsby Natural Gas Co., Ltd.	Ridgway, Pa.
567	Grimsby Natural Gas Co., Ltd.	Grimsby, Ont.
582	Haldimand Gas Syndicate.	Cayuga, Ont.
545	Haldimand Natural Gas Syndicate.	Stevensville, Ont.
544	Highbank Oil, Limited.	Chatham, Ont.
589	Hope Gas Syndicate.	St. Catharines, Ont.
577	Ideal Gas Syndicate.	Fisherville, Ont.
*568	Industrial Natural Gas Co., Ltd.	Port Robinson, Ont.
569	Industrial Natural Gas Co., Ltd.	Port Robinson, Ont.
530	Jasperson, Bon.	Kingsville, Ont.
*563	Kervin and Dawson.	Merlin, Ont.
564	Kervin and Dawson.	Merlin, Ont.
553	Lincoln Gas Co., Ltd.	Toronto, Ont.
570	Llndsay, W. B.	Toronto, Ont.
548	Lymburner Bros. and Webber.	Dunnville, Ont.
580	McKinney, John F.	Niagara Falls, N.Y.
560	Midfield Natural Gas Co., Ltd.	Hamilton, Ont.
555	Mohawk Gas and Oil Syndicate, Ltd.	Toronto, Ont.
643	Niagara Natural Gas Co., Ltd.	Buffalo, N.Y.
531	Niece, Hosea, and Son	Lowbanks, Ont.
*565	Olga Gas and Oil Co., Ltd.	Toronto, Ont.
566	Olga Gas and Oil Co., Ltd.	Toronto, Ont.
*554	Ontario Counties Gas Co., Ltd.	Buffalo, N.Y.
579	Ontario Counties Gas Co., Ltd.	Orchard Park, N.Y.
527	Petrol Oil and Gas Co., Ltd.	Toronto, Ont.
*556	Port Colborne–Welland Natural Gas and Oil Co., Ltd.	Port Colborne, Ont.
557	Port Colborne–Welland Natural Gas and Oil Co., Ltd.	Port Colborne, Ont.
559	Provincial Natural Gas and Fuel Co., Ltd.	Fort Erie, Ont.
581	Rainham Gas Syndicate.	Fisherville, Ont.
536	Romney Gas and Oil Co., Ltd.	London, Ont.
*575	Sarnia Oil and Gas Co., Ltd.	Sarnia, Ont.
576	Sarnia Oil and Gas Co., Ltd.	Sarnia, Ont.
583	Selected Natural Gas and Oil Syndicate.	Toronto, Ont.
585	Sherbrooke Gas Syndicate.	Lowbanks, Ont.

TABLE XI—OPERATORS LICENSED TO PRODUCE NATURAL GAS, 1932—*Continued*

License No.	Name	Address
537	Smith, Robt. H	Lowbanks, Ont.
525	Southern Ontario Gas Co., Ltd	Buffalo, N.Y.
547	Springvale Gas and Oil Co., Ltd	Hagersville, Ont.
635	Standard Gas and Oil Syndicate	Fisherville, Ont.
526	Stevensville Natural Gas and Fuel Co.	Stevensville, Ont.
535	Superior Gas Syndicate	Fisherville, Ont.
634	Sweets Corners Gas and Oil Syndicate	Fisherville, Ont.
*573	Tillsonburg Oil and Gas Co., Ltd	Toronto, Ont.
574	Tillsonburg Oil and Gas Co., Ltd	Toronto, Ont.
550	Union Gas Co. of Canada, Ltd	Chatham, Ont.
558	Vacuum Gas and Oil Co., Ltd	Toronto, Ont.
640	Walpole Gas Syndicate	Cayuga, Ont.
542	Welland County Gas Syndicate	Stevensville, Ont.
586	White Eagle Oil and Gas Syndicate	Sarnia, Ont.
528	Yager, J. J	Selkirk, Ont.

*1931.

TABLE XII—OPERATORS LICENSED TO DISTRIBUTE NATURAL GAS, 1932

License No.	Name	Address
397	Brantford Gas Company	Buffalo, N.Y.
418	Canfield Natural Gas Co., Ltd	Canfield, Ont.
402	Central Pipe Line Co., Ltd	Chatham, Ont.
*419	Cliff Gas Co., Ltd	Lowbanks, Ont.
†420	Cliff Gas Co., Ltd	Lowbanks, Ont.
396	Dominion Natural Gas Co., Ltd	Buffalo, N.Y.
407	Fisherville Gas Companies	Fisherville, Ont.
†421	Fonthill-Ridgeville Gas Co	Portland, Ind.
‡422	Fonthill-Ridgeville Gas Co	Portland, Ind.
423	Fonthill-Ridgeville Gas Co	Portland, Ind.
‡414	Grimsby Natural Gas Co., Ltd	Grimsby, Ont.
415	Grimsby Natural Gas Co., Ltd	Grimsby, Ont.
‡416	Industrial Natural Gas Co., Ltd	Port Robinson, Ont.
417	Industrial Natural Gas Co., Ltd	Port Robinson, Ont.
401	Lake Shore Natural Gas Co., Ltd	Fort Erie, Ont.
403	Leamington, Town of	Leamington, Ont.
438	Lincoln Gas Co., Ltd	Toronto, Ont.
398	Manufacturers Natural Gas Co., Ltd	Buffalo, N.Y.
413	Midfield Natural Gas Co., Ltd	Hamilton, Ont.
‡400	Oil Springs Oil and Gas Co., Ltd	Oil Springs, Ont.
403-A	Oil Springs Oil and Gas Co., Ltd	Oil Springs, Ont.
‡410	Port Colborne–Welland Natural Gas and Oil Co., Ltd	Port Colborne, Ont.
411	Port Colborne–Welland Natural Gas and Oil Co., Ltd	Port Colborne, Ont.
412	Provincial Natural Gas and Fuel Co., Ltd	Fort Erie, Ont.
399	Southern Ontario Gas Co., Ltd	Buffalo, N.Y.
404	Springvale Gas and Oil Co., Ltd	Hagersville, Ont.
405	Union Gas Co. of Canada, Ltd	Chatham, Ont.
‡408	United Gas and Fuel Co., Ltd	Hamilton, Ont.
409	United Gas and Fuel Co., Ltd	Hamilton, Ont.
406	Windsor Gas Company, Ltd	Windsor, Ont.

*1929.
†1930.
‡1931.

TABLE XIII—OPERATORS LICENSED TO OPERATE PIPE LINES, 1932

License No.	Name	Address
89	Central Pipe Line Co., Ltd	Chatham, Ont.
87	Dominion Natural Gas Co., Ltd	Buffalo, N.Y.
88	Southern Ontario Gas Co., Ltd	Buffalo, N.Y.
90	Union Gas Company of Canada, Ltd	Chatham, Ont.

Logs of Wells

The logs of oil and gas wells drilled in Ontario in 1932 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 person whose name appears at the top of each log.

ABBREVIATIONS

C	From Canborough.
C.T	Clement tract.
Con	Concession.
D.T	Dockstader tract.
E	East.
E. ½	East half.
N. ½	North half.
N.E. ¼	Northeast quarter.
N.F.R	North of Forks Road.
N.R	Niagara River survey.
N.T	Nelles tract.
N.T.R	North of Talbot Road.
N.W	Northwest.
N.W. ¼	Northwest quarter.
Pt	Part.
R.R	River range.
S. ½	South half.
S.E	Southeast.
S.E. ¼	Southeast quarter.
S.L.R	South of Longwoods Road.
S.T.R	South of Talbot Road.
S.W	Southwest.
S.W. ¼	Southwest quarter.
St	Street.
Tp	Township.
W	West.
W. ½	West half.
W.F.C	West of Fairchilds creek.
Y.T	Young tract.

Brant County

PREMIER OILS, LIMITED, TORONTO
Lot 16, con. III, W.F.C., Onondaga tp.

Completed March 19, 1932.
Open flow: 55,000 cu. ft.

Formation	Thickness, ft.
Surface	100
Shale	42
Niagara	262
Shale	48
Clinton	28
Red Medina	37
Grey shale	65
White Medina	10
Red shale	3
Total depth	595

Gas at 473 and 595 feet.
Fresh water at 100 and 114 feet.

PREMIER OILS, LIMITED, TORONTO
Lot 17, con. III, W.F.C., Onondaga tp.

Completed August 6, 1931.
Open flow: 50,000 cu. ft.

Formation	Thickness, ft.
Surface	111
Shale	39
Niagara	252
Shale	46
Clinton	24
Red Medina	35
Grey shale	65
White Medina	10
Red shale	3
Total depth	585

Gas at 472 and 572 feet.
Fresh water at 100 and 114 feet.

RESERVE NATURAL GAS CO., BUFFALO, N.Y.
Lot 38, R.R., Onondaga tp.

Completed July 15, 1932.
Open flow: 5,000 cu. ft.
Rock pressure: 110 lbs.

Formation	Thickness, ft.
Surface	73
Lime and shale	30
Niagara	230
Shale	38
Clinton	27
Red Medina	18
Shale	70
White Medina	15
Red shale	55
Total depth	556

Fresh water at 80 feet; salt water at 330 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 20, con. IV, Tuscarora tp.

Completed August 19, 1932.
Open flow: 2,191 cu. ft.

Formation	Thickness, ft.
Surface	89
Salina	46
Guelph and Niagara	274
Rochester	46
Clinton	17
Red Medina	22
Cabot Head	65
White Medina	16
Queenston at 575 feet.	
Total depth	575

Show of gas at 466 and 572 feet.
Sulphur water at 100 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 38, R.R., Tuscarora tp.

Completed June 25, 1932.
Open flow: About 3,000 cu. ft.

Formation	Thickness, ft.
Surface	97
Salina	55
Guelph and Niagara	238
Rochester	70
Clinton	25
Red Medina	18
Cabot Head	45
White Medina	32
Queenston	3
Total depth	583

Show of gas at 3,000 feet.
Sulphur water at 97 feet.

Essex County

BON JASPERSON, KINGSVILLE
Lot G, E. ½, con. II, Gosfield South tp.

Completed June 25, 1932.

Formation	Thickness, ft.
Clay	40
Quicksand	40
Quicksand and gravel	20
Lime	410
Lime and gypsum	20
Lime	560
White water sand	24
Total depth	1,114

Gas at 743 and 763 feet.
Fresh water at 80 and 105 feet; black salt water at 1,093 feet.

BON JASPERSON, KINGSVILLE
Lot 6, con. I, Gosfield South tp.

Completed March 19, 1932.
Open flow: 5,000 feet.

Formation	Thickness, ft.
Surface	105
Brown lime	295
Grey and white lime	80
Hard brown lime	50
Soft grey lime	120
Dark grey and brown lime	65
Hard brown lime	80
Soft grey lime	100
Brown lime	110
White sand	10
Total depth	1,015

Gas at 928, 940, and 993 feet.
Fresh water at 105 and 115 feet; black water at 1,005 feet; salt water at 1,015 feet.

Haldimand County

NATURAL GAS INVESTMENTS, TORONTO
Lot 13, con. I, Canborough tp.

Completed April 7, 1932.
Open flow: 21,000 cu. ft.
Rock pressure: 95 lbs.

Formation	Thickness, ft.
Surface clay	74
Brown and blue shale	55
Niagara	190
Grey lime	61
Shale	30
Clinton	29
Red Medina	40
Grey shale	61
White Medina	16
Red shale	52
Total depth	608

Gas at 210, 439, and 548 feet.
Black water at 76 feet.

NATURAL GAS INVESTMENTS, TORONTO
Lot 13, con. I, Canborough tp.

Completed May 17, 1932.
Open flow: 23,000 cu. ft.
Rock pressure: 100 lbs.

Formation	Thickness, ft.
Surface clay	57
Blue and brown shale	65
Niagara limestone	195
Grey limestone	64
Shale	33
Clinton	29
Red Medina	40
Grey shale	60
White Medina	18
Red Medina	61
Total depth	622

Gas at 310, 421, 455, and 553 feet.
Water at 62 feet.

SELECTED NATURAL GAS AND OIL SYNDICATE, TORONTO
Lot 9, E. ½, D.T., Canborough tp.

Completed June 18, 1932.
Open flow: 30,000 cu. ft.
Rock pressure: 230 lbs.

Formation	Thickness, ft.
Surface	68
Lime and shale	230
Niagara	238
Shale	30
Clinton	27
Red Medina	43
Shale (grey)	55
White Medina	16
Red shale	52
Total depth	759

Gas at 573, 616, and 697 feet.
Fresh water at 53 feet; black at 400 feet.

SELECTED NATURAL GAS AND OIL SYNDICATE, TORONTO
Lot 9, E. ½, D.T., Canborough tp.

Completed May 28, 1932.
Open flow: 20,390 cu. ft.
Rock pressure: 230 lbs.

Formation	Thickness, ft.
Surface	70
Lime and shale	223
Niagara	240
Shale	28
Clinton lime	27
Red Medina	40
Grey shale	56
White Medina	14
Red shale	55
Total depth	753

Gas at 571, 600, and 628 feet.
Fresh water at 60 feet; black at 440 feet.

SELECTED NATURAL GAS AND OIL SYNDICATE, TORONTO
Lots 1, 2, 3, and 4, con. III, Canborough tp.

Completed July 13, 1932.
Open flow: 10,000 cu. ft.
Rock pressure: 212 lbs.

Formation	Thickness, ft.
Surface	72
Lime and shale	220
Niagara lime	236
Clinton shale	35
Clinton lime	30
Red Medina	45
Medina shale	54
White Medina	16
Red shale	50
Total depth	758

Gas at 583, 611, and 701 feet.
Fresh water at 30 feet; black at 400 feet.

DANIEL GLENNEY, DUNNVILLE
Lot 5, con. III, Canborough tp.

Completed August 19, 1932.
Open flow: 42,000 cu. ft.
Rock pressure: 175 lbs.

Formation	Thickness, ft.
Surface	50
Blue shale and brown lime and gypsum	185
Niagara lime	200
Grey lime	60
Rochester shale	30
Clinton	28
Red Medina	38
Grey shale	56
White Medina	18
Red shale	66
Total depth	731

Gas at 577 to 580 feet and 654 to 664 feet.
Fresh water at 54 feet.

DANIEL GLENNEY, DUNNVILLE
Lot 5, con. III, Canborough tp.

Completed July 13, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	57
Blue and brown limestone	178
Niagara lime	195
Grey limestone	61
Shale	32
Clinton	27
Red Medina	38
Grey shale	58
White Medina	14
Total depth	660

SELECTED NATURAL GAS AND OIL SYNDICATE, TORONTO
Pt. lots 1, 2, 3, and 4, con. III, Canborough tp.

Completed August 16, 1932.
Open flow: 30,000 cu. ft.
Rock pressure: 200 lbs.

Formation	Thickness, ft.
Surface	78
Lime and shale	216
Niagara	236
Shale	30
Clinton	29
Red Medina	45
Medina shale	52
White Medina	15
Red shale	50
Total depth	751

Gas at 565, 593, 613, and 690 feet.
Fresh water at 100 feet; black at 330 feet.

MOHAWK GAS AND OIL SYNDICATE, TORONTO
Lot 12, con. I, Canborough tp.

Completed September 13, 1932.
Open flow: 1,000 cu. ft.

Formation	Thickness, ft.
Surface clay	64
Lime and shale	93
Niagara lime	200
Shale	32
Clinton	26
Red Medina	35
Shale	55
White Medina	12
Red shale	4
Total depth	521

Gas at 415 and 521 feet.
Fresh water at 65 feet; black water at 157 feet.

SELECTED NATURAL GAS AND OIL SYNDICATE, TORONTO
Pt. lots 1, 2, 3, and 4, con. III, Canborough tp.

Completed September 7, 1932.
Open flow: 5,300 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	54
Lime and shale	229
Niagara	240
Shale	32
Clinton	31
Red Medina	50
Shale	60
White Medina	16
Red shale	32
Total depth	744

Gas at 560, 598, and 702 feet.
Fresh water at 59 feet; black water at 323 feet.

DANIEL GLENNEY, DUNNVILLE
Lot 5, con. III, Canborough tp.

Completed November 5, 1932.
Open flow: 17,000 cu. ft.
Rock pressure: 165 lbs.

Formation	Thickness, ft.
Surface	56
Blue shale	95
Brown shale	80
Niagara limestone	200
Grey limestone	56
Casing shale	28
Clinton	29
Red Medina	38
Grey shale	53
White Medina	15
Red shale	60
Total depth	710

Gas at 559 and 642 feet.
Water at 57, 60, and 80 feet.
Sulphur gas at 180 feet.

DANIEL GLENNEY, DUNNVILLE
Lot 5, con. III, Canborough tp.

Completed September 20, 1932.
Open flow: 19,000 cu. ft.
Rock pressure: 135 lbs.

Formation	Thickness, ft.
Surface	58
Blue shale	100
Brown limestone	80
Niagara limestone	200
Grey limestone	55
Casing shale	30
Clinton	30
Red Medina	39
Grey shale	52
White Medina	18
Red shale	60
Total depth	722

Gas at 646 and 656 feet.
Water at 60 feet.
Water and sulphur gas at 230 feet.

MOHAWK GAS AND OIL SYNDICATE, TORONTO
Lot 10, con. I, Canborough tp.

Completed October 4, 1932.
Open flow: 20,000 cu. ft.
Rock pressure: 135 lbs.

Formation	Thickness, ft.
Clay	73
Shale	81
Niagara	200
Shale	30
Clinton	30
Red Medina	40
Shale	55
White Medina	12
Red shale	3
Total depth	524

Show of gas at 382 feet.
Gas at 408 feet.
Clear water at 75 feet; black water at 154 feet.

HARRY L. EMERSON, DUNNVILLE
Pt. lots 5 and 6, con. II, Canborough tp.

Completed May 25, 1932.
Open flow: 45,000 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Surface	73
Lime and shale	157
Niagara	200
Shale	30
Clinton	30
Red Medina	40
Grey shale	55
White Medina	12
Red shale	50
Total depth	647

Gas at 490, 530, 585, and 597 feet.
Artesian water at about 80 feet.

E. SHEPHERD, DUNNVILLE
Lot 9, D.T., Canborough tp.

Completed October 20, 1932.
Open flow: 15,000 cu. ft.
Rock pressure: 150 lbs.

Formation	Thickness, ft.
Surface	50
Lime and shale	228
Niagara	235
Shale	30
Clinton	25
Red Medina	43
Shale	53
White Medina	15
Red shale	40
Total depth	719

Fresh water at 60 feet; salt water at 480 feet.

LINCOLN GAS CO., TORONTO
Lot 6, con. II, Canborough tp.

Completed May 21, 1932.
Open flow: 17,000 cu. ft.
Rock pressure: 100 lbs.

Formation	Thickness, ft.
Surface	73
Lime and shale	157
Niagara	200
Shale	30
Clinton	30
Red Medina	45
Shale	50
White Medina	12
Red shale	3
Total depth	600

Fresh water at 90 feet.

LINCOLN GAS CO., TORONTO
Lot 6, con. I, Canborough tp.

Completed April 2, 1932.
Open flow: 14,000 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Surface	73
Lime and shale	81
Niagara	200
Shale	30
Clinton	30
Red Medina	40
Shale	55
White Medina	12
Red shale	3
Total depth	524

Fresh water at 85 feet.

ARAGAIN GOLD AND NATURAL GAS SYNDICATE, TORONTO

Lot 13, con. I, Canborough tp.

Completed August 19, 1932.
Open flow: 7,000 cu. ft.
Rock pressure: 90 lbs.

Formation	Thickness, ft.
Surface	58
Lime and shale	137
Niagara	200
Shale	20
Clinton	30
Red Medina	45
Shale	50
White Medina	12
Red shale	8
Total depth	560

Fresh water at 65 feet.

CONTACT NATURAL GAS SYNDICATE, TORONTO

Lot 14, con. II, Canborough tp.

Completed August 22, 1932.
Open flow: 21,000 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Surface	52
Lime and shale	159
Niagara	200
Shale	40
Clinton	30
Red Medina	40
Shale	51
White Medina	10
Red shale	50
Total depth	632

Fresh water at 53 feet.

MCKECHNIE AND HUSSEY, DUNNVILLE

Lot 6, con. III, Canborough tp.

Completed October 26, 1932.
Open flow: 27,000 cu. ft.
Rock pressure: 155 lbs.

Formation	Thickness, ft.
Surface	51
Lime and shale	179
Niagara	233
Shale	52
Clinton	28
Red Medina	36
Shale	60
White Medina	12
Red shale	50
Total depth	701

Fresh water at 60 feet.

MCKECHNIE AND HUSSEY, DUNNVILLE

Lot 6, con. III, Canborough tp.

Completed October 3, 1932.
Open flow: 21,000 cu. ft.
Rock pressure: 150 lbs.

Formation	Thickness, ft.
Surface	48
Lime and shale	182
Niagara	237
Shale	50
Clinton	28
Red Medina	39
Shale	62
White Medina	12
Red shale	50
Total depth	708

Fresh water at 60 feet.

AIKENS GAS SYNDICATE, VINELAND

Lot 5, W. pt., C.T., Canborough tp.

Completed November 4, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	63
Lime and shale	174
Niagara	225
Shale	50
Clinton	30
Red Medina	40
Grey shale	51
White Medina	16
Red shale	4
Total depth	653

Show of gas at 522 and 532 feet.
Fresh water at 65 feet; salt water at 275 feet.

AIKENS GAS SYNDICATE, VINELAND

Lot 16, C.T., Canborough tp.

Completed January 23, 1932.
Open flow: 82,000 cu. ft.
Rock pressure: 185 lbs.

Formation	Thickness, ft.
Surface	51
Lime and shale	204
Niagara	225
Shale	50
Clinton	32
Red Medina	40
Grey shale	53
White Medina	18
Red shale	56
Total depth	729

Gas at 558 and 667 to 670 feet.
Fresh water at 50 feet; salt water at 300 feet.

AIKENS GAS SYNDICATE, VINELAND

Lot 9, C.T., Canborough tp.

Completed February 18, 1932.
Open flow: 37,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness ft.
Surface	58
Lime and shale	185
Niagara	225
Shale	50
Clinton	30
Red Medina	40
Grey shale	54
White Medina	17
Red shale	9
Total depth	668

Gas at 573 and 654 feet.
Fresh water at 57 feet; salt water at 300 feet.

AIKENS GAS SYNDICATE, VINELAND

Lot 16, C.T., Canborough tp.

Completed March 16, 1932.
Open flow: 42,000 cu. ft.
Rock pressure: 242 lbs.

Formation	Thickness, ft.
Surface	59
Lime and shale	199
Niagara	225
Shale	50
Clinton	30
Red Medina	40
Grey shale	54
White Medina	17
Red shale	24
Total depth	698

Gas at 536, 560, and 669 feet.
Fresh water at 60 feet; salt water at 300 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 14, W. pt., C.T., Canborough tp.

Completed April 6, 1932.
Open flow: 30,000 cu. ft.
Rock pressure: 185 lbs.

Formation	Thickness, ft.
Surface	58
Lime and shale	194
Niagara	225
Shale	50
Clinton	32
Red Medina	40
Grey shale	54
White Medina	17
Red shale	54
Total depth	724

Gas at 530, 579, and 665 feet.
Fresh water at 65 feet; salt water at 285 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 13, C.T., Canborough tp.

Completed May 12, 1932.
Open flow: 82,000 cu. ft.
Rock pressure: 200 lbs.

Formation	Thickness, ft.
Surface	50
Lime and shale	195
Niagara	225
Shale	50
Clinton	31
Red Medina	40
Grey shale	54
White Medina	17
Red shale	62
Total depth	724

Gas at 525, 544, and 657 feet.
Fresh water at 48 feet; salt water at 285 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 13, C.T., Canborough tp.

Completed June 3, 1932.
Open flow: 76,000 cu. ft.
Rock pressure: 200 lbs.

Formation	Thickness, ft.
Surface	60
Lime and shale	187
Niagara	225
Shale	50
Clinton	28
Red Medina	40
Grey shale	54
White Medina	18
Red shale	53
Total depth	715

Gas at 525, 560, and 659 feet.
Fresh water at 55 feet; salt water at 285 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 13, C.T., Canborough tp.

Completed June 25, 1932.
Open flow: 55,000 cu. ft.
Rock pressure: 220 lbs.

Formation	Thickness, ft.
Surface	60
Lime and shale	185
Niagara	225
Shale	50
Clinton	29
Red Medina	40
Grey shale	52
White Medina	18
Red shale	48
Total depth	707

Gas at 567 and 656 feet.
Fresh water at 61 feet; salt water at 275 feet

AIKENS GAS SYNDICATE, VINELAND
Lot 12, C.T., Canborough tp.

Completed July 15, 1932.
Open flow: 105,000 cu. ft.
Rock pressure: 220 lbs.

Formation	Thickness, ft.
Surface	65
Lime and shale	187
Niagara	225
Shale	50
Clinton	30
Red Medina	40
Grey shale	52
White Medina	18
Red shale	56
Total depth	723

Gas at 530, 551, and 657 feet.
Fresh water at 115 feet; salt water at 275 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 10, C.T., Canborough tp.

Completed August 5, 1932.
Open flow: 37,000 cu. ft.
Rock pressure: 190 lbs.

Formation	Thickness, ft.
Surface	59
Lime and shale	179
Niagara	225
Shale	50
Clinton	30
Red Medina	40
Grey shale	53
White Medina	16
Red shale	52
Total depth	704

Gas at 515, 566, and 651 feet.
Fresh water at 85 feet; salt water at 305 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 5, W. pt., C.T., Canborough tp.

Completed August 29, 1932.
Open flow: 140,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	64
Lime and shale	173
Niagara	225
Shale	50
Clinton	30
Red Medina	40
Grey shale	53
White Medina	18
Red shale	52
Total depth	705

Gas at 530, 541, and 647 feet.
Fresh water at 60 feet; salt water at 275 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 6, W. pt., C.T., Canborough tp.

Completed September 17, 1932.
Open flow: 15,000 cu. ft.
Rock pressure: 205 lbs.

Formation	Thickness, ft.
Surface	59
Lime and shale	175
Niagara	225
Shale	50
Clinton	30
Red Medina	40
Grey shale	53
White Medina	18
Red shale	50
Total depth	700

Gas at 512, 551, 566, and 644 feet.
Fresh water at 55 feet; salt water at 275 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 12, C.T., Canborough tp.

Completed September 20, 1932.
Open flow: 76,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	54
Lime and shale	201
Niagara	225
Shale	50
Clinton	30
Red Medina	40
Grey shale	52
White Medina	18
Red shale	58
Total depth	728

Gas at 533, 548, 657, and 666 feet.
Fresh water at 80 feet; salt water at 300 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 12, C.T., Canborough tp.

Completed October 12, 1932.
Open flow: 82,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	62
Lime and shale	189
Niagara	225
Shale	50
Clinton	26
Red Medina	42
Grey shale	52
White Medina	20
Red shale	58
Total depth	724

Gas at 528, 544, 567, and 661 feet.
Fresh water at 65 feet; salt water at 300 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 7, E. pt., C.T., Canborough tp.

Completed October 13, 1932.
Open flow: 33,000 cu. ft.
Rock pressure: 240 lbs.

Formation	Thickness, ft.
Surface	52
Lime and shale	181
Niagara	225
Shale	50
Clinton	34
Red Medina	35
Grey shale	51
White Medina	15
Red shale	3
Total depth	646

Gas at 512 and 554 feet.
Fresh water at 60 feet; salt water at 275 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 12, C.T., Canborough tp.

Completed December 15, 1932.
Open flow: 30,000 cu. ft.
Rock pressure: 220 lbs.

Formation	Thickness, ft.
Surface	66
Lime and shale	186
Niagara	225
Shale	50
Clinton	28
Red Medina	42
Grey shale	52
White Medina	17
Red shale	47
Total depth	713

Gas at 531, 547, 573, and 661 feet.
Fresh water at 75 feet; salt water at 300 feet.

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 7, con. I, Dunn tp.

Completed December 2, 1932.
Open flow: 100,000 cu. ft.
Rock pressure: 370 lbs.

Formation	Thickness, ft.
Surface	23
Flint	45
Lime and shale	350
Niagara	240
Shale	35
Clinton	32
Red Medina	40
Shale	60
White Medina	15
Red shale	43
Total depth	883

Gas at 743, 749, and 832 feet.
Fresh water at 51 feet.

J. V. RILEY, SIMCOE
Lot 14, E. pt., N.F.R., Moulton tp.

Completed October 11, 1932.
Open flow: 18,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	102
Lime and shale	118
Niagara	220
Shale	63
Clinton	26
Red Medina	39
Shale	58
White Medina	12
Red shale	60
Total depth	698

Gas at 628 feet.
Sulphur water at 105 feet.

J. V. RILEY, SIMCOE
Lot 13, N.F.R., Moulton tp.

Completed October 27, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	95
Lime and shale	135
Niagara	220
Shale	57
Clinton	29
Red Medina	36
Shale	56
White Medina	12
Red shale	2
Total depth	642

ROBT. H. SMITH, LOWBANKS
Lot 8, N.F.R., Moulton tp.

Completed December 19, 1932.
Open flow: 30,000 cu. ft.
Rock pressure: 90 lbs.

Formation	Thickness, ft.
Surface	115
Lime and shale	110
Niagara	220
Shale	64
Clinton	35
Red Medina	33
Shale	57
White Medina	10
Red shale	60
Total depth	704

Gas at 520 feet.
Sulphur water at 115 feet.

ROBT. H. SMITH, LOWBANK
Lot 8, N.F.R., Moulton tp.

Completed December 5, 1932.
Open flow: 14,000 cu. ft.
Rock pressure: 175 lbs.

Formation	Thickness, ft.
Surface	93
Lime and shale	118
Niagara	220
Shale	60
Clinton	37
Red Medina	29
Shale	59
White Medina	13
Red shale	60
Total depth	689

Gas at 619 feet.
Sulphur water at 120 feet.

ROBT. H. SMITH, LOWBANKS
Lot 8, N.F.R., Moulton tp.

Completed November 18, 1932.
Open flow: 28,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	107
Lime and shale	111
Niagara	220
Shale	58
Clinton	36
Red Medina	30
Shale	57
White Medina	12
Red shale	50
Total depth	681

Gas at 630 feet.
Sulphur water at 95 feet.

CANADIAN NATURAL GAS SYNDICATE, SIMCOE
Lot 19, N.F.R., Moulton tp.

Completed August 10, 1932.
Open flow: 15,000 cu. ft.
Rock pressure: 120 lbs.

Formation	Thickness, ft.
Surface	85
Lime and shale	165
Niagara	220
Shale	64
Clinton	29
Red Medina	43
Shale	58
White Medina	11
Red shale	50
Total depth	725

Gas at 670 feet.
Sulphur water at 95 feet.

CANADIAN NATURAL GAS SYNDICATE, SIMCOE
Lot 19, N.F.R., Moulton tp.

Completed July 5, 1932.
Open flow: 20,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	83
Lime and shale	159
Niagara	223
Shale	59
Clinton	34
Red Medina	35
Shale	58
White Medina	10
Red shale	50
Total depth	711

Gas at 497 and 640 feet.
Sulphur water at 90 feet.

CANADIAN NATURAL GAS SYNDICATE, SIMCOE
Lot 18, N.F.R., Moulton tp.

Completed June 9, 1932.
Open flow: 25,000 cu. ft.
Rock pressure: 190 lbs.

Formation	Thickness, ft.
Surface	80
Lime and shale	175
Niagara	228
Shale	59
Clinton	29
Red Medina	35
Shale	58
White Medina	11
Red shale	45
Total depth	720

Gas at 490 and 665 feet.
Sulphur water at 90 feet.

SELECTED NATURAL GAS AND OIL SYNDICATE, TORONTO
Lot 3, E. pt., con. I C, Moulton tp.

Completed October 11, 1932.
Open flow: 30.000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	88
Lime and shale	182
Niagara	230
Shale	60
Clinton	32
Red Medina	41
Grey shale	55
White Medina	14
Red shale	53
Total depth	755

Gas at 524, 572, and 653 feet.
Fresh water at 90 feet; black water at 490 feet.

EMERALD GAS SYNDICATE, TORONTO
Lot A, con. II C, Moulton tp.

Completed December 9, 1932.
Open flow: 21,000 cu. ft.
Rock pressure: 185 lbs.

Formation	Thickness, ft.
Surface	96
Lime and shale	91
Niagara	225
Rochester shale	52
Clinton	30
Red Medina	40
Grey shale	50
White Medina	17
Red shale	52
Total depth	653

Gas at 593 feet.
Fresh water at 98 feet; salt water at 250 feet.

PERCY L. JACKSON, DUNNVILLE
Lot 51, Alder St. W., Town of Dunnville, Moulton tp.

Completed November 30, 1932.
Open flow: 15,000 cu. ft.
Rock pressure: 170 lbs.

Formation	Thickness, ft.
Surface	63
Brown lime	50
Shale and lime	197
Niagara	230
Shale	60
Clinton	30
Red Medina	38
Grey shale	58
White Medina	12
Red shale	50
Total depth	788

Gas at 612 and 734 feet.
Fresh water at 70 feet; sulphur water at 310 feet.

GRAND RIVER NATURAL GAS CO., WELLAND
Lot 11, N.F.R., Moulton tp.

Completed May 20, 1932.
Open flow: 12,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	90
Shale and lime	135
Niagara	220
Shale	60
Clinton	32
Red Medina	36
Shale	60
White Medina	11
Red shale	51
Total depth	695

Gas at 478 and 640 feet.
Sulphur water at 90 feet.

GRAND RIVER NATURAL GAS CO., WELLAND
Lot 10, N.F.R., Moulton tp.

Completed February 2, 1932.
Open flow: 28,000 cu. ft.
Rock pressure: 210 lbs.

Formation	Thickness, ft.
Surface	104
Lime and shale	123
Niagara	222
Shale	58
Clinton	31
Red Medina	35
Shale	57
White Medina	11
Red shale	50
Total depth	691

Gas at 528 and 635 feet.
Sulphur water at 104 feet.

GRAND RIVER NATURAL GAS CO., WELLAND
Lot 10, N.F.R., Moulton tp.

Completed in 1932.
Open flow: 42,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	106
Shale and lime	113
Niagara	223
Shale	58
Clinton	36
Red Medina	34
Shale	53
White Medina	14
Red shale	55
Total depth	692

Gas at 543 and 626 feet.
Sulphur water at 100 feet.

HOPE GAS SYNDICATE, TORONTO
Lot 4, W. ½, con. II, Moulton tp.

Completed March 19, 1932.
Open flow: 39,000 cu. ft.
Rock pressure: 150 lbs.

Formation	Thickness, ft.
Surface	96
Lime and shale	89
Niagara	225
Shale	50
Clinton	30
Red Medina	45
Grey shale	47
White Medina	15
Red shale	53
Total depth	650

Gas at 505 and 594 feet.
Fresh water at 96 feet; salt water at 275 feet.

COLONIAL NATURAL GAS AND OIL SYNDICATE, HAMILTON
Lots 2 and 3, N.W. pts., con. I C, Moulton tp.

Completed December 29, 1932.
Open flow: 25,000 cu. ft.
Rock pressure: 130 lbs.

Formation	Thickness, ft.
Surface	72
Lime and shale	190
Niagara	210
Shale	84
Clinton	28
Red Medina	38
Shale	55
White Medina	15
Red shale	50
Total depth	742

Sulphur water at 75 feet.

RICH NATURAL GAS SYNDICATE, TORONTO
Pt. lots 17 and 18, con. II, Moulton tp.

Completed December 20, 1932.
Open flow: 28,000 cu. ft.
Rock pressure: 140 lbs.

Formation	Thickness, ft.
Surface	92
Lime and shale	78
Niagara	240
Shale	47
Clinton	31
Red Medina	37
Grey shale	45
White Medina	24
Red shale	38
Total depth	632

Gas at 493 and 588 feet.
Fresh water at 110 feet; black water at 240 feet.

J. V. RILEY, SIMCOE
Lot 14, E. pt., N.F.R., Moulton tp.

Completed September 23, 1932.
Open flow: 52,000 cu. ft.
Rock pressure: 240 lbs.

Formation	Thickness, ft.
Surface	109
Lime and shale	111
Niagara	220
Shale	56
Clinton	32
Red Medina	37
Shale	58
White Medina	12
Red shale	50
Total depth	685

Gas at 465 and 620 feet.
Sulphur water at 112 feet.

GRAND RIVER GAS AND OIL SYNDICATE, CANFIELD
Lot 16, con. II, North Cayuga tp.

Completed January 11, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	70
Lime and shale	245
Niagara	200
White lime	50
Shale	43
Clinton	27
Red Medina	35
Blue shale	65
White Medina	8
Red shale	5
Total depth	748

Water at 80 feet.

GRAND RIVER GAS AND OIL SYNDICATE, CANFIELD
Lot 18, con. III, North Cayuga tp.

Completed March 4, 1932.
Open flow: 70,000 cu. ft.
Rock pressure: 205 lbs.

Formation	Thickness, ft.
Surface	55
Lime and shale	252
Niagara	200
White lime	50
Shale	45
Clinton	27
Red Medina	37
Blue shale	67
White Medina	8
Red shale	5
Total depth	746

Gas at 609 feet.
Water at 78 feet.

GRAND RIVER GAS AND OIL SYNDICATE, CANFIELD
Lot 18, con. III, North Cayuga tp.

Completed April 11, 1932.
Open flow: 21,000 cu. ft.
Rock pressure: 165 lbs.

Formation	Thickness, ft.
Surface	58
Lime and shale	252
Niagara	200
White lime	50
Shale	39
Clinton	30
Red Medina	35
Blue shale	67
White Medina	0
Red shale	25
Total depth	765

Gas at 607, 617, and 736 feet.
Water at 75 feet.

GRAND RIVER GAS AND OIL SYNDICATE, CANFIELD
Lot 17, con. II, North Cayuga tp.

Completed June 18, 1932.
Open flow: 75,000 cu. ft.
Rock pressure: 285 lbs.

Formation	Thickness, ft.
Surface	70
Lime and shale	253
Niagara	200
White lime	50
Shale	40
Clinton	30
Red Medina	35
Blue shale	65
White Medina	10
Red shale	27
Total depth	780

Gas at 616, 648, and 750 feet.
Water at 80 feet.

GRAND RIVER GAS AND OIL SYNDICATE, CANFIELD
Lot 17, con. II, North Cayuga tp.

Completed July 20, 1932.
Open flow: 18,000 cu. ft.
Rock pressure: 225 lbs.

Formation	Thickness, ft.
Surface	70
Lime and shale	250
Niagara	200
White lime	50
Shale	39
Clinton	25
Red Medina	35
Blue shale	65
White lime	10
Red shale	5
Total depth	749

Gas at 654 feet.
Water at 80 feet.

GRAND RIVER GAS AND OIL SYNDICATE, CANFIELD
Lot 18, con. II, North Cayuga tp.

Completed September 13, 1932.
Open flow: 20,000 cu. ft.
Rock pressure: 185 lbs.

Formation	Thickness, ft.
Surface	70
Lime and shale	244
Niagara	200
White lime	50
Shale	35
Clinton	25
Red Medina	35
Blue shale	65
White Medina	11
Red shale	22
Total depth	757

Gas at 604, 629, and 734 feet.
Water at 80 feet.

GRAND RIVER GAS AND OIL SYNDICATE, CANFIELD
Huff and Jones tracts, North Cayuga tp.

Completed October 29, 1932.
Open flow: 200,000 cu. ft.
Rock pressure: 350 lbs.

Formation	Thickness, ft.
Surface	28
Lime and shale	247
Niagara	200
White lime	50
Shale	30
Clinton	25
Red Medina	35
Blue shale	65
White Medina	12
Red shale	5
Total depth	697

Gas at 578 and 600 feet.
Water at 31 feet.

GRAND RIVER GAS AND OIL SYNDICATE, CANFIELD
Huff and Jones tracts, North Cayuga tp.

Completed December 2, 1932.
Open flow: 180,000 cu. ft.
Rock pressure: 330 lbs.

Formation	Thickness, ft.
Surface	36
Lime and shale	242
Niagara	200
White lime	50
Casing shale	32
Clinton	25
Red Medina	35
Blue shale	65
White Medina	12
Red shale	3
Total depth	700

Gas at 563 and 608 feet.
Water at 37 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 6, con. II, North Cayuga tp.

Completed June 15, 1932.
Open flow: 20,000 cu. ft.
Rock pressure: 220 lbs.

Formation	Thickness, ft.
Surface	53
Lime and shale	230
Niagara	225
Shale	50
Clinton	29
Red Medina	40
Grey shale	52
White Medina	16
Red shale	19
Total depth	714

Gas at 597 and 691 feet.
Fresh water at 65 feet; salt water at 350 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 5, W. pt., con. II, North Cayuga tp.

Completed July 9, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	56
Lime and shale	221
Niagara	225
Shale	50
Clinton	29
Red Medina	40
Grey shale	52
White Medina	16
Red shale	6
Total depth	695

Gas at 604 and 685 feet.
Fresh water at 57 feet; salt water at 350 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 4, con. II, North Cayuga tp.

Completed August 27, 1932.
Open flow: 63,000 cu. ft.
Rock pressure: 185 lbs.

Formation	Thickness, ft.
Surface	48
Lime and shale	212
Niagara	225
Shale	50
Clinton	30
Red Medina	40
Grey shale	52
White Medina	16
Red shale	69
Total depth	742

Gas at 539, 553, 584, 662, and 671 feet.
Fresh water at 45 feet; salt water at 300 feet.

AIKENS GAS SYNDICATE, VINELAND
Lot 4, con. II, North Cayuga tp.

Completed August 3, 1932.
Open flow: 37,000 cu. ft.
Rock pressure: 195 lbs.

Formation	Thickness, ft.
Surface	52
Lime and shale	215
Niagara	225
Shale	50
Clinton	29
Red Medina	40
Grey shale	52
White Medina	16
Red shale	53
Total depth	732

Gas at 545 and 675 feet.
Fresh water at 53 feet; salt water at 300 feet.

W. H. CULVER, JR., DUNNVILLE
Lot 16, con. V, Oneida tp.

Completed January 19, 1932.
Open flow: 53,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	4
Lime and shale	176
Niagara	225
Shale	60
Clinton	28
Red Medina	30
Shale	57
White Medina	12
Red shale	5
Total depth	597

Gas at 471, 477, and 480 feet.
Sulphur water at 35 feet.

EMERALD GAS SYNDICATE, TORONTO
Lot 54, con. I, Oneida tp.

Completed April 22, 1932.
Open flow: 30,000 cu. ft.
Rock pressure: 310 lbs.

Formation	Thickness, ft.
Surface	8
Flint	50
Onondaga	40
Brown lime	100
Grey limestone	150
Shale and gypsum	67
Niagara lime	200
White lime	37
Black shale	40
Clinton	28
Red Medina	40
Grey shale	60
White Medina	12
Red shale	2
Total depth	834

Gas at 702, 735, and 755 feet.

EMERALD GAS SYNDICATE, TORONTO
Lot 55, con. I, Oneida tp.

Completed May 25, 1932.
Open flow: 221,000 cu. ft.
Rock pressure: 335 lbs.

Formation	Thickness, ft.
Surface	6
Flint	50
Onondaga	60
Brown lime	100
Shale and lime	150
Black shale	60
Niagara lime	200
White lime	44
Shale	30
Clinton	28
Red Medina	34
Grey shale	56
White Medina	7
Red (Queenston) shale	1
Total depth	826

Gas at 720 and 743 feet.

EMERALD GAS SYNDICATE, TORONTO
Lot 55, con. I, Oneida tp.

Completed June 22, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	7
Flint	60
Onondaga	50
Brown lime	100
Shale and lime	90
Shale and gypsum	70
Shale	48
Niagara lime	200
White lime	31
Black shale	46
Clinton	29
Red Medina	48
Grey shale	38
White Medina	14
Red shale	2
Total depth	833

CYCLOPS GAS SYNDICATE, TORONTO
Lot 55, S. ½, con. I, Oneida tp.

Completed June 29, 1932.
Open flow: 35,000 cu. ft.
Rock pressure: 415 lbs.

Formation	Thickness, ft.
Surface	7
Flint	53
Lime and shale	360
Niagara	200
White lime and shale	38
Black shale	44
Clinton	43
Red Medina	30
Grey shale	38
White Medina	12
Red shale	5
Total depth	830

Gas at 707 and 720 feet.

EMERALD GAS SYNDICATE, TORONTO
Lot 55, N. ½, con. I, Oneida tp.

Completed July 14, 1932.
Open flow: 45,000 cu. ft.
Rock pressure: 425 lbs.

Formation	Thickness, ft.
Surface	8
Flint	60
Onondaga	60
Brown lime	100
Shale and lime	80
Shale and gypsum	80
Shale	37
Niagara lime	200
White lime	34
Black shale	42
Clinton	24
Red Medina	46
Grey shale	39
White Medina	15
Red shale	1
Total depth	826

Gas at 740 and 745 feet.

EMERALD GAS SYNDICATE, TORONTO
Lot 55, con. I, Oneida tp.

Completed August 18, 1932.
Open flow: 70,000 cu. ft.

Formation	Thickness, ft.
Surface	7
Flint	60
Onondaga	40
Shale and gypsum	63
Brown lime	100
Shale and gypsum	100
Black shale	55
Niagara	200
White lime	32
Black shale	42
Clinton	35
Red Medina	36
Grey shale	40
White Medina	15
Red shale	2
Total depth	827

Gas at 702, 713, and 717 feet.

CYCLOPS GAS SYNDICATE, TORONTO
Lot 56, con. I, Oneida tp.

Completed July 26, 1932.
Open flow: 70,000 cu. ft.
Rock pressure: 430 lbs.

Formation	Thickness, ft.
Surface	5
Flint	55
Shale and lime	360
Niagara	205
White lime	39
Black shale	49
Clinton	41
Red Medina	31
Grey shale	47
White Medina	14
Red shale	2
Total depth	848

Gas at 718, 727, and 779 feet.

CYCLOPS GAS SYNDICATE, TORONTO
Lot 55, S. ½, con. I, Oneida tp.

Completed September 7, 1932.
Open flow: 40,000 cu. ft.
Rock pressure: 370 lbs.

Formation	Thickness, ft.
Surface	10
Flint	54
Shale and gypsum	356
Niagara	202
White lime	32
Black shale	49
Clinton	20
Red Medina	35
Grey shale	60
White Medina	10
Red shale	3
Total depth	831

Gas at 708, 726, 743, and 757 feet.
Fresh water at 45 feet.

EMERALD GAS SYNDICATE, TORONTO
Lot 54, N. ½, con. I, Oneida tp.

Completed September 17, 1932.
Open flow: 250,000 cu. ft.
Rock pressure: 375 lbs.

Formation	Thickness, ft.
Surface	4
Flint and broken lime	52
Onondaga	40
Shale and lime	100
Brown lime	100
Lime and shale	80
Shale and gypsum	44
Niagara	200
White lime	32
Black shale	39
Clinton	24
Red Medina	42
Grey shale	48
White Medina	16
Red shale	30
Total depth	851

Gas at 709, 744, and 818 feet.
Fresh water at 25 and 60 feet.

CYCLOPS GAS SYNDICATE, TORONTO
Lot 56, con. I, Oneida tp.

Completed October 1, 1932.
Open flow: 40,000 cu. ft.
Rock pressure: 415 lbs.

Formation	Thickness, ft.
Surface	10
Flint	54
Lime and shale	356
Niagara	204
White lime and shale	36
Black shale	50
Clinton	20
Red Medina	35
Grey shale	60
White Medina	10
Red shale	3
Total depth	838

Gas at 715 and 750 feet.
Fresh water at 65 feet.

CYCLOPS GAS SYNDICATE, TORONTO
Lot 56, con. I, Oneida tp.

Completed November 22, 1932.
Open flow: 78,000 cu. ft.
Rock pressure: 410 lbs.

Formation	Thickness, ft.
Surface	6
Flint	50
Shale and lime	359
Niagara	205
White lime	49
Black shale	45
Clinton	30
Red Medina	38
Grey shale	48
White Medina	10
Red shale	2
Total depth	842

Gas at 719, 732, and 739 feet.
Fresh water at 55 feet.

W. H. CULVER, DUNNVILLE
Lot 18, con. II, Oneida tp.

Completed December 14, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	5
Lime and shale	390
Niagara	230
Shale	56
Clinton	25
Red Medina	30
Grey shale	51
White Medina	15
Red shale	3
Total depth	805

MELROSE GAS AND OIL SYNDICATE, TORONTO
Lot 19, N. ½, con. III, Oneida tp.

Completed December 28, 1932.
Open flow: 45,000 cu. ft.
Rock pressure: 315 lbs.

Formation	Thickness, ft.
Surface	42
Lime and shale	268
Niagara	240
Blue shale	30
Clinton	28
Red Medina	31
Grey shale	95
White Medina	24
Red shale	50
Total depth	808

Gas at 595 and 741 feet.
Fresh water at 125 feet; sulphur water at 320 feet.

JOHN F. MCKINNEY, NIAGARA FALLS, N.Y.
Lot 17, con. II, Rainham tp.

Completed March 5, 1932.
Open flow: 90,000 cu. ft.
Rock pressure: 405 lbs.

Formation	Thickness, ft.
Surface	7
Flint	60
Lime and shale	373
Niagara	223
Shale	63
Clinton	26
Red Medina	44
Grey shale	60
White Medina	11
Red shale	5
Total depth	872

Gas at 728, 749, and 775 feet.
Sulphur water at 45 feet.

JOHN F. MCKINNEY, NIAGARA FALLS, N.Y.
Lot 17, con. II, Rainham tp.

Completed April 4, 1932.
Open flow: 174,900 cu. ft.
Rock pressure: 435 lbs.

Formation	Thickness, ft.
Surface	10
Flint	65
Lime and shale	369
Niagara	222
Shale	55
Red Medina	43
Grey shale	60
White Medina	10
Red shale	3
Clinton	30
Total depth	867

Gas at 723 and 764 feet.
Sulphur water at 45 feet.

JOHN F. MCKINNEY, NIAGARA FALLS, N.Y.
Lot 17, con. II, Rainham tp.

Completed May 10, 1932.
Open flow: 21,000 cu. ft.
Rock pressure: 360 lbs.

Formation	Thickness, ft.
Surface	6
Flint	69
Lime and shale	371
Niagara	220
Shale	53
Clinton	29
Red Medina	42
Grey shale	60
White Medina	10
Red shale	2
Total depth	862

First gas at 15 feet.
Water at 25 and 40 feet.

SUPERIOR GAS SYNDICATE, FISHERVILLE
Lot 13, con. II, Rainham tp.

Completed February 28, 1932.
Open flow: 6,000 cu. ft.

Formation	Thickness, ft.
Surface	22
Flint	70
Lime and shale	360
Niagara	232
Shale	59
Clinton	28
Red Medina	42
Grey shale	55
White Medina	10
Red shale	8
Total depth	886

Sulphur water at 27 feet.

SUPERIOR GAS SYNDICATE, FISHERVILLE
Lot 13, con. II, Rainham tp.

Completed January 22, 1932.
Open flow: 4,000 cu. ft.

Formation	Thickness, ft.
Surface	12
Flint	73
Lime and shale	375
Niagara	240
Shale	58
Clinton	31
Red Medina	42
Grey shale	50
White Medina	12
Red shale	4
Total depth	897

Sulphur water at 34 feet.
Gas at 761 feet.

SUPERIOR GAS SYNDICATE, FISHERVILLE
Lot 12, con. III, Rainham tp.

Completed March 30, 1932.
Open flow: 66,000 cu. ft.
Rock pressure: 320 lbs.

Formation	Thickness, ft.
Surface	22
Flint	65
Lime and shale	373
Niagara	233
Shale	59
Clinton	31
Red Medina	42
Grey shale	55
White Medina	11
Red shale	4
Total depth	895

Gas at 752, 772, and 798 feet.
Sulphur water at 40 feet.

SUPERIOR GAS SYNDICATE, FISHERVILLE
Lot 12, con. III, Rainham tp.

Completed April 23, 1932.
Open flow: 24,000 cu. ft.
Rock pressure: 325 lbs.

Formation	Thickness, ft.
Surface	18
Flint	72
Lime and shale	372
Niagara	233
Shale	55
Clinton	31
Red Medina	42
Shale	55
White Medina	15
Red shale	7
Total depth	900

Gas at 765, 796, and 806 feet.
Sulphur water at 48 feet.

JOHN F. MCKINNEY, NIAGARA FALLS, N.Y.
Lot 17, con. II, Rainham tp.

Completed June 10, 1932.
Open flow: 90,000 cu. ft.
Rock pressure: 300 lbs.

Formation	Thickness, ft.
Surface	5
Flint	75
Lime and shale	365
Niagara	223
Shale	67
Clinton	30
Red Medina	43
Grey shale	60
White Medina	10
Red shale	3
Total depth	881

Gas at 737 and 785 feet.
Water at 16 and 40 feet.

IDEAL GAS SYNDICATE, FISHERVILLE
Lot 15, con. III, Rainham tp.

Completed July 16, 1932.
Open flow: 195,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	18
Flint	70
Lime and shale	363
Niagara	220
Shale	64
Clinton	29
Red Medina	40
Shale	55
White Medina	15
Red shale	6
Total depth	880

Gas at 738, 752, 751, and 771 feet.
Sulphur water at 170 feet.

IDEAL GAS SYNDICATE, FISHERVILLE
Lot 15, con. III, Rainham tp.

Completed August 2, 1932.
Open flow: 25,000 cu. ft.
Rock pressure: 170 lbs.

Formation	Thickness, ft.
Surface	18
Flint	70
Lime and shale	357
Niagara	225
Shale	61
Clinton	30
Red Medina	35
Grey shale	55
White Medina	15
Red shale	6
Total depth	872

Gas at 781 and 821 feet.
Sulphur water at 35 feet.

SWEETS CORNERS GAS SYNDICATE, FISHERVILLE
Lot 18, con. II, Rainham tp.

Completed August 1, 1932.
Open flow: 24,000 cu. ft.
Rock pressure: 350 lbs.

Formation	Thickness, ft.
Surface	9
Flint	64
Lime and shale	373
Niagara	231
Shale	52
Clinton	29
Red Medina	44
Grey shale	55
White Medina	14
Red shale	33
Total depth	904

Gas at 729 and 758 feet.
Sulphur water at 54 feet.

SWEETS CORNERS GAS SYNDICATE, FISHERVILLE
Lot 18, con. II, Rainham tp.

Completed September 3, 1932.
Open flow: 68,000 cu. ft.
Rock pressure: 325 lbs.

Formation	Thickness, ft.
Surface	5
Flint	75
Lime and shale	370
Niagara	229
Shale	65
Clinton	27
Red Medina	42
Grey shale	56
White Medina	13
Red shale	40
Total depth	922

Gas at 744, 771, and 869 feet.
Sulphur water at 64 feet.

SWEETS CORNERS GAS SYNDICATE, FISHERVILLE
Lot 18, con. II, Rainham tp.

Completed September 28, 1932.
Open flow: 30,000 cu. ft.
Rock pressure: 305 lbs.

Formation	Thickness, ft.
Surface	16
Flint	75
Lime and shale	358
Niagara	284
Shale	56
Clinton	25
Red Medina	40
Grey shale	58
White Medina	12
Red shale	28
Total depth	952

Gas at 789 and 912 feet.
Sulphur water at 48 feet.

STANDARD GAS AND OIL SYNDICATE, DUNNVILLE
Lot 1, S. ½, con. VI, Rainham tp.

Completed November 9, 1932.
Open flow: 440,000 cu. ft.
Rock pressure: 400 lbs.

Formation	Thickness, ft.
Surface	14
Flint	90
Lime and shale	353
Niagara	246
Shale	50
Clinton	27
Red Medina	35
Grey shale	60
White Medina	15
Red shale	6
Total depth	896

Gas at 770, 775, 781, 797, and 806 feet.
Fresh water at 42 feet; black water at 55 feet.

IDEAL GAS SYNDICATE, FISHERVILLE
Lot 16, con. III, Rainham tp.

Completed November 2, 1932.
Open flow: 55,000 cu. ft.
Rock pressure: 190 lbs.

Formation	Thickness, ft.
Surface	14
Flint	75
Lime and shale	356
Niagara	230
Shale	57
Clinton	21
Red Medina	42
Grey shale	59
White Medina	15
Red shale	4
Total depth	873

Gas at 757 feet.
Sulphur water at 20 feet.

IDEAL GAS SYNDICATE, FISHERVILLE
Lot 15, con. IV, Rainham tp.

Completed October 9, 1932.
Open flow: 33,000 cu. ft.
Rock pressure: 340 lbs.

Formation	Thickness, ft.
Surface	25
Flint	50
Lime and shale	360
Niagara	230
Shale	57
Clinton	28
Red Medina	35
Grey shale	55
White Medina	20
Red shale	2
Total depth	862

Gas at 732, 744, and 776 feet.
Sulphur water at 30 feet.

IDEAL GAS SYNDICATE, FISHERVILLE
Lot 15, con. IV, Rainham tp.

Completed August 23, 1932.
Open flow: 23,000 cu. ft.
Rock pressure: 315 lbs.

Formation	Thickness, ft.
Surface	13
Flint	75
Lime and shale	352
Niagara	230
Shale	57
Clinton	28
Red Medina	38
Shale	55
White Medina	15
Red shale	5
Total depth	868

Gas at 747 feet.
Sulphur water at 18 feet.

IDEAL GAS SYNDICATE, FISHERVILLE
Lot 15, con. IV, Rainham tp.

Completed September 20, 1932.
Open flow: 45,000 cu. ft.
Rock pressure: 390 lbs.

Formation	Thickness, ft.
Surface	28
Flint	70
Lime and shale	335
Niagara	230
Shale	60
Clinton	30
Red Medina	40
Shale	60
White Medina	15
Red shale	6
Total depth	874

Gas at 726, 777, and 779 feet.
Sulphur water at 31 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Lot 6, con. I, Rainham tp.

Completed March 2, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	15
Flint	120
Lime and shale	350
Niagara	235
Casing shale	60
Clinton	22
Red Medina sand	18
Red Medina shale	22
Grey shale	63
White Medina	15
Red shale	5
Total depth	925

Water at 75 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Lot 5, con. I, Rainham tp.

Completed March 31, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	11
Flint	82
Lime and shale	382
Niagara	250
Casing shale	55
Clinton	30
Red Medina sand	20
Red Medina shale	11
Grey shale	62
White Medina	12
Red shale	5
Total depth	920

Water at 37 and 52 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Lot 10, S.E. ¼, con. II, Rainham tp.

Completed April 2, 1932.
Open flow: 160,000 cu. ft.
Rock pressure: 325 lbs.

Formation	Thickness, ft.
Surface	21
Flint	89
Lime and shale	365
Niagara	243
Casing shale	40
Clinton	32
Red Medina sand	46
Grey shale	54
White Medina	12
Red shale	6
Total depth	908

Gas at 775 and 805 to 815 feet.
Water at 65 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Lot 10, S.E. ¼, con. II, Rainham tp.

Completed May 2, 1932.
Open flow: 53,620 cu. ft.
Rock pressure: 315 lbs.

Formation	Thickness, ft.
Surface	16
Flint	84
Lime and shale	370
Niagara	240
Casing shale	60
Clinton	25
Red Medina sand	35
Red Medina shale	9
Grey shale	55
White Medina	12
Red shale	3
Total depth	909

Gas at 795 feet.
Water at 98 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Lot 10, S.E. ¼, con. II, Rainham tp.

Completed May 5, 1932.
Open flow: 53,000 cu. ft.
Rock pressure: 380 lbs.

Formation	Thickness, ft.
Surface	13
Flint	82
Lime and shale	377
Niagara	231
Casing shale	61
Clinton	26
Red Medina sand	31
Red Medina shale	14
Grey shale	61
White Medina	8
Red shale	3
Total depth	907

Gas at 767 and 803 feet.
Water at 39 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Lot 10, S.E. ¼, con. II, Rainham tp.

Completed May 26, 1932.
Open flow: 20,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	15
Flint	82
Lime and shale	371
Niagara	238
Casing shale	64
Clinton	25
Red Medina sand	36
Red Medina shale	7
Grey shale	62
White Medina	7
Red shale	3
Total depth	910

Gas at 775 and 922 feet.
Water at 72 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Lot 9, N.E. ¼, con. I, Rainham tp.

Completed June 28, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	15
Flint	75
Lime and shale	380
Niagara	245
Casing shale	50
Clinton	30
Red Medina sand	15
Red Medina shale	25
Grey shale	51
White Medina	14
Red shale	1
Total depth	901

Water at 40 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Lot 10, N.W. ¼, con. I, Rainham tp.

Completed June 28, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	13
Flint	85
Lime and shale	379
Niagara	234
Casing shale	63
Clinton	23
Red Medina sand	30
Red Medina shale	18
Grey shale	56
White Medina	8
Red shale	2
Total depth	911

Water at 25 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Lot 10, N.E. ¼, con. I, Rainham tp.

Completed July 22, 1932.
Open flow: 19,000 cu. ft.
Rock pressure: 230 lbs.

Formation	Thickness, ft.
Surface	7
Flint	80
Lime and shale	388
Niagara	237
Casing shale	53
Clinton	25
Red Medina sand	18
Red Medina shale	27
Grey shale	54
White Medina	15
Red shale	5
Total depth	909

Gas at 790 feet.
Water at 90 feet.

HALDIMAND GAS SYNDICATE, CAYUGA
Lot 6, S.W. ¼, con. IV, Rainham tp.

Completed August 17, 1932.
Open flow: 74,000 cu. ft.
Rock pressure: 270 lbs.

Formation	Thickness, ft.
Surface	22
Flint	68
Lime and shale	374
Niagara	252
Casing shale	45
Clinton	34
Red Medina sand	20
Red Medina shale	20
Grey shale	54
White Medina	15
Red shale	5
Total depth	909

Gas at 795 feet.
Water at 85 feet.

HALDIMAND GAS SYNDICATE, CAYUGA
Lot 6, N.E. ¼, con. III, Rainham tp.

Completed September 8, 1932.
Open flow: 26,000 cu. ft.
Rock pressure: 210 lbs.

Formation	Thickness, ft.
Surface	12
Flint	68
Lime and shale	395
Niagara	240
Casing shale	49
Clinton	31
Red Medina sand	25
Red Medina shale	20
Grey shale	60
White Medina	11
Red shale	4
Total depth	915

Gas at 764 and 795 feet.
Water at 55 feet.

LYMBURNER BROS. AND WEBBER, DUNNVILLE
Lot 16, con. II, Rainham tp.

Completed July 27, 1932.
Open flow: 43,000 cu. ft.
Rock pressure: 270 lbs.

Formation	Thickness, ft.
Surface	8
Flint	75
Lime and shale	365
Niagara	226
Shale	58
Clinton	29
Red Medina	44
Grey shale	62
White Medina	12
Red shale	4
Total depth	883

Gas at 734, 737, and 759 feet.
Black water at 60 and 100 feet.

LYMBURNER BROS. AND WEBBER, DUNNVILLE
Lot 16, con. II, Rainham tp.

Completed August 23, 1932.
Open flow: 95,000 cu. ft.
Rock pressure: 200 lbs.

Formation	Thickness, ft.
Surface	12
Flint	68
Lime and shale	374
Niagara	224
Shale	53
Clinton	22
Red Medina	44
Grey shale	60
White Medina	12
Red shale	3
Total depth	872

Gas at 758 and 778 feet.
Black water at 80 feet.

LYMBURNER BROS. AND WEBBER, DUNNVILLE
Lot 16, con. II, Rainham tp.

Completed September 17, 1932.
Open flow: 56,000 cu. ft.
Rock pressure: 350 lbs.

Formation	Thickness, ft.
Surface	12
Flint	58
Lime and shale	373
Niagara	229
Shale	56
Clinton	27
Red Medina	41
Grey shale	60
White Medina	10
Red shale	51
Total depth	917

Gas at 768 and 861 feet.
Black water at 55 feet.

LYMBURNER BROS. AND WEBBER, DUNNVILLE
Lot 16, con. II, Rainham tp.

Completed October 13, 1932.
Open flow: 27,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	8
Flint	60
Lime and shale	367
Niagara	231
Shale	58
Clinton	28
Red Medina	42
Gray shale	60
White Medina	10
Red shale	3
Total depth	867

Gas at 765 feet.
Black water at 105 and 146 feet.

LYMBURNER BROS. AND WEBBER, DUNNVILLE
Lot 16, con. I, Rainham tp.

Completed December 4, 1932.
Open flow: 30,000 cu. ft.
Rock pressure: 290 lbs.

Formation	Thickness, ft.
Surface	19
Flint	61
Lime and shale	359
Niagara	228
Shale	56
Clinton	24
Red Medina	45
Grey shale	60
White Medina	10
Red shale	52
Total depth	914

Gas at 746, 762, and 859 feet.
Water at 28 and 90 feet.

LYMBURNER BROS. AND WEBBER, DUNNVILLE
Lot 16, con. I, Rainham tp.

Completed December 31, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	21
Flint	40
Lime and shale	377
Niagara	229
Shale	61
Clinton	27
Red Medina	44
Grey shale	60
White Medina	10
Red shale	2
Total depth	871

Water at 60 and 120 feet.

SWEETS CORNERS GAS SYNDICATE, FISHERVILLE
Lot 18, N.E. ¼, con. II, Rainham tp.

Completed June 29, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	14
Flint	61
Lime and shale	362
Niagara	231
Shale	57
Clinton	31
Red Medina	44
Grey shale	55
White Medina	12
Red shale	35
Total depth	902

Fresh water at 45 feet.

SWEETS CORNERS GAS SYNDICATE, FISHERVILLE
Lot 18, N.W. ¼, con. II, Rainham tp.

Completed June 7, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	17
Flint	55
Lime and shale	355
Niagara	231
Shale	55
Clinton	31
Red Medina	44
Grey shale	57
White Medina	11
Red shale	7
Total depth	863

Fresh water at 29 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Lot 9, S.E. ¼, con. II, Rainham tp.

Completed May 30, 1932.
Open flow: 23,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	14
Flint	81
Lime and shale	380
Niagara	235
Casing shale	63
Clinton	30
Red Medina sand	36
Red Medina shale	7
Grey shale	60
White Medina	5
Red shale	5
Total depth	916

Gas at 773 feet.
Water at 63 feet.

WALTER DAVIS, KENMORE, N.Y.
Lot 2, con. VIII, Rainham tp.

Completed December 3, 1932.
Open flow: 15,000 cu. ft.
Rock pressure: 390 lbs.

Formation	Thickness, ft.
Surface	8
Lime and shale	447
Niagara	240
Shale	25
Clinton	35
Red Medina	37
Shale	68
White Medina	20
Red shale	40
Total depth	920

Fresh water at 60 feet; salt water at 475 feet.

E. L. PLUMMER, TORONTO
Lot 17, con. II, Rainham tp.

Completed December 30, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	10
Flint	50
Lime and shale	386
Niagara	230
Shale	50
Clinton	27
Red Medina	40
Grey shale	52
White Medina	17
Red shale	2
Total depth	864

Show of gas at 771 feet.

W. B. LINDSAY, TORONTO
Lot 14, con. I, Rainham tp.

Completed December 30, 1932.
Open flow: 37,000 cu. ft.
Rock pressure: 275 lbs.

Formation	Thickness, ft.
Surface	7
Flint	65
Lime and shale	380
Niagara	265
Shale	16
Clinton	28
Red Medina	42
Shale	60
White Medina	10
Red shale	2
Total depth	875

Fresh water at 38 feet.

W. B. LINDSAY, TORONTO
Lot 15, con. I, Rainham tp.

Completed November 26, 1932.
Open flow: 25,000 cu. ft.
Rock pressure: 275 lbs.

Formation	Thickness, ft.
Surface	7
Flint	65
Lime and shale	379
Niagara	262
Shale	16
Clinton	28
Red Medina	44
Shale	58
White Medina	10
Red shale	2
Total depth	871

Fresh water at 35 feet.

RAINHAM GAS SYNDICATE, CAYUGA
S.E. pt. of S. ½, Y.T., Seneca tp.

Completed September 26, 1932.
Open flow: 17,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	95
Lime and shale	135
Niagara	230
Casing shale	52
Clinton	28
Red Medina sand	25
Red Medina shale	22
Grey shale	45
White Medina	12
Red shale	4
Total depth	648

Gas at 512 feet.
Water at 115 feet.

RAINHAM GAS SYNDICATE, CAYUGA
S.E. pt. of S. ½, Y.T., Seneca tp.

Completed October 13, 1932.
Open flow: 46,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	90
Lime and shale	137
Niagara	233
Casing shale	53
Clinton	30
Red Medina sand	15
Red Medina shale	30
Grey shale	47
White Medina	20
Red shale	3
Total depth	658

Gas at 533 feet.
Show of oil at 543 feet.
Water at 104 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Y.T., Seneca tp.

Completed November 18, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	88
Lime and shale	137
Niagara	240
Casing shale	48
Clinton	26
Red Medina sand	15
Red Medina shale	16
Grey shale	60
White Medina	20
Red shale	4
Total depth	654

Water at 105 feet.

RAINHAM GAS SYNDICATE, CAYUGA
S.E. pt. of S. ½, Y.T., Seneca tp.

Completed October 28, 1932.
Open flow: 125,000 lbs.
Rock pressure: 210 lbs.

Formation	Thickness, ft.
Surface	101
Lime and shale	124
Niagara	245
Casing shale	40
Clinton	25
Red Medina sand	24
Red Medina shale	15
Grey shale	76
White Medina	24
Red shale	6
Total depth	680

Gas at 510 and 535 feet.
Water at 105 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Lot 25, con. II, Seneca tp.

Completed December 6, 1932.
Open flow: 125,000 cu. ft.
Rock pressure: 105 lbs.

Formation	Thickness, ft.
Surface	89
Lime and shale	146
Niagara	235
Casing shale	48
Clinton	25
Red Medina sand	28
Red Medina shale	12
Grey shale	59
White Medina	15
Red shale	3
Total depth	660

Gas at 527 feet.
Water at 105 feet.

RAINHAM GAS SYNDICATE, CAYUGA
Lot 25, con. II, Seneca tp.

Completed December 30, 1932.
Open flow: 92,000 cu. ft.
Rock pressure: 105 lbs.

Formation	Thickness, ft.
Surface	89
Lime and shale	135
Niagara	251
Casing shale	47
Clinton	24
Red Medina sand	22
Red Medina shale	17
Grey shale	63
White Medina	10
Red shale	5
Total depth	663

Gas at 522 feet.
Water at 105 feet.

NEWCASTLE OIL AND MINING CO., TORONTO
Lot C, con. II, Seneca tp.

Completed February 20, 1932.
Open flow: 4,000 cu. ft.
Rock pressure: 115 lbs.

Formation	Thickness, ft.
Surface	38
Lime and shale	82
Niagara	210
Guelph lime	5
Casing shale	10
Shale	37
Clinton	34
Red Medina	46
Shale	70
White Medina	14
Red shale	40
Total depth	586

Fresh water at 50 feet; salt water at 309 feet.

PENINSULA GAS CO., TORONTO
Lot 15, N. ½, con. III, Seneca tp.

Completed April 8, 1932.
Open flow: 10,000 cu. ft.
Rock pressure: 110 lbs.

Formation	Thickness, ft.
Surface	49
Lime and shale	81
Niagara	210
Guleph lime	30
Shale	27
Clinton	20
Red Medina	41
Shale	55
White Medina	12
Red shale	50
Total depth	575

Fresh water at 56 feet; salt water at 200 feet.

WHITE EAGLE OIL AND GAS SYNDICATE, SARNIA
S.W. pt., N.T., Seneca tp.

Completed November 19, 1932.
Open flow: 35,000 cu. ft.
Rock pressure: 200 lbs.

Formation	Thickness, ft.
Surface	80
Lime and shale	80
Niagara	230
Shale	44
Clinton	20
Red Medina	26
Blue shale	72
White Medina	12
Red shale	53
Total depth	617

Gas at 450 and 455 feet.

WHITE EAGLE OIL AND GAS SYNDICATE, SARNIA
S.W. pt., N.T., Seneca tp.

Completed October 17, 1932.
Open flow: 30,000 cu. ft.
Rock pressure: 160 lbs.

Formation	Thickness, ft.
Surface	83
Lime and shale	77
Niagara	236
Shale	44
Clinton	20
Red Medina	25
Blue shale	60
White Medina	15
Red shale	70
Total depth	630

Gas at 454 and 552 feet.

WHITE EAGLE OIL AND GAS SYNDICATE, SARNIA
S.W. pt., N.T., Seneca tp.

Completed September 27, 1932.
Open flow: 35,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	80
Lime and shale	85
Niagara	238
Shale	47
Clinton	25
Red Medina	25
Blue shale	60
White Medina	12
Red shale	68
Total depth	640

Gas at 465, 499, and 565 feet.

WHITE EAGLE OIL AND GAS SYNDICATE, SARNIA
S.W. pt., N.T., Seneca tp.

Completed September 2, 1932.
Open flow: 82,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	90
Lime and shale	80
Niagara lime	235
Shale	50
Clinton	25
Red Medina	32
Blue shale	54
White Medina	14
Red shale	70
Total depth	650

Gas at 485 and 568 feet.

WHITE EAGLE OIL AND GAS SYNDICATE, SARNIA
S.W. pt., N.T., Seneca tp.

Completed August 13, 1932.
Open flow: 42,000 cu. ft.
Rock pressure: 220 lbs.

Formation	Thickness, ft.
Surface	84
Lime and shale	86
Niagara lime	234
Shale	58
Clinton	14
Red Medina	34
Blue shale	48
White Medina	18
Red shale	74
Total depth	650

Gas at 463, 476, and 572 feet.

WHITE EAGLE OIL AND GAS SYNDICATE, SARNIA
S.W. pt., N.T., Seneca tp.

Completed July 7, 1932.
Open flow: 35,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	85
Lime and shale	90
Niagara	232
Shale	51
Clinton	18
Red Medina	36
Blue shale	51
White Medina	20
Red shale	67
Total depth	650

Gas at 463, 476, and 500 feet.

WHITE EAGLE OIL AND GAS SYNDICATE, SARNIA
S.W. pt., N.T., Seneca tp.

Completed June 15, 1932.
Open flow: 42,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	85
Lime and shale	100
Niagara lime	220
Shale	55
Clinton	20
Red Medina	35
Blue shale	50
White Medina	22
Red shale	65
Total depth	652

Gas at 475, 498, and 577 feet.

WHITE EAGLE OIL AND GAS SYNDICATE, SARNIA
S.W. pt., N.T., Seneca tp.

Completed May 13, 1932.
Open flow: 70,700 cu. ft.
Rock pressure: 115 lbs.

Formation	Thickness, ft.
Surface	71
Lime and shale	104
Niagara	232
Shale	51
Clinton	22
Red Medina	35
Blue shale	50
White Medina	20
Red shale	55
Total depth	640

Gas at 472, 510, and 580 feet.

SHERBROOKE GAS SYNDICATE, DUNNVILLE
Lot 17, con. I, Sherbrooke tp.

Completed April 9, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	34
Flint	70
Lime and shale	406
Niagara	226
Shale	64
Clinton	30
Red Medina	43
Shale	50
White Medina	15
Red shale	6
Total depth	944

SHERBROOKE GAS SYNDICATE, DUNNVILLE
Lot 19, con. I, Sherbrooke tp.

Completed March 9, 1932.
Open flow: 35,000 cu. ft.
Rock pressure: 345 lbs.

Formation	Thickness, ft.
Surface	10
Flint	60
Lime and shale	385
Niagara	226
Shale	73
Clinton	30
Red Medina	45
Shale	48
White Medina	16
Red shale	35
Total depth	928

Gas at 757, 779, and 886 feet.
Fresh water at 35 feet.

SHERBROOKE GAS SYNDICATE, DUNNVILLE
Lot 19, con. I, Sherbrooke tp.

Completed May 27, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	11
Flint	50
Lime and shale	377
Niagara	212
Shale	66
Clinton	31
Red Medina	45
Shale	48
White Medina	16
Red shale	3
Total depth	859

Fresh water at 30 feet.

WALPOLE GAS SYNDICATE, CAYUGA
Lot 18, con. VII, Walpole tp.

Completed November 18, 1932.
Open flow: 200,000 cu. ft.
Rock pressure: 455 lbs.

Formation	Thickness, ft.
Surface	28
Flint	67
Lime and shale	354
Niagara	277
Casing shale	50
Clinton	25
Red Medina sand	24
Red Medina shale	11
Grey shale	66
White Medina	10
Red shale	2
Total depth	914

Gas at 776 and 806 feet.
Fresh water at 47 feet.

W. B. LINDSAY, TORONTO
Lot 23, con. II, Walpole tp.

Completed July 2, 1932.
Open flow: 48,000 cu. ft.
Rock pressure: 310 lbs.

Formation	Thickness, ft.
Surface	11
Flint and lime	126
Lime and shale	363
Niagara	282
Grey shale	49
Clinton	26
Red Medina	38
Blue shale	60
White Medina	15
Red shale	3
Total depth	973

Gas at 846 and 877 feet.
Sulphur water at 80 feet.

W. B. LINDSAY, TORONTO
Lot 23, con. II, Walpole tp.

Completed August 12, 1932.
Open flow: 33,000 cu. ft.
Rock pressure: 315 lbs.

Formation	Thickness, ft.
Surface	8
Flint and lime	138
Lime and shale	362
Niagara	280
Grey shale	49
Clinton	25
Red Medina	37
Blue shale	60
White Medina	12
Red shale	3
Total depth	974

Gas at 843, 865, and 880 feet.
Sulphur water at 70 feet.

W. B. LINDSAY, TORONTO
Lot 24, con. I, Walpole tp.

Completed October 10, 1932.
Open flow: 50,000 cu. ft.
Rock pressure: 310 lbs.

Formation	Thickness, ft.
Surface	12
Flint and lime	137
Lime and shale	351
Niagara	266
Grey shale	55
Clinton	26
Red Medina	37
Blue shale	60
White Medina	15
Red shale	4
Total depth	963

Gas at 882 feet.
Sulphur water at 65 feet.

W. B. LINDSAY, TORONTO
Lot 23, con. II, Walpole tp.

Completed May 24, 1932.
Open flow: 100,000 cu. ft.
Rock pressure: 315 lbs.

Formation	Thickness, ft.
Surface	15
Flint lime	130
Lime and shale	360
Niagara lime	287
Grey shale	46
Clinton	28
Red Medina	36
Blue shale	60
White Medina	12
Red shale	2
Total depth	976

Gas at 891 and 917 feet.
Black water at 100 feet.

STANDARD GAS AND OIL SYNDICATE, DUNNVILLE
Lot 24, S. ½ of E. ½ of N. ½, con. VI, Walpole tp.

Completed December 10, 1932.
Open flow: 75,000 cu. ft.
Rock pressure: 395 lbs.

Formation	Thickness, ft.
Surface	8
Flint	80
Lime and shale	360
Niagara	250
Shale	48
Clinton	29
Red Medina	40
Grey shale	55
White Medina	15
Red shale	5
Total depth	890

Gas at 750, 766, 786, 810, 827, and 867 feet.
Fresh water at 30 feet.

EMPIRE GAS AND OIL SYNDICATE, TORONTO
Lot 1, con. I, Walpole tp.

Completed December 30, 1932.
Open flow: 306,000 cu. ft.
Rock pressure: 425 lbs.

Formation	Thickness, ft.
Surface	24
Flint	136
Lime and shale	360
Niagara	270
Black sand	15
White sand	45
Shale	41
Clinton	16
Red Medina	52
Grey shale	33
Total depth	992

Gas at 907 and 959 feet.
Sulphur water at 110 feet; black at 630 feet.

WALPOLE GAS SYNDICATE, CAYUGA
Lot 17, con. VII, Walpole tp.

Completed December 8, 1932.
Open flow: 66,000 cu. ft.
Rock pressure: 445 lbs.

Formation	Thickness, ft.
Surface	3
Flint	86
Lime and shale	363
Niagara	271
Casing shale	57
Clinton	26
Red Medina sand	22
Red Medina shale	12
Grey shale	62
White Medina	11
Red shale	2
Total depth	915

Gas at 780 and 806 feet.
Sulphur water at 76 feet.

WALPOLE GAS SYNDICATE, CAYUGA
Lot 16, con. VI, Walpole tp.

Completed December 28, 1932.
Open flow: 270,000 cu. ft.
Rock pressure: 450 lbs.

Formation	Thickness, ft.
Surface	9
Flint	85
Lime and shale	356
Niagara	279
Casing shale	62
Clinton	26
Red Medina sand	13
Red Medina shale	20
Grey shale	60
White Medina	11
Red shale	3
Total depth	924

Gas at 791 and 817 feet.
Sulphur water at 58 feet.

WALPOLE GAS SYNDICATE, CAYUGA
Lot 17, N.E. ¼, con. VI, Walpole tp.

Completed October 24, 1932.
Open flow: 165,000 cu. ft.
Rock pressure: 455 lbs.

Formation	Thickness, ft.
Surface	7
Flint	86
Lime and shale	357
Niagara	280
Casing shale	50
Clinton	24
Red Medina sand	24
Red Medina shale	20
Grey shale	61
White Medina	6
Red shale	3
Total depth	918

Gas at 780 and 804 feet.
Water at 15 feet.

Kent County

OLGA GAS AND OIL COMPANY, TORONTO
Lot 18, con. VIII, Raleigh tp.

Completed January 25, 1932.
Open flow: 380,000 cu. ft.
Rock pressure: 720 lbs.

Formation	Thickness, ft.
Surface	96
Soap	194
Lime	160
Oriskany	250
Lime	800
Guelph	147
Total depth	1,647

Gas at 1,570, 1,580, 1,605, 1,620, and 1,637 feet.
Showing of oil.
Fresh water at 90 feet; salt at 450 feet.

HIGHBANK OIL, LIMITED, CHATHAM
Lot 146, S.T.R., Raleigh tp.

Completed March 17, 1930.
Open flow: 690,000 cu. ft.
Rock pressure: 600 lbs.

Formation	Thickness, ft.
Gravel and quicksand	38
Clay	138
Gravel and sand	10
Soap	80
Lime	229
Sharp sand	300
Medium lime	213
Lime	557
Total depth	1,565

Gas at 1,423, 1,495, 1,535, 1,540, and 1,548 feet.
Fresh water at 175 feet; salt water at 625 feet; sulphur water at 755 feet.

HIGHBANK OIL, LIMITED, CHATHAM
Lot 147, S.T.R., Raleigh tp.

Completed November 4, 1930.
Open flow: 1,050,000 cu. ft.
Rock pressure: 610 lbs.

Formation	Thickness, ft.
Surface	171
Soap	92
Medium hard lime	222
Sharp sand	249
Hard lime	256
Lime and gypsum	5
Hard lime	119
Medium hard lime	31
Very hard lime	330
Hard lime	25
White lime	53
Hard lime	36
Total depth	1,589

Gas at 1,438, 1,510, 1,553 to 1,563, 1,570 to 1,578, and 1,584 feet.
Salt water at 295 and 455 feet; sulphur water at 734 feet.

UNION GAS CO. OF CANADA, CHATHAM
Lot 21, con. X, Raleigh tp.

Completed May 31, 1932.
Rock pressure: 495 lbs.

Formation	Thickness, ft.
Surface	136
Shale and lime	79
Onondaga grey lime	198
Detroit River grey lime	127
Sharp lime	135
Salina grey and brown lime	175
Grey lime and gypsum	75
Brown and blue lime	80
Brown and blue lime and gypsum	40
Brown and blue lime	220
Salt and lime	70
Salt	65
Brown lime	50
Grey lime	20
Brown lime	22
Grey and brown lime	173
Sharp brown lime	45
Brown and grey lime	90
White lime	20
Rochester blue shale	33
Clinton	7
Red and blue shale	15
Blue shale	10
Red Medina	5
Total depth	1,890

Gas at 230, 1,045 to 1,055, 1,428, 1,437, 1,505 to 1,513, 1,542, and 1,573 to 1,578 feet.
Show of oil at 1,625 feet.
Sulphur water at 375 and 413 feet; salt water at 1,407 feet.

UNION GAS CO. OF CANADA, CHATHAM
Lot 22, con. X, Raleigh tp.

Completed July 27, 1932.
Rock pressure: 590 lbs.

Formation	Thickness, ft.
Surface	118
Shale	107
Onondaga grey lime	150
Detroit River grey and brown lime	175
Sharp grey lime	135
Brown and grey lime	180
Brown and grey lime and gypsum	165
Brown lime	55
Blue lime	15
Brown lime	60
Blue and brown lime	105
Salt	150
Brown lime	50
Grey lime	80
Brown and grey lime	75
Brown lime	145
Grey lime	25
White lime	40
Rochester shale	3
Total depth	1,833

Gas at 1,058, 1,545, 1,547, 1,553, 1,564, and 1,566 feet.
Show of oil at 480 feet.
Sulphur water at 330 to 377, and 425 feet.

ROMNEY GAS AND OIL CO., LONDON
Pt. gore A, Romney tp.

Completed April 14, 1932.
Open flow: 93,000 cu. ft.
Rock pressure: 145 lbs.

Formation	Thickness, ft.
Surface (clay)	140
Top rock	10
Grey lime	250
Sharp sand	150
Lime	178
Gypsum	2
Gypsum and lime	20
Dark-grey lime	330
Light-grey lime	60
Brown lime and shell	23
Light-brown lime	2
Grey lime	10
Light-brown lime	5
Brown lime	24
Grey and brown lime	12
Brown lime	30
Light-grey lime	41
White lime	4
Total depth	1,291

Gas at 1,160 to 1,163, 1,185, and 1,287 to 1,291 feet.
Fresh water at 140 and 250 feet; salt water at 618 feet; black salt water at 672 feet; salt water at 1,291 feet.

RALPH DAWSON, MERLIN
Lot 3, con. XV, Tilbury East tp.

Completed January 14, 1932.
Open flow: 471,000 cu. ft.
Rock pressure: 225 lbs.

Formation	Thickness, ft.
Surface	130
Black shale	10
Soapstone	70
Grey lime	5
Soapstone	20
Grey lime	5
Brown lime	285
Sharp sand	150
Grey lime	175
Blue shale	95
Grey lime	70
Brown lime	10
Grey lime	20
Brown lime	115
Blue shale	25
Brown lime	95
Broken brown and grey lime	60
Total depth	1,340

Gas at 1,200, 1,230, 1,293, 1,304, and 1,322 feet.
Fresh water at 135 feet; black water at 675 feet.

RALPH DAWSON, MERLIN
Lot 3, con. XV, Tilbury East tp.

Completed May 14, 1932.
Open flow: 150,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	138
Shale	20
Soapstone	120
Grey lime	162
Brown lime	40
Grey lime	60
Brown lime and sharp sand	130
Grey lime	115
Grey lime and gypsum	5
Grey lime	45
Blue shale	165
Grey lime	75
Blue shale	120
Brown lime	25
Blue shale	10
Dark-grey lime	98
Total depth	1,328

Gas at 1,203, 1,234, 1,285, and 1,303 feet.
Fresh water at 135 feet; black water at 600 feet; salt water at 1,326 feet.

Lambton County

UNION GAS CO. OF CANADA, CHATHAM
Lot 23, con. II, Dawn tp.

Completed June 9, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	69
Huron shale	211
Hamilton lime	35
Hamilton shale	160
Onondaga grey lime	140
Detroit River brown lime	215
Sharp grey lime	120
Brown lime	90
Blue lime and gypsum	30
Brown and grey lime	25
Blue lime	135
Brown lime	70
Grey and brown lime	35
Blue lime	45
Grey and blue lime	55
Salt and lime	180
Brown and grey lime	50
Dark-brown and grey lime	95
Salt and lime	45
White lime	10
Brown and black lime	10
Brown lime	70
Black lime	30
Grey and brown lime	62
Total depth	1,987

Gas at 1,820 feet.
Oil at 1,815 feet.
Sulphur water at 615 feet; salt water at 1,820 to 1,825, and 1,960 feet; fresh water at 495 feet.

UNION GAS CO. OF CANADA, CHATHAM
Lot 25, con. II, Dawn tp.

Completed August 5, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	69
Brown shale	166
Top rock	70
Hamilton shale	152
Onondaga grey lime	123
Detroit River brown and grey lime	255
Sharp brown and grey lime	125
Brown and grey lime	80
Blue and brown lime and gypsum	70
Blue lime	100
Brown and blue lime and gypsum	10
Brown and grey lime	125
Blue lime	70
Salt	195
Brown and grey lime	95
Black lime	60
Salt	40
White lime	5
Brown lime	140
White lime	10
Brown and grey lime	35
White lime	45
Blue lime	20
Rochester grey shale	42
Clinton	10
Red shale	3
Total depth	2,115

Show of gas and oil at 1,815 feet.
Fresh water at 69 feet; sulphur water at 540 and 580 feet.

UNION GAS CO. OF CANADA, CHATHAM
Lot 24, con. II, Dawn tp.

Completed October 28, 1932.

Formation	Thickness, ft.
Surface	73
Huron shale	182
Top rock	57
Upper soap	115
Middle lime	15
Lower soap	28
Onondaga brown lime	85
Detroit River brown and grey lime	280
Sharp grey lime	123
Salina brown and grey lime and gypsum	479
Salt	173
Blue and brown lime	154
Salt	36
White lime	5
Guelph and Lockport brown lime	163
Grey lime	44
Total depth	2,012

Gas at 1,805 to 1,815 feet; show of gas at 1,817 and 1,954 to 1,959 feet.
Oil at 1,933 to 1,940 feet.
Sulphur water at 555 feet; salt water at 1,954 to 1,959 and 1,995 to 2,012 feet.

UNION GAS CO. OF CANADA, CHATHAM
Lot 24, con. II, Dawn tp.

Completed August 30, 1932.

Formation	Thickness, ft.
Surface	75
Brown shale	170
Top rock	60
Upper soap	118
Middle lime	17
Lower soap	30
Onondaga (grey lime)	110
Detroit River grey and brown lime	255
Hard sharp grey lime	120
Hard brown and grey lime	85
Blue and brown lime and gypsum	150
Blue and brown lime	25
Hard brown lime	30
Blue and brown lime	160
Salt	205
Brown and grey lime	80
Blue lime	30
Grey and blue lime	40
Salt	42
White lime	8
Brown lime	135
Black and grey lime	5
Fine brown lime	10
Total depth	1,960

Oil at 1,813 and 1,824 feet.
Sulphur water at 580 feet.

ERNEST E. KELLS, PETROLIA
Lot 6, E.½, con. XIV, Enniskillen tp.

Completed February 20, 1932.
Oil yield: 16 barrels per month.

Formation	Thickness, ft.
Clay surface	185
Limestone	50
Soapstone	140
Grey limestone	15
Soapstone	43
Limestone	54
Total depth	487

Oil at 450 and 475 feet.

THOMAS JOSH, PETROLIA
Lot 7, con. XIV, Enniskillen tp.

Completed October 5, 1932.
Oil yield: 5 gallons per day.
Open flow: Very small show of gas.

Formation	Thickness, ft.
Clay	12
Blue clay	168
Top rock	50
Top soap	140
Middle lime	15
Lower soap	45
Lower lime	77
Total depth	507

Gas and oil at 465 feet.
Fresh water at 185 feet; salt water at 470 feet.

LAMBTON OIL AND GAS SYNDICATE, BOTHWELL
Lot 28, S.W. corner, con. IX, Euphemia tp.

Completed April 16, 1932.
Oil yield: 35 bbls. per day.

Formation	Thickness, ft.
Surface	68
Top lime	42
Upper soap	127
Middle lime	15
Lower soap	23
Black streak	7
Big lime	26
Total depth	308

Show of oil at 297 feet.
No water.

LAMBTON OIL AND GAS SYNDICATE, BOTHWELL
Lot 27, con. IX, Euphemia tp.

Completed May 5, 1932.
Dry hole.

Formation	Thickness, ft.
Clay and quicksand	58
Hardpan	16
Top lime	34
Upper soapstone	135
Middle lime	15
Lower soapstone	25
Dark streak	3
Lower lime	129
Total depth	415

Very small supply of water at 60 feet.

LAMBTON OIL AND GAS SYNDICATE, BOTHWELL
Lot 28, con. IX, Euphemia tp.

Completed May 23, 1932.
Dry hole.

Formation	Thickness, ft.
Clay	62
Hardpan	8
Top lime	38
Upper soapstone	140
Middle lime	16
Lower soapstone	24
Dark streak	2
Lower lime	60
Total depth	350

Very small showing of gas at 142, 170, and 300 feet.
Fresh water at 64 feet.

J. F. Marshant, Petrolia
Lot 28, con. VIII, Euphemia tp.

Completed October 19, 1932.
Oil yield: 5 bbls.

Formation	Thickness, ft.
Surface	66
Top rock	5
Soap	10
Rock	5
Lower soap	151
Middle lime	15
Soap	25
Lower lime	80
Sand	20
Total depth	377

Oil at 280 to 295, 330, and 335 feet.

Dawn Oil and Gas Co., Chatham
Lot 25, con. XI, Sombra tp.

Completed April 22, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	109
Lime and soapstone	393
Top big lime at 502 feet.	
Lime and salt	1,618
Grey shale	30
Total depth	2,150

Salt water at 645 and 2,015 feet.

Lincoln County

Lincoln Gas Co., Toronto
Lot 1, con. I, Gainsborough tp.

Completed February 20, 1932.
Open flow: 10,000 cu. ft.
Rock pressure: 160 lbs.

Formation	Thickness, ft.
Surface	73
Lime and shale	55
Niagara	200
Shale	30
Clinton	30
Red Medina	40
Shale	55
White Medina	12
Red shale	3
Total depth	498

Fresh water at 80 feet.

Manitoulin

Senator Pascal Poirier, Ottawa
Lot 24, con. XI, Sheguiandah tp.

Completed January 7, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	1
Hudson River lime	40
Hudson River shale	272
Utica	60
Trenton	37
Total depth	410

Show of gas at 200 and 400 feet.
Salt water at 400 feet.

Senator Pascal Poirier, Ottawa
Lot 21, con. XI, Sheguiandah tp.

Completed January 23, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	1
Hudson River lime	50
Hudson River shale	255
Utica shale	92
Trenton	125
Total depth	523

Gas at 210 and 426 feet.
Seepage of water at 3 feet; seepage of salt water at 523 feet.

Senator Pascal Poirier, Ottawa
Lot 22, con. I, Sheguiandah tp.

Completed February 9, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	11
Hudson River lime	34
Hudson River shale	280
Utica	69
Trenton	40
Total depth	434

No water; perfectly dry hole.

Senator Pascal Poirer, Ottawa
Lot 18, con. XIII, Sheguiandah tp.

Completed March 19, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	5
Lime	47
Hudson River shale	282
Black shale	56
Trenton	40
Total depth	430

Black water at 420 feet.

Middlesex County

E. P. Rowe, Toronto
Lot 17, S. ½, con. I, Ekfrid tp.

Completed June 21, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	164
Hamilton	199
Middle lime (Widder)	47
Olentangy shale	10
Black lime	6
Soapstone	1
Delaware-Onondaga	23
Total depth	450

E. P. Rowe, Toronto
Lot 12, S. ½, range 2, S.L.R., Ekfrid tp.

Completed July 19, 1932.
Oil yield: Approx. 1 bbl. per day.

Formation	Thickness, ft.
Surface	150
Soapstone	55
Middle lime	24
Lower soap	31
Onondaga	175
Oriskany	2
Total depth	437

Show of oil at 325 to 335 and 345 to 350 feet.

Norfolk County

Acme Gas and Oil Co., Toronto
Lot 143, con. I, N.T.R., Middleton tp.

Completed July 20, 1932.
Open flow: Showing of gas.
Rock pressure: 26 lbs.

Formation	Thickness ft.
Surface	223
Onondaga	183
Oriskany	6
Salina	535
Guelph and Niagara	265
Grey shale	54
Clinton	29
Red Medina	20
Grey shale	50
White Medina	25
Red shale	10
Total depth	1,400

Gas at 1,285 feet.
Salt water at 248 feet.

ONTARIO COUNTIES GAS CO., BUFFALO, N.Y.
Lot 4, con. I, N.T.R., Middleton tp.

Completed May 5, 1932.
Open flow: 75,000 cu. ft.
Rock pressure: 300 lbs.

Formation	Thickness, ft.
Sand	15
Quicksand	125
Clay	85
Lime	195
Flint	90
Sharp sand	50
Lime and shale	400
Niagara lime	270
Shale	48
Clinton sand	31
Red Medina	21
Shale	40
Total depth	1,370

Gas at 1,324 feet.
Sulphur water at 235 and 360 feet; salt water at 1,000 feet.

AJAX OIL AND GAS CO., TORONTO
Lot 19, con. II, S.T.R., Middleton tp.

Completed March 10, 1932.
Open flow: 70,000 cu. ft.
Rock pressure: 405 lbs.

Formation	Thickness, ft.
Sand	150
Clay	98
Sharp sandy lime	267
Lime	665
Shale	62
Clinton	18
Shale	70
White Medina	27
Red shale	3
Total depth	1,360

Gas at 1,260 feet.
Salt water at 255 feet.

MIDWAL OIL AND GAS SYNDICATE, TORONTO
Lot 19, con. XIV, North Walsingham tp.

Completed November 26, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	225
Lime and shale	160
Flint	130
Lime and shale	405
Niagara	227
Shale	55
Clinton	28
Red Medina	3
Grey shale	7
Total depth	1,240

Fresh water at 226 and 260 feet.

Oxford County

AJAX OIL AND GAS CO., TORONTO
Lot 5, N. ½, con. X, Dereham tp.

Completed January 26, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	145
Limestone	105
Oriskany	135
Lime	515
Niagara	225
Rochester shale	50
Clinton	28
Shale	47
White Medina	35
Queenston shale	5
Total depth	1,290

Fresh water at 84 and 150 feet; salt water at 350 feet

Welland County

HALDIMAND NATURAL GAS SYNDICATE, STEVENSVILLE
Lot 1, con. X, N.R., Bertie tp.

Completed February 4, 1932.
Open flow: 11,000 cu. ft.
Rock pressure: 155 lbs.

Formation	Thickness, ft.
Surface	25
Salina	369
Guelph and Niagara	225
Rochester	81
Clinton	31
Red Medina	64
Manitoulin	31
White Medina	11
Queenston	4
Total depth	841

Gas at 705, 741, and 751 feet.
Fresh water at 30 and 65 feet.

HOUSE AND HARRIS, STEVENSVILLE
Lot 11, con. XIII, N.R., Bertie tp.

Completed July 2, 1932.
Open flow: 26,000 cu. ft.
Rock pressure: 145 lbs.

Formation	Thickness, ft.
Surface	43
Salina	232
Guelph and Niagara	210
Rochester	80
Clinton	30
Red Medina	78
Manitoulin	37
White Medina	10
Queenston	5
Total depth	725

Gas at 570, 603, and 641 feet.
Fresh water at 45 feet; sulphur water at 80 feet.

WELLAND COUNTY GAS SYNDICATE, STEVENSVILLE
Lot 13, con. XIII, N.R., Bertie tp.

Completed April 23, 1932.
Open flow: 4,500 cu. ft.
Rock pressure: 95 lbs.

Formation	Thickness, ft.
Surface	50
Salina	210
Guelph and Niagara	212
Rochester	78
Clinton	32
Red Medina	72
Manitoulin	48
White Medina	13
Queenston	5
Total depth	720

Gas at 558 and 602 feet.
Fresh water at 45 feet; sulphur water at 85 feet.

HALDIMAND NATURAL GAS SYNDICATE, STEVENSVILLE
Lot 3, con. X, N.R., Bertie tp.

Completed March 28, 1932.
Open flow: 12,000 cu. ft.
Rock pressure: 155 lbs.

Formation	Thickness, ft.
Surface	4
Salina	395
Guelph and Niagara	211
Rochester	77
Clinton	32
Red Medina	70
White Medina	40
Queenston	21
Total depth	850

Gas at 719, and 774 to 784 feet.
Sulphur water at 95 feet.

HOUSE AND HARRIS, STEVENSVILLE
Lot 11, con. XIV, N.R., Bertie tp.

Completed September 24, 1932.
Open flow: 12,000 cu. ft.
Rock pressure: 110 lbs.

Formation	Thickness, ft.
Surface	54
Salina	231
Guelph and Niagara	215
Rochester	86
Clinton	32
Red Medina	72
Manitoulin	25
White Medina	20
Queenston	3
Total depth	738

Gas at 604, 630, and 663 feet.
Fresh water at 54 and 300 feet.

HOUSE AND HARRIS, Stevensville
Lot 11, con. XIII, N.R., Bertie tp.

Completed August 9, 1932.
Open flow: 60,000 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Surface	45
Salina	235
Guelph and Niagara	220
Rochester	80
Clinton	30
Red Medina	80
Manitoulin	17
White Medina	18
Queenston	76
Total depth	801

Gas at 590, 617, 630, 660, and 717 feet.
Fresh water at 50 and 85 feet.

Wentworth County

CONTINENTAL GAS CORPORATION, TORONTO
Lot 30, con. VIII, Binbrook tp.

Completed January 29, 1932.
Open flow: 15,000 cu. ft.
Rock pressure: 75 lbs.

Formation	Thickness, ft.
Surface	37
Lime and shale	14
Guelph	25
Niagara	220
Rochester shale	37
Clinton	27
Red Medina	44
Medina shale	73
White Medina	22
Queenston shale	32
Total depth	531

Gas at 353, 383, and 487 feet.
Fresh water at 41 feet; black at 230 feet.

CONTINENTAL GAS CORPORATION, TORONTO
Lot 30, con. VIII, Binbrook tp.

Completed February 27, 1932.
Open flow: 22,506 cu. ft.
Rock pressure: 100 lbs.

Formation	Thickness, ft.
Surface	48
Lime and shale	12
Niagara	238
Shale	30
Clinton	33
Red Medina	46
Shale	75
White Medina	24
Red shale	35
Total depth	541

Gas at 333, 387, 487, and 502 feet.
Fresh water at 38 feet; black at 220 feet.

CONTINENTAL GAS CORPORATION, TORONTO
Lot 30, con. IX, Binbrook tp.

Completed July 9, 1932.
Open flow: 55,000 cu. ft.
Rock pressure: 122 lbs.

Formation	Thickness, ft.
Surface	47
Niagara lime	240
Shale	41
Clinton	35
Red Medina	40
Blue shale	80
White Medina	19
Red shale	32
Total depth	534

Gas at 372 and 494 feet.
Fresh water at 50 feet; black at 190 feet.

CONTINENTAL GAS CORPORATION, TORONTO
Lot 30, con. IX, Binbrook tp.

Completed August 30, 1932.
Open flow: 35,062 cu. ft.
Rock pressure: 110 lbs.

Formation	Thickness, ft.
Surface	44
Niagara	245
Black shale	30
Clinton	32
Red Medina	45
Blue shale	85
White Medina	19
Red shale	34
Total depth	534

Gas at 334, 371, and 493 feet.
Fresh water at 50 feet; black water at 150 feet.

PENINSULA GAS CO., TORONTO
Lot 22, con. IX, Binbrook tp.

Completed February 13, 1932.
Dry hole.

Formation	Thickness, ft.
Surface	56
Lime and shale	20
Niagara	205
Guelph lime	9
Shale	49
Clinton	32
Red Medina	42
Shale	65
White Medina	13
Red shale	5
Total depth	496

Fresh water at 60 feet; salt water at 210 feet.

PETROLEUM IN 1932

By R. B. Harkness

General

After passing through the year of lowest prices since the year 1915, the operators of the Ontario shallow oil fields, now seventy years and more old, have improved the production for the second consecutive year. A mild winter and an absence of snow undoubtedly assists the operators to pump oil, but, on the other hand, they are hindered in their maintenance work by deep and sticky mud during a period when they would ordinarily be working in places accessible in cold weather. The real increase in the total produced is due to a discovery of oil by the Union Gas Company in the Dawn township gas field. Three producing wells were drilled, the oil being encountered at 1,850 and 1,950 feet below the surface, in the lower Salina or in the top of the Guelph formation.

An experiment was made by the Dowell Company of (Midland) Michigan in increasing the production of wells by introducing chemicals into the oil wells. Fourteen wells were chosen for tests; ten in the Petrolia field and four in Oil Springs. After treatment, most of the wells showed an improvement. It remains to be seen whether or not the work will be continued.

The low price of oil has not been conducive to much exploratory work, although the discovery in Dawn township has created considerable interest and points to future activity in Kent and Lambton counties.

The capital invested in operating oil wells and in drilling for oil is $1,377,146; the number of men employed, 173; and the wages paid, $95,138. This information has been supplied by the Dominion Bureau of Statistics in Ottawa.

TABLE I—OIL PRODUCED IN ONTARIO BY FIELDS, 1925–1932

Field	1925	1926	1927	1928	1929	1930	1931	1932
	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.
Petrolia and Enniskillen	53,166	55,485	59,424	60,547	56,284	55,130	57,515	58,871
Oil Springs	39,137	38,349	37,281	35,653	30,737	29,160	30,792	31,438
Moore tp	8,195	2,438	2,112	2,148	1,230	1,576	3,739	3,272
Sarnia tp	1,905	1,890	1,590	1,221	749	1,149	1,466	1,227
Plympton tp	1,424	1,047	1,241	371	315	296	296	274
Bothwell	26,243	25,382	25,224	24,255	23,236	21,176	18,024	19,460
Tilbury East tp	.....	.....	60	736	138	149	.....	.....
Dover West tp	2,957	959	602	773	715	457	891	453
Raleigh tp	887	676	276	.....	.....	.....	.....	.....
Onondaga tp	261	361	210	186	243	231	34	543
Mosa tp	8,397	7,868	7,447	7,268	6,851	7,166	8,517	8,429
Thamesville	289	2,376	4,139	1,006	427	447	462	534
Euphemia tp	39	.....	.....	.....	.....	.....	121	496
Dunwich tp	1,001	139	.....	.....	148	365	507	285
Romney tp	1,235	.....	.....	.....	.....	.....	.....	.....
Brooke tp	.....	.....	.....	.....	52	.....	.....	.....
Dawn tp	.....	.....	.....	.....	.....	.....	.....	5,061
Total	145,136	136,971	139,606	134,164	121,125	117,302	122,364	130,343
Value	$369,154	$376,822	$289,391	$249,981	$253,678	$235,746	$219,993	$247,468
Average price	$2.56	$2.73	$2.11	$1.86	$2.09	$2.00	$1.80	$1.89

TABLE II—OIL WELLS AND THEIR PRODUCTION, 1932

Field	Wells			Wells drilled		Production[1]		Gain or loss in 1932		Average production per well per year
	Operating	Not operating	Abandoned	Producing	Dry			Gain	Loss	
						bbls.	gals.	bbls.	bbls.	bbls.
Petrolia and Enniskillen	817	773	119	2	.....	58,870	31	1,356	.....	72
Oil Springs	804	275	21	.....	.....	31,438	18	646	.....	39
Moore tp	72	21	2	.....	.....	3,272	11	.....	466	45
Sarnia tp	70	47	5	.....	.....	1,227	9	.....	239	18
Plympton tp	26	5	.....	.....	.....	273	34	.....	22	10
Bothwell	147	151	10	.....	.....	19,459	22	1,436	.....	132
Dover West tp	2	.....	.....	.....	.....	452	26	.....	438	226
Raleigh tp	.....	6	.....	.....	.....	.....	.....	.....	.....	.....
Onondaga tp	10	27	.....	.....	.....	543	4	509	.....	54
Mosa tp	84	21	.....	1	.....	8,428	21	.....	88	100
Thamesville	.....	24	.....	.....	.....	534	15	72	.....	22
Euphemia tp	9	71	2	1	5	496	10	375	.....	55
Dunwich tp	10	89	.....	.....	.....	284	30	.....	223	28
Dawn tp	3	40	.....	3	1	5,060	28	5,061	.....	1,687
Brooke tp	2	1	.....	.....	1	.....	.....	.....	.....	.....
Tilbury East tp	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Other fields	.....	1[2]	.....	.....	7[3]	.....	.....	.....	.....	.....
Total	2,056	1,553	159	7	14	130,343	14	9,455	1,476	.....
								Net gain 7,979		

[1]Production figures from Imperial Oil Company.
[2]Nottawasaga.
[3]1 in Nassagaweya; 3 in Sheguiandah; 3 in Ekfrid.

Treating Oil Wells with Acid

After being operated for a number of years, oil and gas wells in limestone fields, as well as in other fields, accumulate sediment paraffin, salt, and other matter, which tend to restrict the production. In the past, the practice has been to remove this accumulation of matter by baling, washing, drilling, and, mainly, by shooting, i.e., exploding a charge of nitro-glycerine or dynamite at the oil or gas horizon. The shooting method is probably more expensive but it is quicker, and it holds out the promise of fracturing the rock and opening new channels whereby the oil and gas may reach the drill-hole or well; in any case, it will produce the same results and possibly better than any of the above-mentioned methods.

It has long been recognized that, in the great majority of cases, limestone reservoirs differ from sandstone reservoirs in that the oil and gas are contained in fissures and cavities, large and small, which may be separated by very minute openings; whereas in sandstone reservoirs, the multitude of openings between the sand grains form the reservoir. Where there is no cementing material present and the sand grains are of uniform size, there is nothing to restrict the flow of oil in one direction more than in another. Many instances are known where a newly drilled well in a limestone field, with a very small production, has been shot and the production multiplied. The supposition is that the shot broke away a barrier between the drill-hole and a series of cavities in the limestone, allowing a great volume of oil or gas to reach the well. In the sandstone fields, if any shooting is

to be effective it must be very carefully done; a large shot may have a very adverse effect, as the resulting heat may fuse the sand grains together and thereby seal up the well. In either case the object is to enlarge the openings between the drill-hole and the larger cavitities.

In recent years some successful experiments have been carried out by using various acids to dissolve the limestone and enlarge these openings. Hydrochloric acid has been used for many years in drilling practice where tools have been stuck in a drill-hole and covered over with cuttings. From 10 to 40 gallons of hydrochloric acid will be poured into the hole to dissolve the limestone and free the tools. This practice has been extended and the acid pumped into the well under pressure. forcing it through the natural openings in the limestone and thereby enlarging them and allowing a free flow of oil or gas, as in the case of shooting.

The advantage claimed in favour of the acid treatment is that nothing need be done after treatment but bail out the remaining acid and sludge, replace the pump (if it be required), and produce oil, whereas after a shot is exploded many cubic yards of broken stone must be removed from the well and there is much risk of fragments falling on top of the tools (which may result in plugging the well permanently). As the promoters of the acid method are still experimenting, it is not known whether or not there are any disadvantages. It is claimed that the acid used will not cause corrosion in steel pipes.

Exploratory Drilling

Exploratory drilling has been partly covered under the heading "Gas Wells Drilled in 1932," on page 2.

In all, 12,476 feet of drilling was done directly for oil and 11,443 feet of drilling in testing for favourable structure without attempting to penetrate a producing horizon. Six drilling rigs were employed, and 15 men operating these worked a total of 439 days. The wages paid drillers amounted to $3,808.

One producing well was drilled in Mosa township by George Porter. One was drilled in Enniskillen by Thos. Josh and another by E. Kells. Three producers and one dry well were drilled in Dawn by the Union Gas Company. One producer and two dry wells were drilled in Euphemia by the Lambton Oil Company. Three dry wells were drilled in Ekfrid township and three in Sheguiandah township, Manitoulin Island. One dry well was drilled in Brooke township and four in Euphemia township. Records of these wells will be seen among the logs immediately preceding this report.

Petroleum Refining

Four refineries were in operation in the year 1932 and worked at full capacity. The Simrall Refining Company of Canada, Limited, are erecting a refinery at Amherstburg, and the Scarboro Refineries are erecting one at Toronto. Both are expected to be in operation in 1933.

PETROLEUM REFINERIES, 1932

Company	Location of refinery	Head office address
British American Oil Co., Ltd....	Foot of Cherry St., Toronto...	Royal Bank Bldg., Toronto.
Canadian Oil Companies, Ltd....	Petrolia.....	Excelsior Life Bldg., Toronto.
Imperial Oil Refineries, Ltd.....	Sarnia.....	Sarnia.
McColl Bros.....	Foot of Cherry St., Toronto...	114 Don Esplanade, Toronto.

The Dominion Bureau of Statistics, Ottawa, gives the following information: The total capacity of these refineries is 36,400 barrels of crude oil per day. The total number of employees for the year was 1,937; the salaries and wages paid amounted to $2,764,208; and the capital invested was $25,732,687.

Table III shows the output of Ontario refineries for the past six years, ending in 1932. It will be observed that 1932 is the first year that shows a reduction in the quantity of oil distilled. This reduction is reflected in the output of straight-run gasoline and in the fuel oils. Cracked gasoline shows an increase. However, the output for 1932 is well above the year 1929.

TABLE III—PETROLEUM REFINING OPERATIONS, 1927-1932[1]

Schedule	Unit of measure	1927	1928	1929	1930	1931	1932
Imported crude distilled	Gallons[2]	218,200,977	257,929,514	321,687,678	343,372,124	364,871,253	327,524,704
	Value	$15,900,079	$17,617,756	$23,341,514	$23,273,547	$17,035,028	$19,197,691
Imported fuel oil	Gallons	.....	.....	.....	.....	.....	1,669,675
	Value	.....	.....	.....	.....	.....	$51,092
Canadian crude distilled	Gallons	5,205,097	4,484,858	4,426,863	3,944,969	4,382,806	4,704,609
	Value	$363,320	$283,959	$292,949	$264,008	$261,334	$290,752
Percentage of total	.....	2.33	1.71	1.35	1.13	1.19	1.43
PRODUCTS							
Gasoline:							
Straight run	Gallons	67,976,379	83,067,789	101,276,701	97,806,121	95,934,920	61,297,731
	Selling value	$9,287,286	$12,403,342	$14,521,648	$12,334,586	$9,886,611	$6,378,577
By cracking process	Gallons	32,968,207	39,724,303	49,884,248	84,496,056	100,120,768	109,519,770
	Selling value	$4,354,802	$5,803,963	$7,176,654	$11,066,369	$10,544,926	$10,673,010
Illuminating oil	Gallons	23,712,369	21,304,385	19,138,614	17,973,730	14,656,833	18,666,252
	Selling value	$2,828,872	$2,650,877	$2,516,618	$1,980,546	$1,397,607	$1,736,164
Lubricating oil	Gallons	17,040,724	16,822,292	20,452,106	16,451,717	13,963,545	14,187,555
	Selling value	$3,237,375	$2,813,371	$3,707,592	$2,756,579	$2,445,410	$3,476,341
Engine distillate and naphtha	Gallons	4,045,416	3,062,787	5,845,447	4,272,751	3,652,973	6,098,784
	Selling value	$510,960	$445,526	$811,240	$504,206	$327,717	$573,585
Gas and fuel oil	Gallons	53,767,638	76,469,354	99,035,616	80,742,218	101,370,904	85,233,170
	Selling value	$3,280,343	$4,104,338	$5,016,370	$3,792,757	$3,627,041	$3,550,598
Tar and grease	Pounds	11,254,706	14,626,752	18,078,346	14,486,464	9,716,022	8,751,758
	Selling value	$221,694	$267,563	$325,206	$276,649	$180,056	$492,339
Paraffin wax and candles	Pounds	9,526,072	17,030,064	10,784,609	10,153,924	10,097,478	9,196,156
	Selling value	$505,133	$599,341	$538,233	$453,601	$368,686	$417,336
Acid and petroleum coke	Short tons	[3]48,660	49,409	67,599	56,946	54,223	62,836
	Value	$329,462	$314,794	$396,565	$316,180	$285,051	$328,067
Still gas	M cu. ft	811,666	823,320	1,103,142	1,551,334	2,128,739	1,942,741
	Value	$207,370	$185,595	$270,479	$421,500	$505,156	$410,222
Asphalt	Gallons	1,060,761	1,276,098	2,664,199	6,029,624	8,778,452	6,885,142
	Selling value	$58,919	$65,003	$137,714	$285,460	$318,005	$555,654
Miscellaneous	Value	$434,655	$387,544	$258,113	$291,404	$219,900	$222,545
Total value of refined products	.....	$25,256,353	$30,033,257	$35,676,432	$34,479,837	$30,106,166	$28,814,438
Employees	Average No.	1,871	1,853	2,313	2,449	1,984	1,937
	Wages	$2,883,575	$3,013,872	$3,657,619	$3,760,870	$2,840,794	$2,764,208
Capital invested	.....	$19,354,638	$19,570,531	$26,784,547	$26,761,273	$25,282,459	$25,732,687

[1]Information furnished by the Dominion Bureau of Statistics, Ottawa.
[2]Gallons refer to Imperial gallons.
[3]Included in this item are 768,171 gallons of acid oil valued at $46,634.

Price of Crude Oil

The market price paid to the Ontario producers for crude oil delivered to the Imperial Oil Company's refinery at Sarnia remained constant during the year, and is shown in the following table. This included a premium voluntarily paid by the Imperial Oil Company over the delivered price of oil from northern Ohio.

Period, 1932	Market price North Lima crude oil	Market price Ontario crude oil	Premium paid by Imperial Oil Co. to Ontario producers
April 11	$1.15	$1.90	$0.75
December 16	1.00	1.90	.90

The price of $1.90 is the rate for Petrolia crude oil. Oil Springs oil commands a premium of seven cents, and other fields a discount of ten cents.

Refined Products Imported into Ontario

Table IV gives a comparative statement of refined products imported into Ontario. The different items do not show a very marked decrease from the previous year, excepting in the crude petroleum imported for refining and the casing-head gasoline for blending purposes. The remainder of the items show a proportionate decrease.

TABLE IV—PETROLEUM AND REFINED PRODUCTS IMPORTED IN 1931 AND 1932[1]

Import	1931		1932	
	Imperial gallons	Value	Imperial gallons	Value
CRUDE PETROLEUM:				
Petroleum, 0.790 specific gravity or heavier, for refining	302,539,949	$6,355,874	261,887,861	$7,902,649
REFINED PETROLEUM:				
For use in concentrating ores	77,371	$37,672	52,387	$30,842
Gasoline lighter than 0.669 specific gravity (casing head)	8,608,202	471,793	3,597,652	126,350
Gasoline lighter than 0.8235 specific gravity	38,210,332	3,225,261	36,900,104	4,022,485
Gas oils, other than naphtha and gasoline, between 0.8235 and 0.775 specific gravity	8,466	561	169,789	6,244
Kerosene and illuminating oils	1,773,721	99,100	1,242,319	77,819
Fuel oil, 0.8235 specific gravity and heavier	7,062,606	322,085	6,067,653	303,417
Lubricating oils, consisting wholly or in part of petroleum, costing less than 25 cents a gallon	4,806,158	827,520	3,781,328	683,421
Lubricating oils, all other	1,817,107	783,215	1,454,902	611,749
All other oils	182,567	78,876	152,867	62,424
Total	62,546,530	$5,846,083	53,419,001	$5,924,751
PETROLEUM PRODUCTS:				
Axle grease.....lbs.	2,495,413	$104,460	1,936,308	$86,809
Vaseline, toilet and medicinal petroleum	.....	103,542	.....	97,371
Paraffin wax.....lbs.	491,466	21,255	598,449	25,224
Paraffin wax candles.....lbs.	348,237	62,202	244,832	46,575
Other petroleum products lighter than 0.8235 sp. gr.....gals.	1,214,371	134,502	1,135,496	117,764
Total	.....	$425,961	.....	$373,743
Total value	.....	$12,627,918	.....	$14,201,143
Total net value of petroleum and refined products imported		$12,627,918		$14,201,143
Duty paid on the above, calculated on the existing tariff schedule		1,426,240		1,326,567
Sales tax at 4 per cent. on taxable items		492,303		607,759
Freight, approximately		10,000,000		8,000,000
Exchange, approximately		500,000		3,020,000[2]
Total value delivered in Ontario		$25,046,461		$27,155,469

[1]These statistics are furnished through the courtesy of the Department of Customs and Excise.
[2]13.6 per cent.

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Zone tp.
See also Bothwell.
Gas statistics 6

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

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

FORTY-SECOND ANNUAL REPORT

OF THE

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Geology of the Pashkokogan-Misehkow Area, by W. S. Dyer - - - - - - - - - 1-20

Geology of the Shabumeni-Birch Lakes Area, by Geo. D. Furse - - - - - - - 21-51

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COLOURED GEOLOGICAL MAPS

(In pocket at back of report)

Map No. 42*d*—Shabumeni-Birch Lakes Area, District of Kenora (Patricia Portion), Ontario. Scale, 1 mile to the inch.

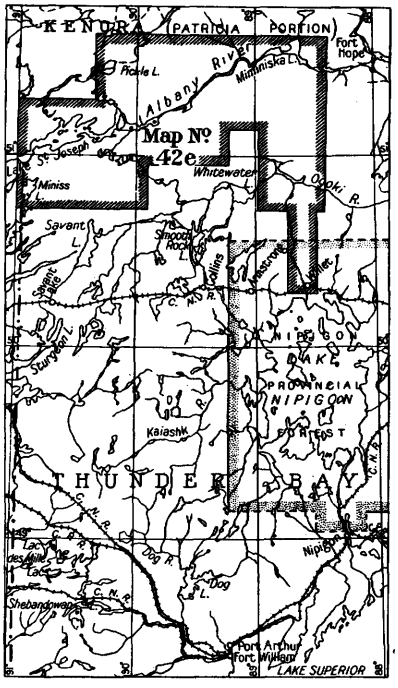
Map No. 42*e*—Pashkokogan-Misehkow Area, District of Thunder Bay, Ontario. Scale, 4 miles to the inch.

Geology of the Pashkokogan-Misehkow Area

By W. S. Dyer

Introduction

The field season of 1932 was spent in geologically mapping a large pre-Cambrian area lying south and east of Lake St. Joseph. The western part of the area lies between Lake St. Joseph, which was reported on by E. L. Bruce[1] in 1922, and



Key map showing the location of the Pashkokogan-Misehkow area.
Scale, 70 miles to the inch.

the Lake Savant area, geologically mapped by E. S. Moore[2] in 1928. The eastern part consists of a strip of country along the Albany river and south of it, extending northeastward to Miminiska lake, which is on the western boundary of the Fort Hope gold area mapped by E. M. Burwash[3] in 1929.

Previous Work

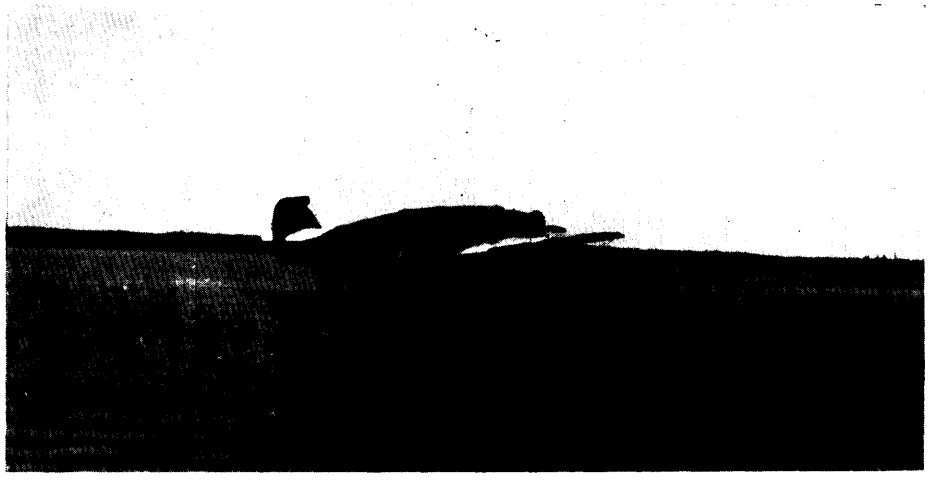
Very little has been known about the geology of this area. The eastern part particularly was *terra incognita*, since no map of it existed until the aeroplane survey of about a year ago.[4] In 1886, Dr. Robert Bell[5] on his way to James bay

[1]Ont. Dept. Mines, Vol. XXXI, pt. 8.
[2]Ibid, Vol. XXXVII, pt. 4.
[3]Ibid, Vol. XXXVIII, pt. 2.
[4]Miminiska Sheet, Map No. 52P, Top. Surv. Can., 1932.
[5]Geol. & Nat. Hist. Surv. Can. Vol. II, 1886.

passed through Lake St. Joseph and along the Albany river to Eabamet lake, where he turned north. He described the rocks outcropping along the route, part of which lies within the Pashkokogan-Misehkow area. On map No. 9a, published by the Geological Survey of Canada in 1910, Keewatin (and Huronian?) volcanics and sediments are shown on the south shore of Lake St. Joseph, on Pashkokogan river, and on the east shore of Pashkokogan lake, extending as far south as the southern end of the lake, but no reference to the geology of the lake could be found in the literature.

Scope of the Report

Obviously a large area such as this (approximately 2,500 square miles) could not be covered in detail in the few months of the field season. The work in the eastern part, particularly, was of a reconnaissance character. The western part, which was examined first, was done in somewhat greater detail. On the map



Junkers hydroplane, Canadian Airways, Limited, delivering supplies on August lake.

(No. 42*e*) accompanying this report, the geology of the shores and islands of Lake St. Joseph is taken from Bruce; that of the Albany river from Achapi (Elbow) lake to the mouth of the Misehkow river, from Bell; and that of the eastern part of Miminiska lake and of the Albany river east of this lake, from Burwash. The map-sheet also shows the geology in the vicinity of Kawinogans (Crow) river and Pickle lake, as worked out by Hurst,[1] and the location of the developments of the Central Patricia and Northern Aerial Canada Golds, Limited. The mill on the first-mentioned property is expected to be in operation early in 1934.

Access

The party detrained at Chivelston lake, 1½ miles east of Savant Lake station, and entered the area by way of Harris, Harold, and Savant lakes and Savant river. This is a quick, easy route to Pashkokogan lake and Lake St. Joseph, but to reach the Misehkow river country, which is regarded as the most favourable part of the area for prospecting, a route north of Collins station would appear to be better. This route leads through Tamarack and Smoothrock lakes, Berg and

[1]M. E. Hurst, Pickle Lake–Crow River Area, Ont. Dept. Mines, Vol. XXXIX, pt. 2, 1930.

Ogoki rivers, Kenoji lake, and Palisade river to Webster lake, and thence to Coles lake. The distance is only about 75 miles, and most of the portages are short. There are two rather long portages, however, one of about 1½ miles near the railway, and the other of about 1 mile between Webster and Coles lakes. This route was not tried by the writer's party, and nothing is known about the condition of the portages.

An aeroplane could land in almost any of the lakes of the region. Two plane-loads of supplies were brought in to us during the summer; the first was landed on Pashkokogan lake on June 15, and the second on August lake on August 15. The trips were made from Sioux Lookout, the flying distance to the first lake being 115 miles, and to the second 150 miles.

Acknowledgments

Very able assistance was given by G. H. Charlewood, V. B. Meen, and B. C. Coles, all of the University of Toronto. Special acknowledgment is made to Mr. Charlewood for valuable co-operation in the solution of certain geological problems in the field and for assistance in studying the rock sections. The courtesy and hospitality of the officials of the Hudson's Bay Company at Sioux Lookout and Osnaburgh House, and of William Cummings, of Sioux Lookout, and W. S. Bruce, of Willet, are gratefully acknowledged.

Physical Features

In an area of such extent different parts vary considerably in physical features. The western part of the area is of low relief and is typical of the glaciated and peneplaned Canadian shield. Differences in elevation greater than 100 feet are rare. Ramifying lakes are numerous and quite large in this section, allowing easy access to all parts of it by canoe. Drainage is by these lakes and spillway rivers between them into Lake St. Joseph and the Albany river. Over the granite areas rock outcrops are numerous and large, there being many bare rock ridges, but in the country underlain by greenstones and sediments there are large stretches of muskeg and drift boulders and sand, and outcrops although numerous are small.

In the eastern part of the area glacial debris is much thicker and more widespread. South and west of Miminiska lake there is a group of morainic hills which rise to elevations of 300 and probably 400 feet above the surrounding country, forming a prominent and picturesque feature of the landscape. Within the area studied no good section of these hills was seen, but judging from the debris carried down by the small rivers cutting them they would appear to consist of gravel and sand. The hills extend westward along the south side of Miminiska lake and along both sides of the Albany to Etowamami river. Still farther west the country becomes lower in elevation, but drift deposits continue heavy to the Misehkow river, and up this river for 20 to 25 miles. Greenmantle river is almost wholly in drift country, and the drift extends to and surrounds Shabuskwia lake. Around the upper waters of Misehkow river and Lowry, Woodilee, Webb, and Coles lakes, the drift is thinner and rock outcrops somewhat more numerous.

In contrast to the western part of the area with its drainage by large lakes connected by spillways, the eastern part is drained by normal rivers of varying size, and lakes are smaller and less numerous. Some of the rivers are very shallow and navigation is difficult, certain parts of the area being very hard to reach by canoe. Misehkow river itself provides fairly good canoeing, but there are several small rapids, especially near Coles lake.

Natural Resources

Most of the forest is green, but it is second growth and too small to be commercial. Small patches of virgin forest still remain, however, with spruce and birch up to 18 inches in diameter. Some parts of the heavy drift country in the eastern part of the area might possibly be suitable for agriculture, but the soil, where noticed, is either very sandy or was covered by muskeg. There are small patches of ground in the western part of the area, notably at Pedlarpath bay and Osnaburgh House, where potatoes and other common garden vegetables are grown; and at Osnaburgh House a very colourful flower garden testifies to the care taken by F. H. Aldous, a former post manager of the Hudson's Bay Company.

Wild life is fairly abundant. Moose, deer, bear, and many small animals were seen. Partridge and duck were plentiful, and rivers and lakes afforded good fishing. Pickerel could always be caught at the foot of rapids, and trout were quite abundant in the Misehkow and smaller rivers. It is a land well suited to the hunter and fisherman. With a canoe one may travel for miles through the beautiful lakes with only short intervening portages. Miniss lake is especially recommended for its beauty.

Much water power is available for development along the Albany river below Lake St. Joseph. On the north branch of this river between Atikokiwam and Achapi lakes there are two falls of 34 feet each, and on the south branch several strong rapids. The Hydro-Electric Power Commission is considering development of the 10-foot fall at the southeast end of Lake St. Joseph, which is about 25 miles south of the Central Patricia mine and also of another site on the Otoskwin river some 12 miles north of the mine.

There are no settlements in the area, the nearest being Osnaburgh House, a Hudson's Bay post, on one of the eastern arms of Lake St. Joseph. Here a few hundred Indians make their headquarters and trade with the company and with independent traders. Fur-bearing animals are becoming more scarce each year, and the Indians are very poor.

General Geology

SUMMARY STATEMENT

The dominant geological feature of the Pashkokogan-Misehkow area is a long belt of Keewatin rocks, which extends east and northeast across the map-sheet. This belt connects to the west with similar Keewatin rocks, which continue as far as the west end of Lake St. Joseph, where they are apparently cut off by granites. The belt also connects with the Fort Hope Keewatin belt, shown by Burwash to extend along Eabamet lake for 9 miles east of Fort Hope. Similar rocks, which may be part of the same belt are reported from Makokibatan and Washi lakes, expansions of the Albany river, 35 miles east of Fort Hope. The total length of the belt is at least 160 miles and may be more nearly 200 miles, thus forming one of the most extensive in northwestern Ontario. The width of the Keewatin belt is variable, but within the Pashkokogan-Misehkow map-sheet, the average is about 10 miles. The structure is clearly synclinal within most of the area studied, although toward the eastern end of the map-sheet the dips are mostly to the south, indicating that the southern limb of the syncline has been blotted out by the intrusion of the granites.

The Keewatin rocks are composed of interbedded volcanic flows and sediments in about equal proportions. The sediments are variable in type and include

quartz-hornblende gneiss, quartz-biotite and quartz-chlorite gneiss and schist, greywacké, quartzite, arkose, and iron formation. An interesting type of rock is the coarse-grained hornblendite, which occurs usually in the form of dikes penetrating the Keewatin greenstones and sediments. Certain factors point to an Algoman age for these rocks, but they are provisionally retained in the Keewatin series, since they may be nothing more than a late phase of the Keewatin volcanics.

Lying along the south side of the Keewatin syncline between the Keewatin rocks and the Algoman granites is a series of sedimentary gneisses which is older than the Keewatin. This series differs from the Keewatin in that it contains no volcanics and the sediments are uniform in character, being almost entirely garnetiferous quartz-biotite gneisses. The series is given the local name "Miniss," from the lake on which it was first studied, but it is thought to be correlatable with the Coutchiching.

A small block of fresh-looking conglomerates, presumably of Timiskaming age, are located on Doran and Thelma lakes.

The Algoman granites and pegmatites as well as forming great batholiths on either side of the Keewatin syncline occur as stocks and dikes throughout the Keewatin and Miniss rocks. Two main types of granite are distinguished, an older, grey gneissic type and a younger, pinkish or greyish massive type. A few dikes of porphyry, presumably of Algoman age, were located, but this type of rock is not abundant. The youngest rocks in the region are the diabase dikes of Keweenawan age cutting Algoman granite and Keewatin sediments.

The Pleistocene deposits are of minor interest. In the western part of the area they are represented only by a few isolated mounds of sand and gravel; no true boulder clay was found. In the eastern part they are represented by the morainic hills of the Miminiska lake region, about which very little is definitely known.

Table of Formations

QUATERNARY	
RECENT:	Alluvium.
PLEISTOCENE:	Glacial drift deposits; sand, silt, gravel, etc.
	Great unconformity
PRE-CAMBRIAN	
KEWEENAWAN:	Diabase dikes.
	Intrusive contact
ALGOMAN:	Feldspar and granite porphyry, pegmatite. Greyish and pinkish massive granite. Grey gneissic granite.
	Intrusive contact
TIMISKAMING:	Conglomerate.
KEEWATIN:	Andesitic lavas with diabasic and gabbroic phases, rhyolite, rhyolitic tuffs, and agglomeratic tuffs; sediments, including quartz-hornblende gneiss, quartz-biotite and quartz-chlorite gneiss and schist, greywacké, arkose, quartzite, and conglomeratic quartzite.
MINISS (Coutchiching):	
	Garnetiferous quartz-biotite gneiss.

MINISS SERIES

The Miniss series forms a definite lithological unit. Whereas the Keewatin, the only other formation in the area containing sediments, consists of interbedded volcanics and sediments of variable type, the Miniss series contains no volcanics,

either flows or tuffs, and the sediments are nearly all of one type—quartz-biotite gneiss. The gneiss is of uniform appearance, coarse-grained and whitish to medium-grey in colour, weathering grey and brown. Banding is present but is not as clearly exhibited as in the Keewatin series. Garnets, which are very commonly found, are usually small and, at any one locality, fairly evenly distributed throughout the rock. On Attwood lake, in the eastern part of the field, many miles east of the more typical "Miniss" localities, staurolite in large crystals was found in quartz-biotite schist considered as belonging to the Miniss series.

Very occasionally other types of rock occur; reddish, finely banded arkose was seen on Coles lake and greywacké on Greenbush and Coles lakes.

The series has been intruded by numerous dikes and stocks of granite and pegmatite, but at most localities the sedimentary gneiss can be clearly distinguished from granite and granite gneiss. In some places, such as the southern end of Rockcliff lake, the two rocks have been intimately mixed into a hybrid rock.

Under the microscope the gneiss shows a mosaic of quartz and biotite, with occasionally a little plagioclase and hornblende; thorough recrystallization has evidently taken place. The proportion of quartz to biotite is about 2 to 1. The sediments were doubtless originally argillaceous sands, but criteria suggesting environment of deposition have been destroyed.

The Miniss series outcrops along the south side of the Keewatin syncline between the Algoman granite and the Keewatin series. That it is older than the Keewatin is suggested by the structure on Coles lake and at the north end of Rockcliff lake, where it dips steeply northward under the Keewatin rocks into the syncline. The contact between the Keewatin and the Miniss could not be followed closely enough to determine whether they were conformable or not, but that they are not widely unconformable is suggested by the uniformity of the strike and dip on each side of the contact. On Greenbush lake and the southern part of Rockcliff lake the intrusion of large stocks of granite has destroyed any regularity of structure.

The Miniss series is well exposed at many places on the north and west shores of Miniss lake and on the islands in the northwestern part of the lake. Quartz-biotite schists were also seen on the south shore of Dawson lake and on Miniss river near Dawson lake; and quartz-hornblende rocks, presumably sediments, occur on Bertaud lake. These rocks are present only in small amount and are apparently nothing more than inclusions in granites. The sediments of Miniss lake are therefore separated from the Keewatin series by large masses of granite, and the structural relations of the two series cannot be determined in this region.

On Miniss lake the sediments are intruded by a great number of dikes and stocks of granite and pegmatite, examples of *lit par lit* injection being very abundant. Granite or pegmatite is commonly found interfingered among the bedding planes of the sediments. The structure is irregular and undulating; the strike is generally about northeast, although there are many variations from this direction, particularly near igneous masses, and the dip ranges all the way from the vertical to the horizontal. The impression is made upon the observer that all through the Miniss lake sedimentary region the granite is very close to the surface.

On the north side of the great syncline granites lie directly against the Keewatin, and none of the older sediments have been found. It is possible that the Miniss sediments varied greatly in thickness laterally and were never present to the north, but it is more likely that on the north side of the syncline the granite batholiths have worked farther into the older rocks and have destroyed all vestiges of the Miniss series.

The Miniss series is probably correlatable with the Coutchiching series as defined by Lawson[1] in the Rainy Lake region. More recent work has demonstrated that metamorphosed sediments older than the volcanics occur in many places in northwestern Ontario and eastern Manitoba. The Miniss series is certainly correlatable and even continuous in the field with part of the lower sedimentary series of the western part of Lake St. Joseph, which Bruce[2] places below the Keewatin. The rocks are also similar in lithology and stratigraphic position to the Marshall Lake series of Hopkins[3] and Kindle,[4] except that the latter contain more garnet, hornblende, and staurolite, and some iron formation. The Miniss series is certainly very like the Coutchiching rocks of Bears Pass section of the Rainy Lake area, which are undoubtedly of similar age, antedating the volcanics.[5] The sediments of the Manigotogan phase[6] of the Rice Lake series, which are also older than the volcanics, are more varied than the Miniss series and include quartzite, greywacké, slate, chert, and agglomerate.

Bruce[7] has given an excellent summary of the whole Coutchiching problem in his paper on the "Coutchiching Delta." He points out the general similarity of the sediments that underlie the volcanics or are interbedded with them: There are no limestones; all the sediments are clastics, except possibly some beds of iron formation, and they are dominantly of terrestrial conditions of deposition. Bruce postulates a great river or several rivers in early geological time which flowed downward from a great Hudson bay land mass. He says:

> Deposition, which may have started far to the north of Rainy lake, may have advanced southward and westward at various rates and with many halts and possible regressions, as the strandline moved northward by elevation of the sea bottom or southward before the deposition of the debris carried down by the river or rivers. . . . In general, however, there would be progressive overlap of the sediments outward from the central part of the area. It is clear that, if such were the case, and if volcanic rocks were extruded at any period during the existence of the delta, there would necessarily be different relations of sediments to lavas in various parts of the floodplain and delta—that is, lavas flowing out beyond the margin of the delta would lie on beds older than the sediments, and might later be covered by the overlapping delta deposits. In the floodplain or delta area the lavas would lie on the sediments. Along the delta margin, if the period of igneous activity were of some duration, the two rocks would be interbanded.
>
> Chronologically the ancient sediments and the lava flows are in part contemporaneous, but the lower sediments of the northern areas probably are much earlier than the period of volcanic activity.

Bruce considered it the logical course to retain the term Coutchiching for the whole series of sediments, "beginning in the earliest known times, antedating the period of Keewatin volcano activity, and possibly continuing after its close." His use of the name Coutchiching, therefore, would be as a lithological rather than a time term. On the Kenora Sheet,[8] compiled by T. L. Tanton for the Geological Survey, the term Coutchiching is used only for the sediments underlying the Keewatin volcanic complex.

The Miniss series forms part of the Coutchiching delta deposits as described by Bruce and is correlatable with that part of it that antedates the volcanic activity. It is thus correlatable with the Coutchiching as defined by the Geological Survey. It differs from beds of similar age in other fields in being of more uniform lithology and in its greater contrast to the sediments of the Keewatin.

---

[1]A. C. Lawson, Geol. and Nat. Hist. Surv. Can., Vol. III, pt. 1, 1887-88; Geol. Surv. Can., Mem. 40, 1913.

[2]Ont. Dept. Mines, Vol. XXXI, pt. 8, 1922.

[3]P. E. Hopkins, The Kowkash Gold Area, Ont. Bur. Mines, Vol. XXVI, 1917.

[4]L. F. Kindle, Kowkash-Ogoki Gold Area, Ont. Dept. Mines, Vol. XL, pt. 4, 1931.

[5]E. L. Bruce, Trans. Roy. Soc. Can., 3rd ser., Vol. 19, 1925.

[6]J. F. Wright, Geology and Mineral Deposits of a Part of Southeastern Manitoba, Geol. Surv. Can., Mem. 169, 1932.

[7]E. L. Bruce, Bull. Geol. Soc. Amer., Vol. 38, 1927, pp. 771-782.

[8]Map No. 266A, 1933.

KEEWATIN FORMATION

Volcanic Flows

The rocks comprising the volcanic flows are largely andesitic in type, dark-green in colour, and fine-grained. At some localities coarser-grained dioritic or gabbroic types were seen, probably representing the inner part of the flows, which cooled more slowly. Rhyolite occurs locally, and also chlorite, talc, and carbonate schists, which represent altered lavas.

A sheared pillow lava under the microscope showed fairly fresh hornblende in parallel arrangement with much fine-grained shreddy material, probably hornblende, and a little fine quartz; no feldspar or chlorite were recognized. A specimen of dioritic greenstone showed hornblende as the predominant mineral with minor amounts of albite, quartz, magnetite, chlorite, and biotite. Some samples showed considerable quartz, and these are probably dacites. One specimen showed hornblende and weathered plagioclase with ophitic structure and a little quartz-biotite and magnetite; it probably represents an old Keewatin diabase dike.

At most localities the greenstones have been sheared in varying degree by the intrusion of the Algoman batholiths. The dip of the schistosity is always steep, from 65 to 90 degrees; and the strike is fairly uniform over wide areas, usually 60 to 90 degrees, except in the vicinity of granite stocks, where it more nearly conforms to the margins of the stocks.

Pillows are well developed locally, as in the massive greenstones along the south shore of the western part of Miminiska lake and at intermittent exposures on the Albany river for 20 miles above Miminiska lake. They are also well developed in the narrow band of greenstone that crosses the middle of Pashkokogan lake.

No attempt was made in the time available to determine the tops or bottoms of flows, and in any case most of the greenstone occurs in rather small isolated outcrops, which did not offer much opportunity for such determinations. One good example of the bottom of a flow was seen; this was at the narrows between Pashkokogan and East Pashkokogan lake, where an outcrop of greenstone shows many irregular nodules of quartzite along the contact of the greenstone with quartzite.

Judging by the manner in which the greenstone and sediments follow each other across the strike in fairly close succession, it is apparent that the greenstone masses are not wide and are rather closely interbedded with sediments. Ordinarily greenstone cannot be followed for more than 400 or 500 feet across the strike without being interrupted by sediments. Such more or less small masses of greenstone are well distributed throughout the Keewatin belt. In a few places thicker masses were seen; the thickest being that of the north arm of Woodilee lake, where massive greenstone was followed continuously across the strike for one and a half miles. Thick masses also occur on and around Pedlarpath bay, on the south shore of the western part of Miminiska lake, and on the Albany river west of the lake. Some very thin lava flows, measuring only 1 to 3 feet, were observed on the west arm of Pashkokogan lake and on Lowry lake and river. On the west arm of Pashkokogan lake, 10 miles from the main lake, there is a 6-inch dike of greenstone between garnetiferous quartzite and quartz-biotite gneiss; for a distance of 20 feet into the quartzite there are irregularly rounded masses of greenstone with chilled edges, which resemble bombs.

The rhyolite occurs usually as comparatively narrow bands in greenstones, as on the south shore of Pashkokogan lake, on Doran lake, and on the Albany river three miles below Snake falls. An isolated mass was seen near greenstone

one mile northeast of Iron falls of the Misehkow river, and dikes of rhyolite cutting greenstone were observed on the west arm of Pashkokogan lake. The rock consists mainly of fine-grained quartz and sericite with subsidiary amounts of biotite; calcite and pyrite were noticed in some specimens; and there is usually some parallel arrangement of the sericite and biotite.

Chlorite, talc, and carbonate schists, evidently altered greenstones, are developed locally. All the outcrops on the Misehkow river for 12 miles below Iron falls are of this type of rock. The schists exposed along the straight line of the river, which parallels the regional strike, represent a strong shear zone in the Keewatin and may be an eastern continuation of the supposed axial fault of Lowry and Woodilee lakes, which is described elsewhere.

Pyroclastic Rocks

Along the north shore of the western part of Miminiska lake and along the north shore of the long point that extends from the east side of this part of the lake, there are several outcrops of pyroclastic rocks, mainly tuffs. One type is composed of fragments of varying size up to 6 inches; the larger fragments are ellipsoidal with the long diameter parallel to the schistosity; the smaller fragments are angular. The rock may be termed an agglomeratic tuff. The fragments and the matrix are siliceous and appear to be the same in composition. Other types are more typically tuffaceous with small angular siliceous fragments in a siliceous matrix. A section of the latter under the microscope shows irregular grains of plagioclase, quartz chlorite, augite, and pyrite; some of the feldspar has weathered to sericite and calcite. Along with the tuffs are grey-black slates and strongly sheared and contorted sericite and chlorite schist. All the tuffs are sheared in varying degree with nearly vertical dips and with strikes between 55 and 65 degrees.

Rhyolitic tuffs were found at two other localities in the map area. The first is on Misehkow river four miles below Coles river, where they are associated with greywackés and quartz-hornblende gneisses. The rock is a medium-grey banded rock, in which the angular quartzose fragments can be clearly seen with the naked eye; it is composed of larger crystals of plagioclase and quartz with a mass of finer-grained crystals domed around them; the smaller crystals are of quartz, chlorite, and plagioclase. The second locality is on Medcalf lake near the portage to Thelma lake. In this case the large crystals are mainly quartz, with some plagioclase, the groundmass of quartz, chlorite, sericite, and biotite being domed around them.

Hornblendite

At several localities in the Pashkokogan-Misehkow area there are basic dikes of uncertain age. These rocks show coarse-grained, fresh-looking hornblende with a little quartz. They cut the Keewatin greenstones and sediments and show chilled edges against them, but they were not found outside the Keewatin belt. They have undergone practically no shearing and are thus in marked contrast to the rocks they intrude. They would appear to have escaped the compressive forces active during the intrusion of the Algoman batholiths and, hence, to be later in age. However, until definite evidence of their age is forthcoming the dikes are included in the Keewatin, since it is possible that they are merely late basic differentiates of the lavas.

Such dikes occur on the north shore of Pashkokogan lake, on Pashkokogan river, on the Albany river between Osnaburgh lake and Lake St. Joseph, between

Caron lake and the small lake one mile to the south, west of Hughes lake, and at the west end of Doran lake. The dikes are mostly small in size.

On the canoe route out to the railway an occurrence of hornblendite was seen which may have a bearing on the age of these rocks. At the head of the first small lake north of the height-of-land on the Picket-Pikitigushi route there is a fair-sized outcrop of hornblendite, which looked to be the same as that of the dikes of the Pashkokogan area. The contacts of the hornblendite with the surrounding rocks could not be seen, but since no rock other than Algoman granite occurs for 2 to 3 miles on either side of the hornblendite it is probable that the latter is part of a dike cutting the granite and hence of later age.

Sediments

The Keewatin sediments include several different types, such as quartz-hornblende gneisses, quartz-biotite and quartz-chlorite gneisses and schists, greywackés, arkoses, quartzites, and conglomerate quartzites. This is in marked contrast to the Miniss series, in which, as previously noted, the sediments are of one type only. Another difference between the two series is the abundance of hornblende in the Keewatin and the lack of it in the Miniss. It is thought that the abundance of hornblende in the Keewatin sediments is due to the breaking-down of the basic volcanic flows.

The quartz-hornblende gneisses are as well shown at the north end of Pashkokogan lake as anywhere else in the area, but are well distributed throughout the map area. They are grey to dark-green and black, banded, quartzose rocks. The bands differ in width and are distinguished by difference in texture and colour. The gneisses are commonly garnetiferous with the garnets often strung out along what must have been original bedding-planes. The garnets are sometimes present in quantity in one band and absent in adjacent bands. Some varieties of the gneiss are massive and fine-grained. Under the microscope the gneisses are seen to consist very largely of fresh-looking, usually coarse grains of quartz and hornblende, with the hornblende occasionally arranged in parallel. A little plagioclase, biotite, and a few small crystals of magnetite, apparently from the alteration of hornblende, are present in some sections. Garnets when present are usually small in size, but often show good dodecahedral outlines. In the case of some of the massive dark-green and black, fine-grained types, the origin is difficult to determine; they may be basic sediments or altered greenstones or tuffs.

Quartz-biotite gneisses and schists are quite abundantly distributed throughout the area. Numerous outcrops of them occur on Pashkokogan river and on the west arm of Pashkokogan lake. Some of them do not differ much from the gneisses of the Miniss series, but they exhibit more distinct banding and are finer-grained. Some crystals of staurolite were noted in a few specimens. The iron formation from Doran lake is essentially fine-grained quartz-biotite schist with magnetite.

In much of the quartz-biotite schist, original bedding is apparent, as shown by differences in texture and in colour. In an outcrop about half-way up the west shore of East Pashkokogan lake, the original bedding is lenslike, similar to beds that exist in shallow-water deposits; one bed has the appearance of a conglomerate, but the pebbles do not differ in composition from the matrix; this may be an intraformational conglomerate or metamorphosed concretionary rock. The quartz-biotite rocks are probably originally argillaceous sandstones.

Quartz-chlorite schists, similar in general appearance to the quartz-biotite schists and probably derived from much the same type of original sediment, were

seen at a few localities. One of the largest and best outcrops of sediments in the whole area is of this type of rock; it occurs on the east side of Pashkokogan lake. Beds of conglomerate with squeezed pebbles and boulders of quartzite and quartz-chlorite rock also occur at this locality.

Impure, fine-grained rocks with a high quartz content, termed greywackés, were observed at many localities. On the south shore of Pashkokogan lake and on the west arm of the lake they are interbedded with greenstones, and on Doran lake they are interbedded with greenstones and iron formation. Isolated exposures occur on Day lake, between Day and Benmeen lakes, on the upper waters of Misehkow river, and in Woodilee and Lowry lakes. Some of the greywackés are rather massive and greenish in colour, but usually they are grey and banded. Small-scale drag-folding is a common feature in the latter type. In section, some varieties show much hornblende with minor amounts of quartz-sericite, magnetite, and chlorite; others have very little hornblende but contain biotite and a fair amount of carbonate, usually in small stringers cutting the other minerals.

Small exposures of quartzite were observed at several localities. A white variety in masses up to 15 feet thick occurs with garnetiferous quartz-hornblende gneiss at the north end of Pashkokogan lake; pinkish quartzite in narrow bands with chlorite schist and greywacké, as well as more massive garnetiferous quartzite, outcrops on the west arm of Pashkokogan lake; massive grey quartzite outcrops on an island at the south end of East Pashkokogan lake; and cherty quartzite was noted at the north end of Coles lake. There is an interesting occurrence of conglomeratic quartzite on Medcalf lake, in which the rounded pebbles and boulders are of grey quartzite and the matrix of gneissic quartzite with biotite.

Arkose occurs at two localities in the area. On the south shore of Lowry lake, near the portage, there is an outcrop of pinkish, finely banded arkose, cut by small dikes of lamprophyre. In section this rock shows varying-sized grains of quartz, green and brown biotite, muscovite, plagioclase, and orthoclase. On Medcalf lake, 1½ miles southeast of the portage into Thelma lake, siliceous rock with prominent quartz eyes was observed, which, under the microscope, show large subangular crystals of orthoclase and quartz in the groundmass of quartz, sericite, and pyrite; it is probably an arkose.

Iron Formation

There are two distinct types of iron formation in the Pashkokogan area; the first is typically developed on Doran lake, and the second north of Misehkow river.

The first type outcrops on the islands of Doran lake and at a few places along the northern shore. It consists of black glistening rock with a peculiar ribbed appearance, due to the alternating bands of resistant and non-resistant material; the former standing up a quarter of an inch or so above the latter. The resistant bands vary from half an inch to six inches in width, and the non-resistant bands from one to twelve inches; they are nearly always very straight and parallel and stand nearly vertically. The microscope shows plainly that the rocks are fine-grained quartz-biotite schists. The iron present is magnetite, usually in the form of tiny flakes and grains strung out parallel to the schistosity, but in some specimens the magnetite is in small recrystallized cubes. The chief difference between the resistant and non-resistant bands appears to be in the much higher magnetite content in the former.

On Thelma lake the same type of iron formation was seen, in one outcrop interbedded with quartzite in 1-inch bands, and in another with coarse-grained quartz-biotite gneiss. Similar iron formation occurs on the south shore and

adjacent islands of Lake St. Joseph, between Thelma river and Pedlarpath bay; and also several miles to the east at Iron falls on the Misehkow river.

The Doran lake iron formation appears to lie stratigraphically near the top of the Keewatin formation, since it is close to the Timiskaming conglomerate that lies along the synclinal axis, which runs east and west along the south shore of the lake. The iron formation is underlain by greenstones and sediments, and overlain first by greenstones and then by the Timiskaming conglomerate. The occurrences on Thelma lake and at Iron falls occupy a similar stratigraphic position, but the relations of the Lake St. Joseph occurrences are not clear.

The iron formation would appear to have originated, in part at least, as ordinary clastic sediments, probably as argillaceous sands with a varying



Keewatin greywacké and iron formation, Iron falls, Misehkow river.

admixture of magnetite derived from the breaking-down of iron-bearing igneous rocks. Some of the iron may have been added by solutions supplied directly to the bodies of water by volcanic flows, which in this area are known to have preceded the iron formation.

The second type of iron formation was seen at two localities in the eastern part of the map area; the first one mile north of the north end of Woodilee lake, and the second two miles north and a little east of Iron falls. This iron formation consists of alternating bands, about 6 inches in width, of black magnetite and white and yellow silica; the country rock is quartz-biotite gneiss. It is more like the common type of Keewatin iron formation than the Doran lake occurrences, and resembles the iron formation described by Burwash from the eastern part of Miminiska lake. Since it is found near the northern edge of the Keewatin syncline, it is thought to lie farther down in the Keewatin series than the Doran lake type.

TIMISKAMING CONGLOMERATE

The conglomerates exposed on the south shore of Doran lake and to the east on Thelma lake are considered to be Timiskaming in age. The pebbles,

some of which reach 4 or 5 inches in length, are rounded and not greatly compressed, and the material composing them is fairly fresh. They consist chiefly of white sugary quartzite and grey biotite granite with bluish quartzes, but some pebbles of greywacké and iron formation from the Keewatin rocks outcropping near by were also observed. The matrix is chiefly a fine-grained, banded, quartz-biotite schist. Massive quartzite with some biotite appears to be interbedded with the conglomerate on Thelma lake.

The actual size of the conglomerate band was difficult to determine, since a large part of it is covered by drift, but the length parallel to the strike appears to be about 3½ miles and the width across the strike about 300 feet at the western end of the band on Doran lake and 2,000 feet at the eastern end on Thelma lake.

The massive beds of conglomerate stand nearly vertically, and the strike is east to a little north of east, thus conforming to the regional strike in the Keewatin series. It is possible that an unconformity exists between the Timiskaming and the Keewatin, but no evidence of it was found in the short time at our disposal.

The conglomerate occurs along the axis of the major syncline and, judging by field relationships, it appears to have been brought into its present position by down-faulting along this axis.

ALGOMAN INTRUSIVES

The intrusives of Algoman age occur as great batholiths of granite to the north and south of the Keewatin syncline, and as stocks and dikes of granite, pegmatite, and porphyry penetrating the Keewatin and Miniss rocks. There are two chief varieties of granite in the batholiths: a gneissic type, which is always grey in colour, and a fresher-looking massive type, which is usually pink or red but may sometimes be grey. In both types biotite is the usual accessory mineral, but hornblende occurs at many places and occasionally muscovite.

The grey gneissic variety is clearly older than the pink massive type; the former occurs as inclusions in the latter, and stringers of the pink granite cut the grey gneissic granite. It may be stated, in general, that the granite near the Keewatin belt is usually the grey gneissic type, whereas farther away from the syncline the massive reddish types are more common. However, inclusions of the grey gneiss may be found almost anywhere in the batholiths.

Such a division of the granite into two types has been noted by many authors,[1] and some of them believe that the grey gneissic type is of Laurentian age and the red massive type, Algoman. In the area examined, however, there is no proof of this. It is more probable that both types are of Algoman age, and that the gneiss represents a somewhat earlier phase, which digested more of the sediments and volcanics, thus becoming grey in colour. It is possible also that the grey phase was originally more basic in composition.

Stocks and dikes of granite intrude the Keewatin in many places, but are more numerous in the western part of the area than the eastern. The granite of such intrusions wherever examined is of the fresher-looking massive type. On Pashkokogan lake, on the north side of Doran lake, and on Caron lake, the granite is pink; whereas on East Pashkokogan lake, Thelma river, Eric lake, and Benmeen lake, it is grey.

[1]E. S. Moore and G. H. Charlewood, Two-Granite Batholiths in the pre-Cambrian, Trans. Roy. Soc. Can., sec. IV, 1930, pp. 133-136.

Pegmatite dikes, presumably of Algoman age, are of common occurrence in the Miniss series and also occur in the Keewatin. Those observed are pink, white, or grey in colour, and the only minerals noted were quartz, orthoclase, biotite, and occasionally muscovite.

Porphyry was found only at four localities. On one of the northeastern arms of Miniss lake there is a large mass of quartz porphyry intruded by pink granite and pegmatite. A small dike of feldspar porphyry intruding Keewatin quartz-biotite gneiss was found at Iron falls on the Misehkow river. An isolated exposure of granite porphyry was seen on the Misehkow, 4 miles above Iron falls, and small red feldspar dikes occur along with quartz veins intruding Keewatin greywacké on the Misehkow, 2 miles below Coles river.

Quartz veins are numerous in almost all parts of the area, but these will be described in the section on "Economic Geology."

Other rock types are rare in the Algoman. Rhyolitic phases of the granite were seen at a few localities. On Greenbush lake there is a mass of quartz diorite between Miniss sediments and Algoman granites that is apparently a contact phase of the latter. Grey quartz dioritic gneiss occurs on Savant river below Velos lake and massive diorite on Velos lake. Grey hornblende syenite occurs on Misehkow river 10 miles above its mouth and gneissic granodiorite on the south shore of Pashkokogan lake.

KEWEENAWAN DIABASE DIKES

Diabase dikes were observed at three localities: the first on Atikokiwam lake, the second on the south branch of the Albany south of Kagami island, and the third on Misehkow river, 2 miles west of Coles river. The northern dike cuts red Algoman granite, and is more than 300 feet wide; the next dike to the south cuts grey Algoman granite; its width was not determined. The southern dike cuts Keewatin sediments and is 250 feet wide. Contacts between the diabase and the intruded rock vary in direction from 10 to 30 degrees east of north. The rock shows fresh crystals of plagioclase and augite with a little quartz. It resembles the Keweenawan diabase so commonly found in dikes in the north central and northeastern parts of Ontario, and is doubtless of the same age.

Structural Geology

The Syncline

The many strike and dip determinations taken of the schistosity or of the bedding where it was visible in the Keewatin belt strongly suggest that these rocks have been folded by the intrusion of the Algoman granite batholiths into a syncline. The Miniss sediments and the small block of Timiskaming have also been included in the same folding. The syncline is fairly definite through the western and central parts of the map area and as far east as Woodilee lake. Strikes are east to north of east (70 to 90 degrees); dips are steep (65 to 90 degrees) and are quite regularly to the north in the southern part of the syncline and to the south in the northern part. When the steep dips and quite considerable width of the syncline (15 miles through Pashkokogan lake) are taken into account, it would seem that the Keewatin rocks reach considerable depths. This is corroborated by the presence of Timiskaming conglomerate on Doran lake. That the Keewatin syncline is deep in the vicinity of Iron falls on the Misehkow river is suggested by the presence there of the Doran lake type of iron formation, which, at the type locality, as noted previously, lies high up in the Keewatin series and close to the Timiskaming.

The axis of the syncline can be traced fairly clearly in some parts of the area. On Doran lake this axis evidently runs east and west along the south side of the lake. There is some evidence that it runs along the long west arm of Pashkokogan lake and through the northern end of the lake. From this point eastward to Lowry lake it has not been traced, but it quite definitely crosses this lake and also the southern part of Woodilee lake.

Along the Misehkow river east of Iron falls the strike of the rocks is more nearly northeast than east (40 to 60 degrees), and at the greenstone outcrop near the mouth of the Misehkow river the strike is 30 degrees. This indicates that the Keewatin belt swings northeastward to join that of the Albany river, although the rocks themselves are hidden completely by drift for 15 or 20 miles. On the Albany river and Miminiska lake the strike again turns to a general east and west direction. In this region the structure is not definite, but since the dips are for the most part to the south it is likely that the northern flank only of the syncline is preserved.

Further study would undoubtedly bring to light many structural complications that were not picked up in the reconnaissance work.

Faults

There is a striking difference in the succession of rocks on either side of the synclinal axis, particularly in the vicinity of Lowry and Woodilee lakes. South of the axis the Keewatin rocks are very largely sediments, greywackés, quartz-hornblende gneisses, etc., and the Miniss sediments form the outer part of the syncline; but north of the axis there are broad bands of greenstone with minor amounts of iron formation and interbedded sediments, and the Miniss sediments are missing. Thus strong faulting along the axis with the downthrown side to the north is indicated. Rock exposures are few along the supposed fault plane on Woodilee and Lowry lakes, and no strong shearing or other direct evidence of the faulting was available; but along the Misehkow river from Iron falls eastward for 12 miles the rocks are quite strongly sheared and consist of chlorite, talc, and carbonate schists. This part of the Misehkow is straight and runs in the very direction that the eastward continuation of the axial fault of Lowry and Woodilee lakes would be expected to run. As noted previously, field relationships indicate that the block of Timiskaming conglomerate of Doran and Thelma lakes has been brought into its present position by down-faulting along the synclinal axis, which can be traced along the southern shore of Doran lake. In this case it is not known which is the down-faulted side.

There is little doubt that a series of faults trending about N.30°E. exists. Insufficient work was done to obtain proof of these faults, but they are indicated by certain long, narrow, and very straight lakes and the way the rock outcrops are arranged on them. Rockcliff lake is a good example; not only is this lake very narrow, long, and straight, but the rock is exposed almost continuously as cliffs along the east side, whereas outcrops are fewer and not so cliff-like on the west. Other lakes of the same type are Minchin and Hamilton, and the lake chains to the east of Hamilton. These lakes often show sharp distinct walls of granite parallel to the direction of elongation of the lakes. The walls are low, rising only 10 to 15 feet above water-level, but are seen only on the eastern side of the lakes. The faults are most obvious in the granites and the Miniss sediments to the south of the Keewatin syncline, but it is more than likely that they continue northward into the Keewatin rocks.

Relationship between Topography and Structural Lines of Weakness

Considerable attention was paid to the relationship between structural lines of weakness and topographical features. Many cases were found, some of which have been cited, of shore lines parallelling the strike of the rocks, and of rivers and long narrow lakes parallelling the strike and lying along supposed fault-planes. There were so many exceptions, however, that it was decided that opinions about the structure of a region formed from aeroplane maps before investigation on the ground would only be misleading. In the southwestern part of the Miminiska sheet many topographical lines are shown trending northeastward, such as Coles, August, Dot, Crozier, and Greenmantle lakes, and Greenmantle and Misehkow rivers. If topographical lines parallelled structural lines of weakness, schists and gneisses with northeasterly strikes would be expected in this region. The rectangular pattern of Greenmantle river north of Suzanne lake is suggestively like topography in schists. As a matter of fact Misehkow river, Coles, Dot, and Crozier lakes are in schists and gneisses with shores in general parallel to the regional strike of the rocks, but Greenmantle lake and river, between Suzanne lake and Shabuskwia river, are in heavily drift-covered granite country and bear no relation whatever to the structure of the rocks. The rocks in the vicinity of Lowry and Woodilee lakes are Keewatin with a very definite east-west strike, but the configuration of the lakes would not suggest it. The very straight northwest-trending western shore line of Lowry lake suggests some dominating structural feature, but in the field it was found that no rock whatever outcrops along this shore.

Economic Geology

GOLD

Some parts of the Pashkokogan-Misehkow area would appear to warrant intensive search for mineral deposits. Interbanded Keewatin greenstone, sediments, and iron formation, cut by stocks or dikes of granite pegmatite and some porphyry, are of wide extent. This rock relationship is of the type usually associated with gold deposits in the Canadian shield. One difference between the geology of many proved gold areas and the Pashkokogan-Misehkow area is that in the former porphyry is very often closely associated with the gold-bearing quartz veins, whereas in the latter this rock is of rather rare occurrence. Gold has not been found in the area examined, and the few quartz veins sampled during the summer were found on assay to contain no gold. Finds have been made at several points at no great distance from the area, i.e. Fort Hope, Pickerel lake, and Savant lake.

The eastern part of the area appears more favourable than the western part. To the west the quartz veins observed are for the most part small and occur as stringers in sediments and greenstones. There is very little mineralization in the veins and no carbonatization or alteration of the wall rock. Porphyry was seen at only one locality, among granites and pegmatites on the northeast arm of Miniss lake. In general the quartz of the western part of the area appears to be a differentiation of the pegmatite dikes. The largest mass of quartz seen is a stockwork 15 feet wide in quartz chlorite rock near the mouth of the small creek flowing into Osnaburgh lake from the south, 4 miles west of Pashkokogan river. The quartz is white and very barren-looking.

Farther east the quartz veins are stronger and better mineralized with pyrite and chalcopyrite, and the walls are at times altered and contorted by the intrusion of the veins. Carbonatization is more in evidence and the green-

stones, particularly along the Misehkow river, are strongly sheared with the formation of carbonate, talc, and chlorite schists. Porphyry dikes were found in three places among Keewatin rocks, although granite intrusions are missing. It is in the eastern part of the area also (Lowry and Woodilee lakes) that strong faulting is suspected along the axis of the syncline. This is considered a favourable feature, as fracturing and shearing along such a fault would present avenues for the penetration of gold-bearing solutions. An unfavourable feature for prospecting in this eastern part of the field is the rather heavy mantle of glacial drift which covers the rocks.

The region from Lowry lake to a point 12 miles downstream from Iron falls on the Misehkow river is recommended to the prospector. Between Aldous and Caron lakes there is a rusty zone with quartz veins in Keewatin sediments and greenstones which might be worth investigation. In the western part of the area the prospector should examine the contacts of the granite stocks with the Keewatin greenstones and sediments.

Miminiska lake and the Albany river above the lake did not look very promising. The greenstones are very massive and little quartz was seen. Moreover, the country is heavily drift-covered.

RARE MINERALS IN PEGMATITE DIKES

An examination of the pegmatite dikes, which are especially abundant in the Miniss series, might be worth while. In southeastern Manitoba[1] some albite-bearing pegmatites carry cassiterite, and others the lithium-bearing minerals lepidolite, spodumene, and montebrasite, and several of the rarer minerals. Microcline granites and pegmatites would appear to be barren of such minerals. No albite-bearing pegmatites were located in the Pashkokogan-Misehkow area, the only minerals seen in the pegmatites being quartz, orthoclase, and muscovite; but only a cursory examination of the dikes was made.

IRON

Iron formation was found at several widely separated localities, and it is thought to be quite widespread through the area. Samples from Doran lake were analysed; the resistant bands[2] were found to contain 34.82 per cent. iron, and the non-resistant bands only 7.66 per cent. As the non-resistant bands are about twice as wide as the resistant ones it is estimated that the deposit would not contain more than about 15 per cent. of iron. It is possible that other portions of the Doran lake iron formation might be richer than this, but it is not expected that better values will be obtained than in the iron formation of the western part of Lake St. Joseph, which it resembles. Samples of the latter were collected for analysis by Bruce in 1921, and in them the iron content ranged from 32.60 to 38.42 per cent.

No samples were taken of the iron formation of the type occurring north of the Misehkow river. This type resembles the iron formation described and sampled by Burwash from the eastern part of Miminiska lake, which contained 37.5 to 40 per cent. iron.

[1]J. F. Wright, Geology and Mineral Deposits of a Part of Southeastern Manitoba, Geol. Surv. Can., Mem. 169, 1932.

[2]See page 11.

Geology along the Route from Shabuskwia Lake to Willet Station

The return canoe route from the Misehkow river country to the railway leads through Shabuskwia lake and a chain of lakes in the area, recently mapped in the Miminiska sheet, across Whiteclay lake (part of the Ogoki river system), thence up the Picket river to the height-of-land, and finally downstream through a series of small lakes and Pikitigushi river to the railway at Willet. This route cannot be recommended for prospectors on the way to the railway from Misehkow river; it is long, and the north end of Shabuskwia lake is not easy to reach from Misehkow river. One has either to use the lower part of Greenmantle river, which is shallow and full of rapids, or go down to the Albany, round the long northern bend, and then paddle upstream through the small winding Shabuskwia river. Once the head of Shabuskwia lake has been reached, however, the rest of the going is comparatively easy. The lakes are quite large with deep water, and the portages are well cut and not long.

Shabuskwia lake and river form part of the glacial moraine country typical of Miminiska lake. Drift hills, some of them over 100 feet high, were noted, and there are several cliffs and beaches of sand and gravel. Rock exposures are few and are all of granite and pegmatite. In the granites outcropping on the portages between Shabuskwia and Musgrave lakes, and on Musgrave lake itself, there are inclusions of quartz-biotite gneiss, and on Kilbarry lake these gneisses outcrop all along the southeast side of the lake, striking N.35°E. and dipping about 80°S. They resemble the sediments of the Miniss series (Coutchiching) and are intruded by numerous dikes of granite and pegmatite, just as in the Pashkokogan-Misehkow area. Granite with inclusions of sediments appears at the north end of Kilbarry lake, but at the portage at the south end of Luella lake there are fine-grained quartz-biotite schists and quartz-hornblende-biotite gneisses, striking E.10°S. and dipping 75°N., cut by a 4-foot dike of quartz porphyry.

Luella is a beautiful lake with high, well-wooded shores and cliffs of granite. The river between Luella lake and Attwood lake is also largely in granite, but on the north side of Attwood lake and along the northeast arm, Miniss sediments are exposed. They consist mainly of quartz-biotite gneiss and schist, but staurolite schist was also seen; the strike is normally N.70°E., and the dip 70°N. At the north end of Attwood lake greenstones are exposed, and on Hurst and Felsia lakes several of the outcrops are of greenstone cut by granite.

This belt of sediments and greenstones was quite unknown before and might be worth examination for minerals, especially the north end of Attwood lake, where some narrow but rather heavily mineralized quartz veins were observed. The dimensions of the new belt are unknown; it is thought to be rather narrow, since granite keeps outcropping along the line of traverse. Burwash mapped Keewatin greenstone, schists, agglomerates, etc., on the Albany river from Frenchman's rapid to the mouth of Opichuan river; this greenstone may be continuous with the Attwood lake belt.

Witchwood river flows through low swampy country, and there are only small isolated outcrops of granite and diabase and garnetiferous quartz-biotite gneiss. Witchwood lake is narrow, long, and straight, and bordered with cliffs of granite, pegmatite, and quartz-biotite schist (Miniss or Coutchiching). It apparently lies along a fault-plane, which appears to extend southward through the northern arm of Whiteclay lake. The two lakes are separated by a thick deposit of glacial sand and gravel.

The rock on the northeastern arm of Whiteclay lake is largely granite, but three miles south of the outlet of the lake into the Ogoki river diabase sills appear above the granite. These sills were subsequently seen lying upon older rocks at intervals all the way to the railway. The western arm of Whiteclay lake has many mounds of sand around the shores with occasional exposures of granite, diabase, and quartz-biotite gneiss.

The lower part of the Picket river shows isolated outcrops of diabase, but the banks are mostly of sand and clay. The small lakes near the height-of-land and the first lake across the height-of-land are in granite. Cliff lake lies between canyon-like walls of diabase 100 feet high, but at the south end of the lake granite appears again and continues for 3 miles to the south.

The small lake crossed by the northern boundary of the Nipigon Forest Reserve has low shores; granite outcrops at its north end, but on the small creek which empties out of it fine-grained massive greenstone appears. The rock from here to Pikitigushi lake is largely greenstone, but the greenstone is overlain here



Diabase cliff about 75 feet high, Cliff lake.

and there by diabase sills. The greenstones observed are for the most part fairly massive; schists were seen, however, and some good pillow lavas. At one place the strike was observed to be E.10°S. and the dip vertical; and three miles to the south the strike is E.40°S., and the dip 60°N. On the south shore of Pikitigushi lake, there is a small outcrop of granite and another of diabase.

Pikitigushi river below the lake is small but has plenty of water. It is extremely winding and flows rapidly through drift deposits. The banks approach 100 feet in height and show boulder clay underlain by beds of gravel and soft laminated clay and silt, which resemble interglacial deposits seen in other parts of Northern Ontario. The only outcrop on this part of the river is one of greenstone at the rapid 2 miles north of the railway. No diabase outcrops on the river, but some distance back of it there are high wooded cliffs, which are probably diabase, at least they were so mapped by the Geological Survey.[1] The diabase occurring on this canoe route is no doubt continuous with the Keweenawan extrusives so widespread around Lake Nipigon and the north shore of Lake Superior.

[1]Map No. 993, 1908.

The greenstone belt is at least 5 miles wide across the strike, and if it is continuous under the drift to the outcrop near the railway it is 14 miles wide. These greenstones were mapped as Keewatin by the Geological Survey.[1] They appear to be continuous westward as far as the northeast end of Caribou lake, where Collins[2] and Hopkins[3] described and mapped Keewatin pillow lavas, green schists, iron formation, etc. Hopkins also followed a canoe route from Caribou lake toward the Pikitigushi river and found massive and schistose greenstone and diabase and hornblende chlorite and talc schists, rusty carbonate, and iron formation. Gold values of 40 and 80 cents per ton are reported by Hopkins from the region. To the east the greenstones may extend to Zigzag and Crescent lakes on the Little Jackfish route, where Burwash[4] has described and mapped Keewatin rocks, mostly schistose pillow lavas, over a belt 2 miles wide from north to south across the strike.

[1]Geol. Surv. Can., map No. 993, 1908.
[2]Ibid, Sum. Rept., 1906.
[3]Ont. Bur. Mines, Vol. XXVII, pt. 1, 1918, pp. 195-198.
[4]E. M. Burwash, Ont. Dept. Mines, Vol. XXXVIII, pt. 2, 1929, pp. 11, 12.

Geology of the Shabumeni-Birch Lakes Area

By Geo. D. Furse

Introduction

During the summer of 1932 a party from the Ontario Department of Mines made a geological survey of the country in the vicinity of Shabumeni and Birch lakes, and examined a number of prospects in this area and in the Woman Lake and Red Lake areas. The south end of Shabumeni lake was studied in detail in order to trace its sediments as far south as possible, and the results of this work are embodied in the geological map (No. 42*d*). Outcrops in the triangular area of greenstones lying north of the 10th base line were mapped and, with the exception of two breaks, the granite contact was traced from the inlet

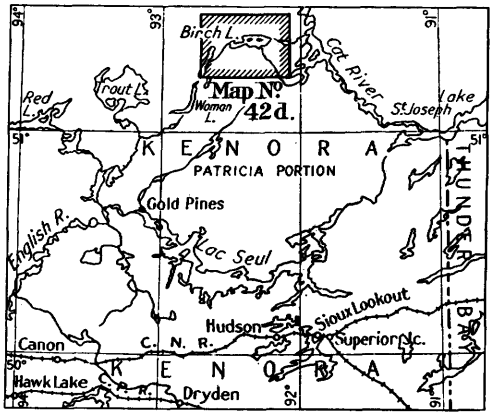


Fig. 1—Key map showing the location of the Shabumeni-Birch Lakes area. Scale, 60 miles to the inch.

of Shabumeni lake to Keigat lake. A compass and micrometer survey was made between Mink and Graham lakes, and the more important claims were located fairly carefully. Detail maps of many claim groups were made.

Acknowledgments

N. D. Runnalls, G. A. Harcourt, and W. L. Brown were assistants throughout the summer. Mr. Runnalls mapped the main granite contact from Shabumeni to Richardson lake, and the general geology of many of the mining claims. Mr. Harcourt continued the work along the granite contact to Keigat lake.

The writer wishes to acknowledge the favours extended by prospectors and members of the Ontario Forestry Branch. Thanks are especially due to J. C. Nelson, of Metals Development, Limited; J. D. Williamson, of Casey Summit Gold Mines; Gus V. Johnson; R. H. Hutchison, of Coniagas Mines, Limited; Geo. Swain, Narrow Lake P. O.; Messrs. N. Bamford and M. Roadhouse, of the Ontario Forestry Branch, and members of their staffs; R. F. Dynes, O.L.S., and H. E. Holland, Mining Recorder, of Sioux Lookout. Practically every person in the area gave valuable information or other assistance.

Previous Work[1] by Ontario Department of Mines

In 1919, E. M. Burwash[2] examined the eastern part and the southwest arm of Birch lake. In 1926, Greig[3] made a reconnaissance survey of the area including Woman, Narrow, Confederation, Birch, Springpole, and Slate lakes. The following year Bruce[4] made a detailed study of the gold occurrences on Woman, Narrow, and Confederation lakes.

Access

During the summer the Northern Transportation Company operated a tri-weekly boat service between Hudson and Red Lake. A canoe route branching eastward at the north end of Pakwash lake leads up Trout Lake and Woman rivers to Woman lake and Swain lake. Portages lead to waters flowing into Birch lake. Casummit lake lies about a mile north of Birch lake, and drains into it by a stream navigable in high water. Between Bruce lake and Woman lake there are 5 portages, totalling 3 miles. Two are about a mile long; all are in good condition and have easy grades. They form part of the winter route up these rivers.

Air transportation is easily obtained. The Canadian Airways makes two mail trips to Red Lake and one to Narrow Lake P. O. each week. This company operates from Sioux Lookout or Hudson, and has a variety of planes available, including a small Junkers. Small planes are available from other companies at Sioux Lookout.

Topography and Drainage

The relief within the area is quite moderate, and usually low. Rocky shores are not common, and where found, cliffs about 30 feet high are a maximum, although hills of 50 or more may be found close to the shore. The central part of Birch lake has rocky shores with outcrops as high as 20 feet. At the east end the land is low, and the outcrops are covered by drift to a greater degree. A cliff about 140 feet high occurs south of the east end of Swain lake; and hills 110 to 185 feet high are found east of the southern part of Shabumeni lake. This group of hills is composed of rhyolitic rock, of which there is a comparatively large exposure. The shores of lakes underlain by granite are usually quite low. Inland, the granite areas are usually covered by muskeg showing here and there small outcrops or ridges of outcrops which cause small steps in the muskeg surface. Little Shabumeni lake is quite shallow, and is so dark coloured that it is not safe to use outboard motors. As seen from the air, the country to the north of the map area appears to be level.

Natural Resources

Timber.—Most of the area is covered by a forest growth classified by the Ontario Forestry Branch as mature.[5] Timber usable for mine or construction purposes is not plentiful. Large evergreens were found on the islands in Casummit lake. Usually the stump diameter is not over 6 to 8 inches, although the maximum is about 20 inches. The total height of the largest conifers is about 40 feet. Some deciduous trees grow slightly larger.

[1]For a detailed account of early explorations, *see* Ont. Dept. Mines, Vol. XXXVI, pt. 3, 1927, p. 90.
[2]Ont. Dept. Mines, Vol. XXIX, pt. 1, 1920.
[3]J. W. Greig, Ont. Dept. Mines, Vol. XXXVI, pt. 3, 1927.
[4]E. L. Bruce, Ont. Dept. Mines, Vol. XXXVII, pt. 4, 1928.
[5]Personal communication.

At the east end of the portage east of Swain lake, trees attaining a diameter of 16 inches occur. North of the east end of this lake 20-inch Banksian pine grow on sand hills. Small tamarac were found in the swamps near by. The southeast shore of Shabumeni, the small islands adjacent, and the west shore near the south end are covered with low second growth of poplar, birch, and pine. The larger island and the north central shore bear a thick growth of mixed timber 40 to 50 feet high having a basal diameter of 16 inches. A few cedars were found along the water's edge on Birch lake. Some large trees occur on the big island, but most of it is covered by windfall. East of the lake along the base line the trees seldom exceed 8 inches in diameter.

Burned areas were found in the northern part of the map area. The southern boundary of a brulé several years old extends from the vicinity of Blondin lake to a point northeast of Graham lake. During the summer a fire approached Blondin lake from the northwest, and another threatened an area of good timber in the vicinity of Okanse lake southeast of Swain lake.

Agriculture.—No large areas of agricultural soil were found, but numerous small patches afford good gardens. Gardens on Casummit lake and Swain lake were especially good. Radishes, carrots, onions, and potatoes were grown successfully and used before September 1.

General Geology

The geological column is as follows:—

QUATERNARY	
PLEISTOCENE and RECENT:	Till, sand, gravel and peat.
PRE-CAMBRIAN	
POST-ALGOMAN (?):	Diorite and lamprophyre dikes.
ALGOMAN type:	Quartz and quartz-feldspar porphyry. Granite, and granite porphyry and syenite.
UPPER VOLCANICS[1]:	Andesite, basalt, some rhyolite and chlorite schist.
TIMISKAMING type (Shabu series):	Greywacké, slate, quartzite, arkose, and conglomerate.
LOWER VOLCANICS[2]:	Greenstone, chlorite schist, basalt, andesite, acidic and basic tuffs and agglomerates, and iron formation.

LOWER VOLCANICS

The most common rock types occurring in this group are greenstones and chlorite schists. The former term is applied where the rock is massive and so much altered that its original composition is uncertain. Where schistose, it is called a schist and named according to the mineral which appears to be dominant. Chlorite and carbonate schists or combinations of these two are most common. They occur throughout the southern part of the area mapped, and are intricately mixed with the more massive types.

The basalts commonly lack ellipsoidal structures, but the andesites have them. The lithological distinction is based on appearance rather than microscopic study. The pillow lavas have a lighter colour than the basalts both on the weathered surface and the fresh fracture.

In the north part of Birch lake, on the south shore of claim K.R.L. 10,054, a rock varying from chlorite schist to altered basalt contains white to dirty-grey coloured areas scattered irregularly through the matrix and ranging in size

[1]On the map the Upper and Lower volcanics are not differentiated, being shown in one group of colours under the term "Keewatin type."

[2]These rocks constitute the greater part of the Keewatin as shown on the map.

from one-half inch square to 2 by 3 inches. The lighter-coloured particles have sharp boundaries suggesting crystal outlines. They show a good cleavage and have a porcelain-like appearance at right angles to this. The grey-coloured areas are granular and grade into the basaltic matrix through a narrow greenish-grey zone. There are no appreciable variations in their concentration, nor regular gradation of size. This type of rock also occurs in massive, coarse-grained basalt in the bay south of mile 28½ on the 10th base line. It closely resembles the basic lavas described by Bruce in the Lake of the Woods area[1] but are not so thoroughly altered.

On the Hurley-McDonald claims, east of the north end of Woman lake, spherulitic rhyolites have an appearance similar to that pictured by Bruce from Lost bay and Washagomis lake,[2] except that the lava is considered to be rhyolite instead of basalt.

The agglomerates occur adjacent to the southeast shore of Shabumeni lake. They are usually of basic to intermediate composition containing grey-weathering oval fragments of andesitic appearance, and as large as 4 by 6 inches, in a matrix of chloritic schist. Some fragments appear to be rhyolite. The agglomerates grade into tuffs, their fine-grained equivalents. Northeast of Mink lake small bands of well-bedded sediments, probably tuffs, occur with unsorted tuffs and agglomerates. This band of pyroclastics extends from the north shore of Mink lake eastward across Joneston and Casummit lakes to the McIntyre property on the north bay of Birch lake. The relations of the two bands of agglomerate to the adjacent rocks is not definitely known, but will be discussed later in the report.

Rhyolites occur in minor amount about a mile northwest of the east end of Swain lake.

The iron formation is chiefly banded magnetite and silica in patches or lenses as small as 3 by 6 feet. It occurs widely distributed in the lavas and pyroclastics north of a line drawn between Mink and Keigat lakes. In some outcrops the iron formation is very thinly laminated and contains jasper. Where the magnetite decreases in amount, the rock becomes a laminated chert. The jasper occurs in that part of the formation which has been exposed to weathering, and in the only place observed lay at the upper edge of the band.

TIMISKAMING TYPE (Shabu Series)

These sediments constitute a folded syncline underlying Shabumeni lake. The west limb follows the edge of the granite from the inlet of the lake to a point near the northeast end. The south end of the east limb was found a short distance northeast of the post of the Ontario Forestry Branch on Swain lake, and was traced northeast in a broad curve through the central southern part of the lake, and along the south shore of the north end, where it is separated from the north limb by a narrow belt of chlorite schist exposed on the islands in this part of the lake.

At the north end most of the sediments are cut out by granite and the rest are displaced to the south. To the north they are metamorphosed to hornblende schists and appear to be mixed with the lavas, especially west of Mink lake. Northwest of Blondin lake the sedimentary character of the rocks is again well shown. Here the acidic types, light-coloured biotite schists, quartzites, greywackés, and acidic tuff-like beds, occur. These sediments form a high

[1]E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, p. 8.
[2]Ibid, Vol. XXXVII, pt. 4, 1928, pp. 6, 7.

rocky ridge lying along the east side of the granite contact, which is usually on the lower slopes of the hills or in the valleys.

The north limb of the fold is chiefly quartzite, slaty quartzite, and greywacké. Greig[1] describes this limb as follows:—

> Next the granite . . . there is a band of dense, dark-grey, finely banded rocks which extend across the full width of the lake at the north. As the granite is approached, small feldspar crystals appear in these schists and gradually increase in size. Microscopically, the rocks are seen to consist of a fine mosaic of quartz and alkali feldspar, and small green hornblende crystals arranged parallel to each other in planes, giving the rock its banded appearance. . . . A thin section of a specimen [from the east side of Shabumeni lake] shows it to be composed of a very fine grained groundmass of quartz and some feldspar, having fine-grained mica, sericite, and light-coloured biotite thickly distributed through it. The banded and crumpled appearance of the rock is due to the arrangement of the mica. The difference in mineral composition between these rocks is probably to be attributed to the granite intrusive.

The smaller islands near the outlet of the lake show fine quartzites and biotite schists, which contain drag folds plunging steeply southwest and having an orientation indicating a syncline to the north.

The south limb is chiefly greywacké, with some arkose, quartzite, slate, and conglomerate. Near the central part of the lake the sediments lie on basic agglomerate and some schistose lavas. Several hundred feet of slate were found in the lower part of the series, but the actual contact was not discovered. Near the narrows of the lake a few outcrops of conglomerate were found above the slates. Pebbles constitute as much as 75 per cent. of the rock. They are dominantly siliceous—rhyolite, quartz porphyry, and a few of vein quartz. They range in diameter from a quarter of an inch to 3 inches, and are fairly well rounded. The matrix is fine and granular, and is composed of quartz, feldspar, and chlorite. To the northwest slaty greywackés overlie the conglomerate, and on the north shore of the small bay are interbedded with some schists, which contain what appear to be slaggy flow tops and ellipsoids, and other rocks which appear to be lavas but lack the structures mentioned.

At the point east of mile 9 on Beattys' meridian the rock is a very fine grained, greenish greywacké consisting of quartz, plagioclase, chlorite, and sericite. A trace of kaolin or leucoxene occurs as an alteration product. The high content of chlorite indicates that the source was a basic volcanic, and the agglomerates to the southeast would provide such material quite readily.

Toward the south end of the lake the basement rocks are andesitic lavas and some breccias. East of the southeast bay the quartzites and slates are usually in thin beds, from one-half to 1 inch thick, with *laminae* as thin as an eighth of an inch. In the greywackés the bedding is about 4 inches thick. A thin section from this vicinity shows a very fine texture; the grain size is about one two-hundredth of an inch. Rock particles of quartz, intermediate plagioclase, and biotite were recognized. Near the northeast corner of Goodall township the sediments appear to thin out and become more slaty.

East of the two large islands in the southern part of the lake evidences of structure were found. Five areas showing gradation of grain indicate that the tops lie on the west. Two observations of fracture cleavage indicate that the structure here is an anticline plunging steeply west. In this vicinity the sediments attain a maximum thickness of half a mile.

Greig's map shows an oval-shaped area of sediments on the south shore of Birch lake. Judging from the close folding in the iron formation on the island southwest of Johnson island, the structure may be quite complicated, and the sediments on the north shore of this island may be related to those mentioned above.

[1]J. W. Greig, op. cit., p. 101.

The area south of Keigat lake contains such a complex of quartz-biotite schists, occasionally garnetiferous, hornblende schists, and chlorite schists that the structure has not been solved.

Between Graham and Keigat lakes there are small areas of quartz-biotite schists having a bedded appearance. These may be merely sedimentary phases in the Keewatin rocks or metamorphosed lavas.

UPPER VOLCANICS

These lavas consist of ellipsoidal andesite, basalt, chlorite schist, and very fine grained, dark-coloured, porphyritic, spherulitic rhyolite. They lie above the sediments in the basin of Shabumeni lake, and where structural evidence was found, they have a similar attitude.

The basic lavas of this group present a much fresher appearance than those of the older group. The andesitic types are light-greenish to greyish-green and have a very fine grained texture. Ellipsoidal structures and dense rounded fragments are common. The basalts are slightly coarser in texture and darker in colour. Narrow bands of chlorite schist in the northern part of Shabumeni lake may be the continuation of this series. Probably the complex group of quartz-biotite and hornblende schists west of Mink lake is due to an interbedding of sediments and younger lavas similar to that on Shabumeni lake.

Rhyolite occurs in an equidimensional mass lying east of the south end of Shabumeni lake in the re-entrant of sediments. It is a very hard, dark-coloured, streaked, amygdaloidal rock containing a few cherty bands. In thin section it consists of a very fine grained interlocking aggregate of quartz, microfelsite, and biotite. The biotite and a trace of limonite are arranged in streaks due to shearing. Some phenocrysts have frayed-out boundaries, and others are fractured into small grains.

A specimen from a point about 20 chains west of the high hill near the lake show quartz phenocrysts in a trachytic mass of quartz, micropegmatite, and plagioclase. This rock has been slightly altered to produce sericite, chlorite, and carbonate. It has been fractured and cemented by fine quartz stringers.

About three-quarters of a mile north of the south end of the lake there is some amygdaloidal rhyolite. The amygdules are composed of chert and some have a concentric structure in the hand specimen, shown by faint colour differences which are not recognized in thin section. Greig[1] described this type as follows:—

> The weathered surface is grey and commonly covered with lighter-coloured knobs more resistant than the rest. When the rock is broken, it is seen that the more resistant material has roughly the form of small, flattened, cigar-shaped bodies, which have their longer axes nearly vertical. A thin section shows that these bodies are composed of a fine-grained mosaic, largely quartz, evidently filling what was once a cavity. The groundmass is too altered to determine the nature of the original rock.

This mass of rhyolite may mark the site of an acidic volcano among a group emitting basic lavas. The interfingering of the rhyolites with andesites and basalts supports this conclusion.

ALGOMAN TYPE

The granitic rocks vary greatly. At the east end of Swain lake there is a medium-grained hornblende syenite bearing traces of quartz. Parts of the batholith are quartz and feldspar porphyry. Contrary to the usual occurrence this mass constitutes a steep hill about 145 feet high immediately south of the lake.

[1]J. W. Greig, op. cit., p. 101.

Syenite occurs on the west shore of Shabumeni lake at the mouth of the Shabumeni river. The granite north of the lake is medium- to coarse-grained, dark-greyish to pink, porphyritic, and massive to gneissoid. Plagioclase is scarce, but orthoclase occurs abundantly as phenocrysts as large as 1 by 1¼ inches. The matrix contains both hornblende and biotite; the latter is dominant, but both increase near the contact. Quartz is interstitial locally, and may have been the last mineral to crystallize. A few small patches of dark-grey granite were found, e.g. north of Keigat lake.

An island in Richardson lake has a similar granitic rock. Orthoclase phenocrysts are about one-quarter by one-third of an inch in size and are oriented parallel to the foliation, which is well shown by the biotite and hornblende. The orthoclase is twinned, and in the hand specimen appears to be more abundant than plagioclase. A field estimate of the mineral content was as follows: quartz, 20 per cent.; orthoclase, 40 per cent.; plagioclase, 20 per cent.; hornblende and biotite, 20 per cent. A thin section shows the following minerals in order of decreasing abundance: albite, andesine, orthoclase, quartz, micropegmatite, microperthite, green biotite, microcline (?), magnetite, and a trace of epidote and limonite as alteration products. Plagioclase was the first mineral to crystallize. The borders of the plagioclase and quartz show some granulation caused by the flow movements that oriented them, but the plagioclase is not always oriented parallel to the foliation. Some plagioclase is crushed, indicating movements when the rock was solid or essentially so. The epidote is an alteration product of biotite or of biotite in contact with feldspar. The micropegmatite is interstitial. From this description, the rock may be called a granodiorite, but no attempt was made to determine the average composition.

Quartz porphyry occurs chiefly as dikes. Between Casummit and Birch lakes there is a small batholith about three-quarters of a mile wide by 4 miles long. On claim K.R.L. 9,820, northeast of Joneston lake, this mass is dark-greyish to greenish-coloured, and contains medium-grained phenocrysts in a very fine grained matrix of quartz, feldspars, and a trace of chlorite and biotite. Near the west end it contains medium- to coarse-grained quartz and feldspar in a light-grey sheared matrix. A thin section taken 10 chains southwest of No. 1 post, claim K.R.L. 8,785, mile 26, 10th base line, shows medium-grained phenocrysts of fractured glassy quartz and some plagioclase in a very fine grained, light-grey schistose matrix. Sheared areas of chlorite and leucoxene indicate former ferromagnesian minerals. The phenocrysts of andesine are slightly altered to sericite.

POST-ALGOMAN (?)

The late intrusives are not so common as in northeastern Ontario. On Mink lake a small dark-grey basic dike cuts the granite. It is very fine grained and so greatly altered that its original composition is uncertain.

A dike on the property of Metals Development, Limited, Confederation lake, 1,100 feet east of the shaft, cuts quartz porphyry and quartz veins. Microscopically the rock has a fine grained, porphyritic texture, showing small phenocrysts of quartz, andesine, and some hornblende in a matrix of carbonate, uralite, chlorite, epidote, and leucoxene. Some hornblende shows rims of magnetite, suggesting that it is secondary after pyroxene. A trace of limonite was observed. Pyrite and tourmaline are introduced minerals. This dike is probably a hornblende kersantite. The mineralization, therefore, must be dated with the later phases of the granitic intrusion or intrusives later than the granite. This dike

may be of approximately the same age as those described by Bruce,[1] but is younger than the quartz veins rather than older.

The freshest rock type in the area is a hornblende porphyrite. Dikes cut greenstones and tuffs in the vicinity of Casummit lake north of the 10th base line. Hornblende is the dominant mineral constituting as much as 40 per cent. of the rock; biotite is subordinate; quartz and andesine are the other essential minerals. There is a trace of introduced quartz, and a small amount of epidote and carbonate as alteration products, and a trace of limonite due to weathering.

Bruce[2] shows areas of diorite in the vicinity of Woman lake. The writer believes that those on the property of Metals Development are partly recrystallized greenstones and partly the basic border phases of granitic knobs. The relations of the masses on the accompanying map have not been determined, and they are, accordingly, still distinguished from the granites. But some bodies show a transition to the surrounding lavas and may be due to underlying granite bosses.

STRUCTURE

Folding

The structure of Shabumeni lake is synclinal with the axis plunging southwest. The east limb dips steeply west and northwest. The tops lie to the west as shown by gradation of grain and the fracture cleavage on the nose of the cross-fold in the southern part of the lake. A study of the flow contacts and cherty tops in the amygdaloidal rhyolites confirms this interpretation. In the northern part of the lake the plunge of the drag folds indicates a syncline to the north of the islands. This syncline of sediments is believed to continue to the vicinity of Blondin lake with a short interruption near the north end of Shabumeni lake.

Near the west end of Mink lake a band of sediments diverges northeastward. The bedded arkose and the greywacké exposed on the western edge of the surveyed claims north of this lake may be the continuation of this band. Since these rocks are highly metamorphosed and the extension to the southwest was not traced, it is not certain whether this easterly band is a part of the sediments or a sorted phase of the pyroclastics southeast of Shabumeni lake.

North of Mink lake gradation of grain in some slaty beds indicates tops to the northwest. Drag folds on the southwest arm of Blondin lake suggest a syncline to the southwest. One and a half miles north of Joneston lake flow tops face southwest, suggesting a continuation of the structure.

In the area immediately north of Mink and Joneston lakes the structure is obscured by the intense shearing. This zone of sheared rocks extends southeastward toward Casummit lake, and the tuffs and agglomerates decrease in width.

In the vicinity of Casummit lake bedded iron formation dips steeply south. Bedding shown by drilling near the vein dips at angles of about 60 degrees. On the southwest corner of claim K.R.L. 8,791, on the north bay of Birch lake, iron formation dips 75°N. This band is bordered on the south by a fragmental flow top and on the north by the chilled edge of a flow becoming coarser 10 feet north. The north side of the iron formation is marked by a jasper zone about 6 inches wide. On the large island in Casummit lake the curving belt of sediments suggests the nose of a fold. Drag folds on the shore to the south indicate that the north side moved east relatively. These evidences point to a synclinal structure plunging eastward in Casummit lake.

[1]E. L. Bruce, Ont. Dept. Mines, Vol. XXXVII, pt. 4, 1928, p. 17.
[2]Ibid, map No. 37*h*.

The northeastern part of Birch lake consists of closely folded lavas and some sediments. Drag folds indicate an anticline trending east-southeast through Johnson island. In the central part near the south shore the structure is more complex. A folded syncline of cherty siderite was found north of the sediments shown on Greig's map, but field work was not continued far enough south to determine the relations between the various areas of sediments.

Faulting

Two faults are shown on the map. The one crossing the north shore of Shabumeni lake at the meridian was actually found. The other east of Little Shabumeni lake south of the 10th base line is indicated on account of the offset in the band of sediments, but its position was not accurately determined. Other faults probably occur two miles southwest where the sediments are broken by the granite projection. The various movements may be earlier than, related to, or later than the granite intrusion.

Shearing

The trend of the schistosity appears to diverge eastward from Casummit lake. This suggests a syncline. However, there has been such intense shearing throughout the area between Blondin lake on the west and Richardson lake on the east that east-west shearing movements must be responsible for most of it. The strike and dip of flow cleavage in narrow shear zones near Richardson lake suggests that the north side moved upward and westward. This movement could produce the vein openings on Casummit lake as tension fractures. Post-vein movements appear to have acted in the reverse direction, and may be due to readjustments or normal faults.

A shear zone extends southwest from the south shore of Richardson lake along the north shore of Casummit lake and south of its west arm. On claim K.R.L. 9,853, of the Ellen syndicate (Stocking group), north of Casummit lake, shear zones having this trend are crossed by narrow shear zones having a strike of S.60°E. This amount of deformation has permitted weathering to extend so deep that bluish to brownish clays and rock fragments are found beneath 8 to 10 feet of till and varved clays.

The No. 2 vein on the Casey Summit property has been faulted along a northeast-southwest line in such a way that the north side has been moved east. Other east-west movements, perhaps of a rotational nature, have displaced this vein. The exact order of these movements is not known at present.

GLACIAL AND POST-GLACIAL DEPOSITS

There is considerable material of glacial age in the area. The granite areas are covered by extensive muskegs underlain by clay. A few small, low morainic ridges of boulder till occur in them. They are concave to the north and have a maximum relief of 50 feet. North of Mink and Joneston lakes other areas of muskeg occur. A few sand hills rising from the muskegs may be old dunes. In the vicinity of the surveyed claims north of Birch lake there are extensive sand plains and ridges. Dr. W. H. Twenhofel, of the University of Wisconsin, described sand samples from this area as clean, well-sorted, weathered, and containing a little mica. The material was deposited in a stream or shallow lake in which there were currents. Their extent favours the latter type of deposition. No observations of physiographic nature were made in this locality.

The bearings of the glacial striae vary from S.65°W. to S.85°W., the chief direction being between S.65°W. and S.70°W.

Geological History

The geological history has been discussed by Bruce. The writer wishes to modify the story to accommodate the Shabu series of sediments. The basal rocks of this group belong to the fine-grained sand-silt type and do not contain any flows or pyroclastics. There must, therefore, have been a widespread area of low relief to which the sediment was brought by the streams and spread out by shore currents to produce this fairly regular series. As uplift of the land areas continued, some coarser material was contributed to form small areas of conglomerate, such as one near the narrows of Shabumeni lake and another on Sundown lake, four miles south of Swain lake.

Since no true contact between either area of sediments and the lower lavas has been found, an unconformity is not postulated, because volcanic activity could be continuous in adjacent areas and yet be interrupted here during the deposition of the Shabu series. Toward the close of the period of sedimentation some lavas were extruded, and are found interbedded with slaty greywacké near the narrows of Shabumeni lake, and finally volcanic extrusion became dominant.

The granite and quartz porphyry intrusives folded and sheared the lavas and sediments, and perhaps formed the quartz veins as a late phase of activity. The fracturing of the quartz veins and the introduction of the metallics is regarded as the last phase of this activity.

Diorite and lamprophyre dikes are the freshest and youngest rocks found in the area.

Economic Geology

After the discoveries of gold on Woman, Narrow, and Confederation lakes in 1926, prospecting spread northeastward to Casummit and Birch lakes. Here, as in the area above mentioned, gold is the only metal occurring in any quantity approaching economic value. The general character of the deposits has been summarized by Bruce.[1] The following sulphides have been found in addition to those mentioned by Bruce: chalcopyrite, sphalerite, and galena. Arsenopyrite is more common than pyrite in the Casummit-Birch lakes section.

WORKING PROPERTIES

Although intensive prospecting continues in the area, most of the properties have not reached the stage of active development. Detailed descriptions of the more important prospects will be given.

Casey Summit Gold Mines, Limited

The original discovery of gold was made at Casummit lake, on claim K.R.L. 9,681, in the spring of 1929 by J. A. Borthwick. In July of that year, the Casey Mountain Operating Syndicate optioned the main Borthwick group of 14 claims, K.R.L. 9,681 to 9,686, inclusive, and 9,733 to 9,740, inclusive. In January, 1930, the Parth-Jones-Fiskness claims, K.R.L. 9,758 to 9,763, inclusive, were optioned also to protect the westerly dip of the vein. During the winter of 1930-31, vein No. 2 was tested by 2,000 feet of drilling. In July, 1931, a mining plant capable of developing to a depth of 500 feet was installed; and in August,

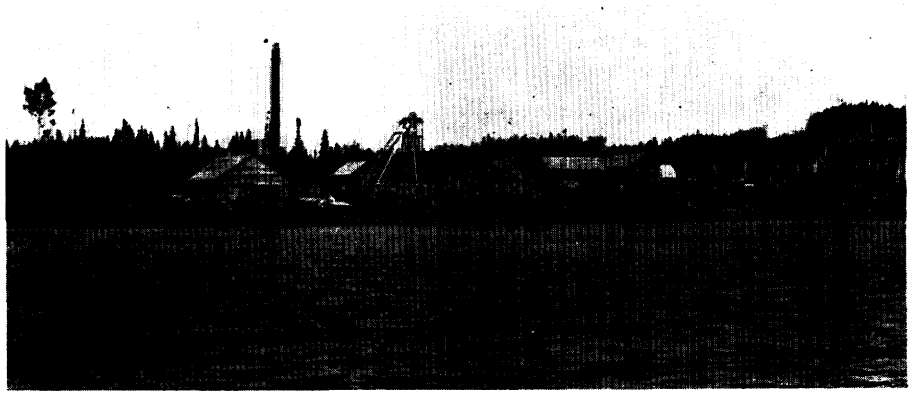
[1]E. L. Bruce, op. cit., pp. 21-23.

Casey Summit Gold Mines, Limited, was incorporated for the purpose of acquiring and developing the 20 claims mentioned above.

Vein No. 2 was explored on the 75-foot level for a length of 140 feet in September, 1931.

In 1933, the Maple Leaf Mines, Limited, took an option on the controlling interest in Casey Summit Gold Mines and is financing the work. The new programme of development is to sink the shaft below 300 feet and establish levels at 200 and 300 feet.

Geology.—The rocks are basalt, andesite, chlorite schist, tuffs, rhyolite breccia, and iron formation. The schistosity and bedding usually strike east-northeast with dips varying from 65°S. to 75°N. Bedding in the iron formation strikes N.65°E., and that in drill-cores dips at approximately 60 degrees. Assuming uniformity of bedding in the drilled area, there are two possible attitudes: N.78°E., dip 58°N.; and S.47°E., dip 58°S. The condition of the drill-core



Plant of Casey Summit Gold Mines, Limited, summer of 1932.

prevented the solution of this problem. The lavas lie in the northwestern part of the property, and are bordered on the south by a mass of tuffs, iron formation, and tuffaceous sediments. On the north boundary of claim K.R.L. 9,684, the tuffs are interbedded with the lavas. The iron formation was probably derived from the fragmental basic volcanics.

In a private report, Hopkins classifies much of the tuff as acidic to intermediate in composition. The writer has mapped the light-coloured tuffs as acidic, and the greenish to dark-green volcanics as basic. Microscopic studies have revealed that the green tuffs are more acidic than field appearance suggested. A description of the rock near the collar of drill-hole No. 9 on claim K.R.L. 9,681 is as follows:[1]—

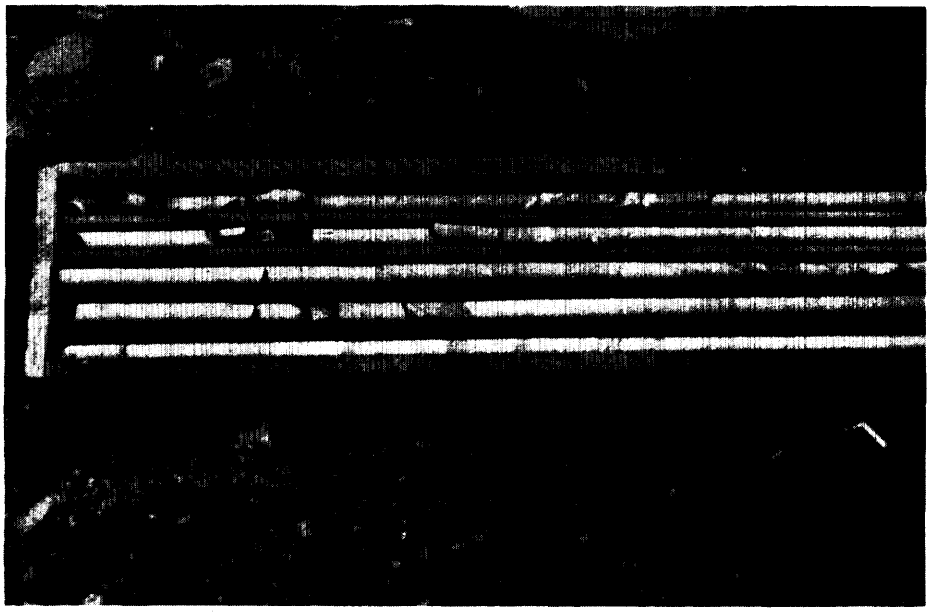
> This is a schistose fragmental rock with large to small, rounded to angular, simple and composite fragments composed chiefly of quartz but containing also considerable altered orthoclase and plagioclase, as well as minor amounts of pyrrhotite in a fine-grained cement consisting of green mica, sericite, and carbonate, and also considerable quartz, altered feldspar, pyrrhotite, and limonite. This is an altered schistose greywacké or volcanic tuff.

A sample from the west wall of No. 2 vein is similar, and differs only in the higher content of altered feldspar and carbonate in the rock fragments.

[1]P. E. Hopkins, private report.

A thin section of tuff from a depth of 122 feet in drill-hole No. 6, examined by the writer, shows rock particles, quartz and feldspar grains slightly altered to chlorite and sericite, in a matrix of very fine grains of quartz, feldspar, and chlorite. Some of the chlorite is regarded as an alteration of former ferromagnesian minerals. Siderite and quartz occur in linear arrangement suggesting introduction. From the proportions of the constituents the rock is considered to be of intermediate to acid composition.

Study of the drill-cores reveals slates, green tuffs, greywackés, quartzite, and some iron formation in lenticular bands, whose width may be from 2 to 40 feet. Hopkins states that these beds dip south. Cross-sections made along the line of drill-holes suggest, but do not prove, that northerly dips occur. In drill-



Core box showing bedded tuffs from diamond-drill hole No. 9, Casey Summit mine.

hole No. 9, gradation of grain and slaty material in tuffs indicate that the tops of the beds are upward. There is no evidence of overturning. In this hole, core from 435 to 460 feet was found to be complete and in correct order, and such a conclusion is considered sound provided the criterion is reliable. No determination of attitude was made where the direction of dip was known.

A few granitic intrusives were observed near by. On claim K.R.L. 9,739, quartz-feldspar porphyry was observed outcropping on the shore. On claim K.R.L. 9,820, 1¾ miles to the northwest, a feldspar porphyry or granodiorite has been found. To the northeast of the property a prong of the main granite mass comes within a mile of No. 2 vein, and probably much nearer in a vertical direction. Quartz porphyry occurs at No. 1 vein about half a mile from the camp.

No basic intrusives were found on the property, but a narrow dike of hornblende porphyrite was uncovered in a trench on the south boundary of claim K.R.L. 9,853.

Veins.—Seven veins have been uncovered on the property. No. 1 showing consists of a number of small quartz veinlets lying in basic tuff immediately south of a narrow feldspar porphyry dike in the southeast corner of claim K.R.L. 9,685. The stringers are about 2 inches wide and are confined to an area about 30 feet long and about 9 feet wide. The vein is composed of coarse white quartz and some siderite, and contains fine and coarse pyrite in its fractures. Similar pyrite occurs in the wall rock, and also coarse arsenopyrite.

The veins branch irregularly and follow no definite trend. They appear to be localized to the vicinity of the porphyry, and some occur within it. They strike about N.30°E., and dip from 25° to 65°W.

No. 2 vein, the most important, outcrops for 165 feet on the north shore of the lake near the east edge of claim K.R.L. 9,681. It lies in fine- to coarse-grained green tuff and greywacké, which strikes roughly east-west. The vein, which strikes N.18°E., and dips 40°W, is composed of coarse-grained, dark-grey or "blue" quartz and is cut by minute fractures one-eighth to one-quarter of an inch wide nearly parallel to the walls, which are usually filled by a very fine clear quartz. Comparatively coarse carbonate replaces the original quartz along these veinlets. Shear zones along the walls are characterized by the development of chlorite and epidote. Arsenopyrite and a small amount of pyrite are found in the walls, usually within a foot of the vein. Where intersected in drill-holes, the vein is usually well mineralized with arsenopyrite, especially in schist inclusions. Pyrite, chalcopyrite, galena, and gold occur in small quantity. Microscopically the vein shows strained quartz in grains 1 to 2 mm. across filled with fluid inclusions.

A section of the vein averages $10.07 across 2.07 feet for 106 feet. Drilling on the 75-foot level shows an average value of $11.10 across 2.5 feet for 150 feet. The drift on this level shows an average value of $18.15 across 3.2 feet for approximately 140 feet. The vein on this level was sampled at intervals of 5 to 7 feet. At a few points samples cut from the wall rock showed a value of $2 to $4 across 1 to 2 feet. All assays were calculated on the basis of $20.67 per ounce of gold. The vein was found in the shaft at a vertical depth of 156 feet and is reported to carry 2.13 ounces of gold across 4 feet.

The writer believes that the results obtained from drilling are conservative, because cores that assay $10.00 across 2.5 feet and $6.40 across 5½ feet are accompanied by sludges valued at $31.30 across 6.3 feet and $122.00 across 5.3 feet, respectively. These sludge values are obtained by assuming that all the gold in the sludge was derived from the vein width as exposed in the core.

The place where the comparatively high assays at the south end of the drift were obtained is about 40 feet north of the place where the highest sludge assay given above was obtained and at the same elevation. Drilling has proved that the vein extends over a length of 600 feet, and to a slope depth of 550 feet. Drill-holes Nos. 10 and 12 cut veins at distances of 220 feet and 440 feet north, respectively. If these veins were projected eastward to the surface at a dip of 45 degrees, the strike would be north-south and the outcrop would lie about 50 feet west of No. 2 vein.

The north end of No. 2 vein is displaced about 5 feet northeastward by a fault. The regional deformation of the area to the north seems to have been a movement of the north side to the west, but it is not known whether the regional movement was earlier or later than the vein The failure to cut the vein in drill-hole No. 5 and other phenomena along the lake shore suggest that the vein has been deformed by rotational movement along an east-west plane, probably dipping steeply.

Vein No. 3 lies in andesites and basalts in the northwest corner of claim K.R.L. 9,759. It strikes north-south and dips 45° to 60°W. It has an overall length of 800 feet, but about 200 feet in the central southern part is obscured. The north end is covered by heavy drift and the south end by a swamp. The vein varies from a series of small stringers to a solid vein and vein breccia 2 to 6 feet in width. Near the north end the vein is a breccia containing angular inclusions of wall rock. Locally small stringers of siderite occur along the walls of the veinlets. Arsenopyrite occurs chiefly in the schist for a maximum distance of 6 inches from the vein, and replaces inclusions of wall rock to the extent of 20 per cent. Traces of galena, chalcopyrite, and gold also occur in the vein. Surface sampling indicates only short, narrow ore shoots. Later work uncovered the vein in the swamp to the south, and indicated a higher gold content.

A vein cut in drill-hole No. 9, when projected eastward to the surface at a dip of 60 degrees, lies on the strike of No. 3. The trenching mentioned above suggests that the vein continues southward to the lake.

Drilling proved the extension of the Hewitt-Zyone vein into this property, where it is known as No. 4 vein. It consists of blue quartz, highly and irregularly mineralized with pyrite, chalcopyrite, and arsenopyrite, lying in a sheared carbonated dacite flow.

Vein No. 5 consists of blue quartz 12 to 24 inches wide in a light-coloured tuff near the shore line on the west side of claim K.R.L. 9,681. It is 40 feet long and dips 45°W.

Vein No. 6, a lenticular quartz stringer ranging in width from 1 to 33 inches, lies on the north boundary of claim K.R.L. 9,758 near the No. 4 post and extends south into this claim for a distance of 110 feet, and north into claim K.R.L. 9,852, of the Ellen Syndicate, for 80 feet. The southern part has a maximum width of 15 inches. Arsenopyrite and pyrite occur chiefly in the andesite wall rock, but some arsenopyrite occurs in fractures in the quartz. The vein dips 52°W.

Vein No. 7 consists of numerous thin parallel stringers of quartz, striking north-south and dipping 85°W., in basalt in the northeast corner of claim K.R.L. 9,761. Arsenopyrite, chalcopyrite, and pyrrhotite are the chief sulphides. One assay from this vein gives $11.80 across 5 feet.

Ellen Gold Syndicate

This syndicate controls the Stocking group of 8 claims lying north of Casey Summit Gold Mines. The south boundary of claim K.R.L. 9,853 was thoroughly trenched in an effort to discover the extension of No. 2 vein of Casey Summit Gold Mines. No. 6 vein of Casey Summit Gold Mines extends into claim K.R.L. 9,852.

Hatch

Joneston Lake Group.—The chief vein occurs on the western part of claim K.R.L. 10,445, in schistose chloritic tuff and agglomerate. It is about 700 feet long, strikes S.54°E., and dips 75°N. The west and consists of fractured quartz containing narrow inclusions of chlorite schist. Pyrite occurs along the contacts of schist and quartz, in the schist, and occasionally in fractures in the quartz. Immediately east the vein becomes quite narrow.

The east half of the vein has been opened by a series of closely spaced pits and averages 8 to 10 inches wide. Where it is wide, pyrite occurs in the hanging wall for a distance of 6 inches from the quartz; where it splits into thin stringers, pyrite is restricted to zones about 2 inches wide on either side of the veinlets.

Some siderite occurs in the quartz, and serpentine in patches in the hanging wall. This part of the vein averages $2.00 across 3 feet 8 inches for a length of 330 feet.

Mink Lake Groups.—A showing on claims K.R.L. 9,259 and 9,260 consists of a set of quartz veins in a fracture pattern in a continuous feldspar porphyry dike about 15 feet wide. The fractures usually have the following directions: north-south, N.75°E., and S.60°E. Veins of quartz half an inch to 6 inches wide and about 10 feet long favour the last direction, i.e. tension set. The quartz carries porphyry inclusions and a small amount of pyrite, but not as much as the porphyry. The schistosity of the greenstone wall rocks has a north-south trend.

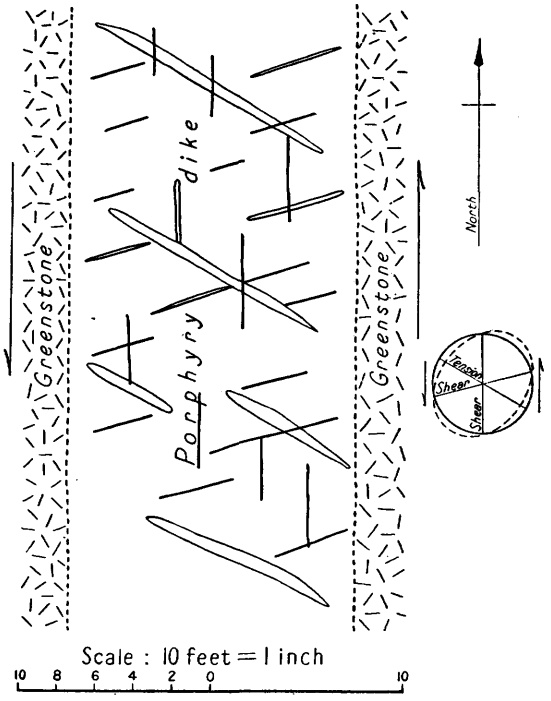


Fig. 3—Sketch of fracture pattern shown by quartz veins in a feldspar porphyry dike on claims K.R.L. 9,259 and 9,260. The wide veins follow tension direction and the narrow veins, shear directions.

A vein of massive quartz, 3 to 10 feet wide, in the northwestern part of claim K.R.L. 9,147, strikes S.25°E., and dips steeply east. It outcrops at irregular intervals over a length of 20 chains and is strongly fractured parallel to the walls and adjacent to them. It is usually barren, but parts of it show siderite, pyrite, and a trace of hematite. The siderite is weathered out and cut by fine-grained barren quartz. Other parts show greenish quartz, siderite, and pink calcite. Fine to coarse pyrite occurs, particularly in seams carrying a small amount of chlorite, but some coarse pyrite occurs where there is no chlorite. The wall rock is a mottled porphyritic amphibolite carrying some coarse pyrite as far as 2½ feet away from the vein. The wider parts of the vein are bordered on either side by about 5 feet of sheared, weathered, recrystallized greenstone, some of which carries fine pyrite. Bordering this is massive amphibolite, which may have been recrystallized by the Mink lake granite.

On the south side of the narrows of Mink lake, a quartz vein strikes nearly north-south and dips vertically in a dark-green tuff. It is about 5 to 8 feet wide and 40 feet long. Near the edges are grey streaks parallel to the walls, and it is white and massive in the centre. The mineralization is chiefly chalcopyrite, with a little pyrite and a trace of galena. A band of siderite 1 foot wide cut by secondary quartz veinlets occurs in the northern extension of the vein. The tuff is cut by a fine-grained quartz-feldspar porphyry, which in turn is cut by a fine-grained greenstone dike.

Blondin

A wide shear zone underlies the valley extending through claims K.R.L. 10,636, 10,637, and 10,638, north of Mink lake. A pit 8 feet wide in tuffaceous rock at the southeast corner of the pond exposes some mineralization. A rusty shear zone in the hanging wall of the pit dips 60°N. It carries knots and thin irregular stringers of quartz, 1 to 8 inches wide, usually following the schistosity. This zone is weathered to a depth of 8 feet. A resistant band in the centre of the pit is light-grey in colour and very fine grained, and carries much pyrite in medium to coarse cubes. The rock to the south is a dark-greenish chlorite schist, well pyritized across 2 feet. Grab samples are reported to run from 80 cents to $11.20, and an 11-foot channel sample is reported to assay $3.60. A pit 180 feet northeast in a rusty schistose tuff dipping 70°N. exposes irregular lenticular quartz veins about 2 feet wide. The quartz has been fractured and contains deformed pyrite crystals and some siderite. Included fragments of the wall rock, a serpentine or sericitic greyish-green schist, are also slightly pyritized.

At the west end of the pond a shear zone 14 feet wide strikes S.80°E., and dips 54°N. It contains a short irregular quartz lens 8 feet wide, which frays out into several small veinlets about 20 feet to the west. The quartz, which is chiefly white, contains some greyish carbonate and is fairly well mineralized with coarse pyrite, which has been broken and cemented by minute quartz veinlets. The wall rock is a sheared tuff, which is quite rusty next the vein. The bedding in the schists is contorted and suggests that the introduction of quartz may be due to openings caused by drag-folding. To the west are other short shear zones, arranged *en échelon* in an east-west direction.

About 500 feet to the west, irregular quartz masses lie in an area of schistose tuff 180 feet long and 60 feet wide. The veins range in width from 2 inches to 12 feet, and branch into numerous veinlets. The quartz is barren except along small inclusions of schist, and the wall rock carries coarse pyrite for a foot or more from the small stringers. Ankerite or other carbonates occur, and sericite was found near the central part of the showing. Where exposed in the largest masses, the quartz is barren and the carbonate has weathered out leaving a porous mass.

Finn

On the northwest corner of claim K.R.L. 9,679 of this group, lying northwest of Joneston lake, a vein zone, about 60 feet long, striking S.60°E., has been uncovered in schistose green tuff. In a width of 8 feet, it contains 3 veins ranging in width from half an inch to 24 inches, and from 10 to 50 feet in length. The veins usually follow the schistosity and drag folds, and where broken are cemented by calcite and ankerite. The quartz, which appears to have been fractured, contains some pyrite and very minute amounts of sphalerite, chalcopyrite, and galena.

A drag-folded and contorted zone of schist extending 50 feet west of the vein zone contains an irregular quartz mass 2 feet wide and many small veinlets. A trace of pyrite, some calcite, ankerite, and chlorite were found in the veins.

Richardson

The rocks on this property, on the north shore of Richardson lake, are granular and recrystallized greenstones lying south of the main granite contact. Two veins have been uncovered. No. 1 pit, on the southeast corner of claim K.R.L. 10,218, shows two quartz veins averaging about 1 foot wide. They strike nearly east-west, diverging slightly toward the east, and dip about 60°S. In the pit they are about 5 feet apart. The quartz of the south vein carries only a little sphalerite, but schist inclusions are well mineralized. The walls of the south vein are well pyritized for at least a foot on either side. Inclusions in the north vein carry pyrite, sphalerite, and some galena. The wall rock adjacent to the north vein is a carbonate chlorite schist, and fractures in it are filled with carbonate. The west edge of the pit is formed by a vertical northwest-southeast fault on which there appear to have been two movements. Fine vertical striae lie on coarse ridges or mullion structure, plunging 50°S.W. The mullion structure may have been caused by the chief movement and the fine striae by later readjustments along the fault plane. Many specimens of gold have been obtained from this pit.

No. 2 pit, in the centre of claim K.R.L. 10,219, shows four irregular quartz stringers ranging in width from 2 inches to 1 foot in a band about 5 feet wide. They strike east-west and dip about 60°S. The quartz has a dark-grey to greenish colour, is fractured, and contains minute streaks of chlorite schist. These stringers are well mineralized, but the quartz is only slightly so. The sulphides are pyrite, sphalerite, galena, and a trace of arsenopyrite along with the gold. The rock between the veins is a carbonated chlorite schist. Where only 6 inches wide, it is well pyritized; but where it is one foot wide, it is only slightly mineralized. The quartz of the vein is medium-grained and shows strain shadows. It has been fractured along closely parallel lines and cemented by a very fine grained quartz, which carries arsenopyrite, gold, tourmaline, chlorite, and carbonate

Graham

Joneston Lake.—Several quartz veins have been found on the pensinula of agglomerate extending westward into Joneston lake from the east shore. On claim K.R.L. 9,038, one vein 55 feet long and 1½ to 3 feet wide strikes S.80°E. and dips 74°N. It is slightly fractured, particularly near the footwall, along seams 1 inch apart, which are marked by thin films of chlorite and traces of chalcopyrite. Small stringers of quartz occur in the footwall close to the vein. Intense shearing is restricted to a zone about 6 inches wide on either side. These zones are rusty due to the oxidation of siderite. The pyrite extends about 4 inches into the footwall and 1 inch into the hanging wall. A channel sample is reported to assay $5.00 across 3¼ feet.

Three short veins have been uncovered to the west. They strike approximately east-west and dip steeply south. The longest is 150 feet. Where the walls are sheared, fine pyrite extends 5½ feet from the vein, but usually occurs within a few inches of the vein. The quartz of the east vein is light-grey in colour and cloudy. It is traversed by thin rusty seams, probably siderite, and these are cut by a clear, dark quartz. The country rocks are greyish-green agglomerates of intermediate to acidic composition, and the walls are altered

to a serpentine or a sericite-serpentine schist. The veins usually pan gold, but assay results are not available.

Richardson Lake.—Several small quartz veins occur in tuffs and agglomerates in the central southern part of the claim, K.R.L. 9,746, on the south shore of Richardson lake. The south vein is 3 feet wide and about 15 feet long, strikes at S.5°E., and dips vertically. The barren, light-grey quartz and numerous schist inclusions forming the bulk of the vein are cut by narrow irregular stringers of bluish-grey quartz heavily mineralized with arsenopyrite. The blue quartz fills fractures in the white quartz and in the schist, and appears to replace the schist. Along such contacts and in the replaced areas there is considerable fine- to medium-grained arsenopyrite. A small amount of pyrite occurs both in the vein and in the wall. Some schist inclusions are slickensided and slightly

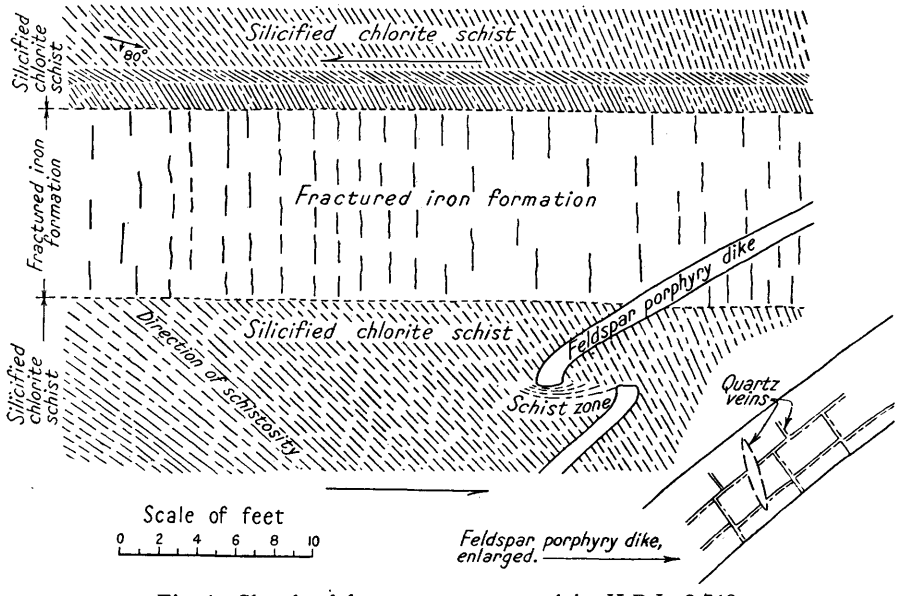


Fig. 4—Sketch of fracture pattern on claim K.R.L. 9,748 indicating differential movement.

altered to serpentine. Other short veins with a similar mineralization occur to the north over a distance of 5 chains. Calcite is found in the veins, and arsenopyrite and pyrite occur in the walls, usually in the footwall, and along the contacts of schist and quartz.

In the northwest corner of claim K.R.L. 9,747 a short vein has been trenched. Near the east side of this claim, 10 chains west of the outlet of the lake on claim K.R.L. 9,748, there is a similar vein showing small vugs.

On claim K.R.L. 9,748, one chain north of the outlet of the lake, a trench exposes a band of iron formation 10 feet wide, bordered on either side by a silicified chlorite schist. The schistosity on both bands strikes east-west and dips 70° and 80°S. The iron formation is composed of *laminae* of chert usually one-eighth to one-quarter of an inch wide and occasionally as thick as one inch, which have been shattered and present a checkerboard pattern. Chert comprises about 75 per cent. of this formation. The chert is grey and pink, and is fractured at right angles to the bedding and cemented by light-grey quartz veins carrying some rusty carbonate and pyrite cubes. Both schist and iron formation are

cut by a dark greyish-green porphyry dike one foot wide, which has been faulted as shown in Fig. 4. Tension fractures are filled with white quartz and rusty carbonate. The porphyry has been faulted about 3 feet, north side to west. This movement apparently caused the flow cleavage in the schist, the fracturing of the iron formation, and the tension fractures in the porphyry. This movement, north side to the west, is dominant throughout the northern part of the Casummit lake area, and may have been responsible for the north-south openings that now contain quartz veins.

On claim K.R.L. 9,748 a pit 4½ chains northeast of the outlet of the lake exposes a flat-lying quartz vein in silicified greenstone. At the north end there is a fractured schistose zone in silicified chlorite schist, which strikes at N.80°E. and dips 62° to 82°S. This part may have been a basic tuff, since the type is common in the vicinity. It is extensively decomposed, so that the only recognizable fragments are chlorite schist and cherty bodies 1 foot wide and 4 feet thick lying parallel to the schistosity. Near the south end of the trench there is a poorly mineralized quartz vein (see Fig. 4). Considerable arsenopyrite occurs to a depth of 6 to 12 inches beneath the vein and some in other parts of the pit. At the south end the vein is cut off by a very fine grained, oxidized quartz porphyry. Below this a very fine grained, light-grey carbonated hornblende dacite protrudes into the trench. Curvature of joints suggests a fault contact against the porphyry. Decomposition masks the actual relations.

Hewitt and Zyone

The rocks in the western part of this group, east of Casummit lake, are basic tuffs with interbedded lavas; in the central part, acidic tuffs; and in the eastern part, schistose basic lavas. A vein zone near the northwest corner of claim K.R.L. 9,687 lies in schistose tuffs. At No. 2 pit, about 5 chains southeast of the northwest corner of the claim, the largest vein exposed is about 2¾ feet thick and dips 15°W. The upper part of the pit exposes very fine grained, light-grey and dark-grey dacitic rocks containing much fine pyrite. These lavas are intruded by an irregular series of quartz stringers, and the main veins also send small projections of quartz into the lavas. The quartz is dark-grey in colour, fractured, and cemented by white quartz. Chalcopyrite and arsenopyrite occur along the crystal boundaries in the dark quartz.

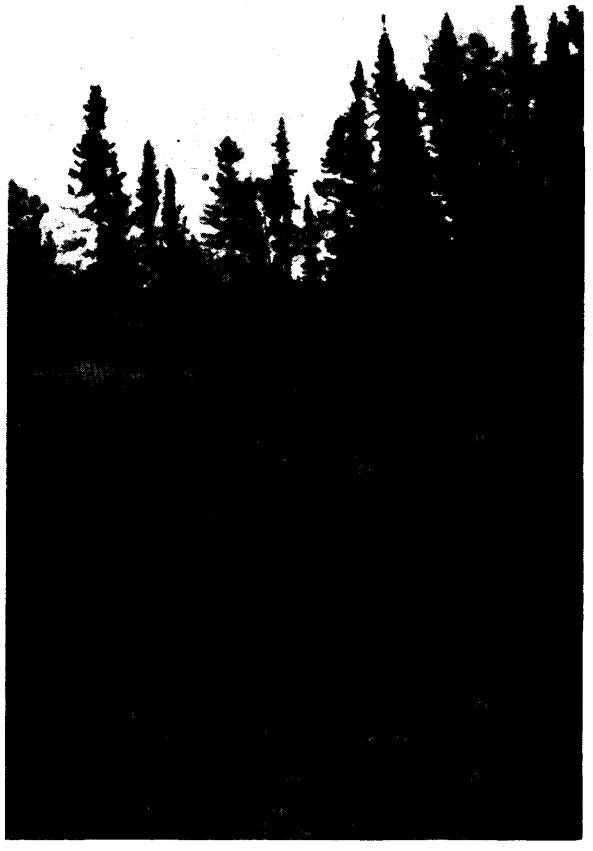
About 200 feet south the vein consists of two quartz stringers in a similar lava, which is bordered on the west by a greenstone tuff. The contact plane is sharp and regular, and the shape of the fractures suggests some movement. Both veins strike about N.25°E. and converge downward to the west; one dips 44°W., and the other 32°W. The upper or west vein is 6 to 12 inches wide. It is composed of a dark bluish-grey quartz and is slightly mineralized. Pyrite and arsenopyrite occur in the dacite and in the schist inclusions The mineralization extends about 3 feet into the footwall. The east vein ranges in width from 6 inches to 2 feet. It is a white to light-grey quartz and slightly mineralized near schist inclusions and for a few inches into the walls. The footwall beneath the east vein appears to be a very fine grained silicified chlorite schist.

The No. 4 vein of the Casey Summit property lies on the extension of this vein zone.

Dynes

This group lies about a mile north of the 10th base line between miles 25 and 26. The vein is situated on the north boundary of claim K.R.L. 8,965, about 5 chains west of No. 1 post, and lies in arkose and greywacké striking

east-west. A pit about 11 feet long exposes a sheared arkose, fairly massive, between thin slaty sediments dipping 80°N. This zone shows a few narrow irregular stringers of bluish-grey quartz containing some white orthoclase, which are bordered by siderite, especially near the south edge of the pit. The rock in the north part carries about 5 per cent. of arsenopyrite and pyrite, and about 10 per cent. in the south. The quartz contains very little, if any, sulphides.



West end of shear zone where gold nuggets were found,
McIntyre claim K.R.L. 8,596, near mile 27
on the 10th base line.

Thin irregular streaks of dark-grey chlorite, a yellowish-grey serpentine, and some sericite are alteration products. The mineralized zone appears to have a vertical dip.

McIntyre

This group is located on the north bay of Birch lake. The main zone, which is about 400 feet long, lies in the southern part of claim K.R.L. 8,596, in basalt, tuff, and iron formation. The west end is exposed by pits having a maximum width of 14 feet in sheared chloritic schist. At the south edge of the mineralized belt there is a pronounced shear zone 3 feet wide composed of limonite and schist fragments. Another shear zone occurs along the north edge of the pit. Between them there are a few narrow quartz stringers half an inch to 2 inches wide parallel to the schistosity, which dips 77°N. These stringers silicify the walls for 2

inches on either side and contribute arsenopyrite and pyrite. Coarse gold occurs in three zones in this pit and a considerable quantity was recovered from the gossan.

Two hundred and fifty feet east the vein lies in altered and oxidized chloritic schists and tuffs containing some short bands of iron formation. Arsenopyrite occurs in the fractures in small quartz veinlets, in inclusions, and in bands as much as 2 inches wide in the schist. Considerable gold occurred here also.

Another vein striking 145 degrees lies in the southwest corner of claim K.R.L. 8,597, and extends into the adjacent claims on the west and south. Trenching over a length of 200 feet showed chlorite schists, tuffs, and iron formation intruded by small quartz stringers. Coarse arsenopyrite, the chief metallic mineral, constitutes about 10 per cent. of the rock, and pyrite and chalcopyrite about 5 per cent. Siderite, calcite, and muscovite are gangue minerals, siderite being most abundant. At the west end of the showing a small vein 2 feet wide contains minute patches of tourmaline needles. The dip of the schistosity ranges from 40° to 60°N.E. Near the west end the vein is vertical.

A showing near the east side of claim K.R.L. 8,600 contains a band of silicified chlorite schist, 6 feet wide and 66 feet long, striking east-west and dipping 84°N. It is traversed by many small stringers of quartz and calcite less than 3 inches wide. The quartz contains black radiating tourmaline crystals, and the schist is mineralized with arsenopyrite and pyrite.

Near the southwest corner of claim K.R.L. 8,601, there is a rusty schist zone, 6 to 12 feet wide and 130 feet long, cut by irregular stringers of quartz about 2 inches wide. One of these stringers has a width of 1½ feet. The zone strikes at S.65°E. and dips vertically. The quartz appears to be barren, but the walls and schist inclusions contain pyrite and arsenopyrite. Parts of the zone are thoroughly disintegrated and rusted.

Boylen

East Group.—The vein zone of this group lies in a platy chlorite schist bordered by basalt and iron formation in the southern part of claim K.R.L. 8,791 quite close to the north bay of Birch lake. It strikes east-west, and dips 50°N. The west end consists of a few short irregular quartz stringers with a maximum width of one foot.

About 50 feet east, two veins occur. The south vein consists of barren quartz one foot wide with 20 per cent. of chlorite schist as inclusions. The north vein is an irregular mass of quartz stringers 1 to 5 inches wide in a zone 2½ feet wide lying parallel to the schistosity. A little carbonate and some pyrite occur adjacent to the quartz. The hanging wall is thoroughly disintegrated and sheared for 2½ feet from the vein.

Eighty feet farther east the vein is a friction breccia about 9 feet wide cemented by thin stringers of white quartz rarely exceeding one inch in width. The quartz contains some coarse carbonate. The schist inclusions are heavily mineralized with arsenopyrite and pyrite, the former predominating, which make up about 10 per cent. of the inclusions. The quartz is not continuous, and near the east end it narrows to a 2-inch vein, which carries some carbonate and a trace of pyrite.

West Group.—On this group, situated at mile 26 on the 10th base line, a series of closely spaced trenches exposes a vein zone over a length of 1,000 feet. At the east end the strike is S.73°E., but near the west end it changes to S.80°E. The schistosity strikes N.85° to 90°E. and dips about 80°N. The vein zone

consists of numerous small quartz stringers approximately following the cleavage in altered acidic tuff, now a sericitic schist, with small amounts of chlorite schist. The quartz is light-grey in colour and forms veinlets 2 to 6 inches wide. Arsenopyrite occurs in the quartz, and some pyrite extends into the walls as much as a foot on either side of the veins. The mineralization is irregularly distributed,

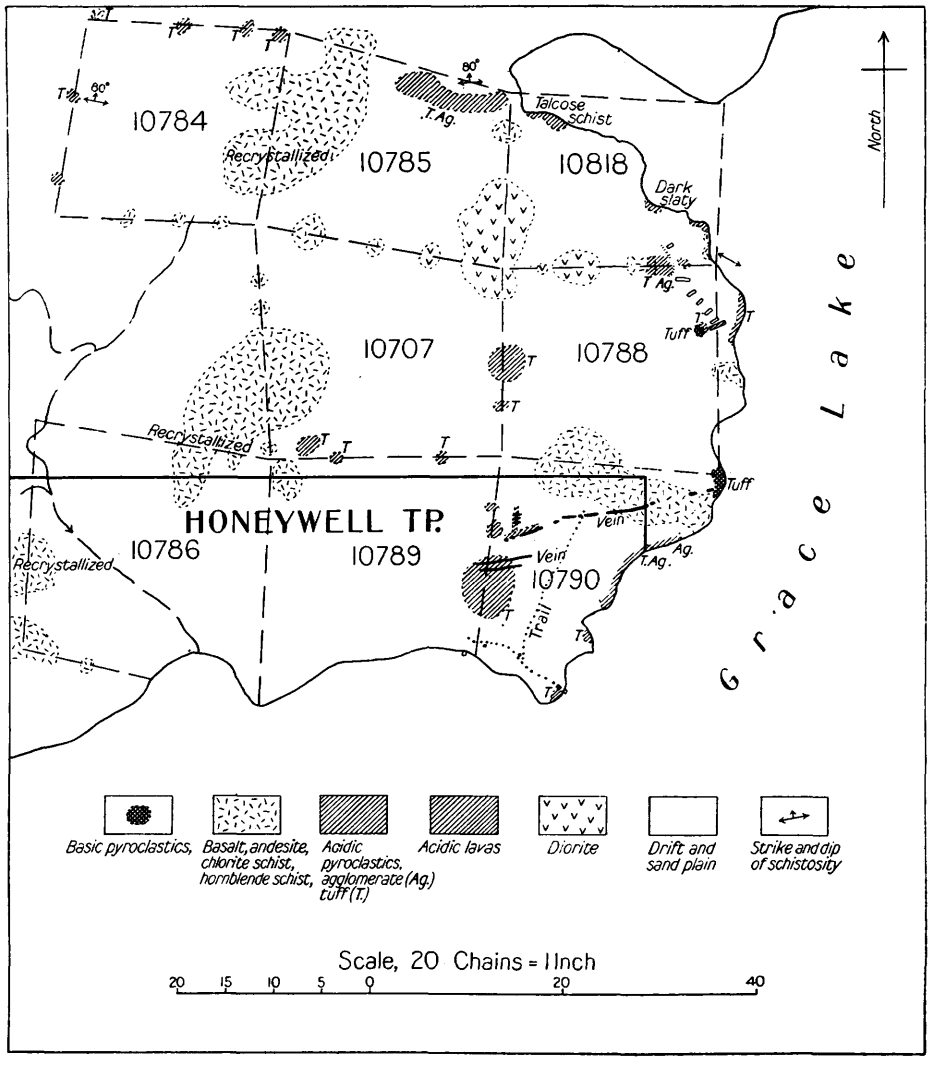


Fig. 6—Geological sketch map of the Bathurst group of claims, Grace lake.

as it was not observed in all the trenches, and the better sections were only 1¼ to 2 feet wide. There is a fairly continuous zone of rusty schist ranging from 3 to 6 feet in width, which contains siderite, which weathers to limonite, giving the rusty colour. No pyrite was observed in this zone.

Bathurst Mines

This group of claims is situated in the western part of Grace lake. The rocks are basalts, acidic tuffs, and a small body of diorite. Seven veins were

examined; six lie in the central and northern part of claim K.R.L. 10,790, and the other in the northeast corner of K.R.L. 10,788. No. 1 vein strikes N.80°E. and dips 67°N. It is exposed continuously for 300 feet, varies in width from 5 to 18 inches, and is composed of a moderately coarse grained, glassy, light-grey quartz cemented by a finer quartz and siderite. In narrow sections considerable orthoclase occurs. A trace of gold was found.

No. 2 vein is about 400 feet long and lies 55 feet north of No. 1 and approximately parallels it, dipping 60°N. It cuts a small, dark-grey dioritic dike.



No. 3 vein looking west, Bathurst Mines. The footwall is rhyolite, and the hanging wall diorite.

No. 3 vein is about 1,000 feet long, strikes N.70°E., and dips 45°N. At the west end it consists of a number of stringers about 2 inches wide, which appear to be barren but contain a small amount of tourmaline. A few chains east the vein is about 2 feet wide and follows the south or footwall of a dioritic sill. The vein contains inclusions of the diorite, which, in turn, contains inclusions of the rhyolitic wall rock. A pit shows the vein to be about a foot wide in the diorite, which is about 6 feet wide. The cribbing obscures a deformation zone in which the east portion of the vein is offset 4 feet north. Several irregular quartz stringers occur in this zone and unite immediately to form the easterly continuation of the vein. The vein carries some fine pyrite, as does the diorite hanging wall. In this section the vein is exposed almost continuously for a distance of 150 feet. Farther east it becomes a series of small stringers and also a vein breccia.

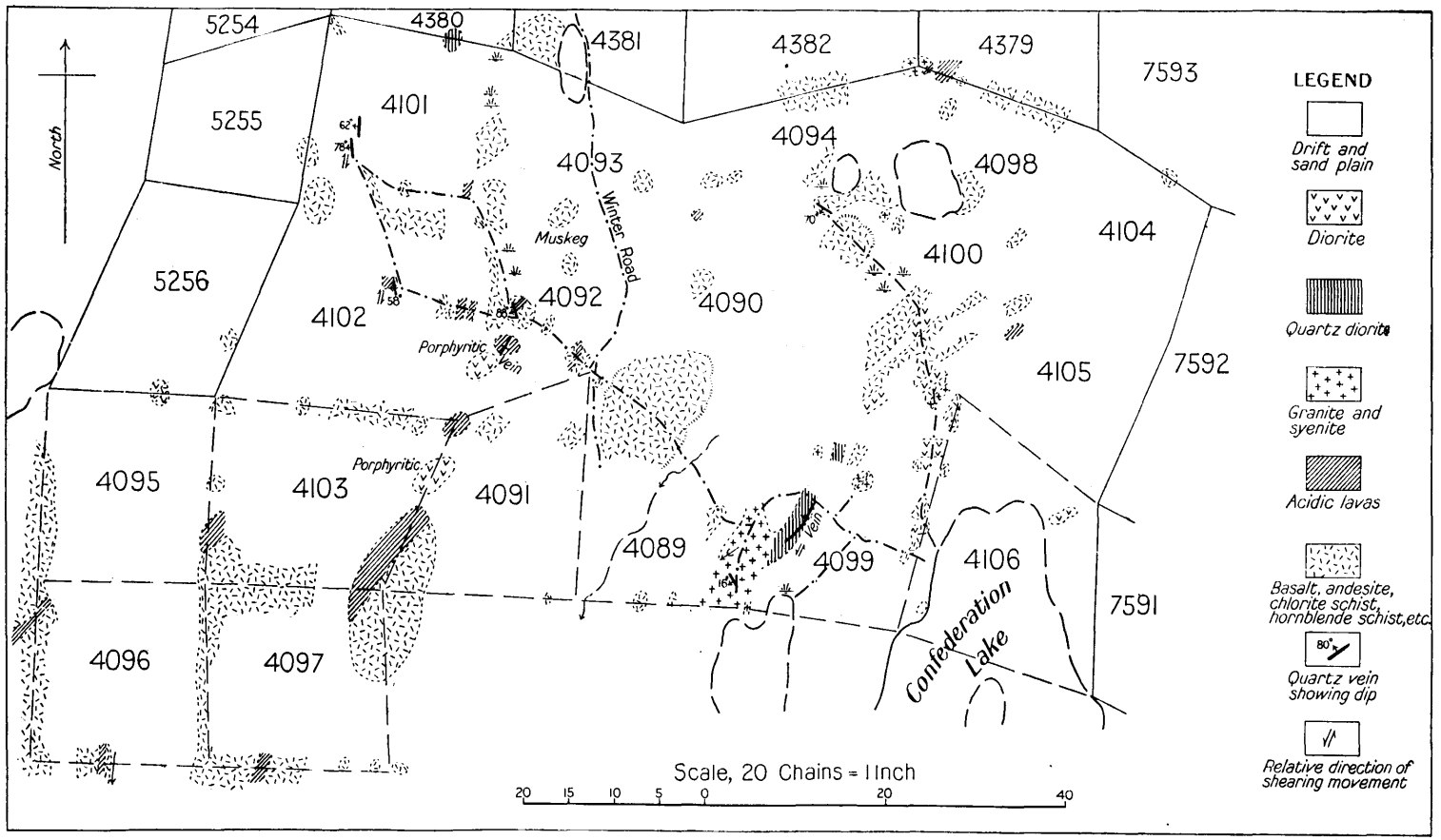


Fig. 7—Geological sketch map of the Rouillard group of claims, Confederation lake.

Veins Nos. 4, 5, and 6 are quite small and have been exposed for a length of only a few feet.

Vein No. 7 has been tested by several trenches and 3 pits over a length of 800 feet. At the west end this vein is a rusty, carbonated, silicified zone in chloritic schist, striking about S.25°E. and dipping about 80°S. The central part of the zone is a silicified chloritic schist slightly mineralized with fine pyrite and arsenopyrite. Two chains east, siderite stringers in the schist are cut by minute quartz veinlets carrying pyrite. At the east end, a pit 20 feet deep shows at the bottom a shear zone 2 feet wide in a carbonated and silicified yellowish-grey schist. Traces of chalcopyrite, pyrite, and arsenopyrite occur, and gold is reported from the pit. A 2½-foot chip sample taken from the bottom assayed one-tenth of an ounce gold.

During the winter of 1932-33, Bathurst Mines and associated interests operated a small Jack Nutt mill on No. 3 vein. About 100 tons of ore were treated and approximately $1,500 obtained.

PROPERTIES NEAR WOMAN LAKE

Metals Development, Limited

This property includes a large block of claims in the northern part of Dent township and the southern part of Goodall just west of Confederation lake. A good summer road connects this property with Woman lake, and winter roads run east and south to Confederation lake.

Geology.—The numerous rock types occurring on the property are complicated by the alterations due to intrusives. The oldest rocks are lavas: basalt, ellipsoidal andesite, amygdaloidal varieties, and granular types that resemble fine diorite. The last-mentioned occur in the northern part of claim K.R.L. 5,605 near the granitic intrusion. The succession of intrusives is believed to be as follows: older granite with basic border phases, quartz and feldspar porphyry, quartz veins, lamprophyre and basic dikes.

The very fine grained altered greenstone extends about 100 feet down the shaft, and then changes to a fine granular, dark-greenish rock, probably slightly recrystallized. Well-developed joints occur at irregular intervals. Some sets intersect at right angles, and others at angles of about 60 degrees. The dominant direction seems to be about N.60°E. The other directions are at right angles to this, or horizontal. Small altered dikes in the lavas, which appear to have a similar composition and which are older than the veins, show a very fine trachytic structure of oligoclase and hornblende. These minerals are greatly altered to carbonate, chlorite, epidote, and quartz.

The older granite has been described by Greig[1] and by Bruce.[2] It varies from a biotite gneiss through quartz diorite to almost normal granite. Bruce regards the dioritic rocks as older than the granites, since they are included as fragments. The border relations of the quartz diorite to the granite, a complete gradation from typical granite to coarse diorite in a distance of 10 feet, and the mineralogical similarity of the granite to the quartz diorite suggest to the writer that the diorites and amphibolites are assimilation products formed along the borders of the granite batholith. The quartz diorite is a fine grained, massive, dark-grey rock composed of quartz, myrmekite, andesine, and a trace of orthoclase. There is a small amount of sericite, carbonate, chlorite, and introduced pyrite. The rock is a myrmekitic quartz diorite. If the myrmekite

[1]J. W. Greig, op. cit., p. 100.
[2]E. L. Bruce, op. cit., p. 18.

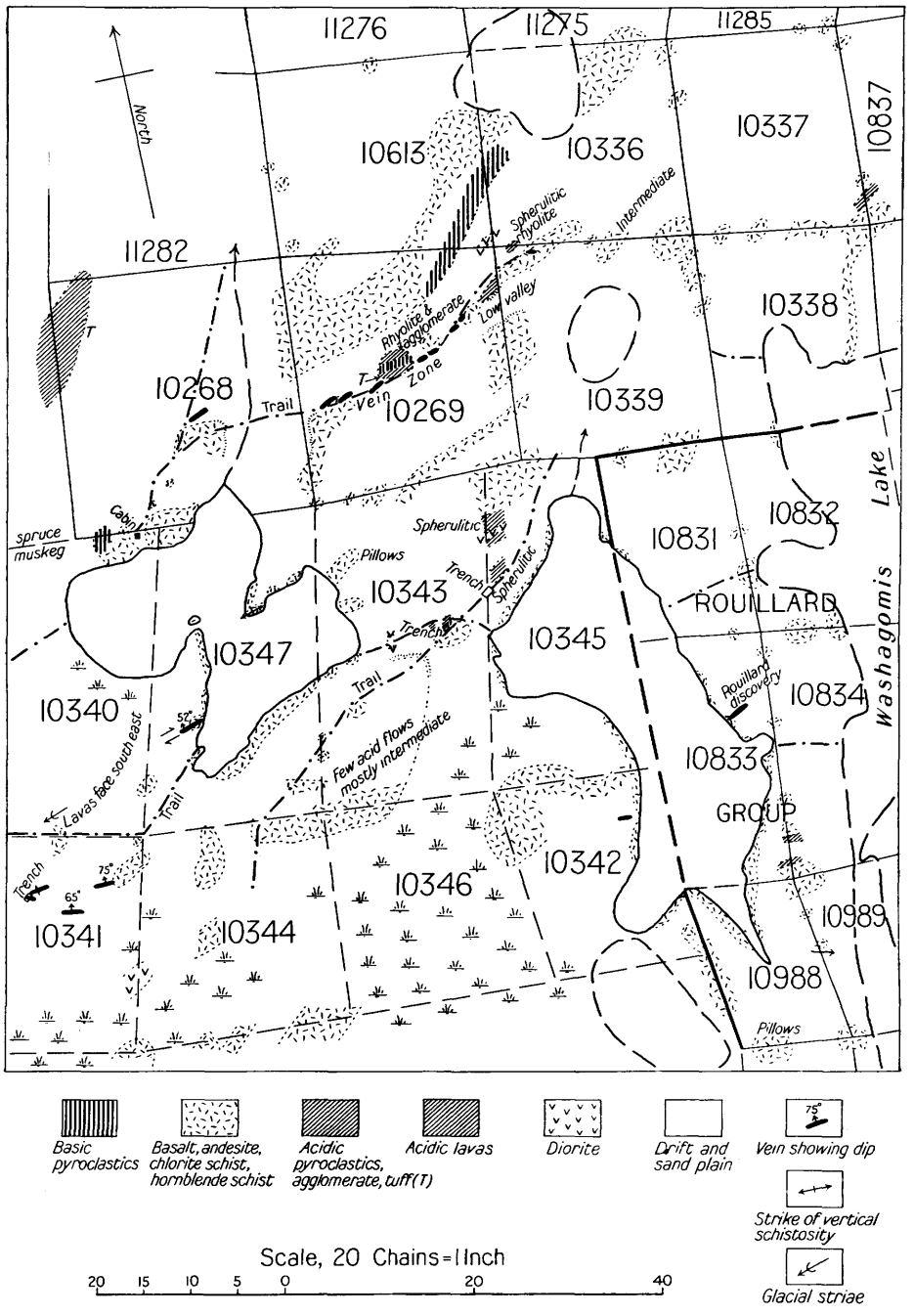


Fig. 9—Geological sketch map of the Hurley-McDonald group of claims, Woman lake.

be assumed to have been derived from a potash feldspar, the name quartz monzonite could be applied.

The quartz porphyry is fine grained and a light pinkish-grey in colour. It contains small phenocrysts of quartz and feldspar in a finer matrix.

Veins.—Gold occurs in several small veins in diorite near the southwest corner of claim K.R.L. 3,889. Pyrite and sphalerite occur in the quartz. Where the sphalerite is fine, it lies in fine grained quartz between grains of coarse quartz. Pyrite is found in chlorite, which appears to be an alteration product of diorite. Pyrite also occurs in schistose zones in greenstone. There are numerous small quartz veins, which carry pyrite in chloritic inclusions. Thinly banded veins contain seams of pyrite parallel to the walls, which are well pyritized. In both cases the quartz is barren.

Exploration has been concentrated chiefly on a vein located in the north-eastern corner of claim K.R.L. 5,603. The vein was traced on the surface for a distance of about 200 feet. It is about 5 feet wide, strikes N.75°E., and dips steeply north. A shaft was sunk along the vein, and a drift was driven at about the 75-foot level. A two-compartment vertical shaft was sunk about 35 feet south of the first. At 200 feet a station was cut, and a crosscut to intersect the vein was begun. At the time of the party's visit the surface pits were caved, and the upper level was filled with water. The writer believes that the ore shoot is short and plunges steeply east.

Rouillard

Several veins on this property, on the north bay of Confederation lake in Dent township, have been described by Greig[1] and also by Bruce.[2] Two others occur on claim K.R.L. 4,101. The northern one consists of a vein of quartz and siderite 6 to 12 inches wide lying in ellipsoidal andesite. It is exposed for a length of 50 feet, strikes N.4°E., and dips 62°W. A little sericite and epidote occur as vein minerals. Pyrite was found, and gold is reported.

About 200 feet south another quartz vein 2 to 6 inches wide lies in a carbonated shear zone about 10 feet wide. This zone is 65 feet long, strikes S.6°E., and dips 78°W. The carbonate is abundant in a band about 1 foot wide on either side of the vein. The vein is brecciated and cemented by siderite carrying pyrite, chalcopyrite, and a trace of pyrrhotite.

A showing on claim K.R.L. 4,092 consists of a quartz vein 1 to 4 inches wide with a few narrow branches extending away from and paralleling the main vein at a distance of 1 to 8 inches. This vein strikes S.20°E. and dips 88°W. It shows some native gold, particularly along or adjacent to the walls, and traces of siderite, pyrite, arsenopyrite, and chalcopyrite. Trenching extends over a length of 5 chains. Three pits at the south, filled with water, were reported to have shown some gold. The southern part of the vein strikes N.20°E.

On claim K.R.L. 4,094, a small vein, 1 to 6 inches wide, in fine granular basalt, strikes S.60°E. and dips 70°S. Small quantities of pyrite and chalcopyrite and a trace of gold were found.

Hurley-McDonald

This property lies in the south central part of Goodall township between Woman and Washagomis lakes. The rocks are chiefly basalt, ellipsoidal andesite, some greyish-green lava (possibly dacite), minor amounts of rhyolite, and acidic and basic tuff. Some spherulitic rhyolite resembles lava described by Bruce.[3]

[1] J. W. Greig, op. cit., p. 108.
[2] E. L. Bruce, op. cit., p. 45.
[3] Ibid, p. 7.

The detailed structure was not determined. The depressions have a northeast-southwest direction indicating a trend of weaker zones. On the south boundary of claim K.R.L. 10,340, a flow contact strikes northeast-southwest, and gradation of texture indicates tops facing southeast. Fine-grained and medium-grained diorites were found intruding the lavas and quartz veins. They may belong to the mass lying along the east shore of Woman lake, but the latter were not examined by the writer.

The main vein zone trends northeastward through the central part of claim K.R.L. 10,269, into the northwest corner of K.R.L. 10,339, and lies in andesitic and rhyolitic tuffs and flows. This zone consists of a number of veins exposed for short distances with strikes ranging from N.50°E. to N.80°E. They appear to have a slight *en échelon* arrangement, and lie in a slightly curved zone. This zone is about 1,800 feet long; it is ordinarily about 4 feet wide, but has a maximum width of 44 feet near the centre. The dip is 70°N. to 90°. The veins have a maximum width of 2 feet, and narrow stringers occur in groups. They contain a small amount of pyrite. The walls carry pyrite for 6 to 12 inches on either side, and are cut by small carbonate veinlets. The wide veins contain numerous small inclusions of chlorite schist and other wall rocks.

Locally the quartz is absent, and the showing becomes a limonitic shear zone. The central 12 feet is a carbonated and silicified rhyolite tuff or breccia showing siliceous fragments in an intricate network of quartz stringers. There is a small amount of pyrite, carbonate, and possibly arsenopyrite. A short distance east the mineralized zone is 20 feet wide. Where the walls are greenstone, the alteration products are limonite, carbonate, chlorite, and serpentine. Samples from the quartz near the central part of the vein were reported to assay $5.60 across 16 inches, and at the east end $8.40 across 32 inches. Five chip samples taken by the party from the best mineralization gave disappointing results.

Near the east side of claim K.R.L. 10,343, two small quartz veins 2 to 8 inches wide and 7 to 8 feet apart lie in a carbonate chlorite schist. They strike N.58°E. and dip 87°N. The walls are slightly oxidized for a depth of 6 feet, and contain much fine pyrite and gold. The quartz of both veins carries some fine galena. Although both veins have given high assays, the intervening rock is barren and too wide to make the zone of economic value.

Other small quartz veins 1 to 8 inches wide occur on the property. They are slightly mineralized with pyrite or galena, or both, and pan gold or show it in visible quantities.

RED LAKE PROPERTIES

Coniagas

This property lies on Dorion island (No. 60, map No. 33*e*[1]). The island is about 2,300 feet long and 700 feet wide, and lies about a mile west of the north end of Mackenzie island.

Geology.—The recognizable rocks fall into three groups: (1) a series of carbonate chlorite schists, which may have been lavas; (2) a belt of sediments, chiefly greywacké, slate, quartzite, some conglomerate, and arkose, occupying the greater part of the island; (3) a medium-grained quartz porphyry occurring on the west end and on the north side of the island near the east end.

No pillow structures were found in the first group. Since they lie on the extension of the greenstone anticline mapped along the north shore of the lake by Bruce,[2] they may be altered lavas.

[1]Ont. Dept. Mines, Vol. XXXIII, pt. 4, 1924.
[2]Ibid.

The sediments consist of conglomerate, greywacké, slate, some arkose, and brecciated cherty rocks, probably a siliceous iron formation. The last type occurs in the sediments at the east end of the island and also in the chlorite schists at the west end. True conglomerates have a maximum width of 25 feet. The pebbles range in size from 1 by 2 inches to 2 by 10 inches, and consist of chert, grey schist, vesicular chlorite schist, quartz-feldspar porphyry, and siderite. The matrix is a schistose patchy mixture of chloritic, slaty, and siliceous material and considerable fine magnetite. The quartzite is fine grained and shows poor cross-bedding. The slate occurs at the northeast tip of the island. Its bedding is poor and varies from thin *laminae* to bands about 6 inches thick. Drilling south of the island disclosed well-bedded sediments.

The quartz porphyry shows medium- to fine-grained ovals of quartz and a few small phenocrysts of feldspar in a very fine dark-greyish matrix. Rounded

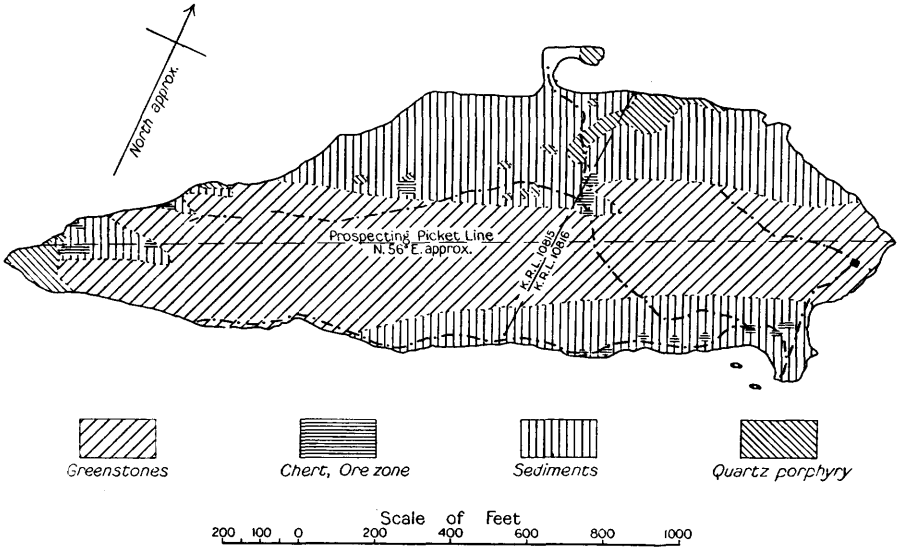


Fig. 10—Geological sketch map of Dorion island, Red lake.

areas of chlorite, quartz, and leucoxene suggest former ferromagnesian minerals. The feldspar is slightly altered to sericite. A small quantity of tourmaline and carbonate have been introduced.

Structure.—The island lies approximately on the strike of an anticline of greenstones and sediments occurring on the north shore of Red lake and crossing the west boundary of Dome township. The chlorite schists in the central part of the island probably belong to the Keewatin series, and the sediments to the Timiskaming. If this is correct, the ore zones or cherty sediments occur on both limbs of the fold near the base of the sediments and may continue for some distance beyond the island.

A small fault was found near the east end of the island. Drag folds in the bedding and fractures in the cherty sediments indicate that the east side moved north. The faulting may be due to an irregular tongue of porphyry occurring in the north central part of the island. The numerous cherty zones at the west end may be due to iron formation bands in the chlorite schists or to duplication by faulting.

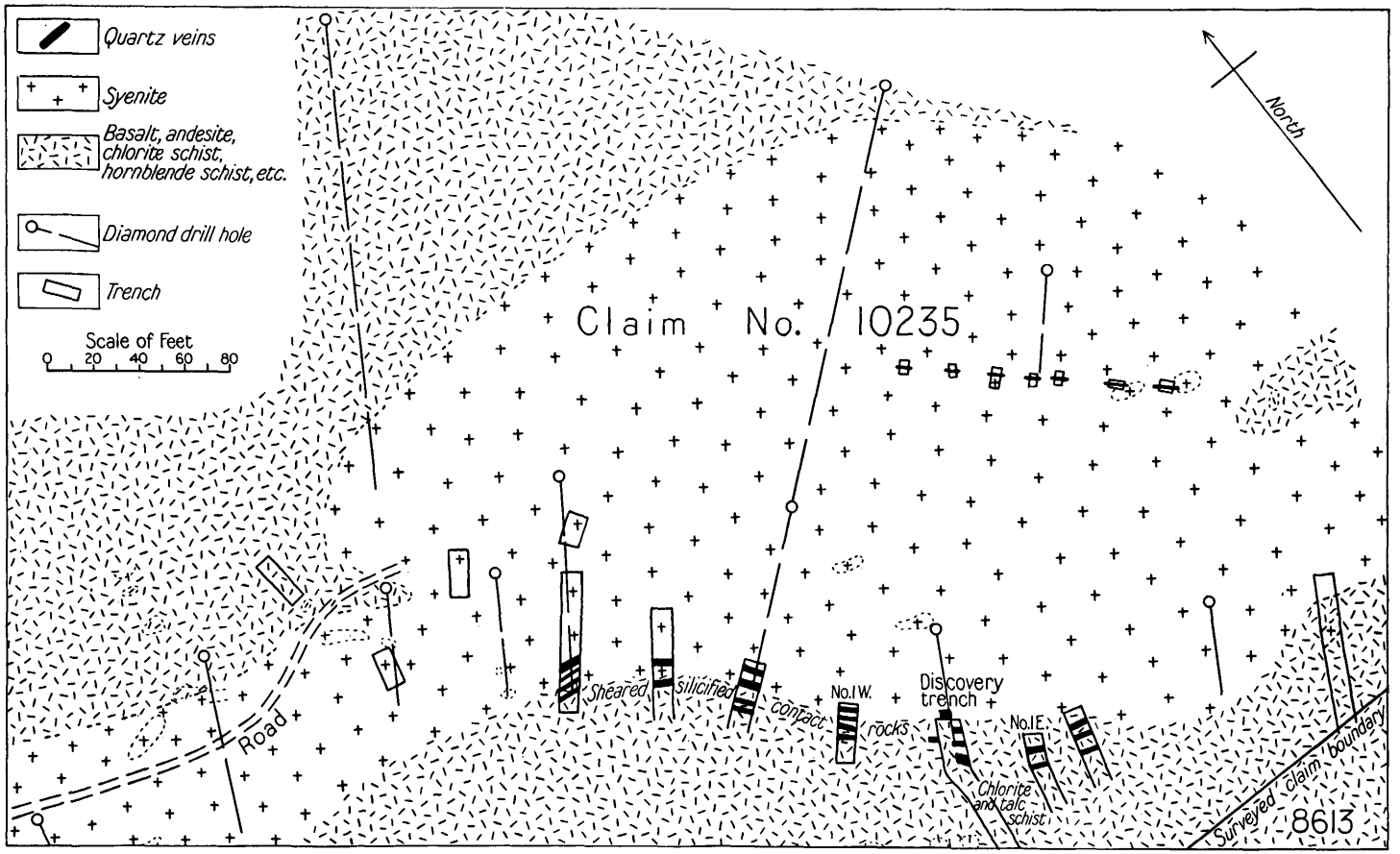


Fig. 11—Geological sketch map of the Rowan discovery, Red lake.

Ore Zones.—The ore zones appear to be bands of metamorphosed cherty siderite iron formation. One lies along the south shore and outcrops at intervals over a length of 500 feet. The irregularity may be due to faulting. This band is weathered and drag-folded, especially near the east end. The width ranges from 5 to 20 feet. Where test-pitted, the ore zone is a brecciated chert cemented by thin stringers of carbonate and some quartz veins. Usually only small amounts of pyrite and pyrrhotite occur in the chert matrix, but where it is composed largely of chlorite, the sulphides occur plentifully. Yellowish to brownish iron oxides are common. A small amount of chlorite and uralite are alteration products. Grunerite and magnetite are metamorphic minerals. Carbonate, quartz, pyrrhotite, and a trace of pyrite have been introduced.

R. H. Hutchison has supplied the following information: "A drill-hole on the westerly extension of this zone cut a brecciated border of a porphyry dike cemented by quartz and sulphides." This indicates that the porphyry is the source of the ore, and the iron formation, on account of its brittle character, is a convenient host rock.

The north zone consists of fairly regularly banded cherts separated by slaty beds. Near the fault the zone is brecciated and weathered, and the matrix appears to be quite siliceous.

Rowan

This property lies in a belt of Keewatin greenstones about one mile west of mile 3 on the eastern boundary of Todd township. The ore zone is located near the southern boundary of claim K.R.L. 10,235. It lies along the south contact of a fine-grained, massive syenite, and is bordered on the south by a sheared amphibolitic greenstone. As determined by drilling the syenite is about 240 feet wide and intrudes greenstone on the north. Along the southern edge the syenite becomes basic and approaches a diorite in composition. It contains a little quartz, some orthoclase, and much oligoclase and andesine. Biotite is common. There is some alteration to sericite and epidote. The transition from syenite to diorite occurs in a silicified zone containing the veins, and the actual relations of the syenite and diorite are not clear but are believed to be gradational. Recrystallized greenstone lies immediately to the south.

The ore zone is about 25 feet wide and about 240 feet long, and strikes S.45°E. As many as four veins have been found in one pit. The west end shows three veins dipping 65°N. They range in width from 1½ to 5 feet and lie in a pyritized, granular, dark-greyish, silicified schist. The schist bands are usually about 1 foot wide. To the south numerous small irregular quartz veinlets occur in a silicified greenstone. The north vein in No. 1 trench west of the discovery trench contains numerous irregular areas of fine to coarse pyrite, and there are cavities which may be due to the weathering out of pyrite. Trench No. 1 east shows a laminated vein 1 to 4 feet wide, dipping 70°N. It contains much coarse to fine pyrite, which weathers to form melanterite and a little bornite. On the north a vein breccia diverges upward from the vein, and is best mineralized next the quartz. At the north edge of this trench an intensely sheared zone contains a fault on which the north wall has moved upward; the dip of the fault plane is parallel to the veins. Near the east end of the zone, schist inclusions are well pyritized, and some pyrite occurs in the vein near the small inclusions. A pit 28 feet deep was sunk on the veins in the discovery trench. Much tourmaline and a small amount of tellurides were found in the drill-cores.

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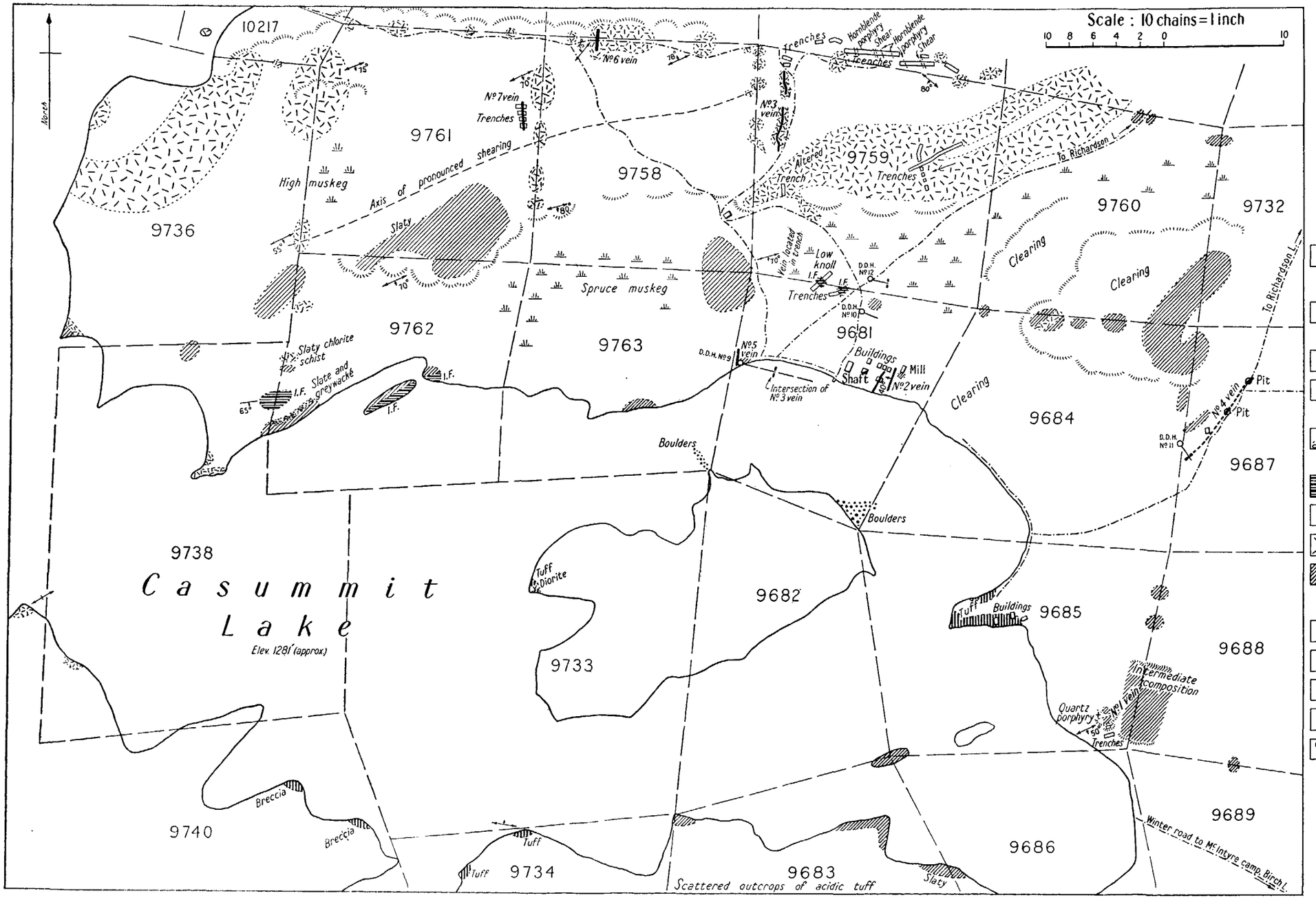
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Zigzag l 20
Zinc. *See* Sphalerite.

Insert to face page 32.



LEGEND

QUATERNARY
Pleistocene and Recent
- Drift and sand plain

PRE-CAMBRIAN
Post Algoman?
- Diorite

Algoman type
- Quartz veins
- Quartz porphyry

Timiskaming type
- Slate and greywacké

Keewatin type
- Iron formation
- Acidic pyroclastics
- Basalt, andesite, chlorite schist, hornblende schist etc.
- Basic pyroclastics

Symbols
- Strike and dip of schistosity
- Strike of vertical schistosity
- Strike and dip of bedding
- Glacial striae
- Diamond drill hole

Note

The boundaries of claims shown on this sketch represent the original lines run by the prospector. At the time of the geological examination the survey of the claims had not yet been made.

FIG. 2—GEOLOGICAL SKETCH MAP OF THE CASEY SUMMIT GROUP OF CLAIMS, CASUMMIT LAKE.

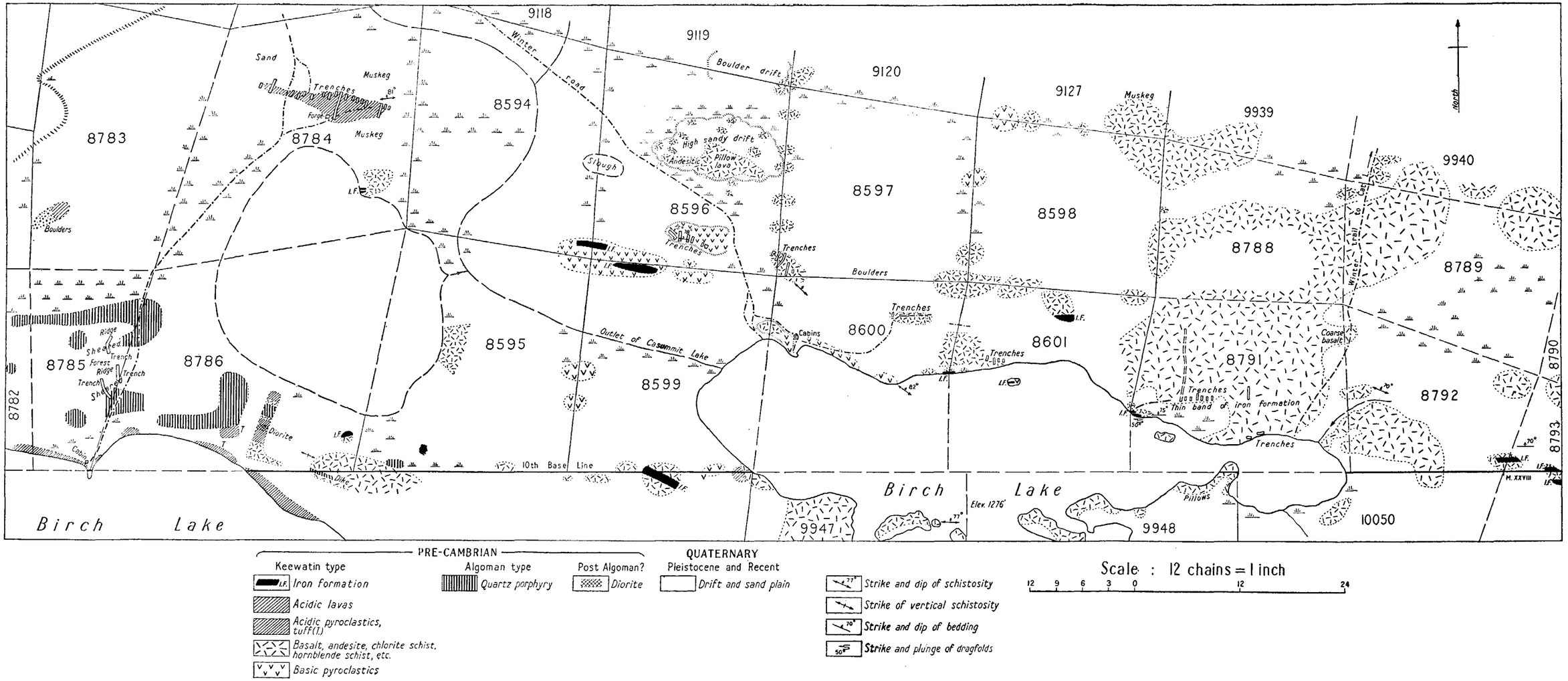


FIG. 5—GEOLOGICAL SKETCH MAP OF THE BOYLEN-MCINTYRE GROUP OF CLAIMS, BIRCH LAKE.

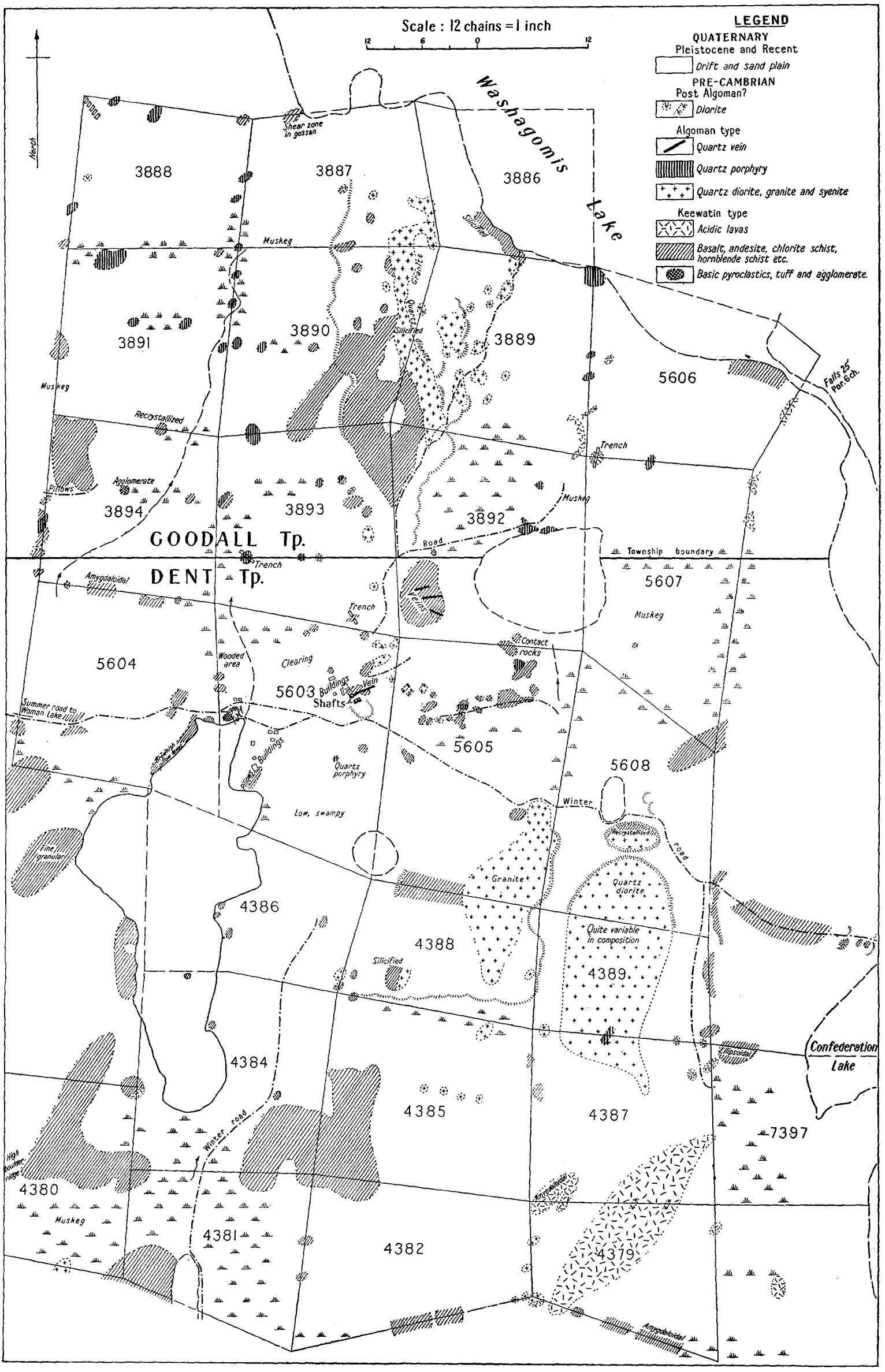


FIG. 8—GEOLOGICAL SKETCH MAP OF THE GROUP OF CLAIMS OF METALS DEVELOPMENT, LIMITED, CONFEDERATION LAKE.









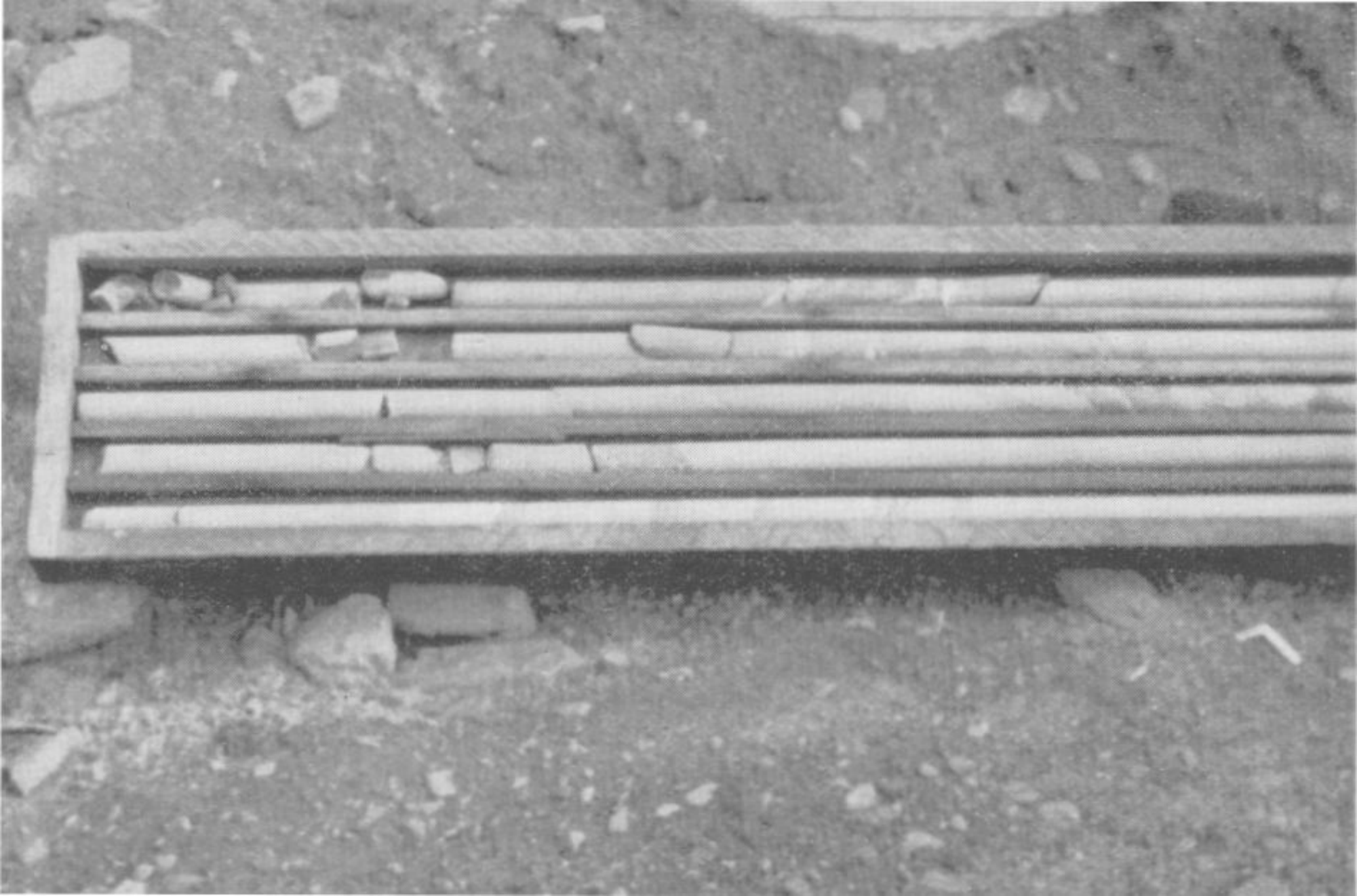
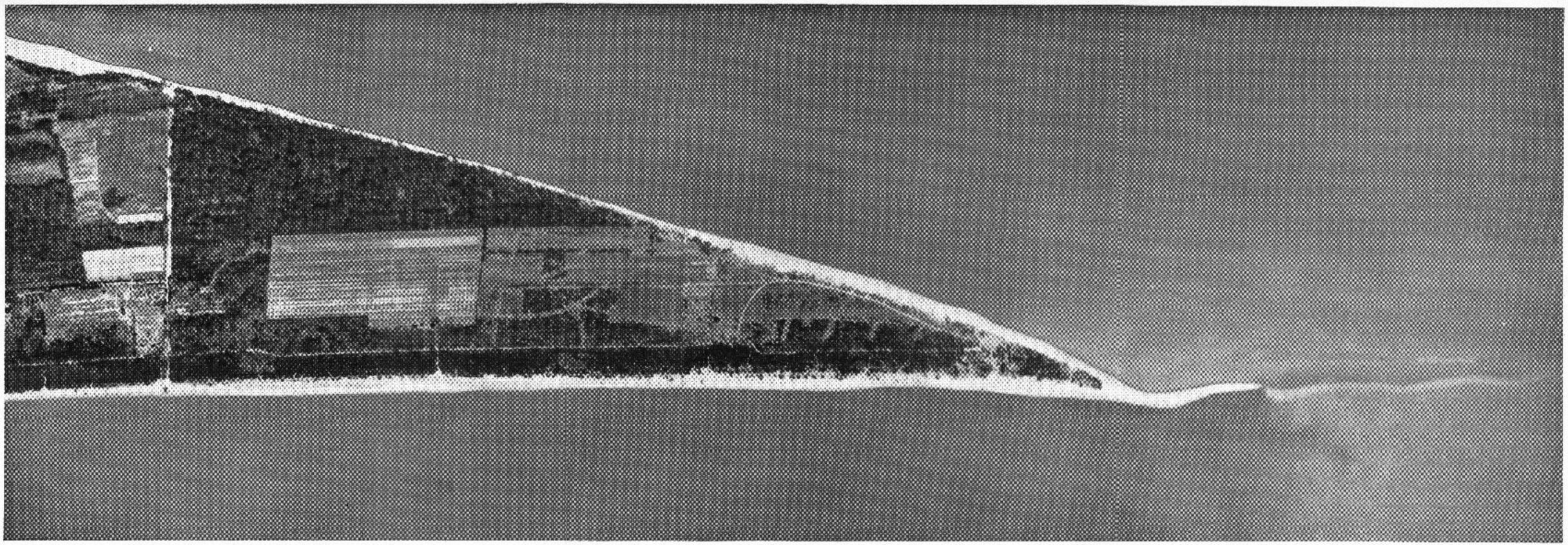






Photo by Canadian Royal Air Force



South

View from the air of the southern part of Point Pelee in April, 1931. Note the underwater extension of the sand spit as a bar.