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LETTER OF TRANSMISSION

To His Honour Henry Cockshutt,

Lieutenant-Governor of the Province of Ontario.

Sir,—I have the honour to transmit to you herewith, for presentation to the Legislative Assembly of the Province of Ontario, the Thirty-fifth 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, 1926.

INTRODUCTORY LETTER

To the Honourable Chas. McCrea,
Minister of Mines.

Sir,—I beg to submit to you herewith, the Thirty-fifth Annual Report of the Department of Mines, published in six parts, as follows:—

Part 1.

Introductory Letter, by Thos. W. Gibson.
Statistical Review of Ontario's Mineral Industry in 1925, by W. R. Rogers and A. C. Young.
Prospectors' Classes, 1925-26, by W. L. Goodwin.
Mining Accidents in 1925, by T. F. Sutherland and staff of Inspectors.
Mines of Ontario in 1925, by T. F. Sutherland and staff of Inspectors.

Part 2.

Sault Ste. Marie Area, by R. G. McConnell.
Batchawana Area, by E. S. Moore.
Sahkatawich (Rush) Lake Section, Woman River Iron Range, by E. S. Moore.
Map No. 35a—Sault Ste. Marie Area, scale 2 miles to the inch.
Map No. 35b—Batchawana Area, scale 2 miles to the inch.

Part 3.

Gowganda Silver Area (Fourth Report, revised), by A. G. Burrows.
Gowganda Vein Minerals, by E. W. Todd.
Anima-Nipissing Lake Area, by E. W. Todd.
Map No. 35c—Anima-Nipissing Lake Area, scale 1 mile to the inch.
Map No. 35d—Part of Gowganda Silver Area, scale ½ mile to the inch.

Part 4.

Reconnaissance from Red Lake to Favourable Lake, District of Patricia, by G. Vibert Douglas; with Appendix on Flora and Fauna by L. F. Kindle.
Map No. 35e—Red Lake Gold Area, scale 2 miles to the inch.
Map No. 35f—Red Lake to Favourable Lake, scale 4 miles to the inch.

Part 5.

Natural Gas in 1925, by R. B. Harkness.
Petroleum in 1925, by R. B. Harkness.

Part 6.

Geology of Ogden, Bristol and Carscallen Townships, by J. E. Hawley.
Geology of McArthur, Douglas and Geikie Townships (Redstone River Area), by E. L. Bruce.
Grassy River Area, District of Sudbury, by T. L. Gledhill.
Notes on the South Part of the Grassy River Area, by T. L. Gledhill.
Wasapika Section, West Shiningtree Gold Area, by F. L. Finley.
Map No. 35g—Carscallen, Bristol and Ogden, scale ¾ mile to the inch.
Map No. 35h—Redstone River Area, scale ¾ mile to the inch.
Map No. 35j—Grassy River Area, scale 1½ miles to the inch.

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

I have the honour to be, Sir,

Your obedient servant,

Thos. W. Gibson,
Deputy Minister of Mines.

Department of Mines,
Toronto, 1926.

ONTARIO

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

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

THIRTY-FIFTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXV, PART I, 1926

CONTENTS

Statistical Review of Ontario's Mineral Industry in 1925	1-63
Classes for Prospectors	64-66
Mining Accidents in Ontario, 1925	67-72
Mines of Ontario in 1925	73-168

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CONTENTS

Vol. XXXV, Part I

PAGE

Letter of Transmission i
Introductory Letter ii

STATISTICAL REVIEW OF ONTARIO'S MINERAL INDUSTRY IN 1925.

Introduction 1
Table I—Summary of Mineral Statistics of Ontario for 1925 2
Table II—Value of Mineral Production, 1921-1925 3
Table III—Total Mineral Production of Ontario 4
General Remarks 5

GOLD 6
Table IV—Ontario's Gold Production, 1925 7
Producing gold mines, 1925 7
Development 8
Power 9
Royal Mint, Ottawa 9
World output 10
Table V—Total Gold Production of Ontario 11
Table VI—Value of Total Production from Porcupine Area 12
Table VII—Value of Total Production from Kirkland Lake Area 13
Table VIII—Dividends and Bonuses paid to Dec. 31, 1925 14
Table IX—Dividends and Bonuses paid by individual gold mines 15

SILVER—COBALT 16
Silver Production, 1924-1925 17
Table X—Total Shipments from Silver mines, 1904 to 1925 18
Table XI—Silver Shipments by Camps 19
Table XII—Silver Shipments, 1904-1925 20
Table XIII—Dividends and Bonuses paid to Dec. 31, 1925 21
Table XIV—Operations of Ontario Silver-Cobalt Refineries in 1925 23

NICKEL, COPPER AND PLATINUM METALS 24
Table XV—Nickel-copper Mining and Smelting 25
Sulphuric acid 26
Table XVI—Nickel-copper Refining, 1925 26
Table XVII—Precious Metals Recovered, 1921-1925 27
Dividends 27

IRON ORE, PIG IRON AND COKE 28
Table XVIII—Iron and Steel Statistics, 1921-1925 28
Coke 29

LEAD AND ZINC 30

NON-METALLIC MINERALS.
Abrasives 31
Actinolite 31

PAGE

Asbestos 31
Barite 31
Feldspar 32
Fluorspar 33
Graphite 33
Gypsum 33
Iron pyrites 34
Mica 34
Mineral waters 35
Natural gas 36
Peat 36
Petroleum 36
Quartz and silica brick 39
Salt 40
Talc and soapstone 41

STRUCTURAL MATERIALS AND CLAY PRODUCTS.
General Remarks 42
Clay products 43
Brick and tile 44
Pottery and porcelain 44
Sewer pipe 44
Brick and tile plants 45
Cement 47
Lime 47
Sand and gravel 48
Sand-lime brick 51
Stone 52

Mining Revenue 55
Mining Company Incorporations 58
Provincial Assay Office 60
Departmental Correspondence 63
Temiskaming Testing Laboratories 63

CLASSES FOR PROSPECTORS
Introduction 64
Average attendance at classes, 1925-26 .. 65

MINING ACCIDENTS IN 1925
Accidents during 1925 67
Fatal accidents 68
Accidents from explosives 70
Infection 71
Prosecutions 71

MINES OF ONTARIO IN 1925
Mines and Metallurgical Works (list) ... 73
Quarries (list) 78
Clay Pits (list) 81
Coal (anthraxolite) 82
Dolomite 82
Feldspar 82
Gold 84
Ankerite Gold Mines, Ltd. 84
Argonaut Gold, Ltd 87
Barry-Hollinger Gold Mines, Ltd 88
Bennett Mining Co., Ltd 88
Blue Quartz Gold Mines, Ltd. 88
Bosquet Gold Mines, Ltd 89
British Canadian Mines, Ltd 89
Canadian Assoc. Goldfields, Ltd 90

PAGE

Champion Gold Mines, Ltd. 90
Cline Canadian Gold Mines, Ltd. 90
Coniaurum Mines, Ltd. 91
Consolidated West Dome Lake Mines, Ltd. 94
Cooper Gold Mines, Ltd. 95
Crown Reserve Mining Co., Ltd. 96
Dome Mines, Ltd. 97
Gold Hill Mining Co., Ltd. 102
Gosselin Syndicate. 102
Goudreau Gold Mines, Ltd. 102
Harker Gold Mines, Ltd. 103
Harkness-Hays Gold Mining Co., Ltd. 103
Harvey-Kirkland Mines, Ltd. 104
Hollinger Consolidated Gold Mines, Ltd. 104
Kirk Gold Mines, Ltd. 110
Kirkland-Hunton Mines, Ltd. 111
Kirkland Lake Gold Mining Co., Ltd. 111
Kirkland Rand, Ltd. 112
Lake Shore Mines, Ltd. 112
McCarthy-Webb Goudreau Mines, Ltd. 113
McIntyre-Porcupine Mines, Ltd. 113
McMaster Syndicate. 119
McMillan Development Co. 119
March Gold, Ltd. 119
Night Hawk Peninsular Mines, Ltd. . . 120
Northland Gold Mines, Ltd. 121
Ore Chimney Mining Co., Ltd. 121
Porcupine Paymaster Mines, Ltd. . . . 121
Power and Mines Syndicate. 124
Queen Lebel Gold Mines, Ltd. 124
Shield Development Co., Ltd. 124
Sylvanite Gold Mines, Ltd. 125
Teck-Hughes Gold Mines, Ltd. 125
Tough-Oakes Burnside Gold Mines, Ltd. 126
Vipond Consolidated Mines, Ltd. 128
Walsh-Katrine Gold Mines, Ltd. 131
Western Ontario Mines, Ltd. 131
Wright-Hargreaves Mines, Ltd. 131
Graphite. 133
Gypsum. 133
Lead. 134
Forbes Galena Mines, Ltd. 134
Kingdon Mining, Smelting & Mnfg. Co., Ltd. 135
Mica. 135
Nickel and Copper
International Nickel Company. 136
Mond Nickel Company, Ltd. 138

PAGE

Silver
Beaver Auxiliary Mines, Ltd. 141
Brewer, Sulllivan and Richardson. . . . 141
Canadian Lorrain Silver Mines, Ltd. . 142
Capitol Silver Mines, Ltd. 142
Castle-Trethewey Mines, Ltd. 142
Clifton Consolidated Mines, Ltd. 145
Cobalt Contact Mines, Ltd. 145
Coleroy Gowganda Mines, Ltd. 145
Colonial Mining Company. 146
Coniagas Mines, Ltd. 146
Crescent Silver Cobalt Mining Co., Ltd. 146
Doherty-Easson Mining Syndicate, Ltd. 147
Genesee Mining Co., Ltd. 147
Gowganda-Duggan Silver Mines, Ltd. 147
Gowganda Keora Silver Mines, Ltd. . 147
J. W. Hamilton. 147
Hamilton Mining Co., Ltd. 148
Hector Silver Mines, Ltd. 148
Huronian Belt Company. 148
Hylands-Gardiner-Johnston claims. . . 149
Keeley Silver Mines, Ltd. 149
Kerr Lake Mines, Ltd. 151
LaRose Mines, Ltd. 151
Lorrain Consolidated Mines, Ltd. 152
McKinley-Darragh-Savage Mines of Cobalt, Ltd. 152
John H. McLeod. 154
Millcrest Mining Co., Ltd. 154
Mining Corporation of Canada, Ltd. . 155
Newton Lorrain Syndicate. 161
Nipissing Mining Co., Limited. 161
Northern Extension Cobalt Mines, Ltd. 164
M. J. O'Brien, Limited. 164
Ontario Solid Silver Mines, Ltd. 164
Carl Reinhardt. 164
John W. Shaw. 165
Silver Bullion Mines, Ltd. 165
Silver Sill Mining Co., Ltd. 165
Tonopah Canadian Mines. 165
Trainmen Silver Mining Co., Ltd. . . . 166
Victory Silver Mines, Ltd. 166
Wigwam Silver Mines, Ltd. 166
Soapstone.
Grace Mining Co., Ltd. 167
H. H. Wood. 167
Talc.
Asbestos Pulp Company. 167
Geo. H. Gillespie Co., Ltd. 167
Metallurgical Works.
Algoma Steel Corporation. 168
International Nickel Co. of Canada, Ltd. 168
Steel Company of Canada, Ltd. 168

ILLUSTRATIONS AND DIAGRAMS

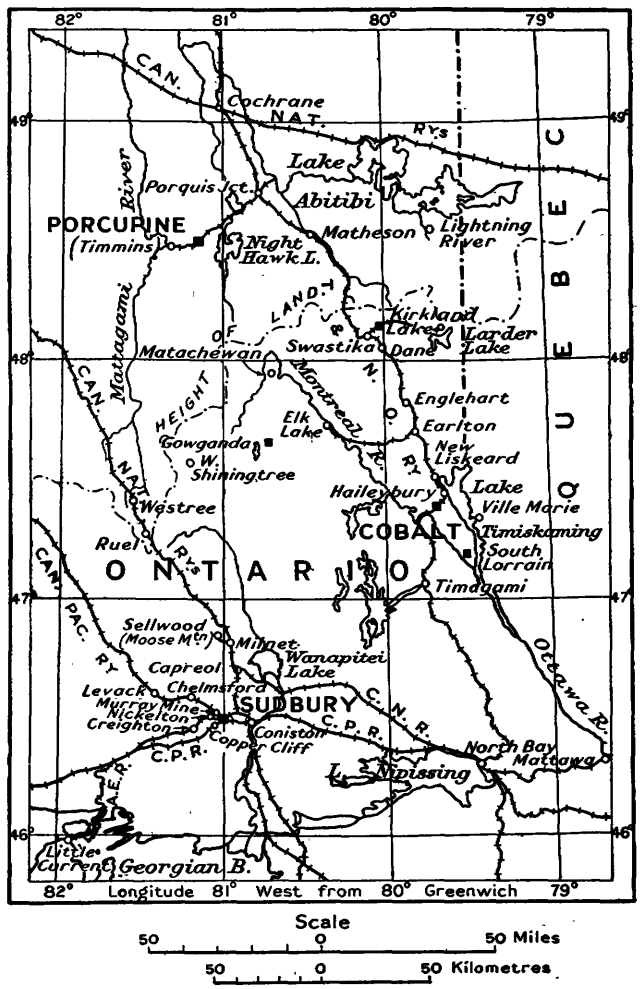
Sketch map showing location of the principal metal mining areas in Northern Ontario. 1
Graph showing nickel and copper content of matte produced in Ontario from the inception of smelting at Copper Cliff in 1887. 25
Ankerite Gold Mines, Limited,—flow sheet of cyanide plant, January, 1926. 84
Flow sheet of Consolidated West Dome Lake mill, 1924. 95
Flow sheet of 350-ton mill, Porcupine Paymaster Mines, Ltd., April, 1926. 123

STATISTICAL REVIEW OF ONTARIO'S MINERAL INDUSTRY IN 1925

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

Introduction

In 1925 Ontario reached the zenith of her mineral production, exceeding 1918, the year of maximum war output when high prices obtained for metals,



Sketch map showing location of the principal Metal Mining Areas in Northern Ontario.

by more than $7,274,334. The increase in valuation over 1924, which ranked next to 1918, was $10,361,379 or 13.42 per cent. This is attributed to a marked advance in metalliferous production, notably gold, nickel and copper. Non-metallics and construction materials show a small decline from 1924 figures while the value of clay products advanced a little.

Table I which follows summarizes production and employment statistics for the year 1925:—

TABLE I.—SUMMARY OF MINERAL STATISTICS OF ONTARIO FOR 1925

Product (tons of 2,000 lbs.)	Quantity	Value	Employees	Wages
METALLIC:		$		$
Gold ... oz.	1,461,039	30,206,432	5,335	8,757,943
Silver ... "	10,001,100	6,964,325	1,739	2,009,848
Copper in matte (a) ... tons	10,039	2,007,734	2,650	3,487,051
Nickel in matte (a) ... "	16,325	5,876,927		
Copper ... lb.	19,582,513	2,730,698		
Nickel, metallic and in speiss exported ... "	32,114,564	7,344,585	(b) 570	917,794
Nickel, oxide and salts ... "	11,774,209	2,725,161		
Platinum metals ... oz.	16,980	1,676,446		
Bismuth ... lb.	19,667	18,566		
Copper sulphate ... "	13,834	692		
Cobalt metallic and in residues exported ... "	625,298		(c) 364	338,155
Cobalt oxide ... "	575,580	2,328,517		
Cobalt salts and unseparated oxides ... "	265,384			
Lead, pig, and in ore exported ... lb.	7,268,193	601,704	165	221,535
Zinc in concentrates ... "	179,545	13,685		
Total ...	.....	62,495,472	10,823	15,732,327
NON-METALLIC:				
Abrasives ... tons	105	945	1	729
Actinolite ... "	40	500	.....	.....
Arsenic, white ... lb.	2,156,441	113,325	(c)	.....
Asbestos ... tons	2	901	.....	.....
Feldspar, crude and ground ... "	17,404	141,059	144	82,271
Fluorspar ... "	12	200	.....	.....
Graphite, crude and refined ... "	2,345	134,213	38	34,501
Gypsum ... "	82,020	491,833	146	152,478
Iron pyrites ... "	685	8,799	.....	.....
Mica ... "	1,605	82,661	56	38,779
Mineral water ... Imp. gals	183,012	25,452	17	5,295
Natural gas ... M cu. ft.	7,257,274	4,083,341	1,184	805,730
Peat ... tons	1,370	8,394	20	9,795
Petroleum, crude ... bbls.	144,250	396,154	2,165	2,702,034
Quartz and silica brick ... tons	188,064	359,691	132	112,471
Salt ... "	226,470	1,466,450	467	555,729
Talc and soapstone ... "	13,678	174,116	51	47,971
Total ...	.....	7,488,034	4,421	4,547,783
STRUCTURAL MATERIALS:				
Cement, Portland ... bbls.	3,462,358	5,253,911	700	921,643
Hydrated lime ... tons	41,610	477,585	409	436,867
Quicklime ... bush.	5,115,882	1,566,540		
Sand and gravel ... tons	3,913,292	1,658,700	618	390,697
Sand-lime brick ... M.	66,392	677,103	208	213,556
Stone, building, trap, granite, etc ... tons	3,023,594	2,817,335	1,170	788,972
Total ...	.....	12,451,174	3,105	2,751,735
CLAY PRODUCTS:				
Brick, face ... M	125,470	2,403,832		
" common ... "	48,028	733,693		
" fancy and ornamental ... "	425	21,728	1,767	1,460,889
" sewer ... "	2,125	37,082		
Tile, drain ... "	13,496	360,710		
" structural ... "	.....	612,138		
Sewer pipe, copings, flue-linings, etc ...	.....	893,443	265	308,627
Pottery ... M	6,200	86,000	28	35,383
Total ...	.....	5,148,626	2,060	1,804,899
Grand Total ...	.....	**87,583,306**	**20,409**	**24,836,744**

(a) Copper and nickel in the matte valued at 10 and 18 cents per pound respectively.
(b) Employees and wages for nickel-copper refineries.
(c) Employees and wages for silver-cobalt smelters and refineries.

The following comparative statement shows the course of the mining industry during the five-year period, 1921 to 1925 inclusive, as indicated by the value of the total production:

TABLE II.—VALUE OF MINERAL PRODUCTION, 1921 TO 1925

Product	1921	1922	1923	1924	1925
METALLIC:	$	$	$	$	$
Gold	14,692,357	20,579,569	20,136,287	25,669,303	30,206,432
Silver	5,763,908	7,800,029	6,843,364	7,233,078	6,964,325
Platinum metals	862,034	924,712	1,418,633	1,891,497	1,676,446
Cobalt (*a*)	502,370	1,080,873	1,456,583	1,662,526	2,328,517
Nickel (*b*)	4,050,601	7,038,202	9,572,662	11,309,326	15,946,673
Other nickel and cobalt compounds	114,258	255,034	347,289	.....	.....
Copper, metallic and in matte	1,101,730	2,069,824	3,456,067	3,825,294	4,739,124
Iron ore (*c*)	459	25,261	26,452	110	.....
Pig iron (*d*)	1,588,751	340,730	423,298	91,862	.....
Lead (pig)	191,113	173,742	347,886	419,405	601,704
Zinc	.....	2,181	.....	.....	13,685
Bismuth	.....	.....	48,139	27,913	18,566
Total	28,777,581	40,290,157	44,076,660	52,130,314	62,495,472
NON-METALLIC					
Abrasives (*e*)	55,965	.....	100,000	9,272	945
Actinolite	975	575	583	1,225	500
Arsenic, white	233,763	299,940	582,785	309,108	113,325
Asbestos	.....	.....	2,600	91,900	901
Barite	.....	.....	4,180	.....	.....
Feldspar, crude and ground	150,457	120,576	134,822	216,791	141,059
Fluorspar	1,744	3,905	597	1,343	200
Graphite, crude and refined	63,439	34,124	65,557	72,842	134,213
Gypsum	433,053	621,668	542,317	467,097	491,833
Iron pyrites	101,306	39,763	99,716	44,542	8,799
Mica	28,891	56,480	110,290	172,252	82,661
Mineral water	14,438	10,528	14,047	13,133	25,452
Natural gas	2,975,502	4,024,767	4,066,244	4,076,014	4,083,341
Peat fuel	6,664	14,500	.....	.....	8,394
Petroleum, crude	559,198	466,587	478,149	390,424	396,154
Quartz and silica brick	220,806	146,446	510,410	221,452	359,691
Salt	1,649,626	1,573,657	1,674,365	1,337,311	1,466,450
Talc and soapstone	140,390	178,397	125,124	130,577	174,116
Total	6,636,217	7,591,913	8,511,786	7,555,283	7,488,034
STRUCTURAL MATERIALS:					
Cement, Portland	6,424,356	6,235,370	5,855,589	5,668,671	5,253,911
Lime, hydrated and quicklime	1,344,188	1,767,543	1,893,663	1,840,152	2,044,125
Sand and gravel	1,496,729	1,816,320	1,623,317	1,587,913	1,658,700
Sand-lime brick	534,531	851,007	897,960	512,361	677,103
Stone, building, trap, granite, etc	4,167,582	2,969,926	2,869,228	2,789,368	2,817,335
Total	13,967,386	13,640,166	13,139,757	12,398,465	12,451,174
CLAY PRODUCTS:					
Brick, face	3,267,018	4,793,224	4,191,145	2,203,617	2,403,832
" common				944,892	733,793
" fancy and ornamental				88,857	21,728
" sewer				40,922	37,082
Tile, drain	397,104	368,180	283,662	373,980	360,710
Tile, structural	421,127	720,101	790,475	550,170	612,138
Sewer pipe, copings, flue-linings, etc.	939,463	973,824	925,858	851,327	893,443
Pottery	69,984	88,889	78,000	84,100	86,000
Total	(*f*)5,183,125	6,944,218	6,269,140	5,137,865	5,148,626
Grand Total	**54,564,309**	**68,466,454**	**71,997,343**	**77,221,927**	**87,583,306**

(*a*) Cobalt, oxide, metallic cobalt, and cobalt content of residues marketed.
(*b*) Nickel in matte, oxide and metallic nickel.
(*c*) Exports and shipments to points other than Ontario blast furnaces.
(*d*) Product from Ontario ore only.
(*e*) Includes corundum, garnets, quartz pebbles.
(*f*) Includes $88,429 valuation of fire clay and products not listed.

In Table III is given the aggregate value of the metals and metallic products from the time production began in Ontario down to the end of 1924. 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 putput, since the great bulk of the iron ore charged into the blast furnaces of the Province is "lake" ore from the mines of Minnesota, Michigan and Wisconsin. Conversely, part of the iron ore raised in Ontario is exported to the United States in the form of briquettes produced from low-grade magnetite ore. In the production tables credit is taken only for the ore exported or shipped to points other than Ontario blast furnaces, since to include the value of the domestic ore converted into pig iron in Ontario furnaces would involve a duplication of this item.

TABLE III.—TOTAL MINERAL PRODUCTION OF ONTARIO

Year	Value of Mineral Production				
	Metallic (a)	Non-Metallic	Structural Materials	Clay Products	Total
	$	$	$	$	$
Before 1891..	9,520,269		(a)		9,520,269
1891.....	388,715		4,316,958		4,705,673
1892.....	864,382		4,509,757		5,374,139
1893.....	614,762		5,505,991		6,120,753
1894.....	842,750		5,244,008		6,086,758
1895.....	616,055		4,554,083		5,170,138
1896.....	963,288		4,271,715		5,235,003
1897.....	1,038,089		(b) 4,480,452		(b) 5,518,541
1898.....	1,689,002		5,546,875		7,235,877
1899.....	2,055,592		6,361,081		8,416,673
1900.....	2,565,286		6,733,338		9,298,624
1901.....	5,016,734		6,814,352		11,831,086
1902.....	6,257,499		7,134,135		13,391,634
1903.....	5,242,575		7,628,018		12,870,593
1904.....	4,906,677		6,665,970		11,572,647
1905.....	10,201,010		7,653,286		17,854,296
1906.....	13,353,080		9,035,303		22,388,383
1907.....	14,550,835		10,468,538		25,019,373
1908.....	16,754,986		8,882,631		25,637,617
1909.....	22,928,496		10,052,879		32,981,375
1910.....	28,161,678		11,152,217		39,313,895
1911.....	29,102,867		12,873,930		41,976,797
1912.....	34,799,734		13,541,869		48,341,603
1913.....	37,507,935		15,724,376		53,232,311
1914.....	33,345,291		12,950,668		46,295,959
1915.....	44,109,679		10,136,000		54,245,679
1916.....	55,002,918		10,300,904		65,303,822
1917.....	56,831,857		15,261,975		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	(c) 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
Total...	823,052,596	.....	416,086,503	.....	1,239,139,099

(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, making a total to the end of 1925 of $823,052,596. No estimate has been made of the output of non-metallics up to 1891.
(b) Estimated on basis of preceding year ($1,618,720 for stone, lime, and clay products).
(c) Includes $88,429 valuation of fire clay and products not listed.

The total production of metals in Ontario is noted hereunder:—

Metal or Product	Production to December 31, 1924	Production, 1925	Production to December 31, 1925
	$	$	$
Silver	221,220,096	6,964,325	228,184,421
Nickel, including nickel oxide	197,595,684	15,946,673	213,542,357
Gold	154,285,601	30,206,432	184,492,033
Pig iron	84,775,556	.....	84,775,556
Copper (*a*)	68,080,426	4,739,124	72,819,550
Cobalt (*b*)	14,245,494	2,328,517	16,574,011
Platinum metals	8,593,411	1,676,446	10,269,857
Iron ore	9,463,516	.....	9,463,516
Lead	1,916,962	601,704	2,518,666
Molybdenite	209,735	.....	209,735
Zinc ore	94,591	13,685	108,276
Bismuth	76,052	18,566	94,618
Total	760,557,124	62,495,472	823,052,596

(*a*) Includes small quantities of copper sulphate.
(*b*) Includes cobalt metal, cobalt oxide, cobalt salts and cobalt content of residues exported.

General Remarks

According to annual statements from banks and other financial institutions, the trend of business for the whole of Canada during 1925 was slowly but surely upward, and as an evidence of this it was stated that car loadings were the largest on record, while both wholesale and retail business showed a fair degree of increased activity. Since the prosperity of the country at large is dependent on the primary industries such as agriculture, mining and lumbering, a considerable portion of this change to better times may be placed to the credit of mining, and in particular to the Province of Ontario, where mining is of such signal importance to the economic progress of the country.

Construction of colonization and trunk roads throughout northern Ontario is keeping pace with mineral development. A new motor road will be open this coming summer connecting Timagami with Cobalt and in 1927 it is expected the gap between North Bay and Timagami will be completed.

During the period, advances have been made in nearly all sections of the industry, and in several, new high records have been attained. Ontario's gold mining industry is worthy of particular mention. In the north where thirteen mines have been producing, important increases are reported, both in the tonnage of ore milled and in the recovery of gold. The famous silver mines at Cobalt have well maintained their normal output, while the newer camps at South Lorrain and Gowganda big fair to add a new lease of life to the production of silver. Gold and silver mines during recent years have been so much in the public eye that the development of the nickel-copper industry has been frequently overlooked. Reference has been made in past reports to the new uses of nickel, found by intense research by the producers. These applications have been continually extended to such fields as the motor industry for radiators, and to submarine cables, where the use of a special nickel-copper alloy increases the sending efficiency very considerably. As evidenced by the figures for 1925 it would appear that the nickel industry is facing an expanding future in which the peace-time needs for the metal will equal those of war, when nickel was so much in demand for armour plating and other war equipment.

Prospecting was carried on intensively. In July what appears to be an important gold discovery was reported at Red lake, District of Patricia, about 130 miles northwest of Hudson station on the Canadian National Railway and 60 miles east from the Manitoba boundary. A feature of this new find was the use of aeroplanes to expedite the movement of men, equipment and supplies to the field before the closing of water navigation. Since the new year, 1926, there has been a rush of prospectors to Red lake, with the result that much snow staking has been done in the vicinity. A preliminary report with geological map of the area was issued by the Ontario Department of Mines in 1924, as a result of field work by Dr. E. L. Bruce in 1923. The first staking at Red lake was done in 1922 when a little gold was found, but it was not until the autumn of 1925 that the favourable assays secured by the Howey Red Lake Syndicate became generally known, precipitating a rush to the new goldfield.

Gold

The total gold produced during 1925 from all sources in Ontario amounted to 1,461,039.37 fine ounces, valued at $30,206,432, as against 1,241,728 fine ounces worth $25,669,303 in 1924. These figures include the gold won from the refining of nickel-copper mattes.

The crude bullion recovered from the gold mines also contains a certain percentage of silver. The total value of the crude bullion from Porcupine was $24,886,615 in 1925 as against $22,439,616 during the previous year, while the corresponding figures for the Kirkland Lake camp were $5,403,289 and $3,480,481, a total gain of $4,369,807 or nearly 17 per cent. for the gold mines of these two camps. From other points a few small properties produced crude bullion worth $2,450 in 1925, while gold recovered from the refining of nickel-copper matte was valued at $84,646. Ore milled increased from 2,867,684 tons in 1924 to 3,399,544 tons in 1925. In these years, respectively, the figures for Porcupine were 2,642,114 and 3,016,178 tons and for Kirkland Lake 225,571 and 383,235 tons milled.

The producing mines were operated at practically full time during the period, employing on the average 5,335 wage-earners and paying $8,757,943 in wages.

In addition to the producing mines many others carried on development operations during 1925, while the usual assessment work on mining claims as prescribed by the Mining Act was performed by claim holders in the several Mining Divisions. Returns were received from 24 companies shown above, most of which were active throughout the entire period, or were developing under contract. The number of days work done per mine during 1925 averaged around 265, while the average of the wage-earners was 589, to whom $854,836 were paid in wages. The total number of wage-earners and wages paid by the active mines, therefore, amounted to an average of 5,924 with a total pay roll of $9,612,779.

If complete statistics were available from all individuals doing assessment work on which day labour was engaged the gold mining industry of Ontario, exclusive of salaried officials, would approximate 10 million dollars in wages alone and supply employment to more than 6,000 men.

The Porcupine area was represented by six producing mines of which the Hollinger, Dome and McIntyre produced the major portion. In Kirkland Lake there were also six producing mines of which the Lake Shore, Wright-Hargreaves and Teck-Hughes were the leaders. Details of production are given separately in the following table:—

TABLE IV.—ONTARIO'S GOLD PRODUCTION, 1925

Source	Ore Milled, tons	Bullion shipped				Total Value of Bullion (a)
		Gold		Silver		
		Fine ounces	Value	Fine ounces	Value	
PORCUPINE			$		$	$
West Dome Lake	35,278	13,581.73	286,835	1,345	923	287,758
Dome	530,200	210,051.21	4,342,145	34,794	23,777	4,365,923
Hollinger	1,929,988	757,305.93	15,654,900	137,221	94,210	15,749,109
McIntyre	419,640	178,556.44	3,690,493	46,515	31,006	3,721,499
Night Hawk Peninsular	39,778	9,460.11	195,563	2,019	1,384	196,947
Vipond	61,294	27,244.00	563,184	3,614	2,195	565,379
Total	3,016,178	1,196,199.42	24,733,120	225,508	153,495	24,886,615
KIRKLAND LAKE						
Argonaut(b)	28,515	10,365.80	213,545	932	638	214,183
Barry-Hollinger	8,136	2,743.10	56,713	382	265	56,978
Teck-Hughes	55,220	48,076.84	993,857	4,518	3,086	996,943
Tough-Oakes-Burnside	34,152	12,624.56	260,973	3,047	2,091	263,064
Lake Shore	109,273	94,455.57	1,952,611	8,890	6,109	1,958,720
Wright-Hargreaves	147,939	92,286.28	1,907,557	8,519	5,844	1,913,401
Total	383,235	260,552.15	5,385,256	26,288	18,033	5,403,289
MISCELLANEOUS						
Champion mine, etc. (c)	131	271.80	5,619	32	22	5,641
Nickel-Copper Refineries	.....	4,016.00	82,437	.....	.....	82,437
Total	131	4,287.80	88,056	32	22	88,078
Grand Total	3,399,544	1,461,039.37	30,206,432	251,828	171,550	30,377,982

(a) There should be deducted from the total, $2,838 which was the discount paid due to differences of exchange.

(b) In addition to gold, copper in concentrates to the value of $12,331 was marketed.

(c) G. Huddlestone (Cody tp.) and W. W. Smith (Grace mine, Michipicoten) were small producers.

The following operators produced gold during the year:

PRODUCING GOLD MINES, 1925

Name of Company	Name of Mine	Locality	P.O. Address of Manager, etc.
*Argonaut Gold, Ltd.	Argonaut	Gauthier township	Argonaut
Barry-Hollinger Gold Mines, Ltd.	Barry-Hollinger	Pacaud township	Boston Creek
Champion Gold Mines, Ltd.	Champion	Kenora district	Fort Erie
Consolidated West Dome Lake Mines, Ltd.	West Dome Lake	Tisdale township	South Porcupine
Dome Mines Company, Ltd., The	Dome	Tisdale township	South Porcupine
Hollinger Consolidated Gold Mines, Ltd.	Hollinger	Tisdale township	Timmins
Lake Shore Mines, Ltd.	Lake Shore	Teck township	Kirkland Lake
McIntyre Porcupine Mines, Ltd.	McIntyre	Tisdale township	Schumacher
Night Hawk Peninsular Mines, Ltd.	Night Hawk Peninsular	Cody township	Connaught Station
Teck-Hughes Gold Mines, Ltd.	Teck-Hughes	Teck township	Kirkland Lake
Tough-Oakes Burnside Gold Mines, Ltd.	Tough-Oakes Burnside.	Teck and Lebel townships	Kirkland Lake
Vipond Consolidated Mines, Ltd.	Vipond	Tisdale township	Timmins
Wright-Hargreaves Mines, Ltd.	Wright-Hargreaves	Teck township	Kirkland Lake

*The name of the company was changed to Argonaut Consolidated Mines, Limited, on Jan. 1, 1926.

The list below gives the names and addresses of the more important companies doing development work during the same period:—

Name	Location	P.O. Address	No. Employees	Days Operation
Abitibi Mines, Ltd.	Lightning River	306 Royal Bank Bldg., Toronto.	Drilling by contract	
Blue Quartz Gold Mines, Ltd.	Painkiller Lake.	328 Confederation Life Bldg., Toronto.	22	310
British Canadian Mines, Ltd.	Mine Centre.	8 Bloor St. E., Toronto.	54	365
Canadel Gold, Ltd.	Porcupine.	Timmins.	4	Pumping
Canadian Associated Goldfields.	Larder.	306 C.P.R. Bldg., Toronto.	47	365
Clifford Gold Mines, Ltd.	Painkiller Lake	328 Confederation Life Bldg., Toronto.	Shaft sinking by contract	
Coniaurum Mines, Ltd.	Porcupine.	St. Catharines.	52	365
Contact Bay Mines, Ltd.	Kenora.	326 Cutler Bldg., Rochester, N.Y.	6	365
Crown Reserve Mining Co., Ltd.	Larder Lake.	Montreal, Que., P.O. Box 386	28	365
Emerald Lake Gold Mines, Ltd.	West of Lake Timigami.	New Hamburg, Ont.	32	196
Gold Hill Mining Co., Ltd.	Boston Creek.	Haileybury.	19	293
Harvey Kirkland Mines, Ltd.	Kirkland Lake.	506 C.P.R. Bldg., Toronto.	2	100
Hayden Gold Mines Co., Ltd.	Porcupine.	509 Brisbane Bldg., Buffalo.	4	90
*Hunton-Kirkland Gold Mines, Ltd.	Kirkland Lake.	32 Imperial Bank Bldg., Toronto.	24	90
Kirk Gold Mines Co., Ltd.	Kirkland Lake.	911 Kent Bldg., Toronto.	19	365
Kirkland Lake Gold Mining Co., Ltd.	Kirkland Lake.	810 Lumsden Bldg., Toronto.	37	365
March Gold, Ltd.	Porcupine.	331 White Bldg., Buffalo, N.Y.	17	365
McMaster Syndicate.	Boston.	Rosegrove.	5	300
Northland Gold Mines, Ltd.	Kirkland Lake.	Kirkland Lake.	15	365
Ore Chimney Mining Co., Ltd.	.....	Northbrook.	22	365
Porcupine Goldfields Dev. & Finance Co.	Deloro tp.	407 Canada Cement Bldg., Montreal.	65	365
Porcupine Paymaster Mines, Ltd.	Deloro tp.	South Porcupine.	56	365
Queen Lebel Gold Mines, Ltd.	Kirkland Lake.	Kirkland Lake.	16	240
Sylvanite Gold Mines, Ltd.	Kirkland Lake.	Kirkland Lake.	43	362
		Total.	589	6.361

*The name of the company was changed in 1926 to Kirkland-Hunton Gold Mines, Ltd.

Development.—Not only in underground development and increased milling capacity is there reason for satisfaction, but construction work carried out on new mills in 1925 indicates a much enlarged output of gold in the future. At the time of writing plans are maturing for the enlargement of the existing milling facilities of the Vipond, Lake Shore and Teck-Hughes. In addition the new fifty-ton mill of the Barry-Hollinger was placed in operation in June, and the milling plant of the Goudreau mine, Algoma district, was being tuned up in December. The Ankerite and Paymaster mills at Porcupine and Blue Quartz at Painkiller lake were in course of construction. The new central shaft of the McIntyre was down over 2,000 feet by the end of the year, or over half of the projected depth. The Hollinger has steadily increased the capacity of its mill and averaged for the year well over 5,000 tons per day. It is expected that the 8,000 tons will be reached gradually. During October, the Kirkland Lake Gold Mining Company in cross-cutting from the 1,975-foot level revealed ore of a good milling grade at a point about 250 feet from the western boundary of the Teck-Hughes.

A comparison of the 1925 annual reports issued to shareholders by the Hollinger and Wright-Hargreaves gold mines affords an interesting comparison, not only of the increase in output over 1924 but also of other salient features of the two mines handling the largest tonnages of ore at Porcupine and Kirkland Lake respectively:

Schedule	Hollinger		Wright-Hargreaves	
	1924	1925	1924	1925
Ore milled, tons	1,659,475	1,929,988	84,487	147,939
Recovery	$13,429,226	$15,786,405	$1,088,725	$1,913,401
Average per ton	$8.09	$8.18	$12.89	$12.93
Average daily tonnage	4,559	5,317	230	402
Net profits	$6,586,215	$8,300,227	$604,387	$1,194,064
Dividends	$3,198,000	$4,378,800	$206,250	$550,000
Average number employees	2,758	2,668	148	207
Labour costs	$4,226,671	$4,637,685	$226,671	$295,408
Operating costs	$7,404,898	$7,829,028	$466,530	$661,511
Costs per ton	$4.461	$4.056	$5.522	$4.471
Mill	$0.943	$0.904	$1.436	$1.159
Mine	$3.093	$2.742	$3.251	$2.710
Sundries	$0.425	$0.410	$0.835	$0.602

The return of Great Britain to the gold standard in May, 1925, in an effort to stabilize her trade conditions and to eliminate the violent exchange fluctuations of the past few years is of interest to the gold mining industry of Ontario.

Power.—The power situation, of vital interest to the gold and silver mines of northern Ontario, seems to have reached a permanent basis. Towards the end of the year press reports stated that the Great Northern Power Company plant on the Montreal river would be sold. This plant, situated only sixty miles from Porcupine, was unable to sell all its power, since the big mines depended on the old-established Northern Canada Power Company with its development at Sturgeon, Sandy and Wawaitin Falls on the Mattagami river and the plant on the Quinze river, Quebec. The Hollinger plant at Island rapids on the Abitibi river was disposed of during the year to the Abitibi Power and Paper Company, which will consume the energy in the manufacture of pulp and paper at Iroquois Falls. Even though the Rouyn copper field of Quebec will make demands on the Quinze plant, with the installation of additional units no question of power shortage may be expected to arise for some years to come. A small portion of the Quinze energy will be delivered to Gowganda camp, but compared with the needs of gold mines the consumption on this latter area will be small. During the past year a second transmission line was constructed from Cobalt to Kirkland Lake and with increased storage facilies on the headwaters of the Montreal river, the Kirkland Lake field is assured of ample power for considerable increases in power consumption.

Royal Mint, Ottawa.—This branch of the Royal Mint of London was opened January 2, 1908, for the refining of Canadian crude gold bullion and for coinage purposes. The receipts since its inception have consisted of gold from all over Canada as well as from foreign countries. The proportion in 1924 and 1925 from Ontario was small until a new agreement between the Federal Department of Finance and the Mint became operative in December, 1925. By this arrangement, initiated by the Ontario Mining Association,

crude gold bullion from Ontario mines will be received, coined and transferred to Canadian banks to the credit of the producer. The silver contents will be sold by the Mint at the best available price and the receipts credited to the owner. The desirability of this method of marketing bullion had been emphasized by the return of Canadian currency to par and further by the fact that American exchange was selling at a slight discount. Advantage has therefore been taken of Clause 5 (1) of the Royal Proclamation of 1907 establishing the Mint by which any person might bring bullion to the Mint and have it struck into gold coin. Under this scheme a saving of approximately $46,800 per year will be made on express rates, the calculated saving being based on an estimated output of $30,000,000. A saving in time will be effected as well as insurance costs compared with shipments to branches of the United States Mint where most of the crude bullion has gone in recent years.

The total receipts of crude gold bullion, from all sources in Canada, at the Royal Mint at Ottawa from its opening on January 2, 1908, to the end of 1925 was 5,938,339.15 crude ounces valued at $95,395,424,24.

RECEIPTS OF CRUDE GOLD BULLION FROM ONTARIO MINES AT THE ROYAL MINT, OTTAWA, 1921-1925

Year	Crude ounces	Precious Metals		
		Gold fine oz.	Silver fine oz.	Total Value $
1921	864,686	672,507	116,163	.....
1922	1,234,895	979,338	160,312	20,352,438
1923	640,535	509,757	80,151	10,588,584
1924	59,220	28,048	4,692	582,960
1925	139,130	105,888	19,130	2,201,974

World Output—The following statement of output by the leading gold-producing countries for the last pre-war year, for 1915 (year of maximum world production) and for the post-war period, has been abstracted chiefly from annual reports of the Director of the United States mint:

OUTPUT BY LEADING GOLD-PRODUCING COUNTRIES AND STATES
(Millions of Dollars)

Source	1913	1915	1919	1920	1921	1922	1923	1924	1925
World	459.9	468.7	365.8	337.0	330.2	319.4	367.8	389. 2	394.0
Transvaal	182.0	188.0	172.2	168.0	167.7	145.1	189.1	197.9	198.4
United States	88.9	101.0	60.3	51.2	50.1	47.3	50.2	50.6	48.0
Canada	16.6	19.0	15.9	15.8	19.1	26.1	25.5	31.5	35.9
Ontario	**4.6**	**8.5**	**10.5**	**11.7**	**14.6**	**20.7**	**20.1**	**25.7**	**30.2**
Russia	.....	26.3	11.0	1.4	0.9	3.0	5.2	19.8	21.9
Mexico	19.3	6.6	15.2	15.3	14.2	15.5	16.2	16.5	16.3
*Oceania	51.8	49.0	26.1	22.6	20.7	18.8	18.1	16.5	13.9
California	20.4	21.4	17.4	14.8	15.7	14.7	13.4	13.2	13.1
Rhodesia	14.1	18.9	12.3	1[illegible].4	12.1	13.5	13.4	13.0	12.0
Australia	.....	.....	.....	.....	15.6	15.9	14.9	14.2	11.6
West Australia	27.1	25.0	15.2	12.8	13.7	11.1	10.4	10.0	9.1
India	11.2	11.5	10.5	10.3	9.7	9.0	7.9	8.2	8.1

Maximum World production.....468.7 million dollars in 1915.
Maximum U.S. production.....101.0 " " "
Maximum Transvaal production.....198.4 " " 1925.
*Includes Australia and New Zealand.

It will be noted that Canada now holds third place among the gold-producing countries of the world, and for this position the Province of Ontario is chiefly responsible.

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

TABLE V.—TOTAL GOLD PRODUCTION OF ONTARIO

Year	Total Production, Value	Porcupine		Kirkland Lake	
		Value	Per cent.	Value	Per cent.
	$	$		$	
1866–1891	(a)190,258	.....	.....	.....	.....
1892–1909	(b)2,509,492	.....	.....	.....	.....
1910	68,498	35,539	51.8	.....	.....
1911	42,637	15,437	36.2	.....	.....
1912	2,114,086	1,730,628	81.8	.....	.....
1913	4,558,518	4,294,113	94.1	65,260	1.2
1914	5,544,979	5,206,006	93.8	114,154	2.0
1915	8,501,391	7,462,111	88.6	551,069	6.5
1916	10,339,259	9,391,408	90.8	702,761	6.8
1917	8,698,735	8,229,744	94.5	404,346	4.6
1918	8,502,480	7,767,907	91.4	632,007	7.4
1919	10,451,709	9,941,803	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	89.3	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
Total	184,492,033	160,332,221	86.9	19,226,143	10.4

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

In the year 1925 Ontario passed the Yukon Territory in gross value of gold produced, the output of the latter being 3¼ million dollars less than Ontario's to the end of 1925. Maximum output from the Yukon was $22,275,000 in the year 1900, owing largely to production from Klondike placer deposits.

Tables on pages 12 and 13 show yearly production by individual gold mines at Porcupine and Kirkland Lake, respectively, while the statements on pages 14 and 15 show yearly and total dividends paid by individual mines.

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

Year	Hollinger	Dome	McIntyre	Porcupine Crown and Northcrown	Vipond	Schumacher (b)	West Dome Lake	Night Hawk Peninsular	Rea and Newray	Davidson	Preston and Clifton-Porcupine	Porcupine Pet	Total Value (c)
	$	$	$	$	$	$	$	$	$	$	$	$	$
1910.....	31,194	4,355	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	35,549
1911.....	6,000	4,277	.....	.....	5,160	.....	.....	.....	.....	.....	.....	.....	15,437
1912.....	909,181	737,499	77,657	.....	16,259	.....	.....	.....	.....	.....	.....	.....	1,740,596
1913.....	2,488,022	1,242,625	236,299	Porcupine Crown. 326,803	.....	.....	.....	.....	Rea. 18,858	.....	Preston.	.....	4,316,807
1914.....	2,719,355	1,059,238	549,166	685,135	73,628	.....	.....	.....	Rea. 125,255	.....	Preston. 15,212	5,000	5,231,989
1915.....	4,206,015	1,530,287	750,812	602,436	246,053	48,236	102,880	.....	.....	.....	.....	5,551	7,495,853
1916.....	5,073,401	2,153,820	1,218,073	578,322	176,686	225,301	16,814	.....	.....	.....	.....	.....	9,442,417
1917.....	4,261,938	1,480,174	1,710,204	377,904	209,738	198,605	44,434	.....	Newray. 1,447	.....	.....	.....	8,285,321
1918.....	5,752,371	82,127	1,578,444	124,474	82,868	92,842	103,745	.....	Newray. 1,516	15,579	.....	.....	7,833,966
1919.....	6,722,266	1,290,301	1,978,014	.....	.....	.....	23,910	.....	.....	27,089	.....	.....	10,041,580
1920.....	6,219,665	2,020,568	2,223,083	Northcrown. 71,529	.....	.....	47,169	.....	.....	11,246	.....	.....	10,690,561
1921.....	9,051,276	2,290,264	1,827,761	97,301 7,943	.....	.....	.....	.....	.....	.....	.....	.....	13,177,244
1922.....	12,274,114	4,178,936	2,021,811	.....	.....	.....	.....	.....	.....	.....	Clifton. 1,664	.....	18,479,325
1923.....	10,446,412	4,374,144	2,550,129	.....	23,876	.....	.....	.....	.....	.....	Clifton. 8,331	.....	17,405,648
1924.....	13,433,063	4,307,624	3,604,874	.....	596,803	.....	60,642	258,618	.....	.....	Clifton. 5,270	.....	22,266,894
1925.....	15,749,109	4,365,923	3,721,499	.....	565,379	.....	287,758	196,947	.....	.....	.....	.....	24,886,615
Total....	99,343,382	31,122,162	24,047,826	2,871,847	1,996,450	564,984	687,352	455,565	147,076	53,914	30,477	10,551	161,345,802

(a) In addition to the mines noted above, the following had a production: Porphyry Hill, $4,200 in 1913 and $2,036 in 1915; Gold Reef, $1,547 in 1915 and $588 in 1917; Tommy Burns, $289 in 1917; Paymaster, $2,800 in 1922; miscellaneous, $2,756 in 1923. All of these are included in the "Total Value" column.

(b) Purchased by the Hollinger in 1922.

(c) A record of total exchange premiums received in addition to the above amounts shows the following: 1920, $1,265,664; 1921, $1,238,211; 1922, $189,022; 1923, $207,742; 1924, $172,721; 1925, $2,607 discount, or a net total of $3,070,753 for the 6 years of which we have record.

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

Year	Lake Shore	Wright-Hargreaves	Teck-Hughes	Tough-Oakes Burnside	Kirkland Lake	Argonaut (a)	Barry-Hollinger	Ontario-Kirkland	Total Value (b)
	$	$	$	$	$	$	$	$	$
1913	.....	1,127	.....	66,632	.....	.....	.....	.....	67,759
1914	.....	.....	.....	117,644	.....	5,204	.....	.....	122,848
1915	.....	.....	.....	555,539	.....	.....	.....	.....	555,539
1916	.....	.....	.....	711,625	.....	.....	.....	.....	711,625
1917	.....	.....	66,722	342,831	.....	.....	.....	.....	409,553
1918	416,414	.....	80,570	139,683	.....	.....	(c) 10,114	.....	646,781
1919	263,354	.....	169,590	.....	56,263	2,631	.....	.....	491,838
1920	503,735	.....	247,757	.....	286,901	26,863	.....	.....	1,065,256
1921	495,276	468,751	322,919	.....	242,417	513	.....	.....	1,529,875
1922	471,341	762,753	596,495	107,481	224,396	.....	.....	10,082	2,172,548
1923	547,600	754,979	1,117,963	12,174	223,102	72,512	.....	.....	2,728,331
1924	1,098,572	1,088,725	1,023,025	47,547	46,512	152,072	.....	.....	3,456,453
1925	1,958,720	1,913,401	996,943	263,064	.....	214,183	56,978	.....	5,403,289
Total	5,755,012	4,989,736	4,621,984	2,364,220	1,079,591	473,978	67,092	10,082	19,361,695

(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: a netal total of $313,048 for the 6 years of which we have record.
(c) Patricia mine, afterwards called Barry-Hollinger.

TABLE VIII.—DIVIDENDS AND BONUSES PAID BY GOLD MINING COMPANIES TO DECEMBER 31, 1925

Name of Company	Date of Incorporation	Authorized Capital	Capital Stock Issued	Par value per share	Dividends and Bonuses paid to end of 1924, Amount	Dividends and Bonuses paid during 1925, Amount	Rate per cent, 1925	Total of Dividends and Bonuses paid to Dec. 31, 1925	Date when last Dividend or Bonus was paid
		$	$	$ c.	$ c.	$ c.		$ c.	
*Dome Mines Company, Ltd.	Mar. 27, 1911	4,500,000	4,290,003	No par	6,447,503.25	1,906,668 00	§ $2	8,354,171 25	Oct. 20, 1925
†Hollinger Cons. Gold Mines, Ltd.	May 25, 1916	25,000,000	24,600,000	5 00	26,152,000 00	4,378,800 00	17.8	30,530,800 00	Dec. 31, 1925
Lake Shore Gold Mines, Ltd.	Feb. 25, 1914	2,000,000	2,000,000	1 00	1,020,000 00	600,000 00	30.0	1,620,000 00	Dec. 15, 1925
McIntyre-Porcupine Mines, Ltd.	Mar. 16, 1911	4,000,000	3,690,283	5 00	4,409,408 00	798,000 00	20.0	5,207,408 00	Dec. 1, 1925
Porcupine Crown Mines, Ltd.	May 26, 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.	Jan. 6, 1914	2,000,000	1,850,000	1 00	.....	.....	.....	.....	.....
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
Wright-Hargreaves Mines, Ltd.	June 16, 1916	2,750,000	2,750,000	1 00	825,000 00	550,000 00	20.0	1,375,000 00	Oct. 1, 1925
Total	.....	.....	.....	.....	40,104,536 25	8,233,468 00	.....	48,338,004 25	.....

*On April 22, 1922, the capital was reduced from $5,000,000 to $4,500,000 and $476,667 distributed to shareholders in addition to dividends above noted.

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

‡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.

§Per share.

TABLE IX.—DIVIDENDS AND BONUSES PAID BY INDIVIDUAL GOLD MINES, 1912–1925

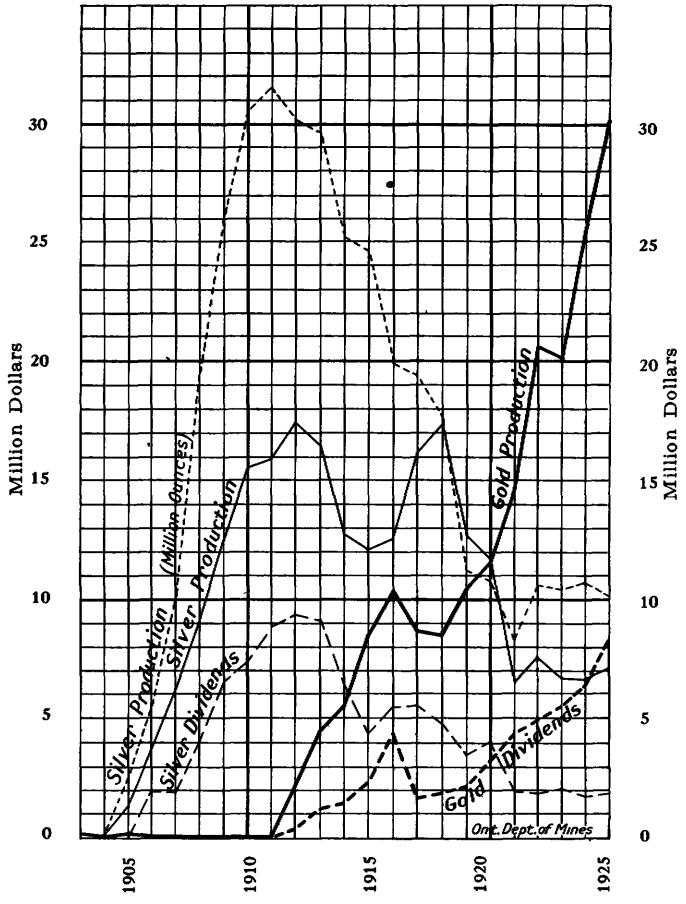
Year	Porcupine					Kirkland Lake			Total
	Hollinger Consolidated	Porcupine Crown	Dome Mines	Rea Consolidated	McIntyre	Tough-Oakes	Lake Shore	Wright-Hargreaves	
	$	$	$	$	$	$	$	$	$
1912	270,000	.....	.....	.....	.....	.....	.....	.....	270,000 00
1913	1,170,000	.....	.....	.....	.....	.....	.....	.....	1,170,000 00
1914	1,170,000	240,000	.....	.....	.....	.....	.....	.....	1,410,000 00
1915	1,560,000	240,000	400,000	12,000	.....	132,875	.....	.....	2,344,875 00
1916	*3,286,000	240,000	800,000	.....	.....	265,750	.....	.....	4,591,750 00
1917	738,000	120,000	300,000	.....	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	.....	546,042 45	.....	80,000	.....	3,256,928 45
1921	3,198,000	.....	478,947 75	.....	546,042 45	.....	120,000	.....	4,342,990 20
1922	3,198,000	.....	715,000 50	.....	546,042 45	.....	80,000	412,500	4,951,542 95
1923	3,198,000	.....	1,430,001 00	.....	548,542 45	.....	160,000	206,250	5,542.793 45
1924	3,198,000	.....	1,906,668 00	.....	774,125 00	.....	380,000	206,250	6,465,043 00
1925	4,378,800	.....	1,906,668 00	.....	798,000 00	.....	600,000	550,000	8,233,468 00
Total	30,530,800	840,000	8,354,171 25	12,000	5,207,408 00	398,625	1,620,000	1,375,000	48,338,004 25

*Includes $160,000 paid by the Acme before amalgamation with the Hollinger.

Silver—Cobalt

The silver mining areas, Cobalt, South Lorrain and Gowganda, were active throughout 1925. In these three camps there were twenty producing mines, thirteen of which were at Cobalt, four in South Lorrain and three in Gowganda.

In the Cobalt camp the old established properties, such as the Nipissing, Mining Corporation, O'Brien, McKinley-Darragh-Savage, produced throughout the entire period. Considerable new development work was performed on the Cobalt Contact on the northern boundary of the area, while several discoveries



Graph showing silver and gold production, and dividends from the discovery of silver at Cobalt in 1903.

of new veins were reported from time to time throughout the field. In South Lorrain interesting developments occurred in which the Keeley, Frontier Lorrain, Lorrain Trout Lake and Lorrain Consolidated mines all reported extension of the rich finds discovered in 1923 and 1924. Canadian Lorrain also developed considerable ore. The re-opening of this area in which the geological features are similar to those at Cobalt has added considerably to the production of silver and to the maintenance of the output of Ontario at the ten million ounce mark.

In Gowganda the Castle-Trethewey, Miller Lake O'Brien, and Tonopah (Walsh) all produced ore. Towards the end of the year the hydro-electric power line of the Northern Canada Power Company was extended from Elk Lake to Gowganda, and transformers are now being transported by sleigh from the Elk Lake terminus of the T. & N. O. Railway. With ample power this camp should show rapid development in the future.

The production of silver from all sources during 1925 totalled 10,001,100 fine ounces having a selling value of $6,964,325 as against 10,699,684 fine ounces worth $7,233,078 in 1924, or a decrease of 6.5 per cent. in quantity and 3.7 per cent. in value. The output and shipments of silver are shown below. It should be pointed out that the figures given are based as nearly as possible on actual sales of bullion silver and silver contained in concentrates and residues exported, with the gross values as reported by the producers before deducting treatment and shipping charges.

SILVER PRODUCTION, 1924-1925

Source	1924		1925	
	Fine Ounces	Value	Fine Ounces	Value
		$		$
Sales of bullion by the reduction companies, smelters and mines	9,330,670	6,317,441	8,365,093	5,833,856
Contained in concentrates and residues exported	1,031,275	692,543	1,249,788	866,273
Contained in crude gold bullion	214,850	141,251	251,829	171,550
Recovered by nickel-copper refineries	122,889	81,843	134,390	92,682
Total	10,699,684	7,233,078	10,001,100	6,964,325

The figures shown in the above table are different from those formerly published in these reports, inasmuch as they more nearly represent the silver actually going as such into the commerce of the country. Heretofore, statistics of silver production were based on the silver content of all ores or concentrates as shipped by the mines and reported by them, and while such figures bear no exact relation to the silver actually marketed in bullion form they are of considerable historical value as statistical records of individual mines and of mining areas. The change made in the system of compilation merely moves the position or point where the count is made, i.e., from the mine or concentrating plant forward to the point where pure merchantable silver is marketed, except in the case of exports of ore, concentrates or residues.

Mines shipping over a quarter million ounces in 1925 are given in order:

Mine	Ounces
Nipissing	3,351,280
Keeley	1,446,678
Mining Corporation of Canada	1,348,176
Frontier Lorrain (Lorrain Operating Co.)	1,158,854
Castle-Trethewey	961,949
O'Brien	742,461
Lorrain Trout Lake	485,591
McKinley-Darragh-Savage	419,479
Miller Lake O'Brien	347,909
Menago	284,144
La Rose	279,296

TABLE X.—TOTAL SHIPMENTS FROM SILVER MINES, SMELTERS AND REFINERIES, 1904 TO 1925

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
Total	25	82,796	669	231,383	141	17,623	5,180	927,695	12,227	16,398,380	55,173	4,560,796	363,774,234	226,296,692	248,515,365

(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.
(d) Prior to 1914 an estimate based on assays was made of the nickel, cobalt and arsenic contained in the ores; subsequently actual recoveries have been reported.
(e) Recoveries of bismuth from base bullion not reported prior to 1923.
(f) Includes 460 tons of speiss residues worth $153,116.

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

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

TABLE XI.—SILVER SHIPMENTS BY CAMPS, 1904-1925

Year	Average price, cents per ounce (New York)	Silver Content in Troy Ounces, 1904-1925					
		Total Ounces	Cobalt	Casey Township	South Lorrain	Gowganda	Montreal River and Maple Mountain
1904	57.221	206,875	206,875	.....	.....	.....	.....
1905	60.352	2,451,356	2,451,356	.....	.....	.....	.....
1906	66.791	5,401,766	5,401,766	.....	.....	.....	.....
1907	65.237	10,023,311	10,023,311	.....	.....	.....	.....
1908	52.864	19,437,875	19,424,251	500	13,124	.....	.....
1909	51.502	25,897,825	25,658,683	26,185	194,955	.....	18,002
1910	53.486	30,645,181	29,849,981	92,544	221,133	471,688	9,835
1911	53.340	31,507,791	29,989,893	114,789	933,912	468,687	510
1912	60.835	30,243,859	28,605,940	253,824	834,119	549,976	.....
1913	57.791	29,681,975	28,105,505	825,108	248,992	502,370	.....
1914	54.811	25,162,841	24,155,699	499,643	108,199	399,300	.....
1915	49.684	24,746,534	24,280,366	223,939	.....	242,229	.....
1916	65.661	19,915,090	19,008,517	445,900	77,280	383,393	.....
1917	81.417	19,401,893	18,327,258	.....	10,000	1,064,635	.....
1918	96.772	17,661,694	16,807,407	143,901	72,188	638,198	.....
1919	111.122	11,214,317	10,314,689	171,278	4,586	723,764	.....
1920	100.900	10,846,321	10,402,249	.....	8,253	433,352	(a)2,467
1921	62.654	8,261,931	7,673,535	1,101	328,886	258,292	117
1922	67.528	10,711,127	9,239,147	1,028	1,284,307	170,651	(b)15,994
1923	64.873	10,377,846	7,259,858	.....	2,955,646	160,761	1,581
1924	66.781	9,935,902	6,704,787	.....	2,633,058	598,057	.....
1925	69.065	10,707,235	6,252,115	.....	3,099,964	1,355,156	.....
Total	.....	364,440,545	340,143,188	2,799,740	13,028,602	8,420,509	48,506

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

In addition to the silver content of ores, concentrates, residues, etc., producing mines are paid for the cobalt content provided the percentage is sufficiently high. Mine shippers in 1925 were paid $233,196 for 827,547 pounds of cobalt, and $17,007 for 154,661 pounds of copper.

From weekly statements, issued by the General Freight and Passenger Agent of the Temiskaming and Northern Ontario Railway, showing railway shipments of ore, concentrates, etc., from the Cobalt area the following information has been compiled: Total shipments, 14,051.37 tons, of which 4,682.30 were consigned to Deloro, 8,435.30 to United States smelters and refineries, and 933.77 tons to Europe.

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

SILVER PRODUCERS IN 1925

Oper tor	Mine or Source	Location
Brewer, Sullivan & Laurentian Mines..	Adanac lease	Cobalt
Castle-Trethewey Mines, Ltd	Castle-Trethewey	Gowganda
Cobalt Contact Mines, Ltd	Cobalt Contact	Cobalt
Coniagas Mines, Ltd., The	Coniagas	Cobalt
Crown Reserve Mining Co., Ltd	Crown Reserve	Giroux Lake
Doherty Easson Mining Syndicate, Ltd.	Penn-Canadian	Cobalt
Frontier (Lorrain) Mines, Ltd	Lorrain Operating & Frontier Lorrain.	Silver Centre
Genesee Mining Company, Ltd	Genesee	Cobalt
Hudson Bay Mines, Ltd., The	Hudson Bay	Cobalt
Irwin, Geo	Silver Queen	Cobalt
Keeley Silver Mines, Ltd., The	Keeley	South Lorrain
Kerr Lake Mining Company, Ltd	Kerr Lake	Cobalt
La Rose Mines, Ltd	La Rose	Cobalt
Lorrain Consolidated Mines, Ltd	Lorrain Consolidated	Silver Centre
Lorrain Trout Lake Mines, Ltd	Lorrain Trout Lake	Silver Centre
Lynch, C. D	Peterson Lake	Cobalt
McKinley-Darragh-Savage Mines, Ltd.	McKinley-Darragh	Cobalt
McLeod, J. H	Foster Cobalt	Cobalt
Menago Mining Company, Ltd	Colonial	Cobalt
Mining Corporation of Canada, Ltd	Townsite City Buffalo and Cobalt Lake	Cobalt
Nipissing Mining Company, Ltd	Nipissing	Cobalt
O'Brien, Ltd., M. J	O'Brien	Cobalt
O'Brien, Ltd., M. J	Miller Lake O'Brien	Gowganda
Reinhardt, Carl	Crown Reserve	Giroux Lake
Tonopah Canadian Mines Company	Walsh & Morrison	Gowganda

In Table XII are shown the shipments of ore, concentrates and bullion from the mines of Cobalt, South Lorrain, Gowganda and outlying silver areas since mining began in 1904. By "shipment" is meant consignment to outside points, whether in Canada or abroad, but not movements within the camp, for example: ore shipped from a mine to a concentrating or reduction plant in Cobalt itself. It will be noted that the quantity of ore shipped away from the camp has been reduced to small proportions in recent years.

TABLE XII.—SILVER SHIPMENTS, 1904-1925*

Year	Producing Mines	Ore			Concentrates and Residues			Bullion	Total Silver, Ounces
		Tons	Silver Content, Ounces	Av. per Ton, Ounces	Tons	Silver Content, Ounces	Av. per Ton, Ounces	Silver, Ounces	
1904	4	158	206,875	1,309	.....	.....	.....	.....	206,875
1905	16	2,144	2,451,356	1,143	.....	.....	.....	.....	2,451,356
1906	17	5,335	5,401,766	1,013	.....	.....	.....	.....	5,401,766
1907	28	14,788	10,023,311	677	.....	.....	.....	.....	10,023,311
1908	30	24,487	18,022,480	736	1,007	1,415,395	1,244	.....	19,436,875
1909	31	27,729	22,436,355	809	2,948	3,461,470	1,714	.....	25,987,825
1910	41	27,437	22,581,714	821	6,845	7,082,834	1,030	980,633	30,645,181
1911	34	17,278	20,318,626	1,176	9,375	8,056,189	858	3,132,976	31,507,791
1912	30	10,719	15,395,504	1,436	11,214	9,768,228	871	5,080,127	30,243,859
1913	35	9,861	13,668,079	1,386	10,016	8,489,321	770	7,524,575	29,681,975
1914	32	4,302	6,504,753	1,511	12,152	8,915,958	733	9,742,130	25,162,841
1915	24	2,865	6,758,286	2,359	11,996	10,001,548	834	7,986,700	24,746,534
1916	28	2,177	4,672,500	2,146	8,561	7,598,011	887	7,644,579	19,915,090
1917	28	2,288	3,271,353	1,429	13,720	6,445,243	469	8,053,318	19,401,893
1918	38	1,456	1,401,050	962	17,958	5,793,756	323	10,466,888	17,661,694
1919	33	850	806,341	949	15,208	4,024,764	265	6,383,764	11,214,317
1920	35	578	668,081	1,152	9,757	3,777,812	387	6,402,423	10,846,321
1921	28	948	986,597	1,041	3,101	2,962,771	955	4,312,603	8,261,931
1922	22	1,485	1,712,878	1,154	7,897	1,675,055	212	7,323,194	10,711,127
1923	24	569	1,361,787	2,393	4,901	3,054,346	623	5,961,713	10,377,846
1924	25	912	1,672,805	1,834	6,321	3,098,193	490	5,004,992	9,775,990
1925	20	1,723	1,310,969	761	6,084	2,800,114	460	5,551,112	9,662,195
Total	.....	160,089	161,633,466	1,009	159,191	98,420,456	618	103,181,641	363,235,563

*Silver recovered from gold and nickel ores is not included.

TABLE XIII.—DIVIDENDS AND BONUSES PAID BY SILVER MINING COMPANIES TO DECEMBER 31, 1925

Name of Company	Date of Incorporation	Authorized Capital	Capital Stock Issued	Par value per share	Dividends and Bonuses paid to end of 1924	Dividends and Bonuses paid during 1925	Total Dividends and Bonuses paid to 31st Dec., 1925	Date when last Dividend was paid
		$	$	$ c.	$ c.	$ c.	$ c.	
Aladdin Cobalt Company, Limited	Aug. 23, 1912	500,000	500,000	5 00	75,000 00	.....	75,000 00	April 30, 1917
Beaver Consolidated Mines, Ltd.	Mar. 1, 1907	2,000,000	2,000,000	1 00	710,000 00	.....	710,000 00	May 31, 1920
Buffalo Mines, Ltd., The (*a*)	April 27, 1906	500,000	500,000	50	2,787,000 00	.....	2,787,000 00	May 28, 1924
Casey Cobalt Silver Mining Co., Ltd.	Dec. 19, 1906	100,000	100,000	1 00	203,249 33	.....	203,249 33	April 22, 1914
Castle-Trethewey Mines, Ltd.	Jan. 20, 1922	2,200,000	2,200,000	1 00	11,027 00	7,000 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. (*b*)	April 16, 1913	1,000,000	1,000,000	1 00	230,000 00	.....	230,000 00	April 1, 1915
Cobalt Silver Queen, Ltd.	April 1, 1906	1,500,000	1,500,000	1 00	315,000 00	.....	315,000 00	Dec. 31, 1908
Coniagas Mines, Limited, The	Nov. 24, 1906	4,000,000	4,000,000	5 00	11,440,000 00	.....	11,440,000 00	May 1, 1924
Crown Reserve Mining Co., Ltd.	Jan. 16, 1907	2,000,000	1,999,957	1 00	6,190,849 00	.....	6,190,849 00	Dec. 28, 1916
Foster Cobalt Mining Co., Ltd.	Feb. 14, 1906	1,000,000	915,588	1 00	45,000 00	.....	45,000 00	Jan. 1, 1907
Hudson Bay Mines, Ltd.	July 16, 1909	3,500,000	3,200,050	5 00	778,909 42	.....	778,909 42	Aug. 31, 1913
Keeley Silver Mines, Ltd.	June 22, 1922	2,000,000	2,000,000	1 00	800,000 00	480,000 00	1,280,000 00	Sept. 15, 1925
Kerr Lake Mining Company, Ltd. (*c*)	Aug. 9, 1905	40,000	40,000	100 00	10,210,000 00	89,000 00	10,299,000 00	Oct. 15, 1925
La Rose Mines, Ltd.	May 31, 1908	1,500,000	1,500,000	1 00	6,600,546 84	.....	6,600,546 84	Mar. 24, 1923
Lorrain Trout Lake Mines, Ltd.	Mar. 20, 1923	1,500,000	1,500,000	1 00	.....	150,000 00	150,000 00	July 15, 1925
McKinley-Darragh-Savage Mines of Cobalt, Ltd.	April 27, 1906	2,500,000	2,247,692	1 00	5,955,391 86	.....	5,955,391 86	Oct. 1, 1920
Mining Corporation of Canada, Ltd.	Nov. 23, 1916	8,300,250	8,300,250	5 00	5,498,874 97	207,506 25	5,706,381 22	July 31, 1925
City of Cobalt Mining Co., Ltd. (*d*)	Jan. 7, 1909	1,500,000	1,500,000	1 00	145,000 00	.....	145,000 00	April 15, 1920

TABLE XIII.—*Continued*

Name of Company	Date of Incorporation	Authorized Capital	Capital Stock Issued	Par value per share	Dividends and Bonuses paid to end of 1924	Dividends and Bonuses paid during 1925	Total Dividends and Bonuses paid to 31st Dec., 1925	Date when last Dividend or Bonus was paid
		$	$	$ c.	$ c.	$ c.	$ c.	
Cobalt Lake Mining Co., Ltd. (*d*)	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. (*d*)	May 8, 1906	100,000	45,011	1 00	1,042,259 61	.....	1,042,259 61	Nov. 11, 1914
Nipissing Mining Co., Ltd. (*e*)	Dec. 16, 1904	250,000	250,000	100 00	27,643,297 25	935,000 00	28,578,297 00	Oct. 20, 1925
Penn-Canadian Mines, Ltd. (*f*)	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 Mining Co., Ltd.	July 13, 1906	500,000	499,518	1 00	324,643 93	.....	324,643 93	Oct. 1, 1909
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
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	.....	.....	.....	.....	90,083,218 66	1,868,506 25	91,951,724 91	.....

(*a*) In 1917 the capital stock of the company was reduced from $1,000,000 to $750,000, in 1918 from $750,000 to $500,000, and on December 21, 1919, from $500,000 to $150,000, by returning to shareholders amounts equal to the reduction in capital, leaving 300,000 shares issued of 50 cents each. The mine was sold to the Mining Corporation of Canada, and operated by it in 1920 and subsequently.
(*b*) Cash assets amounting to $50,000 paid on April 27, 1917.
(*c*) In addition a return of capital amounting to $600,000 was made on July 3, 1919, to stockholders of the Kerr Lake Mines, Ltd.
(*d*) Mining Corporation of Canada, Limited, owns and operates the City of Cobalt, Cobalt Lake and Cobalt Townsite mines.
(*e*) Includes $16,288,297.25 paid in dividends by the Nipissing Mines Co. (the holding company) to the end of 1916.
(*f*) Paid out of capital $40,491.15 on September 10, 1917, and an equal amount on April 24, 1918.

In addition to the foregoing which deals with producing mines only, there was considerable work carried on by organized companies, some of which may join the list of producers in the near future. Not including the usual assessment work carried on by individuals, partnerships and syndicates, there was a total of $225,097 expended in wages on development work and employment given to 225 persons. The names of the companies reporting were:—

OPERATING BUT NON-PRODUCING SILVER MINES, 1925

Company	Name of Mine	Location
Agaunico-Northern Extension Mining Co.	Agaunico	Cobalt
Canadian Lorrain Silver Mines, Ltd.	Canadian Lorrain	South Lorrain
Capitol Silver Mines, Ltd.	Capitol	Cobalt
Coleroy-Gowganda Mines, Ltd.	Coleroy-Gowganda	Gowganda
Gowganda-Duggan Silver Syndicate	Gowganda-Duggan	Gowganda
Gowganda Keora Silver Mines, Ltd.	Gowganda Keora	Gowganda
Hector Silver Mines, Ltd.	Hector	Gillies Limit
Millcrest Mining Company, Ltd.	Millcrest	Cobalt
Nipissing Mining Company, Ltd.	Aladdin Lease	Cobalt
Oxford-Cobalt Silver Mines, Ltd.	Oxford-Cobalt	Gillies Limit
Paragon-Hitchcock Mines, Ltd.	Paragon-Hitchcock	Elk Lake
Wigwam Silver Mines, Ltd.	Wigwam	Gowganda
W. J. Nine Silver Mines, Ltd.	W. J. Nine	Gowganda

Refineries.—The production of refined silver is carried on by two companies in Cobalt which operate reduction plants in conjunction with the mines and mills. The processes of extraction are hydro-metallurgical or wet methods such as the cyanide process applied to silver-bearing ores. The Nipissing Mines, Limited, and the Cobalt Reduction Company (Mining Corporation), both operate such plants and in addition to high-grade silver bullion, they market flotation concentrates and residues. The major portion of the ore and concentrates shipped out of the Cobalt camp for treatment goes to the Deloro Smelting and Refining Company at Deloro. The Coniagas Reduction Company, with plant at Thorold, did not receive material from Cobalt during the period but marketed certain refinery products on hand.

TABLE XIV.—OPERATIONS OF ONTARIO SILVER-COBALT REFINERIES IN 1925

Schedule	Sales	
	Quantity	Value
		$
Silver bullion ..... fine oz.	2,813,071	1,985,755
Arsenic, white ..... lbs.	2,005,252	108,789
Cobalt oxide ..... "	575,580	
Cobalt salts ..... "	100,483	2,328,517
Cobalt-nickel oxides, unseparated ..... "	164,901	
Cobalt, metallic ..... "	625,298	
Nickel oxide ..... "	429,351	38,766
Base bullion(*a*) ..... "	1,239,476	347,834
Speiss residues (*b*) ..... "		
Nickel, metallic ..... "	210,985	52,696
Total	.....	4,862,357

(*a*) Contains silver, lead, bismuth and antimony.
(*b*) Speiss residues contain silver, cobalt, nickel and arsenic.

During 1925 the Deloro refinery was active throughout the entire period, while the Coniagas Reduction Company shipped clean-up material only and did not receive ores for treatment. During the period 3,931 tons of ore and concentrates and 862 tons of residues were treated. The operations of these companies are summarized in Table XIV.

Considerable material is exported from Ontario silver mines to the United States refineries every year for treatment. During 1925 the following plants reported receipts of Ontario concentrates, slags, speiss residues and clean-up material: United States Metals and Refining Company, Balbach Smelting and Refining Company and plants of the American Smelting and Refining Company at Tacoma, Omaha and elsewhere. This material totalled 3,711 tons and contained 1,239,366 ounces of silver, 293,473 pounds of cobalt, 118,894 pounds of copper, 139,545 pounds of nickel, 62,943 pounds of lead, and 18,167 pounds of bismuth paid for; also 1,751 pounds of antimony and 154,927 pounds of arsenic not paid for.

Nickel, Copper and Platinum Metals

The tonnage of ore raised by the nickel mines and that treated in the smelters showed slight decreases in 1925, but the grade of ore was higher, resulting in an increased quantity of matte produced. During the period two companies were active, the International Nickel Company of Canada, operating smelters at Copper Cliff near Sudbury and a refinery at Port Colborne, and the Mond Nickel Company which smelts its ore at Coniston, near Sudbury, and exports the matte to Wales for refining. A portion of the matte made by the former company is exported to Huntington, West Virginia, for the manufacture of Monel metal and the fabrication of nickel articles. During the year the International Company purchased the Murray mine from the bondholders of the defunct British America Nickel Corporation.

The nickel-copper industry continued to enlarge its output first noted in 1923, which is accounted for by an assiduous campaign to find new uses to which nickel may be applied. In addition to cooking utensils, nickel tubes and fittings for the non-corrosive alloys Monel and Mond metal, the field for nickel has been extended in a large way to the motor industry, where as Monel metal it finds a use in radiators, and also to nickel-copper submarine cables. The industry thus seems to be facing an expanding future.

A new development in the nickel mining field has been the introduction of magnetic cobbing machinery by the Mond company at the Garson mine in 1924. Mechanical details were perfected during 1925 and the practice extended to the Levack mine. By means of this new apparatus, which has been patented, the grade of waste rock is lowered while the material going to the smelter is supplied in three grades (coarse rock, slightly magnetic ore and fines) in a much cleaner condition. A saving in man power is also effected. The concentrating is done on a continuous belt passing over magnets of varying intensity.

During the period the International Nickel Company and the Mond Company operated the full twelve months.

Production of ore during the year from the several mines was as follows:

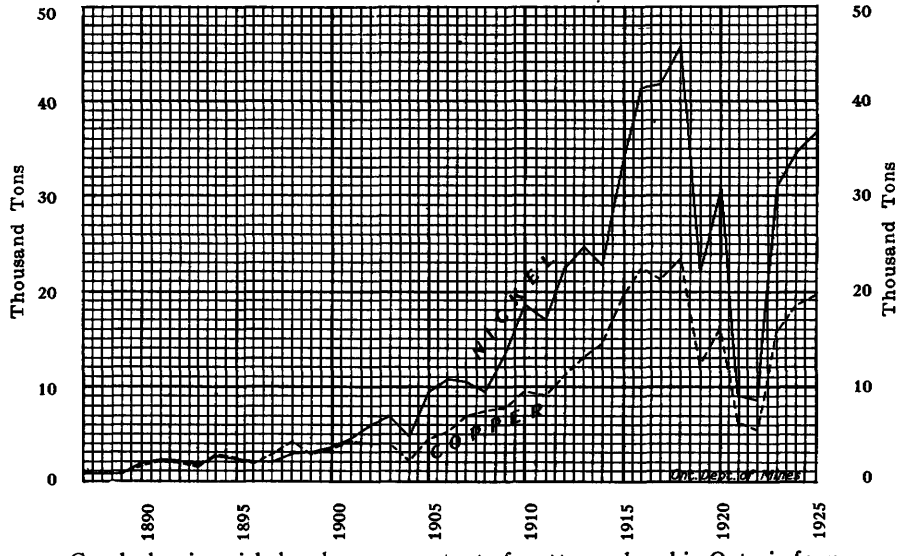
	tons
International Nickel Company—	
Creighton Mine, No. 3 Mine	649,015
Mond Nickel Company—	
Levack, Garson, Frood Extension, Worthington	615,733
	1,264,748

In Table XV, following, the course of the nickel industry during the past five years is indicated. That this metal takes on added importance during times of war is sufficiently shown by the fact that while in 1913 the quantity of ore smelted was 823,403 tons, it rose in 1918 to 1,559,892 tons, fell, as noted in the table, to 314,120 tons in 1922, and through new markets found for nickel it rose again in 1924 to 1,307,694 tons. Nickel and copper contained in matte exported in 1925 were valued at 18 cents and 10 cents per pound respectively.

TABLE XV.—NICKEL-COPPER MINING AND SMELTING, 1921-1925

Schedule	1921	1922	1923	1924	1925
Ore raised.....tons	262,593	259,569	1,187,354	1,411,980	1,264,748
Ore smelted..... "	393,768	314,120	1,140,160	1,307,694	1,258,849
Bessemer matte produced..... "	19,498	17,324	58,084	65,943	70,280
Nickel contents of matte..... "	9,128	8,678	31,029	34,638	36,596
Copper contents of matte..... "	6,323	5,421	15,769	18,490	19,636
Matte exported*..... "	10,466	19,831	21,450	26,565	32,397
Matte refined in Canada..... "	5,558	10,340	31,765	37,613	38,567
Men employed.....No.	1,895	1,492	2,496	2,459	2,650
Wages paid.....$	1,557,696	2,009,335	3,093,402	2,859,600	3,487,051

*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.



Graph showing nickel and copper content of matte produced in Ontario from the inception of smelting at Copper Cliff in 1887.

An indication of the prosperity in this industry may be gathered from the fact that a dividend of fifty cents a share on the common stock was paid by the International Nickel Company on September 20, and while it was not so stated by the company, it is expected that this, the first declaration for five years, will be the regular quarterly dividend. Earnings are understood to be at the rate of about five million dollars a year or approximately 11 per cent. on the

common stock after preferred dividends are paid. This company is now exceeding its pre-war output with the probability that within a very few years it will equal the peak of its war-time production.

Sulphuric Acid.—A new departure in connection with the smelting of nickel-copper ores is the utilization of waste sulphur gases in the production of sulphuric acid which was commenced early in November, 1925, by the Mond Nickel Company. Heretofore it was not considered profitable to install equipment capable of recovering and utilizing sulphurous fumes. The acid is produced by the contact process in which the gas is taken from the converter hoods, and after the usual purification and drying passes through a heat interchange to the contact mass of platinized asbestos and thence to absorption towers and shipping tanks. Acid of the following grades is produced: 66° Bé., 98 per cent or contact, and oleum[1] of any strength. The plant consists of two units and the total output when in full operation will be around 25,000 tons per year. Sulphuric acid is also being manufactured by other producers in Ontario, the most important companies being the Grasselli Chemical Company of Hamilton, and the Algoma Steel Corporation, Sault Ste. Marie, using imported sulphur; and the Nichols Chemical Company at Sulphide, using imported sulphur mainly.

Refineries.—During the year at Port Colborne the International Nickel Company of Canada recovered electrolytic and refined nickel, nickel oxide, converter copper, nickel sulphate and precious metals cement. The plant of the British America Nickel Corporation at Deschênes was idle throughout the period. The record for 1925 is shown in the subjoined table:

TABLE XVI.—NICKEL-COPPER REFINING, 1925

Schedule	Quantity	Value
		$
Matte, treated ..... tons	38,352	.....
Nickel oxide, marketed ..... lbs.	11,329,713	$2,686,395
Metallic nickel, recovered ..... "	31,765,325	7,267,004
Blister copper and electrolytic copper, recovered ..... "	19,140,089	2,701,360
Gold, recovered* ..... ounces	4,016	82,437
Silver, recovered* ..... "	134,390	92,682
Platinum metals, recovered* ..... "	16,980	1,675,706
Employees ..... No.	570	.....
Wages paid ..... $	.....	917,794

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

The data for the following notes has been supplied by T. F. Sutherland, Chief Inspector of Mines for Ontario, who visited South Africa in 1925:

The recent discovery of platinum during the summer of 1924 in commercial quantities in South Africa is of interest to producers of platinum in this country. The outcrops were noted in the Lydenburg district, in a norite formation having a length of 280 miles, of which 140 miles has an average width of three miles. The lower horizon of this norite sheet forms a huge platiniferous belt of about 2,000 square miles and probably contains more platinum than all the other occurrences heretofore known. Commercial occurrences, however, are restricted to fairly definite areas, and ore deposits are of three kinds; the dunite deposits, magmatic nickel, platinum and quartz lode deposits. Of the first type about 50 pipe-shaped hortonolite-dunite deposits have been discovered of which the richest might average over an ounce of platinum to the ton. The second type is known as the Merensky Reef, in which great stretches will average from 3 to 4 dwt. per ton. The third type, the quartz lodes, were discovered in the Waterberg district, and in these the platinum is associated with palladium.

[1]The term "oleum" or "fuming sulphuric acid" refers to sulphuric acid 100 per cent. pure, plus additional amounts of sulphur trioxide.

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

TABLE XVII.—PRECIOUS METALS RECOVERED, 1921-1925

	1921	1922	1923	1924	1925	
	Ounces	Ounces	Ounces	Ounces	Ounces	Value, $
Gold†	4,537	2,094	3,574	4,125	4,016	82,437
Silver	50,341	50,239	100,982	122,889	134,390	92,682
Platinum	5,412	4,802	6,810	9,181	8,692	1,026,737
Palladium	7,729	6,862	7,511	8,923	7,856	608,727
Rhodium, Ruthenium, Osmium and Iridium	277	124	304	593	432	40,242
Total platinum metals	13,814	11,788	15,625	18,697	16,980	1,675,706

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

South Africa may soon dominate the platinum market. Meantime the Soviet government of Russia is marketing platinum in increasing quantity and has ordered modern dredges for operation in the Urals. Colombia has an area of rich new ground available which can be operated cheaply by electrically-driven dredges. It would appear that competition may considerably reduce prices in the not distant future. Platinum was quoted at an average price of $119.09 per fine ounce in 1925 by the *Engineering and Mining Journal Press of New York*, and palladium averaged about $78.

Dividends.—Heretofore no figures have been received by the Department showing dividends paid by nickel companies. This information showing total dividends of $87,474,737 is presented herewith for the first time :

TOTAL DIVIDENDS PAID BY NICKEL COMPANIES

Company		Period (inclusive)	Total dividends to end of 1924	Paid in 1925*	Total dividends to end of 1925
Canadian Copper Company		1894–1901	$1,975,000	.....	$1,975,000
†International Nickel Co.	*preferred*	1906–1924	10,160,250	$534,756	10,695,006
	common	1909–1919	53,113,676	1,673,384	54,787,060
					$67,457,066
Mond Nickel Company	*deferred*	1906–1914	£264,043	.....	£264,043
	preferred	1904–1924	1,619,989	£236,370	1,856,359
	common	1905–1924	1,880,318	112,500	1,992,818
					£4,113,220
					$20,017,671
Total		.....	.....	.....	$87,474,737

*For the Mond Nickel Company the fiscal year ended April 30, 1926, and the figures given are to that date.

†Successors to the Canadian Copper Company.

Iron Ore, Pig Iron and Coke

During 1925 no shipments of iron ore were made from Ontario mines, and since no ore of domestic origin was reported as charged to the blast furnaces, the entire output of pig iron during the year must be credited to foreign ore, and hence the item of pig iron does not appear in Table I.

It might be pointed out that in the preliminary statement (Bulletin No. 55) for the calendar year 1925 it was stated that 6,098 tons of domestic ore were charged, from which 3,814 tons of pig iron, valued at $72,878, were derived. Final statements received from the blast furnaces showed that the 6,098 tons was flue dust re-charged. In consequence the items for iron ore and pig iron shown in the preliminary statement have been deleted from the final report.

The total quantity of iron ore charged during the year was 732,356 tons in addition to the 6,098 tons of flue dust mentioned above, from which there was produced at Hamilton and Sault Ste. Marie a total of 412,837 short tons of pig iron of the following grades: 277,356 tons of basic, 86,326 tons of foundry, and 49,155 tons of malleable iron. The average prices of iron during the period on the Pittsburg market were as follows: Bessemer $22.33, basic $21.26, and No. 2 foundry $21.68 per long ton. On the Toronto market No. 1 foundry was quoted at $25.35 per long ton, No. 2 foundry $24.85, and basic $21.00. Montreal prices were somewhat higher, No. 1 and No. 2 foundry bringing $27.25 per long ton. In computing the values given below the basic and malleable were taken at $21.00 and foundry at $25.00 per long ton. The total value of the pig iron produced during 1925 was $8,048,992.

In the two iron blast furnace plants of Ontario operated in 1925 employment was given to 228 men who received $441,865 in wages.

IRON BLAST FURNACES IN OPERATION, 1925

Name of Company	Furnaces			Fuel used	Location
	No.	Daily capacity, long tons	Days operated		
Algoma Steel Corporation, Ltd.	4	1,500	362	Coke	Sault Ste. Marie
Steel Company of Canada, Ltd.	2	725	365	Coke, coal and gas	Hamilton

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

TABLE XVIII.—IRON AND STEEL STATISTICS, 1921-1925

Schedule	1921	1922	1923	1924	1925
Ontario ore smelted.....short tons	126,653	23,398	36,622	8,231	6,830
Foreign ore smelted..... "	818,749	1,217,543	1,283,886	836,233	732,356
Limestone for flux..... "	221,761	137,852	283,190	187,571	109,198
Coke..... "	420,358	336,301	576,832	438,323	262,344
Pig iron produced..... "	494,901	293,662	674,428	465,888	412,837
Value of pig iron produced.....$	11,856,352	6,493,513	15,995,496	9,484,139	8,048,992
Steel made.....short tons	932,473	358,126	607,385	499,986	529,327
Value of steel made.....$	15,861,635	12,812,927	21,133,664	14,196,029	18,904,520

BLAST FURNACES IN ONTARIO FOR THE PRODUCTION OF PIG IRON

Company	Location	Furnaces		Remarks
		No.	Daily capacity gross tons	
Algoma Steel Corporation, Ltd.	Sault Ste. Marie	4	1,450	Active
Atikokan Iron Company	Port Arthur	1	175	Idle since 1911
Canadian Furnace Co., Ltd.	Port Colborne	1	325	Idle since Nov., 1923
Canadian Steel Corporation, Ltd.	Ojibway (near Windsor)	2	1,100	Under construction
Midland Iron and Steel Co., Ltd.	Midland	1	120	Idle since Feb., 1921
Parry Sound Iron Co., Ltd.	Parry Sound	1	90	Idle since Oct. 1, 1919
Standard Iron Co., Ltd.	Deseronto	1	60	Idle since June 9, 1919
Steel Company of Canada, Ltd.	Hamilton	2	750	Active

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

Coke.—The Algoma Steel Corporation, Sault Ste. Marie, and the Steel Company of Canada at Hamilton, produce coke in conjunction with their blast furnace operations; while the Hamilton By-Products Coke Ovens, Ltd., also at Hamilton, produces coke for domestic purposes, having commenced in January, 1924. At the latter plant the present battery of 25 ovens (450 tons of coal or 315 tons of coke daily) is being increased by the addition of 35 Solvay process by-product ovens. The contract for the new ovens was let in February, 1926. The total coke and coke breeze used and sold was 622,269 tons having a value of $4,554,168 of which 162,527 tons worth $1,563,261 were sold and the balance consumed in the blast furnaces at Sault Ste. Marie and Hamilton.

The materials used and products consumed and sold by the coke plants in Ontario during 1925 are shown in the subjoined table:—

THE COKING INDUSTRY IN ONTARIO, 1925

Kind	Unit	Quantity	Value
			$
MATERIALS USED			
Bituminous coal, foreign	tons	831,450	4,169,969
Sulphuric acid	lb.	13,181,504	104,398
Sulphur	"	3,008,100	18,984
Lime and wash oil	.....	.....	7,061
Total	.....	.....	4,300,412
PRODUCTS MADE			
Coke	tons	594,237	4,449,893
Coke breeze	"	45,942	165,955
Gas	cubic feet	673,954,218	1,482,397
Tar and tar products	Imp. gals.	6,300,024	334,304
Ammonium sulphate	lb.	18,607,070	497,353
Total	.....	.....	6,929,902

Of the products made, shown above the major portion of the coke, breeze and gas were consumed in the plants reporting. The total value of materials made and marketed was $2,717,576. During the period the number of wage earners was 236 to whom $446,821 was paid in wages.

The following table, dealing with Ontario only, has been prepared from data supplied by the Dominion Bureau of Statistics:—

PRODUCTION, IMPORTS, EXPORTS AND APPARENT CONSUMPTION OF COKE, 1925

Item	Tons	Value
Production	766,987	$5,739,698
Imports	739,104	4,571,928
Total	1,506,091	10,311,626
Deduct exports	19,438	462,975
Apparent consumption	1,486,653	$9,848,651

Lead and Zinc

Compared with British Columbia the production of lead from Ontario is small, since the industry is carried on by only one company, the Kingdon Mining, Smelting and Manufacturing Company, which operates a mine, milling plant and smelter at Galetta, near Ottawa. Although lead occurs in Ontario at widely separated points, only one deposit is being worked at the present time. Further, without assurance of a steady supply of lead ore there is no incentive for the erection of a customs lead smelter, which if in existence might be of considerable assistance to a few individual operators who could then find a market for lead ores. The sales of lead in 1925 amounted to 7,268,193 pounds valued at $601,704 as against 5,506,756 pounds worth $419,405 in 1924. These figures, in addition to pig lead sold, include the lead contents of base bullion derived from the treatment of cobalt-silver ores as noted in Table X. The price of lead in New York averaged 9.020 cents in 1925 as compared to 8.097 cents in 1924.

During the past year or two great interest has been aroused in regard to lead mining, owing to the fact that no substitutes have been found for this metal which has been in steady and ever increasing demand by storage battery, cable, and paint manufacturers. Automobiles and radios have greatly extended the market for storage batteries. During this period, due to the high prices obtaining an active campaign was carried on in Ontario in the investigation of old deposits formerly worked, such as the Frontenac mine at Perth Road, while mill enlargement is under way to double the output at Galetta. An interesting development was the finding of a 6-inch galena vein carrying silver in the shaft of the Worthington mine of the Mond Nickel Company. The ore is treated in the company smelter for its silver value, no effort being made to recover the lead. Some development has been reported on prospects near Arnprior, Renfrew and Carleton Place in the Ottawa valley.

The demand for lead has also stimulated interest in its associated metal, zinc, with which it is often found. In Hess township near Geneva lake and also about two miles south of Chelmsford, both localities being west of Sudbury, there has been considerable exploration and diamond-drilling done during the past year on zinc deposits, of which no accurate information as to size and nature has been made public. Bunker Hill and Sullivan interests are behind the Chelmsford drilling operations. During 1925 the accumulated zinc blende concentrates at the Galetta lead mine were marketed from which it was estimated that 179,545 pounds of zinc worth $13,681 were recovered.

NON-METALLIC MINERALS

Abrasives

The only abrasive material produced in Ontario during 1925 was 105 tons of quartz pebbles worth $945, which were gathered in the vicinity of Jackfish on the shore of Lake Superior. These were used chiefly in tube mills in the prairie provinces for grinding cement clinker. No production of corundum or garnets was reported. Carborundum, an artificial product made in the electric furnace, has displaced corundum to a large extent in the abrasive field.

Actinolite

Shipments during 1925 amounted to 40 tons, valued at $500. There is only one producer in the Province, namely, the Actinolite Mining Company, with a mill at the village of the same name, situated about four miles north of Tweed station on the Canadian Pacific railway. The mineral, which is found in serpentine rocks, is mined in the townships of Kaladar and Elzevir, Hastings county, and the head office of the company is Bloomfield, New Jersey. The product, which is fibrous in nature, is used principally for roofing purposes, as an ingredient in coal-tar compounds. Mining in a small way has been carried on intermittently for many years. In 1925 no ore was raised.

Asbestos

The Bowman asbestos property, now known as the Porcupine Asbestos Corporation, Limited, near McKay lake in Deloro township, was the first of its kind in Ontario upon which organized development has been carried out. In 1923, 6 tons worth $2,600 were shipped. In 1924 the output was increased to 172 tons having a value of $91,900, and in 1925, 2 tons valued at $901 were marketed. Considerable surface work consisting of a transmission line, camp buildings and a motor road to Timmins have been constructed, with a view to increasing the production.

Barite (Barytes)

There was a production of barite (heavy spar) in 1921 by H. C. Bellew, 6 Saint Sacrament St., Montreal, Que., of approximately 200 tons, from a deposit which is located on lot 20, concession X, township of North Burgess, Lanark county. No shipments, however, were reported during 1921 or 1922.

In 1923 there was shipped 200 tons worth $4,180 from near Tionaga station in the District of Sudbury. In 1924 and 1925 no production was reported. A deposit in Langmuir township, south of Night Hawk lake, was worked in 1918, when 60 tons of ground barite was shipped. It is owned by Canada Night Hawk Mines, Limited.

The great market for barite in the industrial areas of Canada is the paints and pigments industry. This trade desires a very fine grade of material, between 200- and 300-mesh, which must be perfect as regards purity and colour. In 1923, according to a report of the Dominion Bureau of Statistics for Canada at large, the paint trade consumed more than 2,000 tons of ground barite. Rubber goods took 480 tons and other industries much lesser amounts. The total consumption was then given as 2,747 tons, and in later years must have increased to some extent.

Feldspar

The mining of feldspar from pegmatite dikes in Ontario is in part a seasonal occupation, in which the major portion of the mining done is performed during the summer months. The operations are all in the form of quarrying to which the large outcrops of spar readily lend themselves. During the calendar year 1925 there were mined 17,404 tons of feldspar, of which 1,840 tons were milled in Ontario, and the total value including that added by grinding was $141,059, or a decrease of $75,732 below the total selling value in 1924, when 28,732 tons worth $216,791 were marketed. This decrease was due to the lack of demand in the United States pottery centres because of large stocks held and also in part to a lessened business activity by the feldspar-consuming industries.

During 1925 some 15 companies and individuals mined and shipped spar, most of which was marketed in Rochester, N.Y., Ohio and Pennsylvania. The largest output by any company was 2,881 tons, and the average for all producers was 1,160 tons. Employment was given to 144 workers who received $82,271 in wages, or $571 on the average.

The market for ground or prepared feldspar in the industrial parts of Ontario and Quebec was given as slightly less than 3,700 tons per annum in 1923, when business was at a low ebb. Of this the enamelware, porcelain and pottery trade consumed 2,520 tons, while soaps and washing compounds accounted for 560 tons and the balance was used in the manufacture of abrasive wheels, glass, roofing, floor and wall tile, and paints. The consumption of this ground material has undoubtedly increased during the past few years and might be safely estimated at more than 5,000 tons at the present time.

FELDSPAR SHIPPERS, 1925

Name	Location of Deposit	P. O. Address
Anderson, J. G.	Lot 15, con. A, Head tp., and Wanapitei in Dryden tp.	Lucknow.
Checkley, H. R.	1½ miles northwest of Wanup...	Quartz.
Craig, T. H.	Verona	Verona.
Elizabeth Feldspar Mines, Ltd.	Mileage 115, C.P.Ry. near Dill...	Toronto, 36 King St. E.
Feldspars, Ltd.	Lots 1 and 2, con. XIII and lot 1, con. XII, Loughborough; lots 1 and 2, con. XIII and lots 1 and 2, con. XII, Portland; lot 1, con. I and lot 2, con. II, Bedford tp.	Toronto, 293 Bay St.
Feldspar Mines Corp'n., Ltd.	Lot 11, con. VII, Monteagle tp...	Toronto, 1507 Bank of Hamilton Bldg.
Fowlie, J. A. (shipped in 1924)...	Verona	Kingston, 671 Johnson St.
Genesee Feldspar Co., Ltd.	Hybla	Rochester, N.Y., 82 Augustine St.
Gilpin Corporation	Lot 3, con. III, Bedford tp.	Brunswick, Me., Box 205.
Industrial Minerals Corporation..	Wilberforce and Eau Claire	Toronto, 805 Bank of Hamilton Bldg.
McQuire-Robinson Radium and By-Products, Limited	Conger tp.	Parry Sound.
Morrison, Wm.	Bancroft	Toronto, 517 Strathmore Blvd.
Perth Feldspar Co., Ltd.	Lots 19 and 20, con. IX, Bathurst tp.	Ottawa, Central Chambers.
Rock Products Company	Lot 20, con. IX, Bathurst tp.	Toledo, O., 450 Nicholas Bldg.
*Gardner Feldspar Co. (in 1923).	Lots 1, 2, con. XI and lot 3, con. XIII, Loughborough tp.	Cleveland, Hippodrome Bldg.

*Not reported previously

Fluorspar

Due to the influx of United States fluorspar the Ontario producers have heretofore been unable to compete in the limited market available in Canada. The material is used in the iron and steel industry as a flux, in lead refining plants, also in enamel, porcelain, pottery and glass manufacturing. The market available in eastern Canada for both crude and refined fluorspar is not great, and would not amount to much more than 500 tons per year.

During 1925 only 12 tons of crude fluorspar worth $200 were reported as marketed by the Industrial Mineral Corporation of Toronto, all of which came from a deposit near Wilberforce and was recovered in conjunction with quartz mining.

Graphite

Graphite marketed in 1925 was 2,345 tons worth $134,213 as compared with 1,288 tons valued at $72,842 in 1924. In addition to the Black Donald Graphite Company, near Calabogie in Renfrew county, which has produced steadily for a number of years, the Timmins Graphite Mines in North Burgess township and the Graphite Refining Company at Port Elmsley made shipments from stock.

After the first quarter of 1925 the graphite industry in Ontario experienced a revival. This was due to the depletion of the large stocks of Madagascar and Ceylon graphite which had been held in storage in Europe from 1923 and earlier. Coupled with this there has been a general improvement in the metal trade throughout the world. Another factor has been the application of flake graphite to the manufacture of dry batteries which has recently become important in Europe. Formerly a fine-ground artificial graphite held the market for dry battery manufacture, but due to changes in methods of construction No. 2 flake graphite is now used along with fine-ground manganese which fills the interstitial spaces. With the improved demand the prices of graphite have steadily risen, all of which has been of distinct advantage to the Ontario producer of flake and amorphous graphite recovered from disseminated deposits.

Average prices for Ceylon graphite increased from 4.5 cents per pound at the end of 1924 to 6.8 cents at the close of 1925, while lump prices for the same periods rose from 5.75 cents to 9.0 cents.

The market in Ontario and Quebec for graphite is mainly in foundries for facings, although paints and polishes absorb a few hundred tons per year. The total consumption in Canada of refined graphite is probably around 1,000 tons per annum.

Gypsum

Operations in 1925 were confined to those of the Ontario Gypsum Company, Limited, with head office at Paris. Mines and mills are located at Caledonia and Lythmore, Haldimand county. During the year, exclusive of a trial lot of 463 tons brought in from Nova Scotia for test purposes, 93,102 tons were mined, of which 64,122 tons were calcined. Shipments were as follows: crushed gypsum 24,830 tons, fine ground 548, calcined 8,337, and consumed in manufacturing 48,305, making a total of 82,020 tons worth $491,833. In 1924 the total amounted to 88,121 tons of all grades having a value of $467,097.

Manufactured gypsum products, which include gypsum board and tile, plaster, land plaster, plaster of paris, various materials such as bond-, paris- and pulpstone, have long been known in the building industry. Recently a new building material, now being marketed under the trade name of "insulex," has met with considerable approval as a porous insulator and fire-proof medium.

This material, along with other gypsum products, has been described in a recent report on gypsum issued by the Department, namely, Volume XXXIV, Part 2, 1925. New uses for gypsum, as a result of research, are being found and have resulted in the stimulation and development of this industry.

Iron Pyrites

Because of the fact that Gulf sulphur may be imported cheaply the market for domestic iron pyrites in Ontario has been practically wiped out for the present at least. During 1925 only 685 tons worth $8,799, produced by the Grasselli Chemical Company, Limited, from a deposit near Flower Station, were shipped as against 11,429 tons valued at $44,542 in 1924. The bulk of the iron pyrites heretofore mined in Ontario has been used in the manufacture of sulphuric acid. A new departure has been made by the Mond Nickel Company in the production of this chemical which is now obtained by the utilization of waste sulphur gas resulting from the smelting of nickel-copper ores. Detailed reference to this new process will be found under a subheading in the comment on the nickel-copper industry, page 26.

Mica

Production in Ontario is mainly from the area south and west of the city of Ottawa in Lanark and Frontenac counties, where small deposits are worked spasmodically by individuals, in addition to more regular operation by a few organized companies. Since very little preparation of the crude crystals in the form of thumb-trimming and splitting is necessary to put the material in a marketable form, and also because many small dealers buy and sell in addition to operating and trimming, it has become necessary in order to avoid duplication to consider the final sales as production. On this account it has been difficult to keep accurate records. Some thirty operators made shipments during 1925 and supplied several mica-trimming and splitting plants with crude ore. Mica in different forms finds a ready market in Ontario and Quebec.

The final sales during the year as reported by the operators totalled 1,605 tons valued at $82,661 as against 2,414 tons worth $172,252 in 1924. The output was in the form of rough-cobbed, thumb-trimmed and scrap, the thumb-trimmed being marketed with manufacturers of electrical supplies both in Canada and the United States, while the scrap finds both a domestic and foreign market, being ground and used in the preparation of roofing materials, wallpapers, lubricants, and in the rubber industry. About 600 tons of ground mica is used yearly in Canada.

MICA SALES, 1924-25

Variety	1924		1925	
	Quantity Tons	Value $	Quantity Tons	Value $
Rough-cobbed	235	30,512	142	21,971
Thumb-trimmed	165	113,860	67	45,266
Scrap	2,014	27,880	1,396	15,424
Total	2,414	172,252	1,605	82,661

The prices during 1925 were on the whole considerably below those of the previous year and ranged as follows: scrap, $8 to $12 per ton, splittings averaged,

73 cents per pound, while rough-cobbed mica varies widely in price according to the size of crystals. Thumb-trimmed prices were as follows:

Size	Price per Lb.	Size	Price per Lb.
1" by 1"	8c. to 14c.	2" by 3"	26c.
1" by 2"	10c. to 22c.	2" by 4"	40c. to 65c.
1" by 3"	20c. to 28c.	3" by 5"	$1 00

During the period only 283 tons of the crude ore were mined. Employment was given to 56 men who received $38,779 in wages.

Following is a list of mica shippers:

MICA SHIPPERS, 1925

Name of Owner or Producer	Location or Name of Mine	P.O. Address of Manager, etc.
Austin, Louis	Storrington tp.	Perth Road.
Bennett, Herbert V.	South Elmsley tp.	Perth.
Brown & Fahey	Loughborough tp.	Elgin.
Green, Geo.	Loughborough tp.	Perth Road.
Kent Bros. & Estate J. M. Stoness.	Bedford tp.	Kingston.
Lee, W. W.	Bedford tp.	Bedford Mills.
Loughborough Mining Co. Ltd.	Loughborough tp.	Sydenham.
Mahon Brothers	North Burgess tp.	Rideau Ferry.
Martin, A. G.	South Burgess tp.	Ottawa, 236 Besserer St.
Orser & Wilson	Faraday tp.	Bancroft.
Rock Lake Mica Mining Co.	Storrington tp.	Toronto, 1102 Temple Bldg.
Tory Hill Marble & Mica Co. Ltd.	Glamorgan tp.	Tory Hill.

Mineral Waters

Below are tabulated records of shipments of mineral waters since reports were first received in 1918:—

	1918*	1919	1920	1921	1922	1923	1924	1925
Imperial gallons	208,498	276,833	127,150	308,647	209,072	227,030	201,670	183,012
Value $	133,808	19,290	15,059	14,438	10,528	14,047	13,133	25,452

*Valuation in many cases was given at retail prices in bottled form and not in bulk at the works as in later years.

The companies producing mineral waters in 1925 were as follows:—

PRODUCERS OF MINERAL WATERS, 1925

Name of Owner, Firm, or Company	Location of Spring or Well	P.O. Address of Manager, etc.
Borthwick, W.	Gloucester tp.	10 Albert St., Ottawa.
Caledonia Springs Co., Ltd.	Gloucester and Clarence tps.	2716 St. Urbain St., Montreal, Que.
Deneault, L.	Lot 22, con. IV, Clarence tp.	Bourget.
Goderich Mineral Water Co.	Goderich.	Goderich.
Gurd & Co., Ltd., Charles.	Caledonia tp.	1016 Bleury St., Montreal, Que.
Sanitaris, Ltd.	Lot 27, con. XII, Pakenham tp.	Arnprior.

Natural Gas

Production of natural gas in Ontario in 1925 from 2,125 wells was 7,257,274 thousand cubic feet, with a retail value of $4,083,341, according to the report (Vol. XXXV, Part V) by R. B. Harkness, Natural Gas Commissioner. The selling price ranged from 25 cents to $1.20 per thousand cubic feet. Production in 1924 was 7,370,914 thousand cubic feet. For fuller details the special report above mentioned should be consulted. Labour statistics follow*:—

Schedule	No. Employees	Wages Paid
Gas producers reported	1184	$805,730
Gas distributors reported	224	152,901
Drilling Contractors	81	70,876
Total	1489	$1,029,507

*Includes a few small operators, estimated.

Peat

Peat Fuels, Limited of Montreal operated at the Alfred bog, lot 9, con. VII, Alfred township, Prescott county, from June 15 to September 9. Peat sold was 1370 tons at $6.00 per ton. Shipments were consigned to Montreal, Ottawa, and points as far west as Peterborough.

Petroleum

A report on "Petroleum in 1925," by the Natural Gas Commissioner, appears in Vol. XXXV, Part V. Statistical tables, which are repeated here for convenience, are taken from the above-mentioned report. Other tables are added, the data being supplied by the Dominion Bureau of Statistics.

CRUDE PETROLEUM PRODUCTION,* BY FIELDS, 1921-1925

Field	1921	1922	1923	1924	1925
	Bbls.	Bbls.	Bbls.	Bbls.	Bbls.
Petrolia, and Enniskillen township	68,484	64,935	64,158	60,916	53,166
Oil Springs	40,967	43,214	39,090	41,320	39,137
Moore township	7,536	7,275	4,790	4,483	8,195
Sarnia township	4,069	3,224	2,387	2,068	1,905
Plympton township	481	695	872	525	1,424
Bothwell	26,877	25,681	27,665	26,700	26,243
Dover, West } Tilbury	7,473	5,482	5,618	3,898	2,070
Tilbury East }	1,003	127	1,950	.....	.....
Raleigh township	3,320	663	302	783	887
Dutton	.....	387	315	.....	146
Onondaga township	566	489	237	456	261
Mosa township	10,764	11,959	10,319	8,862	8,397
Thamesville	1,319	384	567	.....	289
Euphemia township	.....	.....	.....	.....	39
Dawn	.....	217	.....	.....	.....
Dunwich township	.....	.....	279	1,351	855
Romney township	.....	.....	849	2,955	1,235
Total production.....Bbls.	172,859	164,732	159,399	154,317	144,249
Value.....$	466,716	466,587	395,300	390,423	369,154
Average price per bbl.....$	2 68½	2 65	2 47	2 51¼	† 2 56

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

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

CRUDE PETROLEUM AND REFINERY STATISTICS, 1921-1925

Schedule	1921	1922	1923	1924	1925
Crude petroleum production:					
Imp. gals.	6,050,062	5,756,602	5,598,985	5,401,102	5,024,770
*Value $	466,716	466,587	395,301	390,424	367,524
Imported crude, distilled:					
Imp. gals.	150,692,113	152,888,816	138,527,971	151,381,481	161,895,295
Value $	14,537,339	13,834,118	11,141,952	11,575,058	13,056,823
Canadian crude, distilled:					
Imp. gals.	5,880,086	5,612,645	5,837,827	5,123,683	4,859,148
Value $	500,418	462,346	450,467	394,398	358,245
Per cent. of total	3.75	3.54	4.04	3.27	2.92
Products:					
Illuminating oil Imp. gals.	29,774,134	36,650,134	33,175,063	28,816,322	18,677,629
Value $	3,335,200	4,077,350	3,758,185	3,055,188	2,222,569
Lubricating oil Imp. gals.	13,848,721	14,556,150	11,584,423	12,011,116	13,297,275
Value $	2,351,975	2,558,278	2,107,530	2,009,732	2,364,320
Benzine, naphtha, gasoline Imp. gals.	51,033,337	59,223,186	50,884,894	61,493,214	73,083,022
Value $	12,655,244	13,920,089	8,739,670	9,392,837	11,032,134
Still gas M. cu. ft.	.....	.....	374,687	524,737	431,713
Value $	.....	.....	131,745	172,555	167,869
*Gas and fuel oil, tar, Imp. gals.	44,364,794	34,508,790	34,727,265	36,702,043	46,064,129
Value $	2,130,685	2,510,427	2,367,050	2,494,858	2,947,378
Paraffin wax and candles lb.	10,777,994	12,063,768	10,484,436	9,112,143	15,502,029
Value $	310,267	329,147	484,416	551,434	734,322
Tar and grease lb.	18,971,400	8,186,013	10,612,588	10,325,835	9,301,674
Value $	142,285	265,150	222,675	187,544	177,474
Acid oil Imp. gals.	.....	.....	1,126,370	1,350,450	1,858,176
Value $	.....	.....	62,006	61,748	85,761
Acid and Petroleum coke tons	.....	38,016	31,505	5,464,484	3,733,772
Value $	.....	263,034	249,425	226,005	212,085
Miscellaneous $	.....	.....	.....	29,261	1,596
Total value of products $	20,925,656	23,923,475	18,122,702	18,181,162	19,945,508
Employees Ave. No.	1,560	1,393	1,515	1,603	2,165
Wages paid $	2,176,700	2,018,765	2,265,307	2,453,082	2,702,034

*The value includes bounty paid to producers.

Refining of oil and the manufacture of oil refinery products was carried on during 1925 by three companies in Ontario, as follows:—

PETROLEUM REFINERIES, 1925

Company	Head Office	Plant
British American Oil Refineries, Ltd	1312 Royal Bank Bldg., Toronto	Toronto.
Canadian Oil Refineries, Ltd	Toronto	Petrolia.
Imperial Oil Refineries, Ltd	445 South Christina St., Sarnia	Sarnia.
Great Lakes Oil Co., Ltd. (idle)	Wallaceburg, Ont	Wallaceburg.
McColl Bros. (under construction)	114 Don Esplanade, Toronto	Toronto.

The average number of employees at the above refineries was 2,165, and the salaries and wages paid totalled $2,702,034. This does not include the

staff of McColl Bros. who were employed in the last month of the year equipping and testing the refinery erected in Toronto. Operations commenced in January, 1926. Considerable quantities of sulphuric acid, sulphur, caustic soda, soda ash, litharge, fullers earth and other materials were consumed, a summary of which appears in the subjoined table.

MATERIALS USED IN OIL REFINING OPERATIONS, 1925*

Schedule	Quantity	Cost at Works
Crude oil (domestic) ..... Imp. gals.	4,859,148	$385,245
" " (imported, U.S.A.) ..... "	161,895,295	13,056,823
Sulphuric acid (not made by firms reporting) ..... lbs.	29,204,439	261,022
Sulphur (not used in acid manufacture) ..... "	25,109	699
Caustic soda ..... "	2,041,261	66,796
Soda ash ..... "	263,900	4,793
Litharge ..... "	158,421	16,735
Fullers earth ..... "	1,281,190	14,433
Compounding material ..... "	.....	457,860
All other material	.....	129,457
Shipping containers (barrels, cans, crates, etc.)	.....	1,112,534
Total	.....	$15,506,397

*Table supplied by the Dominion Bureau of Statistics.

A considerable number of by-products are produced in the refining of petroleum apart from the gasoline, kerosene and other heavier oils derived. In the Canadian practice some of these commodities are consumed in the plant operations and no direct income is received from them. The following table shows materials made for sale, as well as those made for the use of the companies:

PRODUCTS MADE IN OIL REFINERIES, 1925*

	For Plant Use		For Sale	
	Quantity	Value	Quantity	Value
		$		$
Gasoline ..... Imp. gals.	2,073	296	72,146,604	10,871,803
Petroleum spirits ..... "	131	22	934,214	160,013
Kerosene ..... "	27,622	3,089	18,650,007	2,219,480
Fuel and gas oils ..... "	4,084,299	230,028	41,979,830	2,717,350
Lubricating oils ..... "	13,117	2,233	13,284,158	2,362,087
Grease ..... lbs.	2,515	38	8,979,989	174,612
Tar ..... Imp. gals.	17,545	1,404	17,337	1,420
Petroleum coke ..... tons	951	4,842	3,720,870	171,128
Wax and candles ..... lbs.	197	14	15,736,670	734,308
Other products—Sludge ..... Imp. gals.	658,030	31,021	.....	.....
Pitch ..... tons	2,851	3,286	.....	.....
Acid oil ..... Imp. gals.	1,200,146	54,740	.....	.....
Still gas ..... M cu. ft.	431,713	167,869	.....	.....
Acid and black oil coke ... tons	9,141	32,829	.....	.....
Linseed oil soap ..... lbs.	.....	.....	31,913	1,596
TOTAL VALUE $19,945,508	.....	531,711	.....	19,413,797

*Table supplied by the Dominion Bureau of Statistics.

Although there were only three companies operating the capital actually employed was considerable. Cost of lands, buildings, plant, etc., supplies of stock on hand, cash, trading and operating accounts, amounted to $16,372,962, or an increase of $1,851,058 over the figures for 1924. The total cost of fuel

for the three companies was $1,335,343, of which $356,288 worth was derived in the process of manufacture, and included coke, still gas, sludge and pitch. The cost of the coal consumed, both bituminous and anthracite, amounted to $737,633. The electrical power included in the total cost above amounted to $58,883, while the power of the steam boilers installed totalled 7,072 horsepower.

The following table shows the quantity and value (less freight, exchange and sales tax) of crude oil and its refined products imported into Ontario in the year 1925. Practically all of this came from the United States. The information is furnished by the Department of External Trade and Commerce, Ottawa.

PETROLEUM AND REFINED PRODUCTS IMPORTED IN 1925

	Gallons	Value
		$
CRUDE PETROLEUM:		
Fuel and gas oils between .775 and .8235 specific gravity	12,803	2,482
Petroleum, .790 specific gravity or heavier for refining	184,632,857	11,274,102
Total	184,645,650	11,276,584
REFINED PETROLEUM:		
Gasoline	45,115,959	6,471,301
Kerosene and other illuminating oils	2,908,759	249,011
Lubricating and other oils	4,124,186	1,254,658
Total	52,148,904	7,974,970
PETROLEUM PRODUCTS:		
Axle grease ..... lbs.	2,231,926	138,669
Vaseline, toilet and medicinal petroleum	.....	128,291
Paraffin wax ..... lbs.	1,279,225	101,979
Paraffin wax candles	142,923	30,307
Other petroleum products ..... gals.	883,267	160,431
Total ..... $	.....	559,677
TOTAL NET VALUE ..... $	.....	19,811,231
TOTAL GROSS VALUE* ..... $	.....	28,745,098

*Duty calculated, $1,441,243; sales tax, $1,062,624; and freight, $6,430,000.

Quartz and Silica Brick

Shipments during 1925 totalled 188,064 tons valued at $359,691, as against 112,431 tons worth $221,452 in 1924, or an increase of 67 per cent. in quantity and 62 per cent. in value. There were substantial increases in output from the East Neebish and Killarney quartzite quarries of the Dominion Mines and Quarries, Limited. In the figures given above there is included the value added to the crude quartz used in the manufacture of silica brick and silica cement by the Algoma Steel Company. This company manufactures some of its own refractory material, using quartz from a quarry at Mile 19 on the Algoma Central Railway.

In the totals given above the tonnage and value of silica bricks have been included, but the quantity and value of crude quartz used in the manufacture of the brick has been deducted. In 1925 this deduction amounted to 3,208 tons, valued at $11,294. There is also included 7,051 tons of silica sand and ground quartz worth $23,145, the major portion of which was produced in 1924 and 1925 by the Silica Sand Company at Pittsburgh township, Frontenac county.

QUARTZ AND SILICA BRICK PRODUCERS, 1925

Name of Owner, Firm or Company	P.O. Address of Operator	Location of Quarry
Algoma Steel Corporation, Limited	Sault Ste. Marie	Mile 19, A.C. Ry.
Dominion Mines and Quarries, Limited	Toronto, Canada Life Bldg.	East Neebish and Killarney
Mond Nickel Company	Coniston	Neelon tp.
Maloney, M. J	Marmora	Marmora tp.
Orser-Kraft Feldspar Company	Perth	Bathurst, Drummond and S. Sherbrooke tps.
Wright & Company	Sault Ste. Marie	Deroche tp., Mile 19, A.C. Ry.
Gardiner Feldspar Co	Hippodrome Bldg., Cleveland, O.	Hartington.
*Silica Sand Co., Ltd	Trusts and Guarantee Co., Toronto	Pittsburg tp., Frontenac co.
Industrial Mineral Corporation	Toronto, 805 Bank of Hamilton Bldg.	Wanup.
Anderson, J. G	Lucknow	Wanup.
Johnson, Felix	Hybla	Hybla.
Rayner, G. W	Toronto, Lumsden Bldg.	Hybla.

*Now in liquidation.

Salt

Revised figures for salt production by Ontario salt companies during 1925 gave a total of 226,315 tons having a selling value of $1,352,504, as against 203,428 tons valued at $1,337,311 in the previous year. During the period ten companies operating eleven establishments were active, employing on the average 467 workers, of whom 41 were females, with a pay roll amounting to $555,729. The salt industry is centred in the southwestern part of the Province (Bruce, Huron, Lambton and Essex counties), which is underlain by salt beds. Salt brine is pumped from wells, evaporated and graded. Included with the total output is the salt equivalent of brine used in chemical plants at Sandwich and Amherstburg, on the Detroit river, for the manufacture of bleaching powder, liquid chlorine, caustic soda and soda ash. The several grades and total tonnages, with value of salt, exclusive of packages, marketed for the past five years are tabulated as follows:—

SALT STATISTICS, 1921-1925

Schedule	1921	1922	1923	1924	1925
Land ..... tons	2,599	6,585	3,713	4,612	5,125
Coarse ..... "	28,925	28,154	31,282	28,496	43,286
Fine ..... "	36,074	34,684	36,924	42,555	33,197
Table and Dairy ..... "	40,931	41,119	42,468	41,134	46,602
Pressed Blocks ..... "	2,966	2,489	3,431	3,572	4,605
Brine (salt equivalent) ..... "	50,529	63,710	80,099	83,059	93,500
Total sold or used ..... "	161,024	176,741	197,917	203,428	226,470
Value of products sold or used ..... $	1,643,527	1,573,657	1,674,365	1,337,311	1,466,450
Employees* ..... No.	264	409	479	439	467
Wages ..... $	311,205	539,813	508,525	482,263	555,729

*Employees of chemical works are not included.

Companies producing brine or salt in 1925 were as follows:—

OPERATING SALT COMPANIES, 1925

Name of Owner, Firm or Company	Location of Wells or Works	P.O. Address of Manager, etc.
Brunner, Mond Canada, Limited	Amherstburg*	Amherstburg.
Canadian Salt Company, Limited, The	Windsor	Windsor.
	Sandwich*	
Dominion Salt Company, Limited, The	Sarnia	Sarnia.
Elarton Salt Works Co., Ltd	Warwick	Watford, R.R. No. 5.
Exeter Salt Works Company, Limited	Exeter	Exeter.
Goderich Salt Co., Limited	Goderich	Goderich.
Kincardine Salt Co., Ltd	Kincardine	Kincardine.
Western Canada Flour Mills Co., Ltd.	Goderich	Goderich.
Western Salt Company, Limited	Courtright	Courtright.
Wingham Salt Works (Young Estate)	Wingham	Wingham.

*Chemical works using salt brine as raw material.

Talc and Soapstone

Two talc mills were operated in 1925, namely, those of Geo. H. Gillespie Company and Asbestos Pulp Company, both of Madoc. No crude talc was marketed except that from Henderson Mines, Limited, at Madoc, which supplies the Gillespie mill. Sales advanced over 1924 both in tonnage and value as noted in the accompanying table. Refined talc ranged in price from $9 to $21 per ton according to grade, and was marketed in Canada, the United States, and England.

In addition to talc, 64 tons of soapstone were sawn and marketed by the Grace Mining Company from their property at Eagle lake, Kenora district. This product was consigned to the Dryden paper mill. The Wabigoon Soapstone Company did some development on their properties near Wabigoon station. There are also workable deposits near the south end of Wabigoon lake and on an island in the lake itself.

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

TALC AND SOAPSTONE STATISTICS, 1921-1925

Schedule	1921	1922	1923	1924	1925
Ground talc shipped*.....tons	9,967	12,874	*9,531	10,718	13,678
Total value shipments.....$	140,390	178,397	125,124	130,577	174,116
Employees, mine and mill.....No.	30	46	57	40	51
Wages paid.....$	41,978	53,295	36,647	37,075	47,971

*Includes 17 tons soapstone in 1923 and 64 tons in 1925.

STRUCTURAL MATERIALS AND CLAY PRODUCTS

General Remarks

Apart from the statistics of structural materials collected from each operator and which in the aggregate reflect the actual conditions of the industry, there are other factors bearing on the subject, concerning which information is published by the Dominion Bureau of Statistics. These are prices of wholesale commodities, index numbers of employment, and building permits granted. Information as to contracts awarded is published monthly in *MacLean Building Review*.

During 1925 the index numbers of wholesale prices of commodities covering building materials in general declined from 159.1 in 1924 to 153.7 in 1925, based on 100 in 1913. The index number of employment in the building and construction industry declined from 136.9 in 1924 to 130.46 in 1925, as compared with 100 for January, 1920.

Building permits in sixty Canadian cities in 1925 were valued at $124,661,720. Of this total thirty Ontario cities accounted for $59,888,867 or 48 per cent., as noted in the following table abstracted from *A Review of Building Permits in Canada during 1925*, issued by the Dominion Bureau of Statistics :—

BUILDING PERMITS IN ONTARIO, 1920-25

Year	30 Ontario Cities, Value	Toronto Metropolitan Area (*a*) Value	Material Prices Index No. (*b*)	Wages Index No. (*c*)
	$	$		
1920	58,636,365	30,049,413	214.9 (*d*)	180.9 (*d*)
1921	59,315,845	31,979,346	183.2	170.5
1922	81,396,259	36,405,625	162.2	162.5
1923	74,673,080	39,530,877	167.0	166.4
1924	57,330,141	29,636,428	159.1	169.1
1925	59,888,867	32,408,636	153.7	170.4

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

The value of Canadian construction contracts awarded for 1925, reported by *MacLean Building Review*, was $297,973,000 as compared with $276,261,000 in 1924. Ontario contracts in 1925 amounted to $121,248,100. Building costs have been stable for two years and material prices are considerably below the peak of 1920. Mortgage money is plentiful and at rates one-half to one per cent. lower than a year ago.

VALUE OF ONTARIO CONSTRUCTION CONTRACTS, 1922-1925

Classification	1922	1923	1924	1925
Residential	$60,718,000	$55,879,000	$43,090,000	$47,529,600
Business	39,611,000	34,904,000	27,706,000	32,579,800
Industrial	10,245,000	10,668,000	7,017,000	3,754,700
Engineering	56,054,000	54,701,000	58,228,000	37,381,000
Total	$166,628,000	$156,152,000	$136,041,000	$121,248,100

One large Canadian construction company estimates costs as follows: materials 55.13 per cent., labour 28.33 and the balance or 16.64 per cent. covers overhead, insurance, engineering, supervision, profit, etc.

Clay Products

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

CLAY PRODUCTS MARKETED, 1925

Kind	Number or Quantity	Value
		$
Brick—Soft, mud process—Face	24,479,182	476,638
Brick—Soft, mud process—Common	30,799,404	474,114
Stiff-mud (wire cut) process—Face	68,974,611	1,288,382
Stiff-mud (wire cut) process—Common	12,641,690	195,202
Dry-press—Face	32,016,060	638,812
Dry-press—Common	4,587,313	64,377
Fancy or ornamental brick (including special shapes, embossed and enamelled brick)	425,971	21,728
Sewer	2,124,710	37,082
Tile, structural: Hollow blocks (including fireproofing and load-bearing tile)...tons	62,926	577,477
Roofing tile...no.	78,479	6,323
Floor tile (quarries)...sq. feet	140,927	28,338
Tile, drain...no.	13,495,880	360,710
Sewer pipe (including copings, flue linings, etc.)	.....	893,443
Pottery—From domestic clay...no.	6,200,000	86,000
Total Value	.....	5,148,626

VALUE OF CLAY PRODUCTS SOLD OR USED, 1913-25

Year	Brick		Pottery	Drain Tile	Sewer Pipe	Total
	Common	Pressed, Fancy, Building Tile, etc.				
	$	$	$	$	$	$
1913	3,283,894	1,162,860	52,875	292,767	600,297	5,392,693
1914	2,336,207	894,381	25,720	277,530	571,750	4,165,597
1915	763,591	375,865	49,387	321,253	361,283	1,871,376
1916	509,559	495,895	87,025	275,471	216,749	1,584,699
1917	713,824	776,302	94,501	546,040	379,923	2,509,590
1918	665,454	592,286	88,275	309,899	362,536	2,018,450
1919	1,966,711	726,500	119,551	354,700	609,100	3,776,562
1920	2,209,265	1,178,656	127,049	359,373	860,811	4,735,154
1921	2,025,643	2,059,606	69,984	397,104	939,463	5,094,696
1922	2,614,120	2,899,205	88,889	368,180	973,824	6,944,218
1923	2,008,614	2,973,006	78,000	283,662	925,858	*6,270,615
1924	944,892	2,883,566	84,100	373,980	851,327	5,137,865
1925	733,693	3,074,780	86,000	360,710	893,443	5,148,626

*Includes $1,475 worth of silica cement.

Brick and Tile.—Under the new classification, adopted in 1924 after consultation with the Canadian National Clay Products Association, it is possible to publish figures showing much greater detail as to the kinds of brick produced by different processes of manufacture. Heretofore, the data on bricks differentiated between kinds only, and no statistics were available relating to "stiff" or "soft-mud" processes or to "dry-press."

Pottery and Porcelain.—The output of rough pottery in the form of flower pots coming from Toronto and Hamilton during 1925 totalled 6,200,000, with a selling value of $86,000 as against 5,800,000 worth $84,100 in 1924. Glazed ware and insulators are also produced in Ontario by five companies, while four firms produced enamelled steel articles and two firms produce enamelled parts in stove production. Considerable quantities of ball clay, china clay, ground barytes, feldspar, quartz, flint and whiting, much of which is imported, is consumed by these manufacturing industries. Ball clay, china clay and whiting are imported mainly from Cornwall, England.

The Ontario Potteries Company, of Oshawa, the first whiteware pottery firm in Canada, operated in 1924 but closed down during the following year. China clay from England, ball clay from southern Saskatchewan, and Ontario flint and feldspar are the raw materials used. The porcelain insulator industry, which has of late years grown in importance, depends largely on imported raw materials. Plants are located at Hamilton, Niagara Falls, Peterboro and Georgetown.

In the 1924 report of mineral production,[1] mention was made of a deposit of fireclay and china clay located on the east bank of the Mattagami river immediately below Long rapids, which is fifty-five miles due north of Moonbeam station on the National Transcontinental railway. The deposit may be reached by a thirty-four mile winter road from the terminus of the T. and N.O. railway at Oil Can Portage, on the Abitibi river, and will doubtless be used when transportation improves.

Sewer Pipe.—Production of this variety of clay product is carried on by three companies in Ontario, with plants at Hamilton, Mimico and Swansea. The total sales value during 1925 amounted to $893,443, as against $851,327 during the previous year. All shapes and sizes were manufactured and the clay used was a special variety located at Aldershot, near Hamilton. Much of the product of these operations is disposed of by a selling agency in Toronto organized for that purpose, the Toronto Sewer Pipe Company, for which a charter was granted in 1920.

SEWER PIPE AND POTTERY WORKS, 1925

Name of Company	Location of Plant and P.O. Address of Manager, etc.
SEWER PIPE	
Dominion Sewer Pipe and Clay Industries, Ltd.	Swansea and Aldershot.
Hamilton & Toronto Sewer Pipe Co., Ltd.	Hamilton.
Ontario Sewer Pipe & Clay Products, Ltd.	Mimico.
POTTERY	
Davis & Son, John	601 Merton St., Toronto.
Foster Pottery Company	Main St. West, Hamilton.

[1]Ont. Dept. of Mines, Vol. XXXIV, pt. 1, p. 37.

BRICK AND TILE PLANTS, 1925

Name	Address	Product
Alvinston Brick & Tile Co., Ltd	Alvinston, Box 26	Brick and tile.
Baker, Geo. E	Arnprior	Brick, blocks and tile.
Barnhardt, W. H	Stratford	Brick and tile.
Bartonville Pressed Brick Co., Ltd	Hamilton, 620 Lister Block	Brick.
Batchelor, Samuel	Proton Station	Brick and tile.
Bechtel Brick Co., Ltd., The	Waterloo	Brick.
Booth Brick & Lumber Company	New Toronto	Brick.
Brampton Pressed Brick Co., Ltd	Brampton	Brick.
Broadwell & Son, B	Kingsville, Box 137	Brick and tile.
Caledon Mountain Shale Products	Toronto, 600 Bay Street	Brick.
Campbell, Neil F	West Lorne, R.R. No. 1	Brick and tile.
Canadian Fireclay Products	Toronto, 60½ Adelaide St. East	Tile.
Canadian Pressed Brick Co., Ltd	Hamilton, 63 Ottawa St. S.	Brick.
Chapman, John	Napanee, R.R. No. 3	Brick and tile.
Cheeseman, Peter	Hamilton, 670 King St. W.	Brick.
Cooksville Shale Brick Co., Ltd	Toronto, 26 Queen St. E.	Brick and blocks.
Cooper, W. H	Hamilton, 312 Clyde Block	Brick.
Cornhill Sons, Ltd., James	Chatham, Grand Ave	Brick.
Crang, Jethro	Toronto, 22 Thorne Cres.	Brick.
Crawford Bros	Hamilton, 451 King St. W	Brick.
Curtin, Frank	Lindsay, R.R. No. 4	Brick.
Curtis Bros	Peterborough, Box 809	Brick and tile.
DeLaplante & Co., J. E	Coleman	Brick.
Deller & Son, Albert	Brownsville	Tile.
Deller Bros	Norwich, R.R. No. 2	Brick, blocks and tile.
Deller, Wm. H	Thorndale, R.R. No. 4	Brick and tile.
Dolan, John	Watford, R.R. No. 2	Tile.
Donaldson, S. E	Harriston, R.R. No. 4	Tile.
Don Valley Brick Works, Ltd., The	Toronto, 114 Federal Bldg.	Brick and blocks.
Douglas & Turner	Wilkesport	Tile.
Elliott, Chas	Bluevale	Brick and tile.
Elliott, Jas., Jr	Sault Ste. Marie	Brick.
Elliott, Wm	Glenannan	Brick and tile.
Fort William Brick Co	Fort William, 509 Victoria Avenue	Fort William.
Fox, Geo. J	Dresden	Brick.
Frid Bros	Hamilton, Dundas Rd. and Macklin St	Brick.
Gammage, C. R	Dresden	Tile.
Gardiner, Wm	Blenheim	Brick and tile
Godfrey & Co., Thos	Carleton Place	Brick.
Grimsby Brick & Tile Co	Grimsby	Brick.
Hallatt & Son, H	Comber	Brick and tile.
Hallat Clay Products Ltd	Chatham, 4 Richards Block	Tile.
Halton Brick Co., Ltd	Toronto, 28 Symes Rd	Brick
Hamilton Pressed Brick Co., Ltd	Hamilton, Kensington Ave. South	Brick.
Hill, Aaron	Essex	Brick and tile.
Hill, A. W	Coatsworth, R.R. No. 1	Brick, blocks and tile.
Hircock Bros	Bowmanville	Brick.
Hitch, D. A	Ridgetown, Box 236	Blocks and tile.
Hitch, Thos	St. Thomas, Box 254	Brick, blocks and tile.
Hodder, Jos. H	Dutton	Tile.
Houston Co., Ltd., The	Tweed	Brick.
Howlett & Sons, Fred	Petrolia, Box 3	Brick, blocks and tile.
Huntsville Brick & Tile Works	Huntsville, Box 308	Brick and tile.
Interprovincial Brick Co., Ltd	Toronto, 30 Toronto St	Brick.
Jackson, W. B	Brantford, 290 Rawdon St.	Brick and tile.
Jamieson Lime Co	Renfrew	Brick and tile.
Janes, D. A	Mt. Brydges	Brick and tile.
Jasperson, B	Kingsville	Brick and tile.
Jervis, W. J	Dorchester, R.R. No. 3	Brick and tile.
Johnston, Jas	Pembroke, R.R. No. 3	Brick.
Kerr, Chas	Goderich, R.R. No. 4	Brick and tile.
Kerr, F	Crediton	Brick and tile.

BRICK AND TILE PLANTS, 1925—*Continued*

Name	Address	Product
Koebel Bros.	St. Clements, Box 54	Brick and tile.
Kruse Bros.	Seaforth, R.R. No. 3	Brick and tile.
Labey & Son, Geo. A.	Foxboro	Tile.
Lowes Bros.	Chatham, R.R. No. 3	Brick and tile.
Martin, Thos. E.	Thamesville, R.R. No. 4	Brick and tile.
McComb, Chester	Denfield, R.R. No. 2	Brick and tile.
McCormick Bros.	Watford, R.R. No. 5	Brick and tile.
McCredie, Wilson	Belmont, R.R. No. 3	Brick and tile.
McIvor Bros.	Cobourg, Box 636	Brick.
McMahon, Robert	Kerwood, R.R. No. 2	Tile.
Merkley's, Ltd	Ottawa, 53 Queen St	Brick, blocks and tile.
Middleton, Chas.	Wyoming	Tile.
Milton Pressed Brick, Ltd.	Milton	Brick.
Miner, M. F.	Kingsville	Tile.
Moscow Brick & Tile Works	Greenock, R.R. No. 1	Brick and tile.
Napanee Brick & Tile Works (J. Chapman)	Napanee, R.R. No. 3	Brick and tile.
National Fire Proofing Co., Ltd.	Toronto, 601 Dominion Bank Bldg.	Blocks and tile.
O'Dell & Sons, Wm.	Ingersoll, R.R. No. 1	Brick and tile.
Ollman Bros.	Hamilton, 111 Macklin St.	Brick.
Ontario Denison Tile Co., Ltd.	Windsor, 24 Wyandotte St.	Brick and tile.
Ontario Government (Department of Prov. Secretary)	Toronto (Mimico plant)	Brick, blocks and tile.
O'Reilly, T. E.	Ottawa, 320 Bay St.	Brick.
Ott Brick & Tile Mfg Co., The.	Kitchener, 33 King St. E.	Brick and tile.
Ottawa Brick Mfg Co., Ltd., The	Ottawa, 53 Queen St.	Brick.
Owen Sound Brick Co., Ltd., The	Owen Sound	Brick.
Parks, H. W.	Dresden, R.R. No. 2	Tile.
Paxton, Fred R.	St. Catharines, 242 Queenston St.	Brick.
Pembroke Brick Co., The	Pembroke	Brick.
Phillips & Son, Thos.	Lucknow, R.R. No. 2	Brick and tile.
Phippen & Field	Toronto, 150 Dawes Rd.	Brick.
Phinn Bros.	London, 238 Briscoe St.	Brick, blocks and tile.
Piggot & Co., Geo.	Toronto, 72 Guestville Ave.	Brick.
Port Rowan Brick & Tile Co.	Port Rowan	Brick, blocks and tile.
Price & Cumming	Toronto, 58 Wellington St. East	Brick.
Price & Smith	Toronto, 458 Greenwood Ave.	Brick.
Richardson & Son, J.	Kerwood	Brick and tile.
Riselay Brick Co., Ltd.	Hamilton, Main St. W.	Brick.
Russell, Jos.	Toronto, 40 Blake St.	Brick.
Sadler, Frederick L.	Dublin	Brick and tile.
Shale Products, Ltd.	Inglewood	Brick.
Smith, Alex, & Son	Dutton, R.R. No. 2	Brick and tile.
Snelgrove, Andrew	Beaverton	Brick and tile.
Sproat, William M.	Seaforth, R.R. No. 4	Tile.
Sun Brick Co., Ltd.	Toronto, 1104 Bay St.	Tile.
Sutherland, W. A.	Parkhill, Box 293	Brick and tile.
Standard Brick Company, Ltd.	Toronto, 363 Broadview Ave.	Brick.
Stratford Brick, Tile & Lumber Co.	Stratford	Brick and tile.
Steele, Edwin	Vankleek Hill	Brick.
Streetsville Brick Co., Ltd., The	Toronto, 26 Queen St. E.	Brick.
Stroh, M. C.	Conestogo	Brick and tile.
Superior Brick & Tile Co., Ltd.	Fort William	Brick and tile.
Tope Richard, Estate of	Hamilton, 171 Queen St. S.	Brick.
Toronto Brick Company, Ltd.	Toronto, 60 Victoria St.	Brick.
Wagstaff, Albert H.	Toronto, 348 Greenwood Ave.	Brick.
Wagstaff, Charles	Lindsay, R.R. No. 4	Brick and tile.
Wallace & Son, R.	North Bay, 66 First Ave. E.	Brick.
Wein, Aaron	Crediton	Brick and tile.
Winch Bros.	Paisley	Tile.
Windsor Brick & Tile Co.	Windsor, Exchange Bldg.	Brick, blocks and tile.
Wright & Sons, Geo.	Comber, Box 56	Tile.
Woodslee Brick & Tile Co.	Woodslee	Brick and tile.

Cement

During 1925 four cement mills owned and operated by three companies were active in Ontario, namely, the Belleville (No. 5) and Port Colborne (No. 8) plants of the Canada Cement Company, the St. Marys Cement Company at St. Marys, and the Hanover Cement and Stone, Limited, at Hanover. At the end of the year the last mentioned company, which had operated from April 1 to September 9, sold out its plant to the Canada Cement Company.

Details of the Ontario cement industry in the last pre-war year and subsequently are given in the following table:

PORTLAND CEMENT STATISTICS, 1913-1925

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

In the United States the factory price per barrel of 380 pounds averaged $1.81.

In the annual report of the board of directors of the Canada Cement Company for 1925 the yearly consumption in Canada was stated not to exceed 80 per cent. of the pre-war figures. However, the mills of the company were enabled to operate to about 50 per cent. of their capacity, due to increases in the export trade. The Sales Tax, on account of multiplying before reaching the consumer, was mentioned as detrimental to new construction.

Lime

The small lime-kiln for burning quicklime for local use is rapidly disappearing and giving place to larger and more up-to-date plants, several of which are now equipped for the production of hydrated lime. During 1925, the production showed a slight increase. The major portion of the hydrated material, or 23,967 tons, was consumed by the building trades. Quicklime finds its largest market in chemical manufacturing. The consumption percentages of the total shipments during 1925, in order of importance, were as follows: Chemical works, 61.3; building trades, 10.6; dealers, 7.7; sugar refineries, 5.8; pulp and paper, 3.6; and the balance, or 11.0 per cent., by glassworks, tanneries, smelters and other consumers.

The lime burning industry in Ontario gave steady employment to 409 men during the year, who received $436,867 in wages. The largest item in manufacturing costs was that of fuel, which included coal, gas and wood costing $375,220 during 1925.

The following table shows the lime statistics of the Province for the past five years:—

LIME STATISTICS, 1920-1925

Year	Lime Marketed or Used						Fuel Cost	Employees	Wages
	Hydrated			Quicklime					
	Tons	Total Value	Per Ton	Bush. (70 lbs.)	Value	Ave. Price per bush.			
		$	$		$	c.	$		$
1921..	26,863	381,749	14 58	2,763,062	962,439	31.2	.....	366	341,826
1922..	36,408	455,980	12 52	3,939,954	1,311,563	33.3	312,825	425	408,731
1923..	41,727	519,840	12 46	4,810,421	1,373,823	28.5	556,321	542	549,613
1924..	35,989	438,607	12 19	4,391,050	1,401,545	31.9	394,195	396	402,295
1925..	41,610	477,585	11 47	5,115,882	1,566,540	30.6	375,220	409	436,867

Below are given the names of producers and the location of plants operated in 1925:—

LIME PRODUCERS, 1925

Name of Owner or Company	Location of Kilns	Head Office Address
Alabastine Co., Paris, The.....(*)	Elora and Teeswater.....	Paris.
American Cyanamid Co.....(†)	Niagara Falls.....	Niagara Falls.
Beachville White Lime Co., Ltd.....	Beachville.....	Beachville.
Biederman, Albert G.....	Golden Lake.....	Golden Lake.
Brunner Mond Canada, Limited...(†)	Anderdon tp., near Amherstburg.	Toronto, Bank of Commerce Building.
Cameron, W. M.....	Carleton Place.....	Carleton Place.
Chalmers Lime Works.....	Owen Sound.....	Owen Sound.
Christie, Henderson & Co., Limited..	Hespeler(*), Puslinch, Kelso.	Toronto, 201 Crown Office Building.
Canada Lime Co.....	Coboconk.....	26 Queen St. E., Toronto.
Dominion Sugar Company.....(†)	Chatham, Wallaceburg and Kitchener.....	Chatham.
Gallagher Lime and Stone Co., Limited	Barton tp.....	Hamilton.
Harvey, E., Limited.....	Rockwood.....	Guelph.
Jamieson, J. M.....	Forester Falls.....	Forester Falls.
Jamieson Lime Co.....	Renfrew.....	Renfrew.
Marshall, James.....	Barton tp.....	Hamilton.
Robertson Co., Limited, D.....	Nassagaweya tp.....	Toronto, 26 Queen St. E
Standard White Lime Co., Limited...	Beachville, Guelph(*).....	Guelph.
Standard Chemical Company, Ltd...	Eganville(*).....	906 Drummond Bldg., Montreal, Que.
Toronto Brick Co., Limited.....	Coboconk.....	Toronto, 60 Victoria St.
Toronto Lime Co., Limited.....	Dolly Varden.....	Toronto, 26 Queen St. E.
Vogan, Samuel.....	Wiarton.....	Wiarton.
Weppler, Henry.....	Glenelg tp.....	Priceville, R.R. No. 2.

*Hydrated lime plants.
†Product used in manufacture of chemicals.

Sand and Gravel

Although figures for sand and gravel production as given in Table 1 cover the output of the more important operators, it should be pointed out that because of the seasonal nature of the operations and lack of information many small operators of isolated pits have of necessity been omitted. During 1925 a total of 146 individuals and companies reported production of sand and gravel.

In addition several companies were licensed to dredge some of the rivers, shoals and shore lines of the great lakes. A considerable quantity of material was consumed also by the Highways Department and Northern Development Department on road construction. From the above sources there was produced in Ontario 3,913,292 tons worth $1,658,700 in 1925, as against 4,395,478 tons valued at $1,587,913 in 1924.

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

The output of sand and gravel during 1925 was as follows:

Schedule	Tons	Value
Private pit operators	1,900,965	$809,230
Recovered by Licensees from Great Lakes and Rivers	1,219,803	710,394
Northern Development Dept. (Roads)	527,524	39,076
Ontario highway contractors (estimate)	265,000	100,000
	3,913,292	$1,658,700

Following is a list of sand and gravel pit operators who marketed or used 1,000 cubic yards or more during the year:—

SAND AND GRAVEL OPERATORS, 1925.

Name of Owner or Company	Material G—Gravel S—Sand	Location of Deposits	Address
Adelaide, Township of	G.	Adelaide tp., lot 3, con. V.	Arkona.
Allen Bros.	S. and G.	Stop 7, Kingston Road	Toronto, 60 Birchcliffe Ave.
Alexander, Adam	G.	Nassagaweya, lot 4, con. VI.	Kelso.
Ashton, Thos.	S.	Victoria Park Ave	Toronto, 1354 Queen St. E.
Armstrong Supply Co., Ltd.	G.	York St., Hamilton	Hamilton.
Axford, J. B.	S. and G.	Yarmouth, lot 4, con. VII.	St. Thomas.
Bellyou, N. E.	S. and G.	Murray tp., lot 6, con. I.	Trenton, R.R. 4.
Benson & Patterson	S. and G.	Stamford	Stamford.
Brantford, City of	S. and G.	Webster St., Brantford	Brantford.
Brown, S.	S. and G.	Hewat St., Preston	Kitchener, 139 Ontario St.
Bruce, County of	S. and G.	Bruce county	Walkerton, Box 201.
Burrows, John	S. and G.	Widdifield tp.	North Bay, 447 Klock Ave.
Cameron, Chas. M.	S. and G.	Mosa tp., lot 3, con. 1	Glencoe, R.R. 1..
Caradoc, Township of	S. and G.	Caradoc tp., lot 24, con. 1	Mt. Brydges.
Carroll Bros.	S.	Humberstone tp., lots 3, 4, 5, 7, 8, 9, con. I.	Buffalo, N.Y., 490 Ellicott Square.
Chatham, County of	S. and G.	Gloucester, Osgoode and North Gower tps.	Ottawa, Court House.
Chatham, Wallaceburg & Lake Erie Railway Co.	S. and G.	Raleigh tp., lot 129, Talbot Rd.	Toronto, 43 Victoria St.
Circurca, Nicholas	S. and G.	Preston	Preston.
Conlin & Johnson	S. and G.	Scarboro	Toronto, 31 Lockwood Road.
Corley, Ernest	S. and G.	Ops tp., lot 23, Con. V.	Lindsay.
Crosthwaite, F.	S.	Hamilton	Hamilton, 1750 King St. E.

SAND AND GRAVEL OPERATORS, 1925—*Continued*

Name of Owner or Company	Material G—Gravel S—Sand	Location of Deposits	Address
Cudmore, Mrs. Alice	S.	Usborne tp., lots 29, 30, con. IV	Hensall, R.R. 1.
Cudmore, J. W.	S. and G.	Howard tp.	Thamesville, R.R. 6.
Dereham, Township of	G.	Dereham tp., lot 22, con. VI.	Mount Elgin, R.R. 1.
Dodds, Thos.	S. and G.	McKillop tp., lot 31, con. VII	Seaforth, R.R. 1.
Dominion Concrete Co. Ltd.	S.	South Gower tp.	Kemptville.
Dingman, E.	S. and G.	West Zorra tp, lot 35, con. VI	Embro, R.R. 2.
Dunham, J. H.	S. and G.	London tp., lot 5, con. A.	London, R.R. 8.
Durham Stone & Sand Co.	S. and G.	Durham	Toronto, 903 Reford Bldg.
Elgin County Highways	S. and G.	Elgin county	St. Thomas.
Empire Limestone Co.	S.	Sherkston	Buffalo, N.Y., 19 Hudson St.
Farris, Chas. S.	S. and G.	Mosa tp., lot 1, con. I.	Glencoe, R.R. 1.
Faulds, Morley	S. and G.	Southwold tp., lot 14, con. V	Iona Sta., R.R. 4.
Foster, R. R.	S.	Ottawa, Canal basin	Ottawa, 278 Echo Drive.
Fuller Gravel Co. Ltd.	S. and G.	Fuller	Ivanhoe.
Gear, H.	S. and G.	Erin tp.	Erin.
Godson Contracting Co.	S. and G.	Brock tp., lot 12, con. IV.	Toronto, 203 Richmond St. W.
Guelph, City of	S. and G.	Guelph, Edinburgh Road	Guelph.
Halpenny, L. E.	S. and G.	Arthur tp., lot 28, con. VI.	Arthur.
Harpell, R. E.	S.	Kingston tp., lots 23, 24, con. IV	Cataraqui.
Harwich, Township of	S. and G.	Harwich tp.	Blenheim.
Hoffman, Jos.	S. and G.	Kitchener	Kitchener.
Holmes & Webster	S.	York tp., lot 7, con. III.	Toronto, 180 Eileen Ave.
Huron, County of	S. and G.	Huron county	Goderich.
Independent Concrete Pipe Co. Ltd.	S. and G.	Blandford and E. Zorra tps.	Woodstock.
International Sand Co.	S.	Stamford tp.	Niagara Falls, 724 Bridge St.
Johnston, G. F.	S.	Westminster tp., lot 21, con. V	Wilton Grove, R.R. 2.
Kent, County of	S. and G.	Raleigh, Oxford, Harwich, Romney tps.	Chatham.
Keyes, S. W.	S. and G.	E. Axford tp., lots 16, 17, con. XI	Woodstock, R.R. 8.
Kilbourne, H.	S.	Westminster tp., Wharncliffe Rd.	London, 145½ Wharncliffe Road.
Kingston Sand & Gravel Co.	S.	Kingston tp.	Kingston, 183 William St
Lambton, County of	S. and G.	Enniskillen tp., lot 9, con. XIII	Sarnia.
LeViness, J. E.	S.	Stamford	Niagara Falls, R.R. 3.
Lock, Thos.	S. and G.	W. Nissouri tp., lot 18, con. II.	Thorndale.
Lovelace, Edwin J.	S.	Pelham tp., lots 6, 7, con. VIII, IX	St. Catharines, 1 York St
Malahide, Township of	S. and G.	Malahide tp., lot 21, con. VI	Aylmer.
Maple Sand, Gravel & Brick Co. Ltd.	S. and G.	Vaughan tp.	Toronto, 454 King St. W.
McArthur Engineering & Construction Co. Ltd.	S. and G.	Guelph, lots 3, 21, 22, Div. A.	Guelph, 15 Douglas St.
McCannell, A. M.	S.	Guelph tp., lot 1, con. II.	Guelph, R.R. 7
Middlesex, County of	S. and G.	Various pits	London.
Miller, James A.	S. and G.	Lucknow	Lucknow.
Mohawk Sand & Gravel Co.	S. and G.	Brantford tp.	Brantford, Box 336.
Oxford West, Township of	S. and G.	W. Oxford tp.	Woodstock, R.R. 1.
Park, John S.	S. and G.	Biddulph tp., lot 30, con. II.	Lucan.
Peterborough, City of	G.	Cor. Rogers and Wilson Sts.	Peterborough, 133 Simcoe St.
Ponsford Estate, A. E.	S. and G.	Yarmouth tp., lot 1, con. VII	St. Thomas, 605 Talbot St.
Pote and Rogers	S.	Toronto tp.	Toronto, 510 Lumsden Bldg.
Quick, Chas. R.	S. and G.	London, Manor Park	London, 101 Briscoe St.
Quigley, B. C.	S.	Saltfleet tp.	Hamilton.
Quinn & Wilson	S. and G.	W. Garafraxa tp.	Fergus.
Ratcliffe, Ltd., E. B.	G.	Barton tp., lot 1, con. III	Bartonville.
Regan & Blackburn	S. and G.	Mount Dennis	Toronto, 1550 Dufferin St.

SAND AND GRAVEL OPERATORS, 1925—*Continued*

Name of Owner or Company	Material G—Gravel S—Sand	Location of Deposits	Address
Rutledge, J. M.	S. and G.	Terra Cotta	Terra Cotta.
Sacred Heart College	S. and G.	McKim tp., lot 5, con. IV	Sudbury, Box 1360.
Sand & Supplies, Ltd.	S.	N. Dumfries tp.	Toronto, 54 University Ave.
Sarjeant Co. Ltd., The	S. and G.	Barrie	Barrie, Box 88.
Seebach, Ed.	S. and G.	Ellice, lot 8, con. IV	Sebringville, R.R. 1.
Shirk, G. M.	S. and G.	Waterloo tp.	Bridgeport.
Skinner, R.	S. and G.	Usborne tp., lot 11, con. V.	Exeter, Box 81.
Smythe Ltd., C.	S.	Etobicoke tp.	Toronto, 477 Runnymede Road.
Tack, Henry	S.	London tp.	London, P.O. Sub. 1.
Thomson, Geo.	S.	Widdifield tp.	North Bay, 191 Cassels St.
Townsend, Township of	S. and G.	Various pits	Waterford.
Wellington, County of	S. and G.	W. Luther, W. Garafraxa and Maryborough tps.	Guelph, Box 258.
Wilks, Geo.	S.	Woodstock	Woodstock.
Willcox, Hervey	S.	Stamford tp., lots 4, 17	Niagara Falls, 985 Bridge St.
Wilson, M.	S. and G.	Vaughan tp., lot 25, con. IV.	Maple, R.R. 1.
Windsor Sand & Gravel Co.	S. and G.	Leamington	Walkerville.
Wright & Co.	S.	Korah, sec. XIII	Sault Ste. Marie.
Yarmouth, Township of	S. and G.	Yarmouth tp., lot 8, con. V.	St. Thomas.

The following companies, holding sand and gravel licenses from the Ontario Department of Mines, carried on dredging operations during the period:

SAND AND GRAVEL LICENSEES, 1925

Licensee	Location	Address
Caldwell Dredging Company, Ltd.	St. Clair river and Lake Erie	Windsor.
Canadian Dredging Company	Thunder Bay	Midland.
Chatham Sand & Gravel Company	Thames river	Chatham.
Considine-Reid, Ltd.	St. Clair river	Windsor.
Harbour Brick Company	Lake Ontario	Toronto.
Homegardner Sand Company	Lake Erie	Sandusky, Ohio.
Huron Sand and Gravel Company	Lake Huron	Sarnia.
Kilmer & Barber, Ltd.	Lake Erie	Toronto
Lake Erie Sand Company	Lake Erie	Sandusky, Ohio.
Lapish & Small	Lake Superior	Sault Ste. Marie, Mich.
McLean & Sons, A. B.	Lake Superior	Sault Ste. Marie.
Merlo, Merlo & Ray, Ltd.	St. Clair river	Ford.
National Sand & Material Co., Ltd.	Lake Erie	Welland.
Siddall, John P.	Lake Erie	Port Maitland.
Wallaceburg Sand & Gravel Co.	St. Clair river	Wallaceburg.

Sand-Lime Brick

The consumption of sand-lime brick in Ontario during the past five years has continued to increase. In 1925 there was marketed 66,392 thousand brick valued at $819,406 as against 54,460 M. worth $604,781 in 1924. During the latter year the sales value, due to price cutting among the manufacturers in Toronto, was much lower than formerly, and the average quotations were around $11.10 per thousand. This figure rose to $12.34 per thousand for the year 1925. An arbitary value of the lime entering into the manufacture of the product during 1924 was made, which, for the purposes of Table I, was deducted from the total value in order to avoid duplication in the statistics. In 1925, with more complete statistics available, the value of the lime consumed in the manufacture totalled $142,303 for ten companies operating eleven plants, the average

cost of which at the plants was approximately 43¼ cents per bushel. With the exception of the output from one plant in Prince Edward county the entire production of sand-lime brick came from Toronto and vicinity, where, because of cheapness, the product is gaining an increased popularity among the builders for certain portions of dwellings and other buildings, chiefly as inside brick to supplant brick made from clay.

Following is a statement of sand-lime brick production for the past five years, also comparative average price per thousand of common clay brick:—

SAND-LIME BRICK STATISTICS, 1920-1925

Year	No. of Plants Operated	No. of Employees	Wages	Quantity sold, M	Value		Average value per M of Common Clay Brick
					Total	Per M	
1921	6	131	$141,460	36,482	$534,531	$14 65	$17 68
1922	11	199	233,287	52,749	851,007	16 13	17 09
1923	8	205	235,991	60,080	897,960	14 94	16 77
1924	10	186	213,273	54,460	604,781	11 10	16 94
1925	11	208	213,556	66,392	819,406	12 34	15 28

SAND-LIME BRICK PRODUCERS, 1925

Name of Company	Address	Location of Plant
*Caledon Brick Company, Limited	240 Gilbert Ave., Toronto	Toronto.
Canada Sand-Lime Pressed Brick Company, Ltd.	28 Symes Road, Toronto	Toronto.
Don Valley Brick Works	114 Federal Bldg., Toronto	Todmorden.
Harbour Brick Company, Ltd.	408 Lumsden Bldg., Toronto	Toronto.
Hinde Bros.	134 Northlands Ave., Toronto	Toronto.
Toronto Brick Company, Ltd.	60 Victoria St., Toronto	Scarboro and Swansea.
West Lake Brick and Products Company, Ltd.	Wellington	West Lake.
Willcox Lake Brick Co., Ltd.	Richmond Hill	Willcox Lake.
York Sandstone Brick Co., Ltd.	Gerrard and Victoria Park Ave.	East Toronto.

*This company ceased operations in March, 1926.

Stone

As noted in Table I, the total output of stone of all grades was 3,023,594 tons valued at $2,817,335 as against 2,840,173 tons worth $2,789,368 in 1924. The table which follows shows the valuation of the several kinds of stone marketed or used during the past five years:—

VALUE OF STONE PRODUCTION, 1921-1925

Year	Limestone	Sandstone	Trap	Granite	Total
	$	$	$	$	$
1921	3,934,045	6,423	158,467	68,647	4,167,582
1922	2,547,485	9,454	167,630	245,357	2,969,926
1923	2,552,555	23,378	149,746	143,549	2,869,228
1924	2,551,291	30,038	133,743	74,296	2,789,368
1925	2,530,623	44,562	154,107	88,043	2,817,335

During 1925 the quantities marketed were 2,750,997 tons of limestone, 9,030 tons of sandstone, 248,446 tons of trap, and 15,121 tons of granite.

Both high calcium and dolomitic limestones are to-day becoming valuable for an increasing variety of uses, for example, in the paper industry pure limestone is required for the sulphate process, and dolomite for sulphide mills. Ground dolomite is used also in the manufacture of artificial stone in order to give the surface a glistening effect more or less similar to natural dressed stone. The term "granite" in the above table includes monumental stone and paving blocks.

Limestone was marketed for a variety of uses, as follows: Building, 17,183 tons; chemical and fluxing, 278,532 tons; rubble and rip rap, 85,957 tons; crushed stone for concrete and roads, 2,369,325 tons.

The following operated stone quarries in 1925:—

SANDSTONE

Name of Owner, Firm or Company	Location	Address
Robertson & Company, Ltd., D....	Nassagaweya tp.....	Toronto, 26 Queen St. E.
Rogers & Company, Ltd., F.....	Glen Williams.....	Toronto, 9 Queen St. W.

TRAP

Name of Owner, Firm or Company	Location	Address
Fort William, City of.....	Rifle Range.....	Fort William.
Mond Nickel Company, Ltd.....	Coniston.....	Coniston.
Ontario Rock Company, Ltd.....	Belmont and Methuen tps.	Toronto, Crown Office Bldg.

GRANITE

Name of Owner, Firm or Company	Location	Address
Brown, Robt.....	Leeds tp.....	Ottawa, 376 Sparks St.
Campbell & Lattimore.....	Findlay.....	Toronto, 146 King St. E.
Gordon Granite Company.....	Gananoque.....	Toronto, 18 Toronto St.
Hall, R. Reece.....	McDougall tp.....	Parry Sound.
Horne, Wm.....	Butler.....	Winnipeg, 377 Balmoral St.
Morrison, Wm.....	Coehill.....	Coehill.
Streets & O'Brien.....	Gananoque.....	Toronto, 47 Yonge St.

LIMESTONE

Name of Owner, Firm or Company	Location	Address
Barton, Municipality of	Barton tp	Hamilton, Court House.
Beachville White Lime Co. Ltd	Beachville	Beachville.
Bolender Bros	Haliburton	Haliburton.
Bourgie, J. B	Russell tp	Embrun.
Brule & Sons, E. D	Hogs Back	Billings Bridge.
Brunner Mond Canada, Ltd	Anderdon tp	Amherstburg.
Canada Crushed Stone Corp'n, Ltd.	West Flamboro tp	Hamilton, Sun Life Bldg.
Carleton, County of	Gloucester tp	Ottawa, Court House.
Cloutier, Grenon	Casselman	Casselman.
Cook & Son, J. S	Amabel tp	Wiarton.
Farmer & Sons, Geo	Gloucester tp	Ottawa, 45 Bertrand Ave.
Farr, Mrs. L. G	Haileybury	Haileybury.
Foster, R. R	Merivale Road	Ottawa, 278 Echo Drive.
Gallagher Lime & Stone Co., The	Barton tp	Hamilton, Upper James St.
Galt, City of	North Dumfries tp	Galt, City Hall.
Gordon Crushed Stone Co. Ltd., The	Hagersville	Toronto, 137 Confederation Life Bldg.
Gow, James	Fergus	Fergus.
Grenville Crushed Rock Co	Oxford tp	Merrickville.
Hagersville Contracting Co. Ltd	Walpole tp	Hagersville.
Hagersville Quarries, Ltd	Walpole tp	St. Thomas, 4 Flora St.
Haldimand County Good Roads System	Rainham tp	Hagersville.
Halliday, Fred	Gloucester tp	Ottawa, Quarries P.O.
Humberstone, Tp. of	Humberstone tp	Humberstone, R.R. 1.
Hydro-Electric Power Commission	Stamford tp	Toronto, 190 University Ave.
Innerkip, Village of	East Zorra tp	Innerkip, Box 218.
Keeling, James	Owen Sound	Owen Sound, 16th St. E.
Kingdon Mining Smelting & Mfg Co.	Galetta	Montreal, 314 Beaver Hall Hill.
Kingston Penitentiary	Portsmouth	Portsmouth.
Kirkfield Crushed Stone, Ltd	Kirkfield	Toronto, 136 Confederation Life Bldg.
Langton, Thos	Medonte tp	Coldwater.
Law Construction Company, Ltd	Bertie tp	Toronto, 625 Confederation Life Bldg.
Longford Quarry Company, Ltd., The	Rama tp	Orillia, 6 Peter St.
Markus, Ltd., William	Pembroke tp	Pembroke.
McDonell, Dibblee & Covey	Richmond and Wendover	Montreal, 26 Victoria Sq.
McQuigge, J. R	McNab tp	Arnprior.
Oliver Rogers Stone Company, Ltd.	Owen Sound	Owen Sound, 841 4th Ave. E.
Ontario Stone Corporation, Ltd	North Orillia tp	Toronto, 611 Excelsior Life Bldg.
Pirson, John	Grantham tp	Stevensville.
Provincial Secretary, Dept. of	Guelph tp	Toronto, Parliament Bldgs.
Queenston Quarries, Ltd	Niagara tp	St. Davids.
Quinlan, Robertson & Janin, Ltd	Crookston	Montreal, 50 Notre Dame St.W.
Quinton & Brundige	West of Brockville	Jasper.
Robertson & Co., Ltd., D	Nassagaweya tp	Toronto, 201 Crown Office Bldg.
Robillard & Son, H	Gloucester tp	Ottawa, 195 Nicholas St.
Roddy, J. M	Kingston	Kingston, 293 Division St.
Standard White Lime Company, Ltd	Beachville	Guelph, 15 Douglas St.
Stormont, Dundas and Glengarry, United Counties of	Finch tp	Cornwall, County Bldg.
Thames Quarry Company, Ltd	St. Marys	St. Marys.
Thompson, W. G	Orillia	Orillia.
Walker Bros	Stamford tp	Thorold.
Wehman, John	Kingston	Kingston.
Welland County Roads	Humberstone tp	Welland, Box 456.
Welland Ship Canal	Lincoln and Welland Cos.	St. Catharines.
Wentworth, County of	Saltfleet tp	Hamilton, Court House.
Wentworth Quarries, Ltd	Saltfleet tp	Vinemount.
Windmill Point Crushed Stone Co.	Bertie tp	Toronto, 625 Confederation Life Bldg.
Winnipeg Roofing Company, Ltd.	Silver Mountain, Thunder Bay district.	St. Boniface, Man.

Mining Revenue

The revenue of the Department of Mines for the fiscal year ending October 31st, 1925, is given in detail hereunder:—

REVENUE FOR THE YEAR ENDING OCTOBER 31, 1925

Mining Land Sales		$40,694 28
RENTALS—		
Mining Leases	$11,390 13	
Licenses of Occupation	6,163 91	
Gas Leases	25 00	
		17,579 04
Boring Permits		102 00
Sand and Gravel Royalty		98,117 81
Sand and Gravel Licenses		3,805 00
Miners' Licenses	$44,485 05	
Permits	3,171 00	
Recording Fees	38,823 25	
		86,483 30
MINE ASSESSMENT—		
Acreage Tax	$32,165 32	
Profit Tax	287,186 88	
Gas Tax	14,272 03	
Gas Licenses	6 00	
		333,630 23
Casual Fees	$4,855 20	
Temiskaming Testing Laboratories, Fees	18,745 85	
Metal Sales Act	122 15	
Chemical and Assay Office, Fees	2,378 44	
Cable Testing Machine, Fees	1,335 00	
Natural Gas Commissioners' Office, Fees	1,040 30	
Draughting Office, North Bay, Fees	321 50	
Mining Recorders, Rent of Old Office	50 00	
Sulphur Fumes Arbitrator, Damages Collected	3,859 36	
		32,707 80
REFUNDS—		
Explorations and Investigations	$152 40	
Mineral Collections	40 10	
Services and Salaries not otherwise provided for	100 00	
		292 50
Total		$613,411 96

MINING LANDS SOLD AND LEASED IN YEAR ENDING OCTOBER 31, 1924*

District	Sales			Leases			Total		
	No.	Acres	Amount	No.	Acres	Amount	No.	Acres	Amount
			$			$			$
Timiskaming	286	10,654.70	26,107 54	81	3,741.43	881 89	367	14,396.13	26,989 43
Cochrane	71	3,033.47	7,712 01	....	.....	.....	71	3,033.47	7,712 01
Thunder Bay	3	127.10	317 75	....	.....	.....	3	127.10	317 75
Sudbury	14	493.26	1,506 60	27	664.95	653 47	41	1,158.21	2,160 07
Algoma	14	1,697.34	4,259 58	....	.....	.....	14	1,697.34	4,259 58
Kenora	1	40.00	100 00	....	.....	.....	1	40.00	100 00
Nipissing	2	100.00	300 00	12	844.80	130 02	14	944.80	430 02
Elsewhere	9	510.87	1,223 31	....	.....	.....	9	510.87	1,223 31
Total	400	16,656.74	41,526 79	120	5,251.18	1,665 38	520	21,907.92	43,192 17

*These figures do not agree with the first two items of the revenue statement above which records collections or moneys actually received during the fiscal year.

MINING CLAIMS RECORDED IN THE SEVERAL MINING DIVISIONS, 1907-1925

Mining Division	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
Timiskaming	7,860	1,650	1,343	1,021	922	516	1,326	215	222	156	269	184	244	329	159	328	971	735	634
Coleman	291	270	150	40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sudbury	456	254	1,859	1,131	2,309	776	483	237	233	464	262	168	673	267	319	701	436	559	546
Sault Ste. Marie	291	100	.....	818	119	137	127	23	92	44	135	199	90	90	216	541	498	284	451
Port Arthur	317	370	475	207	183	180	182	353	641	172	180	66	171	108	120	296	222	300	494
Kenora	.....	73	102	95	89	91	.....	25	23	45	32	48	31	25	53	168	150	77	229
Parry Sound	102	56	.....	26	15	5	.....	2	....	10	25	12	39	33	Closed	.....	.....	.....	.....
Larder Lake	3,813	540	180	84	1,252	541	1,575	718	915	783	160	423	1,015	712	918	2,344	1,736	1,219	890
Montreal River	866	1,321	2,573	344	98	126	63	28	2	56	294	293	134	81	143	174	400	471	291
Gowganda	.....	.....	3,064	513	258	194	68	23	14	51	113	52	145	215	101	55	33	444	220
Porcupine	.....	.....	.....	2,150	3,756	538	496	240	262	401	236	48	136	192	273	760	1,424	556	620
Kowkash	.....	.....	.....	.....	.....	.....	.....	.....	....	160	135	2	9	21	3	148	106	438	150
Total	13,996	4,634	9,746	5,792	9,001	3,104	4,320	1,864	2,427	2,342	1,841	1,495	2,687	2,073	2,305	5,515	5,976	5,083	4,525

STATEMENT OF MONEYS REMITTED BY MINING RECORDERS FOR THE FISCAL YEAR ENDING OCTOBER 31, 1925

Mining Division	Name of Recorder	Address	Purchase Price	Forest Reserve Permits	Miner's Licenses	Recording Fees	Miscellaneous Fees	Total
			$	$	$	$	$	$
Sudbury	Campbell, C. A.	Sudbury	2,606 47	340 00	4,106 00	4,582 00	277 50	11,911 97
Porcupine	Donaghue, W. A.	S. Porcupine	3,833 03	170 00	3,998 00	4,595 25	693 75	13,290 03
Larder Lake	Ginn, H. G.	Swastika	25,995 55	20 00	4,845 00	8,589 50	1,492 50	40,902 55
Kenora	Holland, H. E.	Kenora	207 00	.....	710 00	949 25	16 50	1,882 75
Timiskaming	McAulay, N. J.	Haileybury	2,959 35	310 00	6,577 00	5,095 50	620 15	15,562 00
Sault Ste. Marie	Miller, W. N.	Sault Ste. Marie	3,088 30	50 00	1,833 00	2,646 50	115 25	7,733 05
Port Arthur	Morgan, J. W.	Port Arthur	501 75	930 00	3,366 50	4,375 50	109 25	9,283 00
Gowganda	Morgan, M. R.	Elk Lake	40 90	850 00	908 00	2,088 45	235 25	4,122 60
Montreal River	Morgan, M. R.	Elk Lake	1,226 72	.....	1,073 00	2,436 50	268 25	5,004 47
Kowkash	O'Rourke, M. F.	Tashota	.....	340 00	675 00	1,653 50	61 00	2,729 50
		Total	40,419 07	3,010 00	28,091 50	37,011 95	3,889 40	112,421 92

SUMMARY OF BUSINESS TRANSACTED IN THE SEVERAL MINING DIVISIONS DURING THE CALENDAR YEAR, 1925

Schedule	Sudbury	Porcupine	Larder Lake	Sault Ste. Marie	Port Arthur	Kowkash	Timiskaming and Coleman	Gowganda	Montreal River	Kenora	Total
1. No. of letters received during the year..	2,559	2,200	5,714	1,039	3,690	317	2,207	483	1,811	1,326	21,346
2. No. of letters written during the year..	1,776	2,054	5,320	486	3,284	338	1,819	429	1,477	1,132	18,115
3. No. of Miners' Licenses issued.....	320	377	239	211	317	41	385	83	18	71	2,062
4. No. of Miners' Licenses renewed.....	489	479	703	201	360	87	1,035	121	184	78	3,737
5. No. of Mining Applications recorded..	546	620	890	451	494	150	634	220	291	229	4,525
6. No. of Mining Applications cancelled..	300	478	684	179	138	26	468	84	45	58	2,460
7. No. of Agreements, Transfers, etc., recorded.....	297	338	808	137	156	86	483	52	115	122	2,594
8. Amount received for Miners' Licenses, Permits, Recording Fees, etc.....$	8,864 50	10,302 50	14,133 25	5,714 75	8,500 75	2,203 25	12,768 50	3,676 25	3,662 00	2,720 50	72,546 25
9. Amount received as Purchase Money or Rental.....$	3,007 33	3,491 32	25,548 18	4,038 53	501 75	Nil	3,597 88	193 20	974 27	200 00	41,552 46
10. No. of Claims of which surveyors' plans were filed during the year.....	33	95	224	33	14	Nil	73	3	32	3	510
11. No. of disputes entered.....	3	1	2	3	2	Nil	3	Nil	Nil	Nil	14
12. No. of disputed cases decided by Recorders.....	3	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	3
13. No. of appeals to Mining Court.....	Nil	Nil	1	1	Nil	Nil	Nil	Nil	Nil	Nil	2
14. No. of extensions of time granted.....	200	115	473	36	36	1	72	49	111	14	1,107
15. No. of Certificates of Record granted..	33	100	245	23	7	Nil	61	8	17	2	496
16. No. of Certificates of Performance of Work granted.....	34	37	296	27	6	Nil	71	8	15	3	497
17. No. of Claims for which papers were forwarded to the Department for issue of title.....	35	34	244	48	5	Nil	47	9	20	Nil	442
18. No. of Forest Reserve Permits issued..	25	16	Nil	5	95	27	34	78	Nil	Nil	280
19. No. of Substitute Miners' Licenses issued.....	7	8	Nil	3	2	Nil	10	2	2	3	37

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

The following statement, prepared by the Accounts Branch of the Department, gives details of the Profit Tax collected under the supervision of G. R. Mickle, Mine Assessor, for the fiscal year ending October 31, 1925:—

DETAILS OF PROFIT TAX

GOLD—		
Dome Mines Company, Ltd.	$20,784 71	
Hollinger Consolidated Gold Mines, Ltd.	152,296 62	
Lake Shore Mines, Ltd.	7,932 87	
McIntyre Porcupine Mines, Ltd.	18,932 31	
Teck-Hughes Gold Mines, Ltd.	6,775 97	
Wright-Hargreaves Mines, Ltd.	7,381 57	
Vipond Consolidated Mines, Ltd.	926 79	
		$215,030 84
SILVER—		
Castle-Trethewey Mines, Limited.	$3,026 04	
Keeley Silver Mines, Ltd.	24,405 87	
Lorrain Trout Lake Mines, Ltd.	353 29	
Menago Mining Co., Ltd.	130 86	
Mining Corporation of Canada, Ltd.	537 19	
Nipissing Mining Co., Ltd.	10,249 80	
		38,703 05
NICKEL-COPPER—		
International Nickel Co. of Canada, Ltd.	$21,777 74	
Mond Nickel Co., Ltd.	11,675 25	
		33,452 99
Total.		$287,186 88

Mining Company Incorporations

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

ONTARIO MINING COMPANIES INCORPORATED AND LICENSED, 1913-1925

Year	Incorporated		Extra-Provincial Companies Licensed	
	No.	Nominal Capital	No.	Capital for use in Ontario
		$		$
1913	119	78,000,000	12	21,735,000
1914	80	39,030,000	13	5,445,000
1915	59	42,005,000	2	10,200,000
1916	83	109,079,500	8	7,011,650
1917	100	117,183,000	7	7,202,000
1918	59	49,800,000	7	15,000,000
1919	149	223,600,000	10	9,554,197
1920	119	146,094,000	12	9,435,000
1921	67	105,715,000	6	1,030,000
1922	91	181,040,000	6	830,500
1923	88	179,295,500	6	1,775,000
1924	85	156,485,000	2	200,000
1925	70*	107,400,000	3	162,510

*Includes 4 companies which issued 9,010,000 shares of no par value.

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

MINING COMPANIES INCORPORATED IN ONTARIO IN 1925

Name of Company	Head Office	Date of Incorporation	Capital
			$
Abitibi Development Syndicate, Ltd.	Toronto	Feb. 26	250,000
Aconda Mines, Ltd.	Ottawa	Dec. 10	3,000,000
Agaunico Cobalt Mines, Ltd.	Cobalt	Nov. 25	2,500,000
Alberta Tar Sand Products, Ltd.	Toronto	Mar. 6	500,000
Algoma Exploration Company, Ltd.	Sault Ste. Marie	Mar. 25	240,000
Ankerite Gold Mines, Ltd.	South Porcupine	Oct. 26	2,000,000
Bellellen Lorrain Mines, Ltd.	Toronto	July 7	3,000,000
Blartner Mines, Ltd.	Sudbury	Aug. 4	40,000
Bonanza United Mines, Ltd.	Toronto	Oct. 9	3,000,000
British America Mines Operating Co., Ltd.	Toronto	Aug. 18	1,000,000
British Associated Oil Company, Ltd.	Toronto	Nov. 26	5,000,000
British Colonial Coal Mines of Canada, Ltd.	Toronto	Apr. 23	5,000,000
Cameron Gold Syndicate, Ltd.	Toronto	June 17	75,000
Canadian Tiles, Ltd.	Toronto	Apr. 30	500,000
Cabrera & Co., Ltd., Charles T.	Toronto	Dec. 19	150,000
Cobalt Argyros Mines, Ltd.	Cobalt	Nov. 16	*2,000,000
Cobalt Contact Mines, Ltd.	Toronto	Mar. 21	3,000,000
Crystal-Comstock Gold Mines, Ltd.	Toronto	Dec. 19	300,000
Dominion Silica Products, Ltd.	Ottawa	Jan. 30	40,000
Dundas Quarries, Ltd. (Private)	Hamilton	Apr. 25	*10,000
Elizabeth Feldspar Mines, Ltd.	Toronto	Mar. 31	450,000
Fisher Quebec Prospecting Syndicate, Ltd.	Timmins	Apr. 20	200,000
Frontier (Lorrain) Mines, Ltd.	Toronto	Feb. 24	3,000,000
Furness Gold Mines, Ltd.	Toronto	June 17	3,000,000
Gamebridge Limestone Products, Ltd., The	Beaverton	May 8	100,000
Garnet Abrasive Corporation, Ltd.	Depot Harbour	Mar. 30	500,000
Gold Hill Mines, Ltd.	Haileybury	Dec. 4	3,000,000
Grace Lake Gold Mines, Ltd.	Toronto	Mar. 6	1,000,000 *2,000,000
Great Eastern Ore & Mining Corporation, Ltd.	Madoc	Mar. 12	500,000
Gull-Kirk Gold Mines, Ltd.	Toronto	June 4	3,000,000
Harkness-Hayes Gold Mining Co., Ltd.	Schreiber	Nov. 10	1,000,000
Hazel Silver Mines, Ltd.	Toronto	Feb. 20	3,000,000
Hazelton Porcupine Gold Mines, Ltd.	Toronto	Apr. 16	2,000,000
International Alumina Company, Ltd.	Toronto	Feb. 19	3,000,000
Iroquois Exploration Syndicate, Ltd.	Toronto	Nov. 14	300,000
Jury Gold Mine Development Co., Ltd., The	Toronto	Aug. 11	2,000,000
Lakefield Lime Products, Ltd.	Lakefield	Oct. 21	300,000
Leonard Silver Mines, Ltd.	Toronto	Apr. 1	1,000,000
Lincoln Gas Company, Ltd.	Grimsby	Nov. 24	100,000
Martin Lorrain Silver Mines, Ltd.	Toronto	June 18	2,000,000
McCarthy-Webb Goudreau Mines, Ltd.	Toronto	Oct. 26	3,000,000
McKenzie Gold Mines, Ltd.	Toronto	Jan. 14	£600,000
Michael Syndicate, Ltd.	Sault Ste. Marie	Mar. 14	100,000
Mickle Silver Mines, Ltd.	Cobalt	Sept. 2	2,000,000
Minto Exploration Company, Ltd., The	Sault Ste. Marie	June 10	300,000
Mount Dennis Vitrified Claywares, Ltd.	Toronto	Apr. 4	300,000
National Feldspar Company, Ltd.	Toronto	May 11	40,000
Norbay Lorrain Silver Mines, Ltd.	North Bay	Apr. 18	2,000,000
Norbec Mining Corporation, Ltd.	Toronto	Mar. 19	2,000,000
Northern Gold Belt Mining Company, Ltd.	Toronto	Aug. 12	3,000,000
Northern Silver Lode Corporation, Ltd.	Haileybury	Apr. 14	1,500,000
Oil & Turpentine Company of Canada, Ltd.	Walkerville	Apr. 9	40,000
Osisko Lake Mines, Ltd.	Ottawa	Nov. 13	2,000,000
Ostrom Gold Mines, Ltd.	Toronto	Apr. 14	5,000,000
Penly Silver Mines, Ltd.	Toronto	June 11	2,000,000
Penn-Central Cobalt Mines, Ltd.	Toronto	Mar. 19	2,000,000
Pine Lake-Lorrain Silver Mines, Ltd.	Toronto	Mar. 4	2,000,000

*See footnote at end of table, page 60.

MINING COMPANIES INCORPORATED IN ONTARIO IN 1925—*Continued*

Name of Company	Head Office	Date of Incorporation	Capital
			$
Pioneer Prospectors Association, Ltd	Toronto	Apr. 9	50,000
Quinte Gold Mines, Ltd	Bowmanville	June 25	1,000,000
Seneca Silver Mines, Ltd	Toronto	June 11	1,000,000
Sarnia Gravel Company, Ltd	Sarnia	May 22	40,000
Serra S. Bruno Mining Company, Ltd., The	Trout Creek	June 18	500,000
Southern Production Company, Ltd	Ottawa	Jan. 2	2,000,000
Sterling Lumber Company, Ltd	Hamilton	Jan. 5	40,000
Trethewey-Ossian Mines, Ltd	Toronto	Jan. 30	3,000,000
United Algoma Mines, Ltd	Toronto	Jan. 29	*5,000,000
Verona Quarries, Ltd. (Private)	Hamilton	Nov. 25	100,000
Walker Silver Mines, Ltd	Toronto	Sept. 15	300,000
W. J. Nine Silver Mines, Ltd	Toronto	Sept. 11	1,000,000
Wood-Croesus Gold Mines, Ltd	Toronto	Nov. 16	2,000,000

Total—70 companies with total capital of $97,355,000 and £600,000.

*Shares of four companies, totalling 9,010,000 shares, without nominal or par value.

MINING COMPANIES LICENSED IN 1925

Name of Company	Head Office for Ontario	Date of License	Capital for use in Ontario
			$
British Allied Estates, Ltd	Toronto	May 27	12,510
British Sulphides-Smelting Company, Ltd	Toronto	June 30	50,000
Tonopah Canadian Mines Company	Haileybury	Feb. 5	100,000

Provincial Assay Office

As an aid in the development of the mineral resources of Ontario an assay office was established in July, 1898, by the Bureau (now Department) of Mines, at Belleville. For convenience the office was moved to 5 Queen's Park, Toronto, in November, 1911.

The Provincial Assayer, W. K. McNeill, reports as follows for 1925:—

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

FREE ASSAYS UNDER THE PROVISIONS OF THE MINING ACT OF ONTARIO

Mining Division	Samples received for Free Assays during 1925													
	Gold	Silver	Copper	Iron	Cobalt	Lead	Zinc	Tin	Nickel	Phosphorus	Silica	Tungsten	Platinum	Total
Eastern Ontario*	7	2	...	1	....	....	....	....	....	....	....	....	....	10
Fort Frances*	50	....	1	....	....	....	....	....	....	....	....	....	....	51
Kenora	17	4	....	....	....	....	....	....	....	....	....	2	....	23
Kowkash	17	6	....	....	....	....	....	....	....	....	....	....	1	24
Larder Lake	57	8	3	....	....	4	2	....	2	....	....	....	....	76
Montreal River	8	16	....	....	....	....	....	....	....	....	....	....	....	24
Porcupine	91	10	6	....	....	....	....	....	....	....	....	....	....	107
Port Arthur	95	15	....	11	....	....	....	....	....	....	....	....	....	121
Sault Ste. Marie	95	6	6	1	....	1	2	1	....	1	1	2	1	118
Sudbury	78	26	5	....	....	1	....	....	2	....	....	....	....	112
Timiskaming	10	31	1	....	2	....	1	....	....	....	....	....	....	45
Total	535	138	22	13	2	6	5	1	5	1	1	4	2	735

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

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. Assays per month ranged in number from 67 in November to 237 in September.

CUSTOMS ASSAYING AND GENERAL WORK, 1925

Gold	1,146 samples.
Silver	271 samples.
Copper	32 samples.
Iron	20 samples.
Radium	19 samples were submitted on which reports were issued. A number were radio-active.
Zinc	16 samples.
Arsenic	13 samples.
Lead	9 samples.
Limestone	6 samples.
Nickel	5 samples.
Oil	5 samples.
Platinum	8 samples.
Miscellaneous	25 samples of other minerals were tested. These included 4 potash; 3 each of cobalt, alumina and silica; 2 each of titanium and coal; 1 each of sulphur, talc, tin, gypsum, salt, barite, molybdenum and water.
Identification	115 samples were received by mail and reports issued. A large number were brought directly to the Laboratory; of these no record was kept.
Rocks	14 samples were submitted by geologists of the Department of Mines for complete analysis.
Total	1,711

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

TARIFF OF FEES FOR ANALYSES AND ASSAYS

	Fee
1. Assays:	
Gold	$1 50
Silver	1 50
Gold and silver in one sample	2 50
Platinum minerals	5 00
Gold and platinum minerals in one sample	7 00
Separation of platinum minerals	Prices on application.
2. Iron Ores:	
Iron (metallic)	$1 50
Silica	1 50
Iron and insoluble residue	2 50
Ferrous oxide	2 00
Phosphorus	3 00
Sulphur	2 50
Iron, sulphur, phosphorus and insoluble	8 00
Manganese	3 00
Titanium	4 00
Complete analysis	Prices on application.
3. Limestones, Dolomites, Marls, Clays, Shales:	
Determination of:	
Insolubles	$1 50
Silica	2 50
Ferric iron	3 00
Ferrous iron	2 00
Alumina	3 00
Lime	2 00
Magnesia	2 50
Potash	5 00
Soda	5 00
Alkalies (in one sample)	6 00
Water (combined)	2 00
Moisture	1 00
Carbon dioxide	2 00
Sulphur	2 50
Phosphorus anhydride	3 00

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

Determination of:

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

5. Coal, Coke, Peat, etc.:

Determination of:

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

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

7. Ores and Minerals:

Determination of:

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

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

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

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

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

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

The pulp of each sample is retained for future reference.

Directions

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

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

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

Samples should be addressed as follows:

Provincial Assay Office,
5 Queen's Park,*
Toronto, Ont.

Terms

Money in payment of fees, sent in by registered letter, post office order, postal note, ro 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.

*It is expected the Assay Office will be moved to the new East Block, Queen's Park, about May, 1927.

Departmental Correspondence

The volume of correspondence necessary for the work of the Department in all its branches is considerable. Figures supplied by the Files Branch show that for the fiscal year ending October 31, 1925, communications received through the several offices numbered 23,416, and communications sent out, 21,970.

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

Temiskaming Testing Laboratories

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

The following is a financial report for the year 1925, with comparative figures for previous years beginning with 1922:—

COMPARATIVE FINANCIAL STATEMENT OF THE TEMISKAMING TESTING LABORATORIES, 1922-1925

Schedule	1922	1923	1924	1925
Cash receipts	$18,096 19	$18,699 22	$26,032 20	$19,922 37
Earnings	17,749 51	20,117 81	25,417 61	20,041 08
Expenditures	19,173 19	19,781 25	23,206 66	20,043 31
Surplus or Deficit	D $1,424 68	S $336 56	S $2,200 95	D $2 23

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

Assaying.—Gold, 2,248 samples; silver, 3,374; copper, 389; silver bullion, 476; cobalt, 150; arsenic, 22; nickel, 52; zinc, 136; lead, 24; iron, 31; platinum, 20; miscellaneous, 24; moisture determination, 101.

Ore Testing.—Amalgamation, 6 lots; concentration, 1; cyanide, 14.

Silver Ore Milled and Sampled.—23 lots weighing 831.82 tons.

Base Bullion Melted.—164 bars containing 149,084.50 gross ounces.

Gold Ore Purchased.—20.14 tons for which $1,141.08 was paid.

Cobalt-Silver Residues Shipped to Deloro.—25 cars containing 948.88 tons in which was contained 39,137 ounces of silver.

CLASSES FOR PROSPECTORS, 1925-26

By Dr. W. L. Goodwin, Instructor

Introduction

As some of the material for the classes had been exhausted I spent the time from September 10 to 26, 1925, in collecting rock and mineral specimens, in the neighbourhood of Kingston, Cobalt, Kirkland Lake, Timmins and South Porcupine. Large quantities of material were obtained from the Mining Laboratory of Queen's University through the kindness of professors S. N. Graham and J. G. McKay. By permission of Dr. Chas. Camsell, Deputy Minister of Mines, Ottawa, some surplus material was obtained from the research laboratory of the Mines Branch and I wish to thank C. S. Parsons for assistance in selecting it. By permission of the Deputy Minister, E. Poitevin, of the Victoria Memorial Museum, supplied me with a considerable quantity of chips from the materials used in making standard collections for schools and prospectors.

On October 13 I began the work of preparing the materials for the season's campaign, being assisted by M J. Splane of Haileybury. This preparation consists of breaking up the material and packing it in boxes, one for each place where a class is held. The material must be inspected so as to make sure it will be suitable when broken into pieces about the size of a walnut. A second box for each place is filled with the printed envelopes in which the members of the classes put their specimens after identification, and in this box are also packed the necessary printed tables for the identification of minerals and rocks, a copy of which is given to each member of the class.

After completing these preparations the classes were carried on in sixteen places, beginning on November 11. Mr. Splane accompanied me and gave efficient assistance throughout the season.

After long experience with these classes, rather a new departure in education, and as a consequence of careful study of the requirements of prospectors, it is possible to compress into the eight lessons of two hours each and the five evening lectures, a pretty complete outline, so that the prospector has something to guide him in filling in the details as he gets opportunity. A feature that is made more prominent in the evening lectures is the relation of rocks to mineral deposits and the selection of the most promising territory for prospecting. By means of lantern slides showing geologically coloured maps of Ontario mining areas, it is possible to show and emphasize the geological features of these areas. This part of the work is of growing interest to the prospector.

The classes were held for eight days in each place, the class at the first place, the Kingdon Lead Mine, Galetta, having been opened on November 11, and that at the last place, Fort William, having been closed on May 18. Fort William was not on the programme as advertised before the classes began, but was added at the request of the Mayor and City Council. In spite of the late date the class was particularly well attended.

In every place visited, the advertising by posters and in some cases through the local newspapers was arranged by friends, who also saw to the selection of

places for the classes to meet. For this volunteer service and much help in other ways the following are mentioned gratefully:—

R. R. Rose, Manager, Kingdon Lead Mine, Galetta.
W. N. Miller, Mining Recorder, Sault Ste. Marie.
J. W. Curran, Editor, Sault Star, Sault Ste. Marie.
A. V. J. Selkirk, Franz.
G. L. White, Chapleau.
C. A. Campbell, Mining Recorder, Sudbury.
Bruce L. Morrison, Port Arthur.
A. C. Vaughan, Sioux Lookout.
J. Cordingley, Nakina.
R. C. Mortson, Cochrane.
E. L. Longmore, Timmins.
J. Atwell Hough, Matheson.
H. Geo. Ginn, Mining Recorder, Swastika.
W. E. Loudon, Kirkland Lake.
J. H. Grainger, Larder Lake.
H. Weeks, Mayor, Englehart.
J. H. McCrea, Mayor, New Liskeard.
J. E. Crawford, Mayor, Fort William.
A. McNaughton, City Clerk, Fort William.
Alf. Cooper, Fort William.

There follows a statement of the places where classes were held, with the average attendance and the registration. As in former years, only those attending the day classes were registered. No attempt was made to keep a record of those attending the evening lectures, but the numbers were counted:—

AVERAGE ATTENDANCE AT CLASSES FOR PROSPECTORS, 1925-26.

Place	Day Classes	Evening Lectures	Registration
Galetta	6	48	27
Sault Ste. Marie	45	61	74
Franz	9	39	17
Chapleau	11	18	22
Sudbury	31	27	49
Port Arthur	67	77	100
Sioux Lookout	15	48	30
Nakina	24	46	51
Cochrane	10	19	22
Timmins	16	46	39
Matheson	15	67	34
Kirkland Lake	20	26	39
Larder Lake	5	12	9
Englehart	40	59	85
New Liskeard	32	41	55
Fort William	28	75	60
Total	374	709	713

Comparison of the totals with those of 1924-1925 shows a considerable increase. Part of this is explained by the fact that classes were held in sixteen places in 1925-1926 but in only fifteen the preceding season. Making due allowance for this there still remains a substantial advance in numbers, as follows:—

	Day Classes	Evening Lectures	Registration
For 1924-1925	285	617	528
" 1925-1926	346	634	653
Increases	61	17	125

MINING ACCIDENTS IN 1925

By

Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, G. E. Cole, Timmins; D. G. Sinclair, Sudbury; J. G. McMillan, Cobalt; A. R. Webster, Toronto.

Accidents during 1925

During the year 1925 at the mines, metallurgical works, quarries, clay, sand, and gravel pits regulated by the Mining Act of Ontario, there were 2,263 accidents reported to the Department up to January 25, 1926. Thirty-seven of these accidents were fatal, resulting in the death of forty-two men. This is an increase over 1924 of two men killed. In 1924, fourteen men were killed at the quarries, clay, sand, and gravel pits; and in 1925, nine men were killed in these operations.

Distribution	Fatal	Non-fatal	Total
Mines, underground	28	1,375	1,403
Mines, surface	2	394	396
Metallurgical works	2	240	242
Quarries	3	167	170
Clay, sand, and gravel pits	2	50	52
Total	37	2,226	2,263

Workmen's Compensation Rates

The assessment per $100 of pay-roll made by the Workmen's Compensation Board is based on the actual cost of the accidents occurring in each class during the previous year, and consequently shows the accident hazard of each class.

The rates for the years 1922 to 1925, inclusive, were as follows:—

Schedule	1922 Adjusted	1923 Adjusted	1924 Adjusted	1925 Provisional
Silver mining	$2.40	$2.20	$2.40	$2.40
Treatment of ores, with heat, in a silver-mining industry	1.20	1.10	1.20	1.20
Treatment of ores, without heat, in a silver-mining industry	.60	.50	.60	.60
Gold mining	2.40	2.20	4.00	4.00
Treatment of ores, with heat, in a gold-mining industry	1.20	1.10	2.00	2.00
Treatment of ores, without heat, in a gold-mining industry	.60	.50	.90	.90
Nickel or nickel-copper mining	2.75	2.50	4.00	4.00
Treatment of ores, with heat, in a nickel or nickel-copper mining industry	1.40	1.25	2.00	2.00
Treatment of ores, without heat, in a nickel or nickel-copper mining industry	.60	.50	.90	.90
Mining N.O.S.	2.25	2.00	2.40	2.40
Treatment of ores or minerals, with heat, in an industry in this group	1.10	1.00	1.20	1.20
Treatment of ores or minerals, without heat, in an industry in this group	.60	.50	.60	.60
Iron smelting, as a business	2.00	1.80	2.00	2.00
Treatment of ores or minerals, with heat, N.O.S., as a business	2.00	1.80	2.50	2.50
Treatment of ores or minerals, without heat, N.O.S., as a business	.60	.50	.60	.60
Refining of nickel, as a business	1.50	1.50	2.50	2.50
Sand, shale, clay, or gravel pits	2.75	2.25	3.50	3.50
Quarries, as a business; stone crushing	5.00	4.00	5.00	5.00

Fatal Accidents

A comparison of fatal accidents for the last five years is given in the following table:—

Distribution	1921	1922	1923	1924	1925
Mines, underground	11	15	21	23	30
Mines, surface	1	3	3	1	1
Metallurgical works	4	0	4	2	2
Quarries, clay and sand pits	8	12	2	14	9
Total	24	30	30	40	42

By months, the fatalities occurred as follows:—

January	2	July	2
February	0	August	5
March	5	September	4
April	8	October	3
May	3	November	4
June	5	December	1
Total			42

Classifying the fatalities according to the industry gives the following:—

Nickel mines and metallurgical works	5
Silver mines and refineries	7
Gold mines and mills	18
Lead mines	3
Quarries	7
Clay, sand, and gravel pits	2
Total	42

ANALYSIS OF FATALITIES AT MINES, 1921-1925

Cause	1921	1922	1923	1924	1925
	per cent.	per cent.	per cent.	per cent.	per cent.
Falls of ground	33.33	11.11	25	25	19.35
Shaft accidents	16.66	44.44	16.66	29.16	19.35
Explosives	16.66	11.11	20.83	16.66	25.8
Miscellaneous underground	25	16.66	25	25	29.03
Surface	8.33	16.66	12.5	4.16	6.45

TABLE OF FATAL ACCIDENTS IN MINES, METALLURGICAL WORKS, QUARRIES, AND GRAVEL, SAND, AND CLAY PITS, 1901-1925

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
1901	13	4,135	550	4,685	2.77
1902	10	4,426	450	4,876	2.05
1903	7	3,499	400	3,899	1.79
1904	7	3,475	400	3,875	1.8
1905	9	4,415	500	4,915	1.83
1906	11	5,017	750	5,767	1.9
1907	22	6,305	1,140	7,445	2.93
1908	47	7,435	1,750	9,185	5.11
1909	49	8,505	2,000	10,505	4.66
1910	48	10,862	2,000	12,862	3.73
1911	49	12,543	2,000	14,543	3.37
1912	43	13,108	2,000	15,108	2.84
1913	64	14,293	2,000	16,293	3.93
1914	58	14,361	1,500	15,861	3.6
1915	22	13,114	1,500	14,614	1.51
1916	51	14,624	2,000	16,624	3.07
1917	36	16,791	1,000	17,791	2.02
1918	32	14,726	500	15,226	2.1
1919	39	11,926	1,000	12,926	3
1920	29	10,486	1,000	11,486	2.61
1921	24	8,436	1,000	9,436	2.54
1922	30	9,914	1,500	11,414	2.63
1923	30	12,250	1,500	13,750	2.18
1924	40	14,050	1,500	15,550	2.57
1925	42	14,075	1,500	15,575	2.69

The occupation and nationality of the men killed are set out in the following table:—

Occupation	English-speaking	Finn	Norwegian	Czecho-Slovak	Austrian	Hungarian	Croatian	Italian	Total
Miner	11	2		1	1	1	1		17
Labourer	7							1	8
Shaftman	3								3
Electrician	2								2
Shift boss	2								2
Blaster	1				1				2
Shoveller	1			1					2
Brakeman	1								1
Deckman			1						1
Scaler	1								1
Teamster	1								1
Shovel operator	1								1
Trammer	1								1
Total	32	2	1	2	2	1	1	1	42

The ages of the men killed were as follows:—

Age	14-16	17-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	Total
Number killed.	1	5	10	10	4	3	5	2	1	1	42

Accidents from Explosives

Cause	Number of accidents	Number injured	
		Fatal	Non-fatal
Struck by rock from blast	4	1	3
Detonator exploded	1		1
Premature explosion	6	4	4
Delayed too long lighting fuse	2	1	1
Drilled into explosive	4	3	2
Sledging, struck explosive	3		3
Returned to delayed blast	3		3
Reloading missed hole	1		1
Explosion while tamping	1		1
Delayed by gas after lighting fuse	1		1
Delayed by illness after lighting fuse	1	1	
Picked into explosive	2		2
Total	29	10	22

Infection

Records show that infection followed in 193 cases out of a total of 2,226 non-fatal accidents in 1925:—

Location	No. of accidents	Accidents followed by infection	Per cent. infection
Mines, underground	1,375	131	9.5
Mines, surface	394	36	9.1
Metallurgical works	240	20	8.3
Quarries, clay, sand, and gravel pits	217	6	2.7
Total	2,226	193	8.67

Prosecutions

Before Magistrate Hawkshaw, in the County Police Court at London on February 23, W. H. Thornton was fined $10 and costs for removing material from a gravel pit by undermining. Information was laid against Mr. Thornton, and it was expected that the penalty provided for under Subsection 1, Section 179, would be imposed if he were found guilty. His defence was that the particular gravel pit which was being undermined was on a road allowance in the subdivision of Manor Park, in the county; that he could not keep teamsters out of this pit; and that while he was charging 52½ cents a load, the charge was really for the privilege of crossing his property. The magistrate then made the fine under Subsection 2, Section 179.

Walker Brothers, quarry owners, were fined $100 and costs by Magistrate J. H. Campbell, at Thorold, on June 25, 1925. The charge was that blasting caps and electric detonators were kept in the magazine with explosives.

W. E. McCaul, Mount Dennis, was tried before Magistrate Brunton on August 6 and August 20, 1925, for employing a boy under sixteen years of age, operating a sand pit with the banks not at an angle of safety, and negligence. He was convicted on the first two charges and fined $200 and costs. The charge of negligence was dismissed.

William G. Teal, Niagara Falls, was tried before Magistrate Fraser, on September 4, 1925, for operating a sand pit in Stamford township with banks not at an angle of safety. The case was dismissed.

Before Magistrate Atkinson at Haileybury, on September 12, Sylvester Carroll, John Culhane, and Godfrey Billedeau pleaded guilty to the charge of violating Regulation 50a, Section 164, of the Mining Amendment Act, by riding the bucket on or about August 29 at the Red Rock shaft of the Cobalt Contact mine. A fine of $10 and $6 costs was imposed in each case.

Hagersville Quarries, Limited, was tried before Magistrate Massie on September 24, 1925, for violation of Regulation 203, Section 164, of the Mining Amendment Act, in not providing adequate clearance from the ground for 550-volt lines leading to the drills. They were convicted and fined $100 and costs. An appeal was heard by Judge Hopkins, in the fourth division court of the county of Haldimand, on November 27. Judgment was given on December 7,

when the appeal was allowed and the conviction quashed on the grounds that lines leading to the drills cannot be considered to be supply lines under Section 203.

At South Porcupine before Magistrate S. Atkinson, on November 5, 1925, W. S. Cowan was fined $100 and costs for being intoxicated at the Consolidated West Dome Lake mine, a violation of the Mining Amendment Act, 1919.

MINES OF ONTARIO IN 1925

By

Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, J. G. McMillan, Cobalt; D. G. Sinclair, Sudbury; Geo. E. Cole, Timmins; A. R. Webster, Toronto.

As an introduction to a description of the mines and metallurgical plants of the province, it will probably be found advantageous to give a list of the same. The list which follows is alphabetically arranged, both for metals or minerals extracted, and also for the names of the companies concerned. The inclusion of any given property in this list does not necessarily imply that it is a producing one, or that it is being worked at the present time. The table contains the names of all operating properties and works inspected in 1925.

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

MINES AND METALLURGICAL WORKS

Operator	Mine	Manager	Address
COAL			
British-Colonial Coal Mines, Ltd....	British-Colonial..	A. Wilson.....	Larchwood.
DOLOMITE			
Carfrae, A. J. J.....	Carfrae.....	A. J. J. Carfrae....	Bancroft.
FELDSPAR			
Anderson, J. G. (lessee).....	McPhee.....	.....	Lucknow.
Angus & Taylor, Ltd.....	Angus & Taylor..	R. Y. Angus.....	North Bay.
G. C. L. Cotnam.....	Cotnam.....	Lamarche Bros.....	Pembroke.
Craig, T. H.....	Craig.....	.....	Verona.
Cronk & Van Luven.....	Cronk & Van Luven	A. J. Van Luven...	Hartington.
Crystal Feldspar Co.....	Crystal.....	P. J. Dwyer.....	Hybla.
Dewar, Duncan, & Gibson, W. H....	Aylen.....	Duncan Dewar.....	Pembroke.
Elizabeth Feldspar Mines, Ltd.....	Elizabeth.....	F. D. Henderson...	Sudbury.
Ferril, J. T.....	Ferril.....	.....	Bird's Creek.
Genesee Feldspar Co., Inc.....	Genesee.....	P. MacDonald.....	Hybla.
Holditch & Checkley (lessee).....	Wanup.....	E. Holditch.....	Sudbury.
Mackey Feldspar Co.....	Mackey.....	Rudolph Carniel...	Mackey.
McQuire-Robinson Radium & By-Products Co., Ltd.	McQuire.....	P. W. Checkley....	Mackey.
Northern Feldspar Mines, Ltd.....	Northern.....	A. Weisman.....	Sudbury.
O'Brien & Fowler, Ltd.....	O'Brien & Fowler	C. C. Orser.....	Mattawa.
Purdy, George.....	Purdy.....	.....	Eau Claire.
Rock Products Co.....	Rock Products...	W. A. Hannah.....	Toledo, Ohio.
Stewart, R. T.....	Stewart.....	.....	Sudbury.
Vaillancourt, E. D.....	Vaillancourt.....	.....	Dill Siding.

MINES AND METALLURGICAL WORKS—*Continued*

Operator	Mine	Manager	Address
	GOLD		
Ankerite Gold Mines, Ltd	Ankerite	H. E. Doelle	Box 535, South Porcupine.
Argonaut Consolidated Mines, Ltd.	Argonaut	D. R. Thomas	Argonaut.
Baldwin Gold Mining Co., Ltd	Baldwin	M. P. McDonald	Kenogami Lake.
Barry-Hollinger Gold Mines, Ltd	Barry-Hollinger	L. B. Smith	Boston Creek.
Bennett Mining Co., Ltd	Bennett	James Houston	Sesekinika.
Bennett Mining Co., Ltd	Smith-Labine	James Houston	Sesekinika.
Blue Quartz Gold Mines, Ltd	Blue Quartz	J. G. McGregor	Matheson.
Bosquet Gold Mines, Ltd	Bosquet		
British Canadian Mines, Ltd	Foley	W. N. Hutchings	Mine Centre.
Canadian Associated Goldfields, Ltd.	Associated Goldfields.	T. A. Graves	Larder Lake.
Champion Gold Mines, Ltd	Champion	Charles Brent	Kenora.
Clines Canadian Gold Mines, Ltd	Cline	O. P. Powell	Goudreau.
Coniaurum Mines, Ltd	Goldale	John Redington	Schumacher.
Coniaurum Mines, Ltd	Newray	John Redington	Schumacher.
Coniaurum Mines, Ltd	Strong-Bow	John Redington	Schumacher.
Consolidated West Dome Lake Mines, Ltd.	Dome Lake	Duncan McPhail	Box 523, South Porcupine.
Continental Mines, Ltd	Continental	J. P. Hussey	Kirkland Lake.
Cooper Gold Mines, Ltd	Cooper	J. C. Kirkland	Wawa.
Cooper Gold Mines, Ltd	Minto	J. C. Kirkland	Wawa.
Crown Reserve Mining Co., Ltd	Crown Reserve	N. J. Everett	Kirkland Lake.
Dome Mines, Ltd	Dome	H. P. De Pencier	South Porcupine.
Gold Hill Mining Co., Ltd	Gold Hill	D. H. Angus	Haileybury.
Gosselin Syndicate	Gosselin	P. Gosselin	Timagami.
Goudreau Gold Mines, Ltd	Goudreau	A. R. McDonald	Goudreau.
Harker Gold Mines, Ltd	Harker	Horace G. Young	Matheson.
Harkness-Hays Gold Mining Co., Ltd.	Harkness-Hays	W. D. Hays	Schreiber.
Harvey-Kirkland Mines, Ltd	Harvey-Kirkland	A. McLean	Kirkland Lake.
Hollinger Consolidated Gold Mines, Ltd.	Hollinger	A. F. Brigham	Timmins.
Kirk Gold Mines, Ltd	Kirk	H. L. Donaldson	Kirkland Lake.
Kirkland Hunton Mines, Ltd	Hunton	John McPhee	Kirkland Lake.
Kirkland Lake Gold Mining Co., Ltd.	Kirkland Lake	William Sixt	Kirkland Lake.
Kirkland Rand, Ltd	Kirkland Rand	W. R. Osborne	Kirkland Lake.
Lake Shore Mines, Ltd	Lake Shore	E. B. Knapp	Kirkland Lake.
McCarthy-Webb Goudreau Mines, Ltd.	McCarthy-Webb	M. B. R. Gordon	Goudreau.
McIntyre-Porcupine Mines, Ltd	McIntyre	R. J. Ennis	Schumacher.
McMaster Syndicate	McMaster	Harry McMaster	Rose Grove.
McMillan Development Co. (under option),	Gold Nugget	Ewen J. McMillan	Ess Creek.
March Gold, Ltd	March	E. S. McEwen	South Porcupine.
Morning Star Mines	Morning Star	H. P. Prather	Eagle River.
Night Hawk Peninsular Mines, Ltd.	Night Hawk Peninsular.	A. J. Keast	Connaught.
Northland Gold Mines, Ltd	Northland	J. J. Byrne	Kirkland Lake.
Ore Chimney Mining Co., Ltd	Ore Chimney	J. M. Wolchuck	Northbrook.
Porcupine Paymaster Mines, Ltd	Paymaster	H. E. Clement	South Porcupine.
Power & Mines Syndicate, operating under contract to purchase.	Grace (Michipicoten).	R. P. Teare	Michipicoten River.
Queen Lebel Gold Mines, Ltd	Queen Lebel	E. B. Wood	Kirkland Lake.
Shield Development Co., Ltd	Huronian	Jas. G. Harkness	Kashabowie.
Sylvanite Gold Mines, Ltd	Sylvanite	C. E. Rodgers	Kirkland Lake.
Teck-Hughes Gold Mines, Ltd	Teck-Hughes	D. L. H. Forbes	Kirkland Lake.
Tough-Oakes Burnside Gold Mines, Ltd.	Tough-Oakes Burnside.	Alan Stuart	Kirkland Lake.
Vipond Consolidated Mines, Ltd	Vipond	R. E. Dye	Timmins.
Walsh-Katrine Gold Mines, Ltd	Walsh-Katrine	C. W. Dolby	Larder Lake.
Western Ontario Mines, Ltd	Fenning	Louis Fenning	Schreiber.
Wright-Hargreaves Mines, Ltd	Wright-Hargreaves	James E. Grant	Kirkland Lake.

MINES AND METALLURGICAL WORKS—*Continued*

Operator	Mine	Manager	Address
GRAPHITE			
Black Donald Graphite Co., Ltd.	Black Donald	C. N. Daly	Calabogie.
GYPSUM			
Ontario Gypsum Co., Ltd.	Caledonia	A. J. Parkhurst	Caledonia.
Ontario Gypsum Co., Ltd.	Lythmore	A. J. Parkhurst	Caledonia.
Seneca Gypsum Co., Ltd.	Seneca	W. T. Walsh	Caledonia.
LEAD			
Forbes Galena Mines, Ltd.	Frontenac	John M. Forbes	Ottawa.
Kingdon Mining, Smelting & Manufacturing Co., Ltd.	Kingdon	R. R. Rose	Galetta.
MICA			
Loughborough Mining Co., Ltd.	Lacey	G. W. McNaughton	Sydenham.
S. Orser & D. J. Wilson	Orser & Wilson		Bancroft.
NICKEL			
International Nickel Co. of Canada, Ltd.	Creighton	J. L. Agnew	Copper Cliff.
International Nickel Co. of Canada, Ltd.	No. 3 mine	J. L. Agnew	Copper Cliff.
Mond Nickel Company, Ltd.	Frood	A. D. Carmichael	Box 480, Sudbury.
Mond Nickel Company, Ltd.	Garson	A. L. Sharp	Garson.
Mond Nickel Company, Ltd.	Levack	F. J. Eager	Levack.
Mond Nickel Company, Ltd.	Worthington	W. J. Mumford	Worthington.
SILVER			
Beaver Auxiliary Mines, Ltd.	Beaver	H. L. Donaldson	Elk Lake.
Brewer, Sullivan & Richardson (lessee)	Adanac	Roy Sullivan	Cobalt.
Canadian Lorrain Silver Mines, Ltd.	Canadian Lorrain	Hugh MacMillan	Silver Centre.
Capitol Silver Mines, Ltd.	Capitol	W. J. Dobbins	Bestel.
Castle-Trethewey Mines, Ltd.	Castle-Trethewey	H. G. Young	Bestel.
Clifton Consolidated Mines, Ltd.	Provincial	Maurice E. Young	Cobalt.
Cobalt Contact Mines, Ltd.	Cobalt Contact	J. M. C. Dunlop	Cobalt.
Cobalt Contact Mines, Ltd. (lessee)	Green-Meehan	J. M. C. Dunlop	Cobalt.
Cobalt Contact Mines, Ltd. (lessee)	Law	J. M. C. Dunlop	Cobalt.
Cobalt Contact Mines, Ltd. (lessee)	Red Rock	J. M. C. Dunlop	Cobalt.
Coleroy Gowganda Mines, Ltd.	Coleroy	John W. Shaw	Gowganda.
Colonial Mining Co.	Colonial	J. P. Hussey	Cobalt.
Crescent Silver Cobalt Mining Co., Ltd.	Crescent	S. W. Barber	Guelph.
Doherty-Easson Mining Synd., Ltd. (under option)	Penn-Canadian	J. C. Houston	Haileybury.

MINES AND METALLURGICAL WORKS—*Continued*

Operator	Mine	Manager	Address
	SILVER—*Continued*		
Genesee Mining Co., Ltd	Genesee	L. F. Steenman	Cobalt.
Gowganda-Duggan Silver Mines, Ltd.	Gowganda-Duggan	Jas. A. McVichie	Gowganda.
Gowganda Keora Silver Mines, Ltd.	Keora	Thomas Reilly	Gowganda.
J. W. Hamilton, *et al*	Hamilton	Frank Clement	Gillies Depot.
Haultain Mining Co., Ltd	Haultain	F. A. S. Carnegie	Gowganda.
Hector Silver Mines, Ltd.	Hector	W. J. Adair	Haileybury.
Huronian Belt Company	W. J. Nine	Leonard Smith	Gowganda.
Hylands-Gardiner-Johnston (under option).	Hylands-Gardiner-Johnston.	C. L. Hershman	Gowganda.
Keeley Silver Mines, Ltd.	Keeley	M. C. H. Little	Silver Centre.
Kerr Lake Mines, Ltd.	Kerr Lake	R. R. Brown	Cobalt.
Lakeside Lorrain Silver Mines, Ltd.	Lakeside Lorrain.	F. V. Marsden	Silver Centre.
La Rose Mines, Ltd.	La Rose	G. E. H. Booth	Cobalt.
Lorrain Consolidated Mines, Ltd.	Lorrain Consolidated.	Horace F. Strong	Haileybury.
Lorrain Trout Lake Mines, Ltd., under management of Mining Corporation of Can., Ltd.	Trout Lake	M. F. Fairlie	Cobalt.
McKinley-Darragh-Savage Mines of Cobalt, Ltd.	McKinley	H. C. McCloskey	Cobalt.
McKnight, Alex., *et al* (lessee)	Giant Silver Nugget.	Owen Enright	Cobalt.
McLeod, John H. (lessee)	Foster	John H. McLeod	Giroux Lake.
Millcrest Mining Co., Ltd.	Millcrest	W. H. Fairburn	Bestel.
Mining Corporation of Canada, Ltd.	Mining Corporation.	M. F. Fairlie	Cobalt.
Mining Corporation of Canada, Ltd.	Crompton	M. F. Fairlie	Cobalt.
Mining Corporation of Canada, Ltd.	Frontier	M. F. Fairlie	Cobalt.
Mining Corporation of Canada, Ltd.	Peterson Lake	M. F. Fairlie	Cobalt.
Newton Lorrain Syndicate	Newton	William Newton	Cobalt.
Nipissing Mining Company, Ltd.	Nipissing	Hugh Park	Cobalt.
Nipissing Mining Company, Ltd.	Nipissing Lorrain.	Hugh Park	Silver Centre.
Northern Extension Cobalt Mines, Ltd.	Agaunico	T. R. Buchanan	Cobalt.
O'Brien, M. J., Ltd.	Miller Lake O'Brien.	H. G. Kennedy	Bestel.
O'Brien, M. J., Ltd.	O'Brien	J. G. Dickenson	Cobalt.
Ontario Solid Silver Mines, Ltd.	Solid Silver	James A. McRae	Cobalt.
Reinhardt, Carl (lessee)	Crown Reserve	Carl Reinhardt	Cobalt.
Shaw, John W., *et al* (lessee)	Hudson Bay	Joseph Gaynor	Cobalt.
Silver Bullion Mines, Ltd.	Silver Bullion	Horace F. Strong	Haileybury.
Silver Sill Mining Co., Ltd.	Silver Sill	Horace F. Strong	Haileybury.
Tonopah Canadian Mines Co. (under option).	Morrison	Ernest Craig	Gowganda.
Tonopah Canadian Mines Co. (under option).	Walsh	Ernest Craig	Gowganda.
Trainmen Silver Mining Co., Ltd.	McAndrew	John J. McAndrew.	Cobalt.
Victory Silver Mines, Ltd.	Victory	W. D. Taylor	Cobalt.
Wigwam Silver Mines, Ltd.	Wigwam	John W. Sanderson.	Gowganda.
	SOAPSTONE		
Grace Mining Co., Ltd.	Grace	W. J. Richards	Kenora.
Wood, H. H	Wood	H. H. Wood	Mine Centre.

MINES AND METALLURGICAL WORKS—*Continued*

Operator	Mine	Manager	Address
TALC			
Asbestos Pulp Co., Ltd.	Asbestos Pulp.	Roy Taylor	Madoc.
Gillespie, Geo. H., Co., Ltd.	Henderson	Geo. H. Gillespie	Madoc.
METALLURGICAL WORKS			
Algoma Steel Corporation	Blast furnace	Jas. H. Bell	Sault Ste. Marie.
Cobalt Reduction Co., operated by Mining Corporation of Canada, Ltd.	Silver refinery	M. F. Fairlie	Cobalt.
Deloro Smelting and Refining Co., Ltd.	Silver refinery	S. B. Wright	Deloro.
International Nickel Company of Canada, Ltd.	Blast furnace	Donald MacCaskill	Copper Cliff.
International Nickel Company of Canada, Ltd.	Nickel refinery	H. W. Walter	Port Colborne.
Mond Nickel Company, Ltd.	Blast furnace	John F. Robertson	Coniston.
Steel Company of Canada, Ltd.	Blast furnace	H. G. Hilton	Hamilton.

QUARRIES

County	Operator	Address	Location	Product
Algoma district	Dominion Mines & Quarries, Ltd	McLennan	East Neebish island	Quartzite, coarse and screened.
Bruce	Alabastine Co., Ltd	Teeswater	Lot 14, Con. VI, Culross	Hydrated lime.
Carleton	Belanger, Victor	Hawkesbury	Gloucester tp	Limestone for roads.
"	Robillard, H., and Sons	Quarries, via Ottawa	Gloucester tp	Limestone for roads.
Essex	Brunner Mond Co., of Canada, Ltd	Amherstburg	Lots 6, 7, 8, con. I; lots 2, 3, con. II, Anderdon.	Limestone for chemical works.
Frontenac	Freeman, L. G	106 Cowdy St., Kingston	Kingston tp	Building stone.
"	Roddy, J	Kingston	Kingston tp	Building and crushed limestone.
"	Silica Sand Co., Ltd	Geo. M. Thompson, Box 264, Kingston.	Lots 19, 20, con. I, Pittsburgh.	Sandstone.
Grenville	Grenville Crushed Stone, Ltd	J. P. Bains, Oxford Mills	Lots 8, E. ½ 9, con. IV; S. ½ lot 8, con. III, Oxford.	Crushed and screened limestone for ballast.
Grey	Chalmers, Stewart	Owen Sound	Owen Sound	Lime.
"	Keeling, James	1179 16th St., Owen Sound.	8th St., Owen Sound	Building stone.
"	Lapierre & Checkley	Owen Sound	Owen Sound	Limestone for building.
"	McKay, Alex. L	E. Rowbottom, Owen Sound.	Owen Sound	Limestone for building.
"	Oliver Rogers Stone Co	Owen Sound	Owen Sound	Building stone; crushed stone.
Haldimand	Gordon Crushed Stone Co., Ltd	Hagersville	Walpole tp	Crushed stone.
"	Hagersville Contracting Co	Hagersville	Lots 13, 14, con. XIII, Walpole.	Crushed stone for roads and concrete.
"	Hagersville Crushed Stone Co	Hagersville	S. W. ½ lot 28, con. I, Oneida.	Crushed stone for roads and concrete.
"	Hagersville Quarries, Ltd	Hagersville	Lot 13, con. XIII, Walpole.	Crushed stone for roads and concrete.
Halton	Christie Henderson Co., Ltd	Kelso	Lot 4, con. V, Nassagaweya.	Grey lime.
"	Hurst & Rogers	1193 Queen St. W., Toronto.	Lot 26, con. X, Esquesing.	Building stone.
"	Logan, Hugh	Glen Williams	Lot 27, con. IX, Esquesing.	Building stone.
"	Robertson, D., & Co	Milton	Esquesing tp	Lime and building stone.
"	Rogers, F., & Co	1193 Queen St. W., Toronto.	Esquesing tp	Lime and building stone.
"	Toronto Lime Co., Ltd	Limehouse	Esquesing tp	Lime and building stone.

Hastings	Canada Cement Co.	Point Anne	Point Anne	Limestone for cement.
"	Quinlan & Robertson	Crookston	Lot 10, con. X, Huntingdon.	Building stone.
Lanark	Cameron, James	Fallbrook	Lot 4, con. XI, Drummond.	Pegmatite for road material.
"	Cameron, William	Carleton Place	Lot 24, con. XI, Drummond.	Lime.
Leeds	Gordon, David J.	Gananoque	Lot 11, con. II, Leeds	Red granite.
"	Streets & O'Brien	Box 73, Gananoque	Lot 6, con. II, Leeds	Granite paving blocks.
Lincoln	Queenston Quarry Co.	St. Davids	St. Davids	Crushed, monumental, sawn limestone.
"	Wickett, James A.	Geo. E. Stocker, 16 Salter Street, Toronto.	Grantham tp.	Crushed stone.
Ontario	Theodore Crushed Stone Co.	Longford Mills	Longford Mills	Crushed stone.
Oxford	Beachville White Lime Co.	Beachville	Beachville	Stone, lime, agricultural lime.
"	Standard White Lime Co.	Beachville	Beachville	High calcium, magnesian and hydrated lime.
Perth	St. Marys Cement Co.	St. Marys	Blanchard tp.	Limestone for cement.
"	Thames Quarry Co.	St. Marys	St. Marys	Limestone.
Peterborough	Ontario Rock Co.	Preneveau	Lot 7, con. VI, Belmont	Crushed trap.
Prescott	Bissonnette, A.	Alfred	Longueuil tp.	Limestone.
"	McDonald, Neil A.	R. Allard, L'Orignal	Longueuil tp.	Limestone.
Renfrew	Jamieson Lime Co.	Renfrew	Lot 5, con. II, Horton	Crystalline limestone and lime.
"	Markus, Wm.	Pembroke	Lot 12, con. I, Pembroke	Limestone.
Russell	McDonell, Dibblee & Covey	Clarence	Con. I, Clarence	Limestone.
Simcoe	Langton, Thomas	Coldwater	Lots 19, 20, con. XII, Medonte.	Crushed stone.
"	Ontario Stone Co.	R.R. 4, Orillia	Lot 10, con. IV, N. Orillia	Crushed stone.
Sudbury district	MacNamara Construction Co.	Sudbury	Rumford	Crushed stone for roads.
" "	Mond Nickel Co., Ltd	Coniston	At Coniston smelter	Quartzite for flux.
Thunder Bay district	Fort William, City of	Cyril Symmes, City Engineer, Fort William.	At foot of Mt. McKay	Road material.
Timiskaming district	Abitibi Pulp & Paper Co.	August Johnson, Haileybury.	W. ½ lot 11, con. III, Bucke.	Limestone.
Victoria	Canada Lime Co.	Coboconk	Coboconk	Limestone and lime.
"	Kirkfield Crushed Stone Co.	Kirkfield	Lot 49, con. IX, Eldon	Crushed limestone.
"	Toronto Brick Co.	Coboconk	Coboconk	Lime.
Waterloo	Christie Henderson Co.	Hespeler	Hespeler	Hydrated lime.
Welland	Bertie Township	Stevensville	Lot 8, con. VIII, Bertie	Crushed limestone for roads.
"	Bertie Township	Ridgeway	Lot 21, con. III, Bertie	Crushed rock for roads.
"	Canada Cement Co.	Port Colborne	Port Colborne	Limestone for cement.
"	Canada Cement Co.	Port Colborne	Lot 5, con. I, Wainfleet	Limestone for cement.
"	Law Construction Co.	Ridgeway	Lot 13, con. V, Bertie	Limestone for roads.

QUARRIES—*Continued*

County	Operator	Address	Location	Product
Welland	Pirson, John	Stevensville	Lot 8, con. VII, Bertie	Crushed stone.
"	Walker Bros	Thorold	Lots 31, 32, con. IX, Stamford.	Limestone for flux and paper mills.
Wellington	Alabastine Co. of Paris	Elora	Nichol tp	Hydrated lime and agricultural lime.
"	Christie Henderson Co	R.R. 2, Puslinch	Lots 1, 4, con. I, Puslinch	Limestone and lime.
"	Gow, James	Fergus	Fergus	Crushed limestone.
"	Harvey, E., & Son	Rockwood	Rockwood	Limestone and lime.
"	Ontario Reformatory	Box 1448, Guelph	Guelph	Crushed limestone for roads.
"	Standard White Lime Co	Guelph	Wellington tp	Hydrated lime.
Wentworth	Barton Township	Mount Hamilton	Lot 13, con. VII, Barton	Crushed and screened limestone.
"	Canada Crushed Stone Corp., Ltd	Dundas	Dundas	Crushed and screened limestone and building stone.
"	Gallagher Bros	R.R. 2, Hamilton	Lot 14, con. VI, Barton	Limestone and lime.
"	Marshall, James	Hamilton	Lot 14, con. VII, Barton	Limestone and lime.
"	Middleton, J	Ancaster	Ancaster	Building stone.
"	Wentworth Quarry Co., Ltd	Vinemount	Lot 4, con. V, Saltfleet	Crushed and screened limestone.

CLAY PITS

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

COAL (Anthraxolite)

British-Colonial Coal Mines, Limited

Mining operations were commenced in December, 1925, on the property of the British-Colonial Coal Mines, Limited, in lot 10, concession I, Balfour township, district of Sudbury.

When last inspected on July 13, 1926, an incline had been driven to a depth (inclined) of 120 feet.

A Sullivan gasoline-driven compressor, type WK 312, 5½ by 5 inches, and a Sullivan portable hoist had been installed.

In January, 1926, a carload shipment was made to Toronto and distributed to shareholders and others for test purposes.

A. Wilson, Larchwood, is in charge of the mining operations.

The officers of the company are: F. L. Barrett, London, Ont., president; Stewart Hood, Toronto, vice-president; and A. Slade, Toronto, secretary-treasurer.

DOLOMITE

A. J. J. Carfrae

The dolomite quarry of A. J. J. Carfrae, on lots 3 and 4, concession XII, Herschell township, Hastings county, was worked for about three months, employing three men. About 750 tons of ore was shipped to the Crystallite Stone Products Company of Hamilton.

FELDSPAR

T. H. Craig

T. H. Craig, Verona, shipped 41 cars of feldspar during the year. The greater part of the ore was shipped from lot 1, concession XII, Loughborough township, and the west half of lot 2 and the east half of lot 3, concession X, Portland township, Frontenac county.

Mr. Craig employed an average of seven men during the year.

Cronk and Van Luven

Messrs. Cronk and Van Luven operated a feldspar mine on the east half of lot 3, concession XII, Loughborough township, Frontenac county, from January to October, 1925.

They shipped 14 cars of feldspar and employed an average of six men.

A. J. Van Luven, Hartington, is the owner of the property.

Elizabeth Feldspar Mines, Limited

The operations of the Elizabeth Feldspar Mines, Limited, lot 2, concession IV, Dill township, Sudbury district, were intermittent during the summer of 1925.

Shipments were resumed on October 19, 1925, and were continued until February 25, 1926, when the plant was again shut down until such time as a sorting plant could be erected and put into commission.

When visited on April 27, the frame work for this plant had been erected and a crusher was being installed.

When the plant is completed, it is proposed to bring the material from the mine up an incline in cars into the sorting house, where after a preliminary screening and rough sorting it will be fed to a 10- by 16-inch jaw crusher set to 3 inches. After crushing, the material will be elevated to a bin from which it will feed to a sorting belt. The spar will be picked off the belt into bins discharging to cars along the side of the building and let down an incline to the loading platform at the Canadian Pacific Railway siding. The waste discharged over the end of the belt will be hauled to the waste dump.

During the four-month period mentioned above when shipments were being made, 28 cars of spar were shipped. This was produced from a stope approximately 60 feet in length, 75 feet wide, and about 35 feet in height.

F. D. Henderson of Sudbury is manager of the property.

Holditch and Checkley

Considerable feldspar was shipped from Wanup during 1925 from the operation of a quarry on lot 2, concession III, Dill township, district of Sudbury. The operations were under the direction of E. Holditch of Sudbury.

Northern Feldspar Mines, Limited

A feldspar quarry is being opened up by the Northern Feldspar Mines, Limited, in lot 2, concession II, Dill township, district of Sudbury. A. Weisman, Sudbury, is president and general manager of the company; J. S. McKessock, Sudbury, is secretary-treasurer.

Shipments will be commenced during the season of 1926.

O'Brien and Fowler, Limited

Shipments of feldspar were made from Mattawa during the winter of 1925-26 from the operation of a quarry in lot 29, concession III, Mattawan township, district of Nipissing, by O'Brien and Fowler, Limited, 114 Wellington Street, Ottawa.

C. C. Orser, Mattawa, was in charge of the work, and 22 men were employed.

As there is only a winter road from Mattawa to the property, a distance of about five and a half miles, the quarry was closed down about April 1, 1926, and another property near Eau Claire is being opened up for summer operation.

George Purdy

George Purdy, employing three men, shipped several cars of feldspar from a quarry opened up in the spring of 1926, in the south half of lot 14, concession VII, township of Calvin, district of Nipissing.

Rock Products Company

This company operated the property on lot 20, concession IX, Bathurst township, Lanark county, for ten months in 1925 and mined 1,966 tons of feldspar. The pit is from 75 to 120 feet deep. George Paddock, Balderson, was superintendent, employing an average of 15 men. W. A. Hannah is general manager.

R. T. Stewart

R. T. Stewart, Sudbury, operated a feldspar quarry located in lot 12, concession VI, Loughrin township, district of Nipissing, about three-quarters of

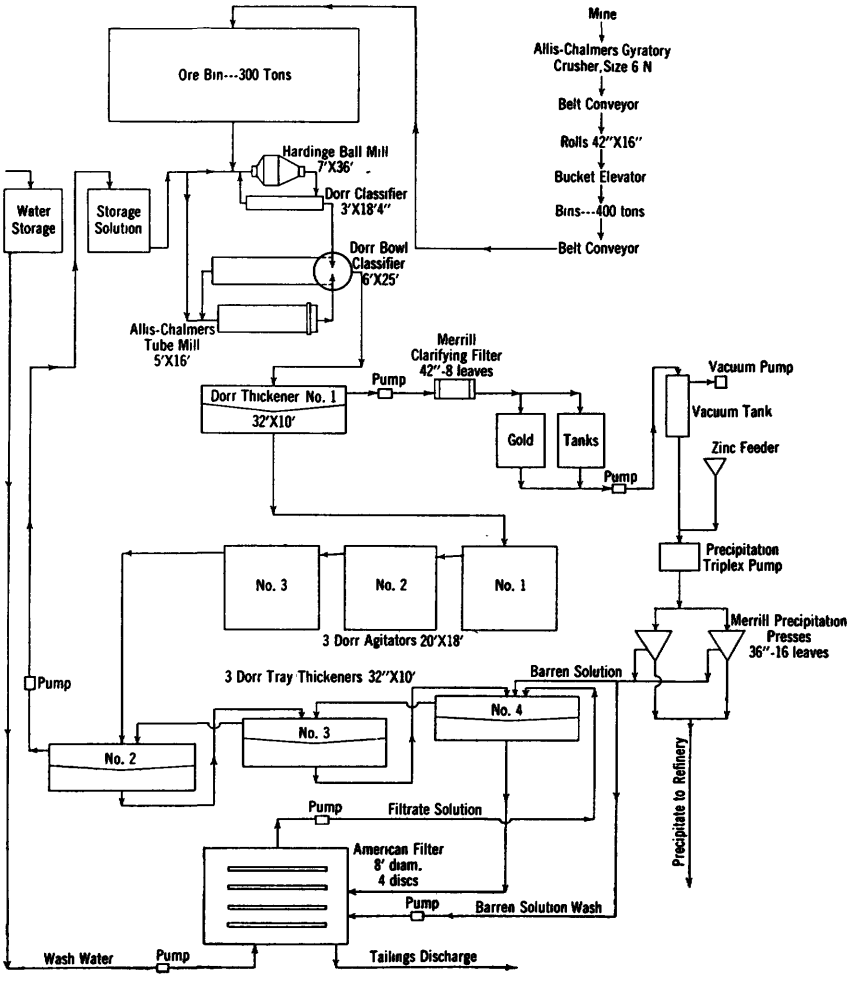
a mile south of Crerar, from February to November 15, 1925, shipping 1,209 tons of spar and 783 tons of quartz during this period.

An average of 13 men was employed during the shipping season.

GOLD

Ankerite Gold Mines, Limited

This company is capitalized at $2,000,000, divided into shares of $1 par value each. Of these shares, 1,500,000 have been issued. The company owns



Ankerite Gold Mines, Ltd.—Flow Sheet of Cyanide plant, Jan., 1926.

three claims, M.E. 60-62, (T.R.S. 1,564-66), situated near the middle of the north boundary of the township of Deloro, district of Cochrane. Work for the most part has been confined to claim M.E. 60.

The development of the Ankerite mine, for the past three years, has been carried on by the Porcupine Goldfields Development and Finance Company, Limited, an English concern which, in conjunction with the Goldfields American

Development Company, Limited, and the National Mining Company, Limited, has been actively engaged in the principal mining areas of Canada.

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

The officers of the Ankerite Gold Mines, Limited, are as follows: H. R. Norsworthy, Montreal, president; F. R. Weekes, Montreal, vice-president; J. E. Dorion, Montreal, secretary-treasurer; H. E. Doelle, Box 535, South Porcupine, Ont., manager. The directors are: H. R. Norsworthy, F. R. Weekes, and J. E. Dorion, Montreal; C. E. C. Smith, National Club, Toronto, and W. S. Walton, Royal Bank Building, Toronto. The head office is at the Canada Cement Building, Montreal.

During the year 1925, development work was actively carried on in the Ankerite mine at the following levels:—

Level	Drifting	Crosscutting	Raising
	feet	feet	feet
350-foot	306	89	143
475-foot	788	1,785	23
Total	1,094	1,874	166

The diamond-drilling was as follows:—

Location	Holes	Feet
SURFACE:		
Claim M.E. 60	4	1,149
UNDERGROUND:		
350-foot level	6	681
475-foot level	11	2,529
Total	21	4,359

A new shaft, No. 2, was sunk to a depth of 483 feet during the year and was completed to 620 feet at March 3, 1926. There is a level established at a depth of 461 feet and a loading pocket at a depth of 521 feet. This No. 2 shaft is 580 feet distant, N. 5° E., from the former working shaft, No. 1. Both shafts are on claim M.E. 60 and are connected at the 475-foot level.

No. 2 shaft has four compartments, three of which measure 4 feet 5 inches by 5 feet, and the fourth 3 feet 8 inches by 5 feet. The last named will be the main working shaft, and two compartments will be used for hoisting rock, which will be passed to the crusher lying to the east and adjoining the shaft.

A crosscut extends 800 feet north from No. 2 shaft and taps No. 5 vein, which was originally located by diamond-drill holes from the surface. An ore shoot on this vein, 400 feet in length, has been proved, the width varying from 16 to 30 feet.

A complete surface equipment has been installed around the new shaft. In the compressor building, which is 60 by 42 feet, of wood frame construction with galvanized iron cover, there is the following equipment: Canadian Ingersoll-Rand compressor, 14 by 9 by 12 inches, type ER2, driven by a 100 h.p., 550-volt induction motor, 750 r.p.m. (this was formerly installed at the No. 1 shaft); Chicago Pneumatic Tool Company Simplate valve compressor, 20 by 12 by 14 inches, driven by a 200 h.p., 550-volt induction motor, 730 r.p.m.; Canadian Ingersoll-Rand hoist, type PE1, double-drum, 48-inch diameter and 48-inch face, single-reduction helical gears, air-operated band clutches on both drums, and gravity-operated post brakes. This hoist is designed for 10,000 pounds pull and an unbalanced load of 9,000 pounds at a hoisting speed of 900 feet per minute and a depth of 2,000 feet. The cable is seven-eighths of an inch, and the hoist is completely equipped with Lilly controls for speed and overwind. The hoist is driven by a 150 h.p., 550-volt induction motor, 750 r.p.m.

A wing of the compressor house, 25 by 36 feet, of frame construction, contains an 80 h.p., locomotive-type boiler used for heating and emergency power.

A blacksmith shop, 30 by 48 feet, is equipped with Leyner drill sharpener, forges, emery wheels, drill press, and threading machine.

A two-storey bunkhouse, 27 by 68 feet, was also built during the year, as well as a bungalow 30 by 45 feet.

During 1925, complete designs for a crushing and grinding plant were made by André Dorfman of the Huronian Belt Company, Limited (formerly with the McIntyre-Porcupine Mines, Limited). The construction of the building was undertaken towards the latter part of the year. Both the crushing plant building and the grinding and cyanidation plant building are of all-steel frame construction, covered with shiplap and galvanized iron.

The flow-sheet of the cyanidation plant is designed to follow the practice of counter-current decantation, with a final wash by an American filter. The capacity of the plant is 200 tons per day.

Ore from the mine is dumped into an Allis-Chalmers gyratory crusher, size 6N (driven by a 60 h.p., 550-volt induction motor, 750 r.p.m.). It is next carried to a set of Allis-Chalmers' rolls, 42 by 16 inches, on an 18-inch belt conveyor; after passing through the rolls, it is raised into a steel bin in a bucket elevator. The rolls and conveyors are driven by a 40 h.p. induction motor, 750 r.p.m.

From the steel bin in the crusher building, the ore is conveyed to a 300-ton bin in the grinding and cyanidation plant on an 18-inch belt conveyor rising on a slope of 18 degrees. The belt is 167 feet in length (double). The grinding and cyanidation plant lie to the south of the crusher building. The crushing plant building is 72 by 30 feet, and the grinding and cyanidation plant building, 180 by 86 feet.

The equipment of the grinding and cyanidation plant includes: an 18-inch belt conveyor driven by 10 h.p. induction motor, 750 r.p.m.; Hardinge conical mill, 78 by 36 inches, driven by a 125 h.p. induction motor, 375 r.p.m.; Dorr classifier, 3 feet by 18 feet 4 inches, driven by a 5 h.p. induction motor, 750 r.p.m.; Dorr bowl classifier, 6 by 25 feet, driven by a 5 h.p. induction motor, 750 r.p.m.; Allis-Chalmers tube mill, 5 by 16 feet, driven by a 150 h.p. induction motor, 375 r.p.m.; Dorr thickener, 32 by 10 feet, three Dorr agitators, 20 by 18 feet, and three Dorr tray thickeners, 32 by 10 feet, driven by a 10 h.p. motor, 750 r.p.m.; Ingersoll-Rand vacuum pump, 13 by 6 inches, driven by a 30 h.p. motor, 750 r.p.m.; Ingersoll-Rand air compressor, type ER1, 14 inches by 8 feet, driven by a 30 h.p. motor, 750 r.p.m.; Ingersoll-Rand vacuum pump, for the Crowe process, type 15, 8 by 5 inches, driven from a line shaft.

Other electric motors include the following: three 5 h.p. motors, 750 r.p.m., for triplex pump, Gould pump and clarification; two 7½ h.p. motors, 750 r.p.m., for storage and booster pumps. The American filter is 8 feet in diameter and has four discs. It is operated by a 1½ h.p. motor, 685 r.p.m. All motors in the mill are on 550 volts.

The Merril clarifying press is 42-inch frame and 8 leaves. The Merril precipitation press is 36-inch frame and has 16 leaves.

Milling operations began June 19, 1926, under the superintendency of H. G. Surrey. Twelve men are employed in the mill.

The average number of men employed during the year was 30 on the surface and 27 underground. This number was increased by 25 during mill construction.

Argonaut Gold, Limited

This company is now operated by Argonaut Consolidated Mines, Limited, which has a Dominion charter and an authorized capital of $3,500,000, of which 3,000,000 shares are issued. The officials of the company are: J. H. Rainville, president; F. A. Labelle, first vice-president; J. A. Naud, second vice-president and general manager; Louis A. Marchand, treasurer; A. Brodeur, secretary; D. R. Thomas, general superintendent. The directors are: H. L. Reddy, Robert Starke, Avila Raymond, Louis Gratton, L. H. Dupré, Wilfrid Archambault, Wilfrid Duquette. The head office is at 145 St. James Street, Montreal.

The company operated its property in Gauthier township, district of Timiskaming, during 1925, with a force of 90 to 100 men. Operating costs were $322,152, and capital expenditures amounted to $74,736, of which $43,021.34 was for 14.2 miles of transmission line to Kirkland Lake; $14,040.52 was for a substation of 900 k.v.a. capacity.

The following is from the report of the general superintendent for the year 1925:—

During the year the following progress was made:—	Feet
Drifting and crosscutting	5,723.1
Raising	500.2
Sinking	57.5
Station-cutting	23.7
Total	6,304.5

This work was successful in locating an ore body, Nos. 767-69 on the 750-foot lveel. The copper content of this ore shoot is higher than the average of the mine. Another ore shoot was found in December on the 625-foot level just before closing down the level for shaft-sinking. This is known as No. 658, and as soon as sinking to the 1,000-foot level is completed, it will be developed further.

From January 1 to March 6, 1925, the mill was closed down pending the completion of the new transmission line, and during this time ore was broken and left in the stopes. In March stoping on a normal scale was resumed and continued until the end of the year.

Milling was resumed on March 6, and the mill continued in operation during the remainder of the year with a total operating time of 92.73 per cent.

Some 28,514.6 dry tons were milled from which there was recovered:—

Recoveries	Troy ounces	Total value	Value per ton
Gold—mint returns	8,363.290	$172,884.55	$6.06
Gold—smelter returns[1]	2,033.011	40,660.23	1.43
Total gold	10,396.301	$213,544.78	$7.49
Silver—mint returns	932.07	638.47	0.02
Total gold and silver	.....	$214,183.25	$7.51
Copper—smelter returns, 336,079 lbs[1]	.....	39,170.17	1.37
Total recovery	.....	$253,353.42	$8.88

[1]October, November, and December, estimated.

Barry-Hollinger Gold Mines, Limited

This company operated their property at Boston Creek in Pacaud township, district of Timiskaming, during 1925 with a force of 55 to 60 men. The company has an authorized capital of $3,000,000 in shares of $1 par value. The directors are: H. C. Crowe, president; James A. Dunn, vice-president; Robert Fennell, 807 General Insurance Building, Toronto, secretary-treasurer. The directors are: H. C. Crowe, Robert Fennell, E. H. Greene, J. H. W. Whitehead, and James A. Dunn. L. B. Smith is superintendent.

Underground work during 1925 included 100 feet of shaft-sinking, 406 feet of raising, 332 feet of drifting, 176 feet of crosscutting, and 99,440 cubic feet of stoping. Station-cutting amounted to 2,580 cubic feet, and slashing to 4,150 cubic feet.

The 50-ton mill erected on the property was put in operation in the spring and treated 8,135 tons during the remainder of the year.

Bennett Mining Company, Limited

The company has an authorized capital of $2,000,000 in $1 shares. W. F. Bennett is president; Murray Gordon, vice-president; and Alex. Dennison, secretary-treasurer. The head office of the company is at 1 St. Clair Avenue West, Toronto. In the summer of 1925, the company transferred their operations from McVittie township to a property comprising parts of lots 9 and 10, concession II, Maisonville township, district of Timiskaming, which includes the Smith-Labine group of three claims.

Work began on buildings and roads with a force of five men, later increased to 25 men, under James Houston as superintendent. The following buildings were erected: bunk-house, 26 by 50 feet; power-house, 30 by 40 feet; office, 28 by 36 feet; boiler-house, 18 by 36 feet; and shop, 16 by 24 feet. A plant comprising a 750 cubic foot Sullivan air compressor, a double-drum Jenckes hoist, and a 150 h.p. semi-Diesel engine was installed.

A shaft was started in October and sunk to a depth of 125 feet by April, 1926.

Blue Quartz Gold Mines, Limited

This company is capitalized at $3,000,000, divided into shares of $1 par value each. The officers of the company are: H. C. Crowe, president; Jas. A. Tuck, vice-president; Miss A. V. Marat, secretary-treasurer. The directors are: H. C. Crowe, Jas. A. Tuck, and J. Bennet, all of Toronto; J. H. W. Crowe, Birmingham, England; and H. Hibbard, Gillingham, England. The head office of the company is at 328 Confederation Life Building, Toronto. J. J. Hollinger was superintendent until May 23, 1925, when he was succeeded by J. G. McGregor. On May 1, 1926, N. Carpenter was appointed superintendent. The mine office is at Matheson, Ont.

The company owns seven claims in Beatty township, district of Cochrane, lying about or under Painkiller lake.

Development was carried on throughout the year on the 500-foot level, where 500 feet of drifting, 150 feet of crosscutting, and 35 feet of raising were done. A shoot of some 200 feet in length was opened in what is known as the No. 11 or Contact vein, lying northeast of the shaft; this has a strike of S. 40° W., and ranges from two to three and a half feet in width. The Blue Quartz vein described in previous reports has a strike of N. 20° E.

Early in 1926, a test mill with a capacity of 30 tons a day was installed. Ore was hoisted in cars from the mine and was trammed to a sorting house, 14 by 16 feet, lying 200 feet from the shaft, where some 25 per cent. of the waste was sorted out. The sorted ore was then conveyed on an aerial tram, 300 feet in length, to a 30-ton bin in the mill, from which it was fed to 10- by 7-inch jaw crusher and then hoisted in a bucket elevator to a 20-ton bin, and in turn fed to a 50-ton Hardinge mill. After grinding it was elevated some 20 feet and passed over an amalgamating plate, 12 by 6 feet, pitched one inch to the foot. A drag classifier, 12 by 2 feet, followed, the fines passing to a second amalgamating plate the same length as the first but with double the width. The coarse material from the first plate was placed in closed circuit with the Hardinge mill and classifier, and slimes from the last plate were passed to a tailings pond. The mill building was of frame construction, 40 by 23 feet, with a wing 15 by 15 feet. A 40 h.p. steam engine operated the plant.

The mill ran for a short time and was closed down. The average number of men employed at the mine was 28.

Bosquet Gold Mines, Limited

During the winter of 1925-26, a shaft was sunk 22 feet by hand steel on one of the claims held by the above company in the Howry Creek area, district of Sudbury.

A plant consisting of hoist, compressor, and boiler was installed in the late winter, but no further work done.

The operations were under the direction of the late Harold Tough.

British Canadian Mines, Limited

The British Canadian Mines, Limited, is incorporated under the Ontario Companies Act, having an authorized capital of $3,000,000 in shares of $1 par value.

The directors and officers of the company are: president, J. M. Aitken, Toronto; secretary-treasurer, Geo. F. Beaumont, Clifford Smith, A. G. Seaman, Port Arthur; W. D. McKay, F. McQueen, Toronto; C. R. Fitch, Fort Frances.

The operations of the company at the Foley mine, six miles south of Mine Centre on the Canadian National railway, in the district of Rainy River, have been carried on continuously during the past year.

The chief development work accomplished in this period is given in the following summary:—

SINKING:

Completion of the vertical winze from 400 to 850 feet.

DRIFTING AND CROSSCUTTING:

400-foot level	100 feet drift north on Jumbo vein. 30 feet drift north on West vein. 30 feet drift south on West vein. 125 feet crosscut west. 40 feet crosscut east.
500-foot level	300 feet drift north on Bonanza vein. 75 feet drift south on Bonanza vein. 50 feet drift south on small stringer off Bonanza vein.
600-foot level	Station at winze. 60 feet crosscut to the Bonanza vein. 330 feet drift north on Bonanza vein. 125 feet drift south on Bonanza vein. 150 feet drift south on small stringer off Bonanza vein.

725-foot level—Station at winze.

DIAMOND-DRILLING:

Holes totalling approximately 1,000 feet were drilled from surface during the period under review.

A mill building, at present not completely equipped, was erected during the year. Two 120 h.p. semi-Diesel engines were installed in a new power-house replacing the old steam equipment in the plant near Shoal lake. A 542 cubic foot, Pennsylvania, belt-driven air compressor has been installed in this new power-house and is at present supplying the air for the development work.

All underground operations were carried out from the north shaft.

It is expected to have hydro-electric power available at the mine about the end of the present year.

W. N. Hutchings is manager at the mine, with W. Timmins as mine captain.

Forty-one men are at present employed on the property.

Canadian Associated Goldfields, Limited

This company has an authorized capital of $30,000,000, in shares of one dollar par value. Dr. MacKay is president, and the head office is at 306 C.P.R. Building, Toronto. The company operated their property at Larder lake in McVittie township, district of Timiskaming, during 1925 with an average force of 35 men. T. A. Graves is manager.

The underground development consisted of a total of 2,717 feet of drifting and crosscutting, and the stations on three levels were enlarged to accommodate double tracks.

The construction of a mill was begun during the year and the building completed early in 1926, except for the installation of machinery.

Champion Gold Mines, Limited

This company operated the Champion mine, in Kenora district, from March to November, 1925, employing from 10 to 22 men during this period.

A test mill was installed, consisting of a Tremaine steam stamp followed by an amalgamation plate. One hundred and thirty tons of ore were treated, from which a recovery of $2,112.11, or $16.24 per ton, is reported to have been made.

The officers and directors of the company are: president and general manager, Charles Brent, Buffalo, N.Y.; secretary-treasurer, B. J. Hatmaker, East Aurora, N.Y.; Geo. S. Buck, W. G. Barney, Chas. J. Bianchi, Buffalo, N.Y.; Frank R. Swift, East Aurora, N.Y. The head office is at 329 Chamber of Commerce, Buffalo, N.Y.

The capitalization of the company is $500,000 in shares of $5 par value.

Clines Canadian Gold Mines, Limited

This company, which is controlled by the Canada Mines Syndicate, operated on the Cline property in the Goudreau area, district of Algoma, continuously throughout the year 1925 and up to about the middle of May, 1926, at which time they allowed their option to lapse, the property and equipment reverting to Jas. W. Cline according to their agreement.

At No. 1 shaft the work was carried on by hand steel intermittently throughout the year.

At the time of stopping work, this shaft had been sunk to a depth of about 140 feet with 70 and 20 feet of drifting east and west, respectively, on a level established at about 80 feet from the surface. A crosscut of six feet had been driven off the shaft at 138 feet.

No. 2 shaft, which was started during the summer of 1925, was sunk to a depth of 215 feet on an inclination of about 70 degrees.

A small plant was installed for the purpose of sinking this shaft and carrying on the development work from it. This consists chiefly of the following pieces of equipment: Holman air compressor (driven by a self-contained gasoline engine), 250 cubic feet per minute; reversible Holman winch, 5 by 7 inches; 25 h.p. steam boiler (added in the spring of 1926 to supply steam for hoisting).

The development work completed at No. 2 shaft, at the time of shutting down, in addition to the shaft-sinking, consists of 33 feet of crosscutting south of the shaft, 19 feet of crosscutting north of the shaft at the 100-foot level, and about 40 feet of crosscutting on the 200-foot level.

Twenty-two men were employed under the direction of O. P. Powell when the property was last visited on May 11, 1926.

Coniaurum Mines, Limited

This company has a capitalization of $5,000,000, divided into 1,000,000 shares of par value of $5. The officers of the company are: R. W. Leonard, president; A. L. Bishop, vice-president; Fraser D. Reid, general manager; J. J. Mackan, secretary-treasurer. The directors are: R. W. Leonard and A. L. Bishop, St. Catharines, Ont.; Fraser D. Reid, Cobalt, Ont.; Alex. Longwell, W. G. Watson, J. E. Day, and J. Y. Murdoch, Toronto. The head office of the company is at St. Catharines, Ont. The mine office is at Schumacher, Ont., and John Redington is mine superintendent.

The Coniaurum Mines, Limited, was formed to take over the properties of the Newray Mines, Limited, the Goldale Mines, Limited (Group No. 1), and the Strong-Bow Mines, Limited, all in the township of Tisdale, district of Cochrane, and comprising a block of 640 acres.

The property of the Newray Mines, Limited, had been under working option to the Coniagas Mines, Limited, for the years 1923 and 1924, during which time the shaft was sunk to a depth of 1,000 feet and some lateral work was done on the upper levels.

On the property of the Goldale Mines, Limited, Group No. 1, development work had been done at the 500- and 1,000-foot levels.

The Strong-Bow Gold Mines, Limited, was a company incorporated and controlled by the Coniagas Mines, Limited, for the purpose of developing the Armstrong-Booth claims, lying immediately south of the Newray.

Under an agreement dated June 12, 1924, the Goldale Mines, Limited, received 228,000 shares in exchange for its No. 1 property of 120 acres; Newray Mines, Limited, received 172,000 shares for its property of 321 acres; and the Strong-Bow Mines, Limited, 60,000 shares, in exchange for the Armstrong-Booth claims of 200⅜ acres. The remaining 540,000 shares were taken up by the Coniagas Mines, Limited, at a price of $1,050,000, of which $250,000 was paid on allotment and the balance paid on June 12, 1926.

The balance sheet taken from the financial report for the year ending December 31, 1925, shows the following:—

ASSETS

CAPITAL ASSETS (Coniaurum mine):		
Cost of property	$2,198,337.70	
Mine development	342,586.49	
	$2,540,924.19	
Machinery and plant	71,243.12	
Camps and buildings	47,997.47	
Construction work in progress	6,382.31	
Camp equipment	2,008.02	
Assaying and engineering equipment	850.16	
Office equipment	510.55	
		$2,669,915.82
CURRENT ASSETS:		
Cash on hand and in banks	$8,601.19	
Accounts receivable	441.90	
Inventory of stores	20,421.44	
		$29,464.53
CONIAGAS MINES, LIMITED:		
For balance on subscription for 539,992 shares of stock, payable on or before June 12, 1926		650,000.00
DEFERRED CHARGES:		
Unexpired insurance		1,181.45
DISCOUNT ON STOCK		1,650,000.00
		$5,000,561.80

CAPITAL AND LIABILITIES

CAPITAL STOCK:		
Authorized and issued, 1,000,000 shares of $5.00		$5,000,000.00
CURRENT LIABILITIES:		
Coniagas Mines, Limited	$135.16	
Sundry accounts payable	408.11	
Unclaimed wages	18.53	
		$561.80
		$5,000,561.80

The following statement of the working account is given in the financial report for the year ending December 31, 1925:—

DEBITS

Head office and administration	$9,795.10
Mines office and supervision	16,565.04
Mining	199,198.16
Maintenance of buildings	2,882.58
Camp expense	2,515.53
Lands and roads	195.97
Legal expense	1,244.65
Transportation and travelling	831.76
Taxes and royalties	1,635.85
Fire insurance	2,317.99
Accident insurance	4,364.39
Employees' bonus	357.24
Total	$241,904.26

CREDITS

Cash discounts	$111.68
Gold revenue	19.22
Interest	1,444.93
Rent	501.00
Net cost of mine development for the year transferred to mine development account	239,827.43
Total	$241,904.26

The mine development account gives the following:—

DEBITS

Balance January 1, 1925, brought forward	$102,882.33
Net cost of mine development for the year transferred from working account	239,827.43
Total	$342,709.76

CREDITS

Adjustments re previous year's operations	$123.27
Cost of mine development to date carried forward	342,586.49
Total	$342,709.76

A summary of the mine development for the year is taken from report of the general manager dated March 23, 1926, and covering the year ending December 31, 1925:—

Level	Drifting	Crosscutting	Raising
	feet	feet	feet
700-foot	1,317	499	19
1,000-foot	2,132	5,124	247
Total	3,449	5,623	266

Total advance, 9,338 feet.

DIAMOND-DRILLING

	Feet
700-foot level (12 holes)	3,569
1,000-foot level (50 holes)	13,025
1,090-foot level (bottom of main shaft)	590
Total in 1925	17,184

Development was vigorously carried on throughout the year to exploit the 700- and 1,000-foot levels, and the presence of a large porphyry mass at these horizons indicated the necessity for further development at greater depths. It is proposed during 1926 to sink the main shaft to a depth of 1,500 feet in order to carry on the development at the 1,250- and 1,500-foot levels.

At the 1,000-foot level, the presence of the quartz porphyry mass was determined to be elliptical, running northeast and southwest and having a length of 1,800 feet and a maximum width of 400 feet. The pitch is to the east or northeast at an angle of 55 degrees. On both the north and south sides of the mass, the rock is basalt containing zones of fracturing, in some of which veins were found. A second porphyry mass on the company's Goldale property seems to be a separate one but also pitches to the east.

At the end of the year 1925, five veins with encouraging ore shoots had been encountered in crosscuts and were partially developed by drifting. It is also noted in the general manager's report that five other veins were encountered, but the gold content being low they are not yet considered of economic importance.

ORE AND ROCK HOISTED, 1925

	Tons
Ore hoisted	7,607
Rock hoisted	36,843

As the Great Northern Power Company discontinued the supply of power in the Porcupine area, a contract was made with the Northern Canada Power, Limited, and the frequency of the motor equipment at the Newray mine had to be changed from 60- to 25-cycle.

For increased compressed air supply a Canadian Ingersoll-Rand compressor, capacity 2,000 cubic feet per minute, was installed. It is driven by a 350 h.p. synchronous motor with a 7½ h.p. induction motor, 1,500 r.p.m., and a D.C. generator, 5½ k.w., 1,500 r.p.m., compound wound for the exciter set.

The main additions to buildings during the year were an assay building, 21 by 31 feet, and a boiler plant building for steam heating, which is done from a 115 h.p. boiler (HRT type).

The average number of men employed was 45 in the mine and 35 on the surface.

Consolidated West Dome Lake Mines, Limited

The company has a capital of $5,000,000, each share of a par value of $1. It owns 360 acres in the southeast portion of Tisdale township, district of Cochrane.

The officers of the company are: Sir Henry M. Pellatt, president; Wm. H. Kinch, first vice-president; Chas. L. Sherrill, second vice-president; C. H. Manaton, Toronto, secretary-treasurer; F. L. Hutchinson, New Liskeard, Ont., assistant secretary-treasurer; Frank G. Stevens, 36 Oakmount Road, Toronto, consulting engineer; Duncan McPhail, Box 523, South Porcupine, Ont., superintendent; Carl Frank, South Porcupine, mill superintendent. The directors of the company are: Sir Henry M. Pellatt, Richard L. Baker, John A. Murray, M.P. Van Der Voort, and Frank G. Stevens, Toronto, Ont.; Wm. H. Kinch, Chas. L. Sherrill, and Frank L. Babst, Buffalo, N.Y.; and Angus A. McKelvie, New Liskeard, Ont. The head office of the company is 420 Bank of Hamilton Building, Toronto.

Mining and milling operations were carried on continuously throughout the year 1925, the ore produced coming from the 6th to the 10th level. The stopes produced 34,501 tons and development 2,500 tons with a total of 37,001 tons.

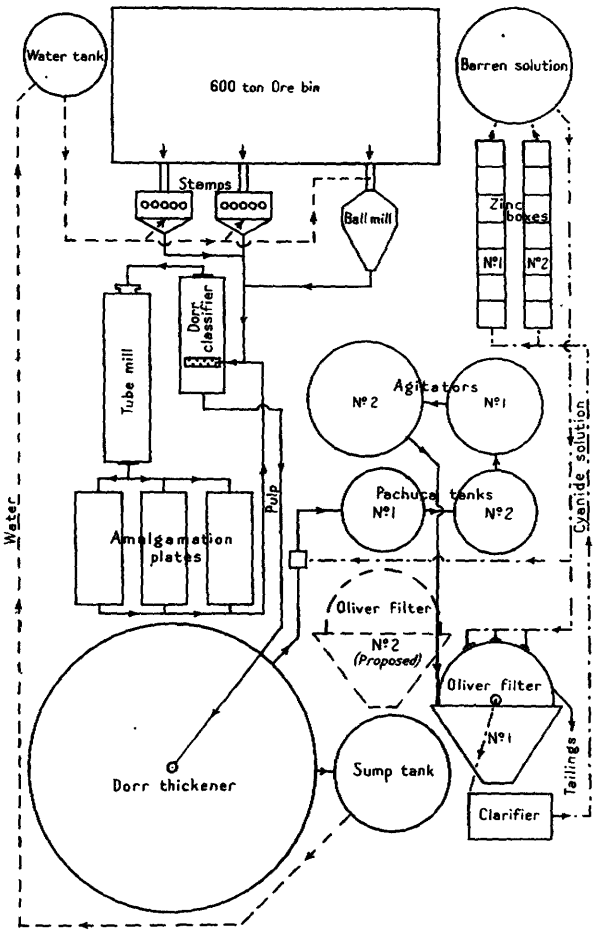
Development work was carried on to the east and north of the main shaft, as follows:—

Level	Drifting	Crosscutting	Raising
	feet	feet	feet
5th	246.5	603.5	.....
7th	185	.....	.....
9th	256.5	.....	17
10th	719	107	120
Total	1,407	710	137

The main shaft is sunk to a depth of 1,103 feet with the lowest level at 1,050 feet. A two-compartment winze was sunk to a depth of 165 feet, at a point N. 52° E. and 455 feet from the main shaft. A station was established at a vertical depth of 150 feet below the 1,050-foot level. Drifting 35 feet to the west

and 25 feet to the east was done. Another level was made at a depth of 35 feet (vertically) below the collar of the winze, and drifting 40 feet to the west and 35 feet to the east was done. The winze had a dip of 83° N.

The average number of men employed during the year was: mine, 53; mill, 14; surface, 10.



Flow Sheet of Consolidated West Dome Lake Mill, 1924.

Cooper Gold Mines, Limited

This company has a capital of $2,000,000 in shares of a par value of $1 each, and holds 22 claims in township 29, range 23, in the Michipicoten area, district of Algoma. Ten of these claims (S.S.M. 3,455, 3,406-8, 3,130-35) comprise the group formerly known as the Minto property. The remaining 12 claims (S.S.M. 3,090, 3,089, 3,555-58, 3,531, 4,020, 4,097, 3,231, 3,232) constitute the group known as the Cooper claims.

The head office of the company is Suite 52, Trusts and Guarantee Building, 302 Bay Street, Toronto. The directors are: W. H. Stafford, J. Mackintosh Bell,

E. H. Blake, R. S. Dening, and A. S. Hamilton. The following are the executive officers: president, W. H. Stafford; managing director and consulting engineer, J. Mackintosh Bell; mine manager at Wawa, Ont., J. C. Kirkland; secretary, A. S. Hamilton; assistant secretary, A. L. Burgess.

On the Cooper claims the development work being done consists of surface trenching and diamond-drilling. At the time of writing it is proposed to do about 4,000 feet of diamond-drilling.

On the Minto group, a set of camps and a plant were built during the spring of 1926 and mining operations commenced on May 1.

When the property was visited on May 14, 1926, the old shaft on claim S.S.M. 3,134, which is about 130 feet (inclined depth), had been pumped out, a station had been cut at the bottom, and 20 feet of drifting north and 15 feet of drifting south had been completed.

The principal pieces of equipment installed at the Minto mine are as follows: Ingersoll-Rand air compressor, 16 by 10 by 12 inches, PRB2, 720 cubic feet per minute, driven by a 125 h.p., 550-volt, 3-phase, 60-cycle induction motor; Ingersoll-Rand, double-cylinder, single-friction, air-driven hoist, 8¼ by 10 inches, SSR, having drum dimensions of 32-inch diameter by 24-inch face; two 100 k.v.a., 60-cycle transformers; 5 k.v.a., 60-cycle transformer; 3-phase, 200 k.v.a., 60-cycle, 1,000-volt transformer; 3-phase, 200 k.v.a., 60-cycle, 1,200-volt transformer; complete blacksmith shop equipment, including IR drill sharpener, forge, grinding wheel, etc.

The number of employees at the Minto mine at the time of writing is 31. The work is under the supervision of J. C. Kirkland, mine manager. Electric power is purchased from the Insull Power Company, which has purchased the power plant of the Algoma Power Company at Michipicoten falls on the Michipicoten river.

Crown Reserve Mining Company, Limited

The authorized capital of the Crown Reserve Mining Company, Limited, is $4,000,000, of which some 3,000,000 shares are issued. The officers of the company are: William T. Gear, president; James G. Ross, vice-president; James Cooper, secretary-treasurer; N. J. Evere, resident manager. The head office of the company is at the Dominion Express Building, Montreal.

The company's Cobalt property was operated under lease during 1925 by Carl Reinhardt with an average force of seven men.

At the company's Larder Lake property, in McVittie township, district of Timiskaming, an average of 30 men was employed during the year.

The company's ore reserves, as estimated by the resident manager, comprise 137,194 tons of ore assaying $6.88 per ton developed in No. 1 vein above the 675-foot level. No blocks of ore assaying under $5 per ton are included, though over 100,000 tons of such material, assaying between $4 and $5 have been developed. Additional pay ore is known to exist in other veins but has only been developed on one side, and it has not been included.

The following summary of operations during 1925 is taken from the resident manager's report:—

The total development work done during the year was as follows:—

	Feet	
Drifting	1,303.5	
Crosscutting	1,160	
Winzing	97	
Raising	27.5	
Underground excavations	149	= 7,003 cu. ft.
Diamond-drilling	3,323	

Cobalt Property

This property has been worked under lease by Mr. Carl Reinhardt throughout the year, with seven men. The sorting operations on the old dump, which was not included in the lease, produced a net profit of $561.57.

Gillies Limit

A pit was sunk 11 feet on a calcite vein in one of the seven claims owned by the company in Gillies Limit, but only low silver values were obtained. No other work was done on this group of claims.

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 Timiskaming.

The directors of the company are: Jules S. Bache, Morton F. Stern, New York; W. S. Edwards, Chicago; Alex. Fasken, Wallace Nesbitt, Toronto; G. C. Miller, R. W. Pomeroy, Buffalo, N.Y.; Innis P. Allan, Rochester, N.Y.; and Dwight B. Lee, Detroit, Mich.

The executive officers are: Jules S. Bache, president and treasurer; H. P. De Pencier, 1st vice-president and general manager; Morton F. Stern, 3rd vice-president; Alex. Fasken, secretary; C. W. Dowsett, general superintendent; E. P. Goetz, assistant treasurer and assistant secretary; C. C. Calvin, assistant secretary; John B. Robinson, assistant secretary. The offices of the executive and financial departments are at 42 Broadway, New York, and the Toronto office at 36 Toronto Street.

In the annual report of the directors for the financial year ending December 31, 1925, the balance sheet shows the following:—

ASSETS

CAPITAL ASSETS:			
Mining claims and properties		$3,483,794.36	
Plant, etc., at depreciated replacement values as per appraisal plus additions since		2,951,986.77	
			$6,435,781.13
CURRENT ASSETS:			
Cash on hand and in banks	$565,056.96		
Bullion en route	80,036.14		
Accounts and interest receivable	54,800.02		
Government, railway, and other bonds at cost	1,074,469.37		
Supplies—mining, milling, and mercantile	341,729.35		
		$2,116,091.84	
DIVIDEND ASSURANCE FUND consisting of following:			
Cash in bank	$17,041.58		
Government, railway, and other bonds at cost	2,156,786.13		
		$2,173,827.71	
			$4,289,919.55
PREPAYMENTS AND DEFERRED CHARGES			34,137.64
			$10,759,838.32

LIABILITIES

Capital and Surplus:			
Capital: Authorized 1,000,000 shares of no nominal or par value, all authorized to be issued for the properties and assets of the old company, the Dome Mines Company, Limited, at $7 per share. (Of these shares 46,666 are held in trust for the company and all dividends paid thereon are immediately returnable to the company.)		$7,000,000.00	
Surplus		2,019,664.92	
			$9,019,664.92
Current Liabilities:			
Accounts and wages payable		$121,954.01	
Accrued income and other taxes		172,941.69	
Dividend payable January 20, 1926	$500,000.00		
Less: Dividends on the shares held in trust for the company as above	23,333.00		
		$476,667.00	
Unclaimed capital repayment and dividends		29,272.88	
			$800,835.58
Reserves:			
Operating equalization		$35,145.35	
Depreciation plant and equipment, etc		904,192.47	
			$939,337.82
Contingent Liabilities:			
Certain claims have been made for damages by the owners of lands on which tailings from the company's mill have encroached.			
			$10,759,838.32

The net excess of current assets over current liabilities (including dividends payable January 20, 1926, amounting to $476,667) was the sum of $3,489,083.97, as compared with $3,489,719.95 for 1924. This net excess for 1925 includes the sum of $2,173,827.71 set apart for the dividend assurance fund as compared with $2,065,993.07 set apart for the same fund at the end of 1924.

The operating and profit and loss account for the year ending December 31, 1925, showed the following:—

EXPENDITURE

		Cost per Ton of Ore Milled
Operating and Maintenance:		
Mining, including hoisting	$790,737.63	$1.491
Development	749,174.27	1.413
Crushing and conveying	69,708.23	.131
Milling	490,577.43	.925
Bullion expense	28,336.40	.054
Fire protection expense	10,558.35	.020
Warehouse expense	9,820.24	.019
Auditors' and legal expense	2,456.60	.005
Administrative expense—mine office	108,660.79	.205
Administrative expense—executive offices	19,992.71	.037
Provincial, municipal, and U.S. taxes	62,088.89	.117
Insurance	26,499.39	.050
	$2,368,610.93	$4.467
Reserve for Dominion of Canada income war tax	120,538.09	
	$2,489,149.02	
Profit for the year	2,053,008.78[1]	
		$4,542,157.80

REVENUE

Earnings:		
Amalgamation bullion	$2,635,976.90	
Cyanidation bullion	1,730,048.62	
	$4,366,025.52[2]	
Non-operating revenue	176,132.28	
		$4,542,157.80

[1]For the year ending December 31, 1924, the profits were $2,151,092.24.
[2]Earnings from bullion for the year ending December 31, 1924, were $4,307,720.04.

The surplus for the year ending December 31, 1925, was $2,019,664.92, as compared with that for 1924 of $2,419,277.86.

The appropriation account showed that $439,603.80 was reserved for depreciation of buildings and plant, and that $40,975.89 was written off for the balance of the development account, a total of $480,579.69 as compared with a total of $464,971.40 for 1924. During the year in review there were four quarterly dividends paid, amounting to $1,906,668.00.

The following information is taken from the report of the general manager, H. P. De Pencier:—

During the year ending December 31, 1925, there were 630,686 tons hoisted, as compared with 595,863 in 1924; of this, 530,200 tons was ore and was treated in the mill. The waste dumped on the surface amounted to 100,486 tons.

The 530,200 tons milled yielded bullion worth $4,366,025.52, the average yield per ton being $8.2349, as compared with the previous year, when it was $8.7307. The decrease in value per ton of the ore was more than offset by the increase, 7.458 per cent. in tonnage over the previous year.

The yields of ore for the years 1924 and 1925 are as follows:—

Source	No. of tons		Value per ton	
	1924	1925	1924	1925
Stopes	455,384	487,448	$9.118	$8.614
Development	38,016	42,752	6.643	6.295
Total	493,400	530,200	$8.927	$8.452

The ore drawn from Dome Extension ground amounted to 43,874 tons, valued at $380,797.60, or $8.679 per ton.

Development and Mining.—Stoping was carried on at from the 3rd to the 13th levels, except on the 3rd and 4th.

No developments of importance are noted above the 10th level except in the eastern hanging-wall area. At the 10th level in the extreme northeast in Dome Extension ground, a stope has been opened up from which location it is probable that more low-grade ore will be developed. A small ore shoot was also opened out south and west of No. 1,022 stope in the hanging-wall area. This corresponds to No. 931 on the 9th level and extends 50 feet below the 10th level.

An ore body, No. 1,130, at the 11th level lies in basalt and was fully opened up during the year. The development work and stoping operations proved it to be considerably larger than was known in the previous year. The western end of this ore body extended westward above the 11th level for a distance of 90 feet and reached to the 10th level as a three-foot stringer of basalt, slightly mineralized, and lying between two bands of porphyry south of drift No. 1,028. The stringer became poor and unprofitable above the 10th level. At the east a considerable extension of the ore body was found, and the total length of the body is now shown to be 550 feet with an average width of 45 feet. The bottom of this body is about 50 feet above the 12th level.

At the 13th level, the hanging-wall area has been fully opened up by drifts and crosscuts. Not much ore was encountered in the development work at the level, but a large stope was cut out above the level. Most of the ore terminated at a height of 85 feet above the level.

Other stopes at the 13th level which produced during the year were: No. 1,302, in Dome Extension ground; No. 1,316, lying farther north partly in

greenstone and partly in sedimentary rock; and No. 1,320 lying about 300 feet east of the eastern end of the hanging-wall zone and in sedimentary schists. The irregularity of No. 1,302 makes its future uncertain; No. 1,316 has not proved persistent and the downward extension of the shoot was not located.

At the 14th level, a main drift was driven from No. 3 (main) shaft a distance of 1,501 feet into Dome Extension ground, and from the drift a crosscut was driven south to the porphyry in the hanging-wall area. An ore body, No. 1,404, was tapped and opened up for a length of 147 feet. It extended only a few feet above the 14th level, but diamond-drilling proved it to reach nearly to the 15th. The width indicated in this ore body was 15 to 20 feet.

From this ore body drifting was carried on to the east in the sediments for 120 feet, where No. 1,405 was encountered and drifted on for 205 feet. A raise 70 feet above the level has been put up in the ore. This ore body has also been intersected by diamond-drill holes between the 14th and 15th levels and also a short distance below the 16th.

Drifting was continued to the east from this ore body in the sediments to a point near the Dome Extension line, but no continuous ore body was found. The development work at the 14th level shows the greenstone on the north side of the sedimentary basin dipping to the north, and the sedimentary area here is wider than was expected. The porphyry on the south side of the sediments continues to dip to the north, so that the gain in sediments is not great. Diamond-drilling done below the 14th level shows that the porphyry continues to dip to the north for several levels below the 14th and will probably be found to underlie the whole western end of the sediments. The mass of porphyry is several hundred feet thick.

To explore the sedimentary basin below the 13th level, a winze, No. 4, was sunk from that level to a point near the Dome Extension boundary line to the 16th level, where crosscuts were directed to the northeast and northwest for distances of 279 and 130 feet, respectively, at which points diamond-drill stations were cut from which dipping holes were drilled across the sedimentary zone. Two holes drilled from the northwest station intersected a small ore shoot in the greenstone close to the contact of the greenstone and sediments, but no ore was found in the sediments by these holes. Porphyry was reached to the south of the sediments at a depth 300 feet below the 16th level, showing that the sediments at this point are 170 feet in width.

A hole drilled from the northeast station, which is 110 feet east of the boundary line between the Dome and Dome Extension, failed to locate ore and evidently passed under the sedimentary basin, the rocks cut being those encountered at the contact of the greenstone and the sediments.

These holes drilled from the 16th level stations have intersected the ground below the level for a distance along the general course of the Dome ore zone of 450 feet. The report of the general manager admits that the results of this drilling and that done from the 13th level are disappointing, and it is pointed out that practically no ore will be found in the sediments below the 13th level in the vicinity of the boundary between the Dome and Dome Extension, though there are chances of a downward extension east of the greenstone.

The development work and diamond-drilling done below the 14th level and on the 14th level do not indicate that ore bodies comparable in size with those on the upper levels are likely to be found.

The No. 3 (main) shaft has been sunk to a depth of 2,139 feet, with levels known as the 15th and 16th cut out. Loading pockets have been made below the 16th level, which is at 2,079 feet.

Drifting was started at the 15th level from No. 4 winze to enable rapid development of the level to be carried on. Connections have been made with the No. 3 shaft at the 14th level.

SUMMARY OF DEVELOPMENT WORK FOR YEAR 1925

Level	Drifts	Cross-cuts	Crosscut slashing	Raises and winzes	Box-holes	Stations	Shafts	Raise and winze slashing	Total	Diamond-drilling
	feet	feet	feet	feet	feet	feet	feet	feet	feet	feet
Surface	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,444.5
3rd	370	362	109	44	488	.....	.....	.....	1,373	738.5
5th	154	.....	18	162	.....	.....	.....	.....	334	913
6th	302	89	35	74	881	.....	.....	12	1,393	1,038
7th	17	.....	7	123	.....	.....	.....	.....	147	648
8th	144	27	25	112	223	.....	.....	65	596	721
9th	555	404	137	274	705	.....	.....	36	2,111	1,737.5
10th	635	221	110	241	293	.....	.....	17	1,517	1,036.71
11th	1,001	521	80	439	1,247	.....	.....	2	3,290	1,679.4
12th	1,214	248	105	698	1,522	.....	.....	18	3,805	5,699.25
13th	1,429	837	353	389	1,283	52	150	.....	4,493	9,209.08
14th	2,310	1,034	346	355	72	18	176	41	4,352	10,762
15th	.....	148	.....	3	.....	181	294	.....	614	194
16th	.....	409	.....	55	.....	159	64	26	725	2,119
Total	8,131	4,300	1,325	2,969	6,714	410	684	217	24,750	38,939.94

Waste hoisted: 100,486 tons.

The expenditure on mining was $1.491 per ton milled, as compared with $1.543 during the preceding year.

The expenditure on development work was $1.413 per ton milled, as against $1.380 per ton milled in 1924.

Diamond-Drilling.—During the year, 38,939.94 feet of diamond-drilling was done, this exceeding the previous year's footage by 83.6 per cent. Drilling was done in the vicinity of known ore shoots as well as to test areas farther removed. The results showed that no important ore bodies existed in the areas.

From the surface south of the mine workings, five holes, totalling 2,211.5 feet, were drilled to explore ground which, for geological reasons, was considered favourable, but in no case was ore found. The report states that "it appears altogether unlikely that any important ore bodies exist to the south of the main ore zone from which the Dome production has come."

Ore Reserves.—In his remarks on the ore reserves, the general manager states:—

> The development work and diamond-drilling carried out during the year have failed to disclose or indicate a tonnage of ore equal to that milled, and consequently there has been a falling off of the ore in sight. The failure of the 13th level to provide ore of a grade equal to that drawn from the stopes of the upper levels, particularly the 7th, 8th, and 11th, has resulted in a decided decrease in the gold content of the broken ore reserves, though the tonnage of broken ore now stands at around 620,000 tons.

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

	Total value	Per ton
Heads, 530,200 tons	.....	$8.452
Amalgam bullion	$2,635,976.90	4.9719
Cyanidation bullion	1,730,048.62	3.263
Total	$4,366,025.52	$8.2349

The tonnage milled was at a monthly rate of 44,183 tons, as against 41,116 tons for the year 1924. There was a slight falling off in the extraction due to the considerable increase in the tonnage. At the increased tonnage the filter presses in the mill were being operated to their limit.

The milling cost per ton of ore milled was $0.925, as compared with $0.999 for the previous year.

During the year 1925 the average number of employees was: mine, 510; mill, 58; surface, 222; total, 790.

Gold Hill Mining Company, Limited

This company operated their property in Catharine township, district of Timiskaming, during 1925 with a working force of about 25 men. The company has an authorized capital of 3,000,000 shares of which 2,066,563 are issued. D. H. Angus was president, and Dan Hughes contractor.

A new bunk-house, 20 by 40 feet, was erected, also an icehouse, an oil-house, and a magazine, each 12 by 14 to 16 feet.

Development work during 1925 included 1,700 feet of drifts and crosscuts on the 300-foot level and 120 feet on the 400-foot level.

A 125 h.p. boiler and a 10- by 12-inch Jenckes hoist were installed in the first two months of 1926; sinking was resumed in the shaft on March 7.

Early in 1926, a new company, Gold Hill Mines, Limited, was formed with the same capital as the old, and a sale was made of the assets of the old company. One-third of the issued shares were optioned at 30 cents a share to Gold Hill Mines, Limited, so as to give the new interests control, and new shares were issued for the remaining portion of the shares in the old company. The directors of the new company are: D. H. Angus, president; E. W. Kearney, vice-president; C. F. Tuer, secretary-treasurer; A. R. Farrell and George Tough. The head office is at Haileybury, Ont.

Gosselin Syndicate

The Gosselin property in Cassels township, district of Nipissing, was operated by the Gosselin Syndicate with three to five men in charge of P. Gosselin. A winze was sunk on a 55-degree incline from near the bottom of No. 2 shaft, which has a depth of 73 feet.

Goudreau Gold Mines, Limited

Mining operations at the property in township 28, range XXVI, district of Algoma, were recommenced early in the fall of 1925 and carried on continuously until the end of May, 1926, the mill being run from about the first of the year until operations ceased.

When the property was visited on May 10, 1926, the total development work completed stood as follows:—

SHAFTS:
No. 1 sunk to the 400-foot (vertical) level.
No. 2 sunk to the 200-foot (vertical) level.
CROSSCUTTING:
On 100-foot level, 190 feet.
On 200-foot level, 641 feet.
On 400-foot level, 311 feet.
DRIFTING:
On 100-foot level, 355 feet.
On 200-foot level, 893 feet.
On 400-foot level, 381 feet.

A small stope west of No. 1 shaft on the 100-foot level was being worked at this time; some ore had been stoped previously on the same level east of the shaft.

Crushing and milling equipment installed during 1925 consists of: Allis-Chalmers Blake crusher, 24 by 12 inches; a pair of Allis-Chalmers, style B rolls, 36 by 16 inches; 40 h.p. motor, driving both the above machines; 18-inch belt conveyor delivering the roll product to the mill bin, driven by a 7½ h.p. motor; 4½-foot Hardinge ball mill, driven by a 40 h.p. motor; 3 h.p. motor, driving the ball mill feed belt and a drag belt of home construction; 2 amalgamation plates of approximately 50 square feet surface each.

No. 1 shaft was repaired and a skip of about two tons capacity installed to replace the bucket previously used, the skids being replaced by rails to the 400-foot level.

Thirty-two men were employed at the property when it was visited on the above date.

The directors of the company are: president, Albert Foster, Leamington, Ont.; vice-president, A. V. J. Selkirk, Franz, Ont.; secretary, M. P. Van Der Voort, Toronto; directors, Albert Foster, A. V. J. Selkirk, Douglas Maynard, R. C. Johnson, Geo. F. Macdonald; A. R. McDonald, Manager.

Harker Gold Mines, Limited

Seventeen claims in the southeast corner of Harker township and two on the west boundary of Holloway township, district of Timiskaming, are owned by the Harker Gold Mines, Limited.

The properties may be reached in winter from Ramore on the Timiskaming and Northern Ontario railway over a sleigh road of 27 miles; and in summer from Matheson over good road by way of the Croesus mine, for a distance of 27 miles, and then 12 miles of rough road unfit for wagon. Or the area may be reached by way of the Canadian National railway from Low Bush or La Reine and Abitibi lake.

Mining operations were carried on continuously from January 1 to October 9, 1925. The shaft, 7 by 11 feet, started in 1924 on claim No. 13,138, was continued; and levels were established at every 125 feet. As the vein[1] on which the development was being done dipped 70° S., crosscuts were made at each level to pick up the vein and drifting was done on the 125-, 250-, 375-, and 500-foot levels.

The head office of the company is at 801 Dominion Bank Building. The officers of the company were: J. Hammel, president; G. M. Huycke, secretary; Horace G. Young, manager.

Harkness-Hays Gold Mining Company, Limited

Capitalized at $1,000,000, the company holds two claims, T.B. 3,327 and T.B. 3,354, located in the district of Thunder Bay, about two miles east of Schreiber on the main line of the Canadian Pacific railway.

The officers and directors of the company are as follows: W. Dean Hays, Schreiber, Ont., president and general manager; E. Edward Bickel, 336 Madison

[1]For description of the geology of the property, *see* "Lightning River Gold Area," by T. L. Gledhill, Ont. Bur. Mines, Vol. XXXIV, pt. 6, 1925, pp. 87-89, 94.

Avenue, New York, secretary; Hallett Addoms, 15 Grenfell Avenue, Kew Gardens, New York, treasurer; H. Harkness, Fort William, Ont.; W. F. Langworthy, Port Arthur, Ont.

Surface exploration was carried on during the summer of 1925; in the spring of 1926, buildings comprising a blacksmith shop, powder magazine, cook camp, and sleep camp were erected. Driving of an adit crosscut was commenced on May 20, 1926, with hand steel. This adit had advanced a distance of 18 feet when the property was visited on June 5.

Seven men were employed at the time of the above-mentioned visit. W. D. Hays is the manager, and Gus Anderson mine foreman.

Harvey-Kirkland Mines, Limited

The company did 2,300 feet of diamond-drilling on their property in Lebel township, district of Timiskaming, in the summer of 1925, under the direction of Professor A. McLean, ten men being employed from July to October and five men for a month later. The officials of the company are: C. J. Beilby, president; Dr. Switzer, vice-president; J. W. Beilby, secretary-treasurer. The head office is at 506 C.P.R. Building, Toronto.

D.D. hole No. 1 was pointed north from a point 100 feet west of the shaft at an angle of 65 degrees and ended at an angle of 20 degrees at a depth of 730 feet.

D.D. hole No. 2 was pointed north from a point 300 feet south of No. 2 shaft at an angle of 85 degrees, and ended at 320 feet at about 70 degrees.

D.D. hole No. 3 was started between 700 and 800 feet south of No. 2 shaft at an angle of 85 degrees and drilled to the north for 500 feet when the angle was 75 degrees, and then flattened and continued to a depth of 1,250 feet, ending at an angle of 15 degrees from the horizontal.

Hollinger Consolidated Gold Mines, Limited

This company has an authorized capital of $25,000,000 in 5,000,000 shares of $5 par value each; 4,920,000 of these were outstanding on January 1, 1926.

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

The following information is taken from the directors' report to the shareholders as given in the 15th annual report covering operations for the year 1925:—

The power development at Island falls, on the Abitibi river, was sold to the Abitibi Power and Paper Company, Limited, but is still being carried as a capital asset, since the details of the sale and transfer of titles to the purchaser took longer to work out than was expected.

The balance sheet for the year ending December 31, 1925, shows assets and liabilities as follows:—

ASSETS

CAPITAL:			
Mining properties			$22,493,785.17
Plant, brought forward from 1924		$1,043,426.53	
Additions during 1925		630,276.13	
		$1,673,702.66	
Less depreciation for 1925		1,051,135.46	$622,567.20
Investments in other companies and properties:			
Brought forward from 1924		$49,968.27	
Additions during 1925		15,079.55	
		$65,047.82	
Less depreciation for 1925		4,509.26	$60,538.56
Tailings disposal site:			
Brought forward from 1924		$58,917.60	
Less depreciation for 1925		12,625.20	$46,292.40
Hollinger power development:			
Brought forward from 1924		$5,120,397.00	
Additions during 1925		787,294.56	$5,907,691.56
			$29,130,874.89
DEFERRED:			
Material and supplies, solutions, and litharges and slags, etc., on hand		$765,307.51	
Charges paid in advance, fire insurance		3,884.60	$769,192.11
CURRENT:			
Cash on hand in bank	$410,458.57		
Bullion in transit	537,969.01		
Accounts receivable	94,239.20		
		$1,042,666.78	
Bonds and debentures		$4,465,877.93	
Accrued interest on investments		55,948.32	$5,564,493.03
			$35,464,560.03

LIABILITIES

CAPITAL STOCK:			
Authorized		$25,000,000.00	
In treasury		400,000.00	$24,600,000.00
CURRENT LIABILITIES:			
Wages unpaid		$175,848.29	
Accounts payable		523,949.26	$699,797.55
Reserve for Dominion of Canada 1925 taxes			388,000.00
SURPLUS:			
Balance of account from 1924		$7,616,851.76	
Profits from January 1 to December 31, 1925		7,606,980.64	
		$15,223,832.40	
Less—dividends	$4,378,800.00		
Plant depreciation	1,051,135.46		
Tailings disposal site depreciation	12,625.20		
Investments in other companies and properties written down	4,509.26		
		$5,447,069.92	
Net surplus carried forward			$9,776,762.48
			$35,464,560.03

The profit and loss statement is taken from the general manager's report for the year 1925, and is compared with that of 1924:—

			1925	1924
Sources of Income:				
Gold and silver produced			$15,786,405.04	$13,429,226.87
Premium on U.S. exchange			.....	145,549.00
Interest on investments, etc			342,850.66	416,337.67
			$16,129,255.70	$13,991,113.54
Disposal of Income:	1925	1924		
General charges	$791,615.95	$705,844.45		
Mining charges	5,292,152.81	5,133,252.27		
Milling charges	1,745,259.86	1,565,801.81		
			$7,829,028.62	$7,404,898.53
Operating profit			$8,300,227.08	$6,586,215.01
Paid out in dividends			4,378,800.00	3,198,000.00
			$3,921,427.08	$3,388,215.01
Deduct:	1925	1924		
Taxes, province of Ontario	$152,296.62	$50,141.60		
Municipal taxes (includes $35,000 royalty to town of Timmins)	95,352.48	81,235.65		
Dominion of Canada 1925 taxes	388,000.00	187,000.00		
Dominion of Canada 1924 taxes (adjustment)	57,597.34	.....		
	$693,246.44	$318,377.25		
Depreciation:				
Plant	$1,051,135.46	$1,147,927.97		
Tailings disposal site	12,625.20	12,625.20		
Investments in other companies and properties written down	4,509.26	2,247.33		
			$1,761,516.36	$1,481,177.75
Added to surplus			$2,159,910.72	$1,907,037.26

The yearly average costs are given as follows:—

Distribution of General Charges

Account	Sundries	Labour	Stores	Total	Per ton milled
General miscellaneous charges and administration	.....	$311,161.81	$73,888.07	$385,049.88	$0.1994
Surface services	.....	46,940.30	46,155.54	93,105.84	.0482
Insurance	$15,007.28	.....	.....	15,007.28	.0078
Marketing bullion	88,013.89	.....	.....	88,013.89	.0456
Workmen's compensation	.....	207,998.55	.....	207,998.55	.1078
Discount on U.S. exchange	2,440.51	.....	.....	2,440.51	.0013
Milling charges	.....	676,928.48	1,068,331.38	1,745,259.86	.9043
Mining charges	.....	3,394,656.10	1,897,496.71	5,292,152.81	2.7421
Total	$105,461.68	$4,637,685.24	$3,085,881.70	$7,829,028.62	$4.0565

The total cost per ton of ore milled in 1924 was $4.4622.

The Mine.—The development progress during the year 1925 was as follows:—

Level	Shafts	Drifts	Cross-cuts	Raises	Diamond-drilling	Timbering		Excavation
						Shafts	Stopes	
	feet	feet	feet	feet	feet	feet	feet	tons
Surface	.....	.....	.....	.....	2,294	.....	.....	.....
100-foot	.....	248	346	.....	1,676	.....	.....	.....
200-foot	.....	3,565	97	.....	12,374	.....	884	30
300-foot	.....	1,240	371	.....	3,788	.....	1,419	.....
425-foot	.....	2,537	645	.....	7,220	.....	1,088	.....
550-foot	.....	2,469	666	.....	8,070	.....	2,126	.....
675-foot	.....	2,704	804	.....	5,435	.....	537	150
800-foot	.....	893	1,546	15	3,339	19	381	65
950-foot	12	2,352	711	.....	9,773	157	944	282
1,100-foot	.....	2,448	736	.....	8,811	149	1,510	265
1,250-foot	150	3,529	3,278	.....	17,153	150	3,400	75
1,400-foot	150	6,478	3,371	.....	14,143	150	4,392	824
1,550-foot	150	4,262	5,040	.....	6,703	167	.....	2,403
1,700-foot	267	68	3,828	107	736	300	.....	1,618
1,850-foot	300	961	4,996	391	1,995	300	.....	2,209
2,000-foot	259	268	2,842	329	380	256	.....	2,704
2,150-foot	327	.....	1,147	471	.....	331	.....	3,089
2,300-foot	300	.....	295	374	.....	300	.....	3,028
2,450-foot	236	.....	73	.....	.....	229	.....	360
2,600-foot	150	.....	72	.....	.....	150	.....	245
2,750-foot	52	.....	.....	.....	.....	12	.....	60
Total, 1925	2,353	34,022	30,864	1,687	103,890	2,670	16,681	17,407
Total, 1924	1,713	21,623	22,489	490	88,023	2,041	15,493	24,983

The total sinking, drifting, crosscutting, and raising for 1925 was 68,926, and for 1924 was 46,315 feet.

At March 31, 1926, the central shaft, through which all ore is hoisted to the surface, had reached a depth of 2,380 feet. At the 2,150-foot level another 48-by 60-inch jaw crusher was being installed to crush all ore mined below the 1,550-foot level. The 8-inch product from this crusher will be discharged into a loading pocket at the 2,300-foot level.

To assist in the working of this shaft, an auxiliary known as No. 21 is sunk as a winze near the central shaft. At March 31, 1926, this No. 21 had reached a depth of 2,800 feet below the surface.

The No. 19 shaft (Schumacher) had at March 31, 1926, reached a depth of 2,000 feet. Early in 1926, preparations were being made to have the central shaft served by larger hoists and to move the Vulcan hoist, double drum, each 10 feet in diameter, formerly used at the central shaft, to No. 19 shaft where it would serve for men and material hoisting.

MINE PRODUCTION

Level	Broken ore in mine, Jan. 1, 1925	Ore broken during 1925	Ore removed during 1925	Broken ore in mine, Dec. 31, 1925
	tons	tons	tons	tons
Above 100-foot	700	25,490	22,243	3,947
Above 200-foot	45,712	165,257	145,774	65,195
Above 300-foot	35,119	92,599	90,786	36,442
Above 425-foot	119,756	180,974	165,870	134,860
Above 550-foot	54,488	161,209	149,864	66,530
Above 675-foot	42,951	76,448	60,792	58,607
Above 800-foot	53,497	53,539	63,927	38,224
Above 950-foot	307,871	248,428	479,381	81,596
Above 1,100-foot	191,461	420,543	290,120	321,884
Above 1,250-foot	5,866	457,492	248,627	214,731
Above 1,400-foot	.....	254,640	160,993	93,647
Above 1,550-foot	.....	43,695	39,335	4,360
Above 1,700-foot	.....	868	868	.....
Above 1,850-foot	.....	8,457	8,457	.....
Above 2,000-foot	.....	2,491	2,491	.....
Total, 1925	857,421	2,192,130	1,929,528	1,120,023
Total, 1924	724,503	1,792,694	1,659,776	857,421

Below the 800-foot level, the track gauge is 36 inches and cars are of 3-ton capacity. Trolley locomotives are used, and trains are hauled to tipples situated at each level near the central shaft. Four cars can be dumped at a time into passes which, in the case of ore lead to the crusher stations at the 1,550- and 2,150-foot levels, central shaft. A feature of the tipples is that ore and waste can be disposed of from the one train at the same time. Normally the floors under the tipple are set to send the ore into special passes, but by lowering any of the four doors waste can be passed into pockets provided for it. All the waste rock is sent back into the mine for stope filling.

During the year 1925 the compressed air capacity for the mine was increased by the installation, at the power plant near Gillies lake, of a Canadian Ingersoll-Rand compressor, which will supply 10,200 cubic feet of free air per minute at a pressure of 100 pounds per square inch. This is one of the largest units ever built in Canada and belongs to the PRE 2 class of horizontal duplex, two-stage cylinder, with countercurrent intercooler air compressors. Dimensions are as follows: bore of low-pressure cylinder, 50 inches; bore of high-pressure cylinder, 30 inches; stroke, 36 inches. The compressor is direct connected to a 1,650 h.p., 11,000-volt, 3-phase, 25-cycle unity power factor Canadian Westinghouse synchronous motor.

SUMMARY OF ORE RESERVES

Vein No.	Tons	Value per ton	Estimated gross value, Dec. 31, 1925	Estimated gross value, Dec. 31, 1924
Veins over $10:				
39	5,320	$23.50	$125,020	$125,020
97	310,485	20.45	6,348,582	4,149,196
200	3,682	16.54	60,882	60,882
86	217,644	14.89	3,240,248	1,225,205
107	132,961	14.08	1,872,325	449,560
68	19,255	13.66	263,040	393,288
84	409,774	13.01	5,330,005	5,576,410
115	3,899	12.28	47,884	.....
1	87,632	12.00	1,051,895	1,092,737
48	6,588	11.92	78,500	96,831
44	19,081	11.79	224,932	169,684
226	67,168	11.35	762,135	555,754
82	7,020	11.30	79,326	.....

SUMMARY OF ORE RESERVES—*Continued*

Vein No.	Tons	Value per ton	Estimated gross value, Dec. 31, 1925	Estimated gross value, Dec. 31, 1924
Veins over $10—*Continued:*				
38	6,200	$11.18	$69,335	$69,335
13	17,153	11.15	191,249	191,249
51	77,027	11.10	855,064	1,189,957
58	123,638	10.83	1,339,121	1,363,013
47	13,463	10.58	142,471	142,471
26	21,703	10.56	229,242	513,188
101	41,198	10.49	432,113	236,628
50	113,846	10.42	1,186,246	1,212,200
5	23,273	10.36	241,022	241,022
15	117,812	10.35	1,219,231	653,936
111	26,268	10.33	271,352	.....
92	103,818	10.31	1,070,522	1,311,939
14	33,564	10.29	345,500	345,500
61	8,698	10.11	87,962	87,962
Total	2,018,170	$13.46	$27,165,204	$21,452,967
Veins, $10 to $8:				
8	10,567	$9.78	$103,371	$103,371
10	21,352	9.78	208,820	208,820
116	10,320	9.69	100,007	.....
16	10,586	9.66	102,277	102,277
91	273,341	9.55	2,611,543	2,417,804
66	42,138	9.53	401,619	227,128
65	145,063	9.45	1,370,453	1,638,975
56	59,314	9.34	553,976	678,166
33	103,516	9.32	964,982	861,946
4	37,762	9.19	346,940	346,940
2	102,349	9.17	939,048	970,174
63	156,784	9.07	1,421,881	2,058,233
88	60,034	8.89	533,742	976,594
53	245,853	8.71	2,142,049	2,240,497
55	625,147	8.68	5,428,671	6,314,580
85	381,757	8.57	3,272,795	3,493,728
87	17,686	8.55	151,174	64,958
52	68,796	8.51	585,502	585,542
37	24,810	8.37	207,600	152,898
59	41,603	8.26	343,622	384,107
54	170,003	8.22	1,397,717	2,379,913
12	202,172	8.22	1,662,288	1,399,617
9	37,508	8.11	304,256	404,546
79	.....	.....	.....	79,478
206	.....	.....	.....	31,339
Total	2,848,461	$8.83	$25,154,333	$28,121,631
Veins, $8 to $6:				
95	212,327	$7.78	$1,652,545	$709,141
64	1,096	7.60	8,330	8,330
11	15,236	7.59	115,654	115,654
99	14,797	7.46	110,389	286,833
150	5,674	7.37	41,811	42,378
113	20,021	7.36	147,449	.....
3	14,354	7.29	104,677	88,897
90	1,535	7.20	11,052	11,052
96	4,832	6.89	33,300	56,226
7	8,738	6.34	55,398	.....
45	4,291	6.20	26,604	16,055
94	.....	.....	.....	52,192
Total	302,902	$7.62	$2,307,209	$1,386,758
Total ore reserves	5,169,533	$10.57	$54,626,746	$50,961,356
Surface outcrops	94,330	7.03	663,343	778,803
Add probable ore in veins under $6	1,926,692	5.07	9,778,710	7,564,726
Total	7,190,555	$9.05	$65,068,799	$59,304,885

The Mill.—Milling results were as follows:—

Ore milled	tons	1,929,988
Average value per ton		$8.51
Gross value		$16,422,507.04
Deduct loss in tailings		636,102.00
Net value recovered		$15,786,405.04
Bullion shipped in 1925	$15,749,711.12	
Difference in inventories Jan. 1 and Dec. 31, 1925, of solutions, slag, litharge, etc.	36,693.92	
		$15,786,405.04

Average tons per day		5,317
Per cent. of possible time run		95.5
Tons per 100 per cent. running time		5,568
Solution precipitated per ton ore		1.55
Value per ton in tailings		$0.33
Cyanide consumed per ton of ore	lbs.	0.402
Zinc consumed per ton of ore	lbs.	0.090
Zinc consumed per ton of solution	lbs.	0.058
Lime consumed per ton of ore	lbs.	1.912
Lead nitrate per ton of ore	lbs.	0.017
Average value of pregnant solution		$5.27

An addition was made to the mill, a building 70 by 85 feet, and 55 feet high, to accommodate 20 Pachuca tanks, each 15 feet in diameter by 45 feet.

Eleven Oliver continuous filters, making 18 in all, 14 feet in diameter by 16 feet long, with concrete instead of steel tanks, were installed with spur instead of worm reduction gears. Six act as primary filters and twelve as secondary.

The vacuum clarification of the gold solutions has been discarded in favour of four Merril rectangular presses, 34 by 34 inches, with 22 leaves; a new press, 42 by 42 inches, with 50 leaves, was added.

Eight 30-foot Dorr thickeners have been replaced by three 40-foot tray Dorr thickeners.

Changes are also under way to increase the concentration branch of the milling.

One set of Traylor rolls, 60 by 24 inches, was installed early in 1926 and another set is to be added, making three sets in all.

Since May, 1925, practically all tails from the mill have been sent to the storage at the McKay lots, a mile and a half south of the main Hollinger holdings.

Employees.—The average number of men employed during the year 1925 was 2,668, distributed as follows:—

Miners:		Mechanics:		General:	
Exploration	30	Operation	139	Mill and refinery	268
Development	389	Maintenance	189	Engineering staff	81
Production	1,323	Construction	53	Clerical staff	52
				Miscellaneous	144
Total	1,742	Total	381	Total	545

Kirk Gold Mines, Limited

During the year, this company continued operations on their property in Lebel township, district of Timiskaming, with a force of 14 men. The directors of the company are: J. A. Morden, Toronto, president; J. S. Knechtel, Hanover, Ont., vice-president; C. L. Messecar, Brantford, Ont.; A. Moir, Peterborough, Ont., and A. Sieling, Hanover, Ont. H. L. Donaldson is manager.

Development work during the year included 86 feet of sinking which brought the shaft to a depth of 300 feet, 1,100 feet of crosscut north at the 300-foot level, about 190 feet of drifting on a vein which was encountered about 700 feet from the shaft, and 400 feet of drifting on a vein 800 feet distant from the shaft.

Kirkland-Hunton Mines, Limited

This company was formed with a capital of $4,000,000 on February 19, 1925, by reorganization of the Hunton-Kirkland Gold Mines, half of the shares being given to the former shareholders on the basis of one share of the new for two of the old. Leo Erenhous is president and John McPhee is superintendent.

The workings in Teck township, district of Timiskaming, were pumped out between October 22 and November 18, and 115 feet of drifting was done on the 125-foot level in November and December. A station was cut on the 375-foot level, and sinking started on an incline winze in an effort to locate the ore reported from diamond-drilling in 1923 at a depth of about 675 feet. Twenty men are employed.

Kirkland Lake Gold Mining Company, Limited

The company has an authorized capital of $5,000,000 in shares of $1 par value, 1,000,000 of which are preferred shares. A total of 936,115 preferred shares and 3,372,235 common shares have been issued. The board of directors comprises: F. L. Culver, president; J. B. Tyrrell, vice-president and managing director; W. D. McPherson, and J. A. Dennison, who replaced J. A. P. Gibb, deceased. R. Graham is secretary-treasurer, and the head office of the company is at 810 Lumsden Building, Toronto. William Sixt is superintendent, and from 30 to 50 men are employed at the property in Teck township, district of Timiskaming.

The new Canadian Ingersoll-Rand double-drum hoist, purchased in 1924, was installed at the main shaft. The drums are 6 feet in diameter with a 4-foot face, and the hoist is operated by a 100 h.p. motor. A new high lift pump was installed first on the 1,600-foot level and afterwards moved to the 1,975-foot level. This pump lifts water to the 900-foot level to be raised from there to the surface by the old equipment. Necessary repairs were made to buildings, and an addition was made to the manager's house.

The main shaft was sunk 435 feet to a depth of 2,075 feet, and stations were cut at the 1,725-, 1,850-, and 1,975-foot levels during the year, and deepened two more levels in the first quarter of 1926.

The following summary of mining operations is taken from the managing director's report:—

1,300-Foot Level.—A crosscut was driven southward 123 feet to the south vein in preparation for the further development of the ore shoot in which rich ore had been left in the floor of the 1,100-foot level.

1,600-Foot Level.—A crosscut was driven southward for 707 feet to within 37 feet of the south boundary of the property in order to reach and eventually to cut across the Chaput-Hughes property in fulfilment of the agreement made with the Chaput-Hughes Mines, Limited. A little ore was encountered in this crosscut, and 107 feet of drifting was done on two veins. One hundred and sixty-two tons of ore were mined and raised from these and placed on the stock-pile, but as we were sinking and exploring at greater depths, this work was temporarily discontinued.

1,725-Foot Level.—A station was cut, and a crosscut was driven southward for 27 feet.

1,850-Foot Level.—A crosscut was driven southward 175½ feet until the south vein was encountered, and afterwards a drift was driven 79 feet eastward on this vein.

1,975-Foot Level.—A crosscut was driven southward from the shaft for 185 feet. At 121, 142, and 165 feet veins were encountered, and it was decided to drive eastward on the most northerly of the three. From the drift on this north vein, at a distance of 100 feet east of the main crosscut, a crosscut was driven southward to the south vein; and again at 200 feet east of the main crosscut another crosscut was driven south to the same south vein, and this time very rich ore was encountered. From this point the south vein was driven on for 30 feet westward and

280 feet eastward to within 17 feet of the eastern line of our property, opening up a shoot of rich ore 210 feet long, for a thickness of 5½ feet, which is the average width of the drift, but the full thickness of the vein has not yet been determined. For the last hundred feet at the eastern end of the drift the vein is also continuous, well defined, and everywhere contains gold. From the development work on this level, 991 tons of ore were mined, raised, and placed on the stock-pile.

SUMMARY OF MINING OPERATIONS

Shaft-sinking	435.7 feet
Station-cutting	108 feet
Crosscutting	1,542 feet
Drifting	784.5 feet
Diamond-drilling	1,469 feet
Ore drawn	1,204 tons
Waste drawn	16,177 tons

Kirkland Rand, Limited

The company resumed operations on their property in Teck township, district of Timiskaming, in May, 1925. W. F. Empey is president, and W. R. Osborne is superintendent. From 11 to 30 men are employed.

The development work for the thirteen months ending June 15, 1926, comprised 308 feet of shaft-sinking, 84 feet of raising in the shaft from the 550-foot level, 1,482 feet of drifts and crosscuts on the 550-foot level, and 259 feet of crosscut on the 800-foot level, besides stations equivalent to 137 lineal feet of drift. The sinking of the shaft to the 800-foot level, with an additional 27 feet for a pocket and 13 feet for a sump, was completed early in May, 1926.

Lake Shore Mines, Limited

This company has an authorized capital of $2,000,000, in shares of $1 par value.

The officials and directors of the company are: president and managing director, Harry Oakes; vice-president, W. H. Wright; treasurer, W. P. St. Charles; secretary, Kirkland Securities, Limited; directors, Louis Oakes, Albert Wende, Ernest Martin, William H. Wright. E. B. Knapp, Kirkland Lake, is mine superintendent.

During the year four dividends, amounting to $700,000 were paid. The mine and mill are in Teck township, district of Timiskaming.

The following information is taken from the eleventh annual report of the company, for the year ending June 30, 1926:—

During the year, 143,542 tons were mined and hoisted. Of this, 125,676 dry tons was ore which was sent to the mill and treated.

The 125,676 tons of ore yielded bullion worth $2,235,184.40, the recovery per ton being $17.79. The tonnage milled during the year showed an increase of approximately 30 per cent. over that of last year, while the bullion produced shows an increase of $422,689.74.

During the year 225,236 tons of ore were broken, of which 104,534 tons came from the stopes and 24,533 from development. The broken ore reserves now amount to 181,534 tons as against 85,365 tons last year.

The total footage for the year was 8,411.45 feet. Diamond-drilling amounted to 4,622 feet.

An incline shaft has been sunk, connecting the railroad spur on the surface with the 200-foot level. All mine supplies, such as powder, rails, timber, oil, etc., are now taken into the mine through this shaft.

All ore on and above the 800-foot level is now dropped through a series of ore passes direct to a large jaw crusher, or hauled thereto in 2½-ton cars by electric haulage. This connects with the skip-loading pocket located on the 900-foot level. Operating from this loading pocket are 3½-ton skips hoisting ore to ore bins on the surface.

Both No. 1 and No. 2 veins have shown very encouraging results on both the 800- and 1,000-foot levels. A total footage of over 2,000 feet of ore has been opened up on these two levels. Development work for the year is as follows:—

Level	Drifts	Cross-cutting	Raises	Shafts	Ore pass	Total footage	Diamond-drilling	Box-holes	Station-cutting
	feet	feet	feet	feet	feet	feet	feet	cu. ft.	cu. ft.
No. 2 shaft	.....	.....	.....	593	.....	593	.....	.....	.....
200-foot	741.45	31	.....	.....	.....	772.45	.....	.....	.....
400-foot	508	405.5	424	.....	.....	1,337.5	.....	.....	.....
600-foot	402.5	.....	978	.....	271	1,651.5	.....	1,450	.....
800-foot	1,490.5	175	412	.....	293	2,370.5	167	6,652	18,060
1,000-foot	1,530.5	54	.....	.....	102	1,686.5	4,455	.....	.....
Total	4,672.95	665.5	1,814	593	666	8,411.45	4,622	8,102	18,060

Milling.—The old model C classifiers were found to be of too light construction for the tonnage milled and were replaced with heavier type machines. The ball mills have been placed in closed circuit with simplex classifiers, this arrangement giving increased grinding capacity with a considerable reduction in grinding costs.

Oliver filters have been installed to handle the tailings.

These and various other changes in the mill circuit have materially increased the extraction.

Construction.—During the year four new modern cottages—all having full cement basements—of frame construction, a storey and a half high, were erected.

A concrete and tile hoist building has been built, also a 600-ton concrete coal bin. A new 120 h.p. Babcock-Wilcox water tube boiler has been installed for heating purposes. New steam and water lines connecting all the buildings on the property have been laid, also a 12-inch sewer line from the accommodation building to the lake.

A 2,500 cubic foot Bellis and Morcom compressor has been purchased and is now being installed.

An auxiliary lighting plant of 100 k.w. capacity has been connected to the fire pump engine. This will run the mill's small motors and take care of the lighting load.

The new hoist ordered last year has now been in use for several months.

A Northern Electric automatic telephone system has been installed, telephones being located in all the principal buildings on the property.

The underground equipment has been added to, such as electric locomotives, cars, etc.

A general summary of the year's work shows:—

1. The completion of a series of ore passes underground whereby all ore above the 800-foot level is dropped directly to the underground crusher or hauled to it in large cars.
2. The installing of electric haulage.
3. Underground crushing.
4. The installation of skips in the shaft for handling of ore.
5. A further increase in mill tonnage to approximately 16,000 tons monthly.
6. The development and blocking out of ore on the 800- and 1,000-foot levels on both No. 1 and No. 2 veins.

McCarthy-Webb Goudreau Mines, Limited

The company was incorporated on November 12, 1925, under the Ontario Companies Act, with an authorized capital of $3,000,000, in shares of $1 par value.

The officers and directors of the company are: president and general manager, M. B. R. Gordon; vice-president, R. A. Hutchison, Whitby, Ont.; secretary-treasurer, Stuart D. Terry, Toronto; D. J. McCarthy, Sault Ste. Marie, Ont.; Norman Paxton, New York. The head office is at 902 C.P.R. Building, Toronto.

The properties held consist of seven claims: S.S.M. 2,048-53, and 2,102 in township 49, range XXVII, in the Goudreau area of the district of Algoma.

The work accomplished to date consists of surface stripping, sinking of two test shafts to depths of 28 and 35 feet, respectively, 1,100 feet of diamond-drilling, and the erection of camps and a blacksmith shop.

The operations are in charge of the general manager.

McIntyre-Porcupine Mines, Limited

This company has an authorized capital of $4,000,000, divided into 800,000 shares of a par value of $5, of which 798,000 are issued.

The officers of the company are: J. P. Bickell, president; W. J. Sheppard, vice-president; M. P. Van Der Voort, secretary; Balmer Neilly, treasurer. The

directors are: J. P. Bickell, Toronto; W. J. Sheppard, Waubaushene, Ont.; J. B. Tudhope, Orillia, Ont.; N. J. Miller, New York; Jos. Errington, Toronto. R. J. Ennis is general manager. The mines and plant are at Schumacher, in the township of Tisdale. The head office of the company is at the Standard Bank Building, Toronto.

During the year 1925, the company increased its holdings by purchase of the outstanding interest, amounting to 25 per cent., in the Platt Veteran Gold Mines, whose property adjoined to the southeast. The property comprising 160 acres has been transferred to the McIntyre-Porcupine Mines, Limited, and the Platt veteran charter surrendered.

The balance sheet for the year ending June 30, 1926, shows the following:—

Assets	
Current assets	$2,074,306.46
Investments	859,993.23
Fixed assets	7,053,072.69
Deferred charges	59,133.09
	$10,046,505.47
Liabilities	
Current liabilities	$234,322.75
Reserves	2,645,376.84
Capital liabilities	3,990,000.00
Surplus	3,176,805.88
	$10,046,505.47

Included in the investments is the sum of $279,992.23 for Blue Diamond Coal Company, Limited, and Canadian Coal Fields, Limited. The reserves include $2,496,389.81 for depreciation of plant, equipment, and development expenditures on Porcupine properties.

The profit and loss statement as for July 1, 1925, to June 30, 1926, shows the following:—

Earnings—bullion recovery		$3,804,774.90
Operating costs	$1,932,019.33	
Administrative and general expense	189,303.21	
Total operating costs—before providing for taxes and depreciation		$2,121,322.54
Operating profit before providing for taxes and depreciation		$1,683,452.36
Non-operating revenue		104,444.15
		$1,787,896.51
Appropriations—for municipal, provincial, and Dominion taxes for current year		66,514.00
Net profit for the year—before depreciation provision—transferred to surplus account		$1,721,382.51

The net profit for the previous year was $1,618,886.19.

During the year four dividends of 5 per cent. each and aggregating $798,000 were paid. The sum of $568,251.38 was written off for depreciation of buildings and equipment, while $460,759.45 was written off for development undistributed. After deducting these amounts and $29,108.55 for sundry adjustments, the surplus at June 30, 1926, amounted to $3,176,805.88, as compared with $3,311,542.75 at July 1, 1925.

The following information is taken from the fourteenth annual report covering the operations for the fiscal year[1] ending June 30, 1926:—

[1]The fiscal year of the company has been changed from June 30 to March 31.

MINING

	Tons
Ore broken in stopes	499,461
Ore from development	56,487
Total ore	555,948
Ore hoisted	461,846
Waste hoisted	124,190
Total hoisted	586,036

SUMMARY OF ORE HOISTED

Level	Tons	Assay	Value
1,125-foot	1,573	$6.25	$9,868
1,250-foot	22,715	10.20	231,721
1,375-foot	37,873	9.50	350,116
1,500-foot	48,089	6.65	319,264
1,625-foot	48,585	7.15	348,186
1,750-foot	65,867	8.95	590,821
1,875-foot	22,945	11.10	254,513
2,000-foot	52,392	8.50	446,076
2,125-foot	34,724	10.05	348,372
2,250-foot	35,627	9.45	332,790
2,375-foot	57,724	8.40	486,522
2,500-foot	12,033	8.50	102,585
2,625-foot	16,590	7.20	120,029
2,750-foot	5,109	4.35	22,305
Total	461,846	$8.60	$3,963,168

Development

No sinking was done at No. 5 shaft (2,435 feet deep) or at No. 6 (main) shaft (3,019 feet deep). No. 11 was continued from 952 feet to 2,936 feet, and stations were cut 250 feet apart from the 1,250- to the 1,750-foot levels, and 125 feet apart from the 1,750- to the 2,875-foot levels. Connections have been made with No. 6 shaft-workings on the 1,875- and 2,375-foot levels.

Owing to the main shaft being taxed to the limit for hoisting of ore, development work on the lower levels was curtailed.

Development work was carried out on veins Nos. 3, 5, 7-10, and 12. Another vein was encountered in No. 11 shaft at a depth of 2,250 feet, dipping to the north and passing out of the shaft at 2,375 feet. This had a width of 6½ feet for the distance exposed.

No. 3 Vein.—The work done on this vein is shown in the following:—

Level	Drifting in ore	Width of vein
	feet	feet
1,725-foot	810	8
2,000-foot	215	12

Diamond-drill holes have intersected the vein on the 1,625-foot horizon. Stopes on this vein produced 27,445 tons of ore, averaging $9.80 per ton.

No. 5 Vein.—Diamond-drilling has not disclosed any large additions to this vein. The fracturing in which the system occurs dips 70° N., and as depth is attained it moves away from the quartz porphyry into less favourable ground. Production from this vein amounted to 65,308 tons of ore, averaging $9.30 per ton.

No. 7 Vein.—The following shows the work done:—

Level	Drifting done in ore	Width of vein
	feet	feet
1,875-foot	210	8.5
2,000-foot	250	8.5
2,500-foot	960	8
2,626-foot	1,120	8.5
2,750-foot	405	narrow
2,875-foot	200	.....

On the 2,750-foot level, as drifting advances on No. 7 vein to the east, more favourable ground is entered and the vein increases in width and values.

Stopes on No. 7 vein produced 237,005 tons of ore, averaging $8.70 per ton

No. 8 Vein.—Extension to the vein was opened up on the 1,625- and 1,750-foot levels, and the stopes continued to yield a small tonnage of average grade ore.

No. 9 Vein.—On the 1,375-, 1,500-, and 1,725-foot levels, advances to the east were made in ore below average grade. On the 2,500-foot level, the vein was opened up for 200 feet, averaging 8 feet in width. A crosscut on the 2,625- and another on the 2,750-foot level intersected the vein in the quartz porphyry and showed low assays.

No. 10 Vein.—This vein produced 83,053 tons of ore of average value of $10.70 per ton. Development work on the 1,750-, 2,000-, and 2,250-foot levels has opened up a large tonnage of ore under average grade. On the three lower levels, the vein is in the basic schist in close proximity to the quartz porphyry; and while it has not improved in grade, more favourable results are expected when development can be carried on more energetically from No. 11 shaft.

No. 12 Vein.—No work was done on this vein during the year, the present face being 240 feet into Plenaurum ground. This drift will be continued to the east boundary of the property and the ground explored with diamond-drills. A drift, 18D, was driven on line and advanced 1,430 feet.

SUMMARY OF DEVELOPMENT AND EXPLORATION, 1925-26

Period	Drifts	Cross-cuts	Raises	Winzes	Shafts	Stations	Sumps	Pockets and ore passes	Total footage	Total excavation	Diamond-Drilling
	feet	feet	feet	feet	feet	cu. ft.	cu. ft.	feet	feet	cu. ft.	feet
1	528	521	.....	.....	130	10,486	.....	1,510	1,179	11,996	1,700
2	355	705	71	.....	236	.....	.....	.....	1,367	.....	1,938.5
3	310	783	95	.....	168	4,000	.....	.....	1,356	4,000	1,897
4	566	862	177	.....	185	16,975	.....	.....	1,790	16,975	2,151.5
5	649	870	130	.....	202	5,142	.....	.....	1,851	5,142	2,097
6	680	710	.....	.....	174	.....	.....	.....	1,564	.....	2,089.5
7	504	401	.....	.....	141	14,825	.....	.....	1,046	14,825	2,203.5
8	1,038	447	16	.....	143	14,425	.....	.....	1,644	14,425	2,131
9	1,393	313	77	.....	188	7,721	.....	.....	1,971	7,721	2,142.5
10	1,632	228	44	.....	158	10,925	.....	.....	2,062	10,925	2,492
11	1,517	261	5	.....	142	9,681	.....	.....	1,925	9,681	1,479
12	1,323	595	.....	.....	129	12,743	.....	.....	2,047	12,743	1,916
Total	10,495	6,696	615	.....	1,996	106,923	.....	1,510	19,802	108,433	24,237.5
Previous years	74,050.8	30,996 3	8,784 4	579.7	9,428.9	381,046	36,823	131,592	123,840.1	549,461	123,100
Total to date	84,545.8	37,692 3	9,399 4	579.7	11,424 9	487,969	36,823	133,102	143,642.1	657,894	147,337.5

ESTIMATED ORE RESERVES

	Tons	Assay	Value
McIntyre claims	605,448	$7.60	$4,612,372.00
McIntyre Extension claims	203,449	11.00	2,245,362.00
Jupiter claims	304,269	10.70	3,277,620.00
Plenaurum claims	14,818	10.70	159,084.00
Broken ore in stopes	315,127	8.70	2,743,603.00
Total	1,443,111	$9.00	$13,038,041.00

In the estimate of ore reserves, allowance has been made for the dilution of broken ore by wall rock.

ANALYSIS OF MINING COSTS PER TON MILLED

	Stoping	Drifting	Cross-cutting	Raising	Stations and sumps	Sinking (No. 6 and No. 11 shafts)	Total cost	Cost per ton
Labour	$474,389.57	$72,277.11	$47,602.62	$6,049.13	$22,609.65	$139,210.33	$762,138.41	$1.6536
Explosives	116,420.97	39,034.90	22,753.18	2,476.54	2,009.55	16,872.92	199,568.06	.4330
Supplies	87,556.91	10,116.89	5,891.58	730.75	1,121.57	19,156.13	124,573.83	.2703
Power	45,411.61	6,223.55	3,597.59	586.12	2,220.07	13,963.21	72,002.15	.1562
Timbering	89,999.45	.....	103.83	186.80	12,419.42	107,447.82	210,157.32	.4560
Shaft repairs and alterations	2,426.71	.....	.....	.....	.....	5,801.14	8,227.85	.0178
Steel sharpening	40,981.43	10,202.37	4,990.51	581.75	869.04	10,892.28	68,517.38	.1486
Drill repairs	21,458.29	3,596.33	1,671.35	292.02	33.77	4,123.88	31,175.64	.0675
Surveying and engineering	20,452.29	2,554.69	1,146.13	215.69	234.07	1,026.06	25,628.93	.0557
Sampling and assaying	28,988 51	5,223.53	2,722.27	501.69	.....	306.71	37,742.71	.0819
Pumping and ventilating	11,968.16	.....	105.08	.....	297.52	12,834.01	25,204.77	.0547
Tramming	60,395.78	8,316 24	5,586.37	346.87	172.75	39.61	74,857.62	.1624
Surface tramming	.....	.....	482.25	.....	1,844.73	22,090 10	24,417.08	.0530
Hoisting	102,213.93	11,651.15	10,461.27	1,349 44	5,703.06	45,386.91	176,765.76	.3835
Total	$1,102,663.61	$169,196.76	$107,114.03	$13,316.80	$49,535.20	$399,151.11	$1,840,977.51	$3.9942
Less: charged to undistributed development	.....	.....	9,754.63	2,318.51	49,535.20	399,151.11	460,759.45	.9996
	$1,102,663.61	$169,196.76	$97,359.40	$10,998.29	.....	.....	$1,380,218.06	$2.9946
Exploration	.....	.....	.....	.....	.....	.....	30,417.63	.0660
Examination of prospects	.....	.....	.....	.....	.....	.....	12,367.22	.0268
Total	.....	.....	.....	.....	.....	.....	$1,423,002.91	$3.0874
Unit cost per ton	$2.3924	$0.3671	$0.2112	$0.0239	.....	.....	.....	.....

The cost per ton milled during the operating year 1924-25 was $3.1022.

Milling

The ore treated amounted to 460,909 tons of an average value of $8.72 per ton, or a gross value of $4,020,326, as compared with 400,259 tons of an average value of $9.43 and a gross value of $3,774,068 for the operating year 1924-25. The bullion recovered in 1925-26 was $3,804,774.90 and contained 182,631 fine ounces of gold and 44,833 fine ounces of silver.

PRODUCTION SINCE THE COMMENCEMENT OF MILLING OPERATIONS IN 1912

Date	Period	Tons milled	Value per ton	Gross value	Recovery per ton	Total value
1912	12 months	14,500	$7.00	$101,555.16	$5.25	$76,166.38
1913	12 months	31,979	7.85	251,314.45	7.05	225,752.25
Jan. 1,'14, to Mar. 31,'15	15 months	85,654	8.87	760,232.16	8.39	718,331.71
April 1,'15, to Mar. 31,'16	12 months	105,758	7.71	815,345.49	7.38	779,990.94
April 1,'16, to June 30,'17	15 months	195,307	10.00	1,954,793.28	9.55	1,864,914.28
July 1,'17, to June 30,'18	12 months	178,327	10.05	1,793,197.55	9.61	1,714,258.00
July 1,'18, to June 30,'19	12 months	179,874	9.78	1,759,627.40	9.29	1,671,646.03
July 1,'19, to June 30,'20	12 months	188,835	11.52	2,175,891.31	11.02	2,080,178.44
July 1,'20, to June 30,'21	12 months	171,916	11.67	2,005,672.00	11.08	1,904,326.36
July 1,'21, to June 30,'22	12 months	193,971	10.69	2,074,088.40	9.99	1,937,105.07
July 1,'22, to June 30,'23	12 months	240,615	9.96	2,397,303.00	9.35	2,249,741.63
July 1,'23, to June 30,'24	12 months	360,140	9.69	3,488,863.00	9.14	3,291,178.22
July 1,'24, to June 30,'25	12 months	400,259	9.43	3,774,068.00	8.86	3,546,637.52
July 1,'25, to June 30,'26	12 months	460,909	8.72	4,020,326.00	8.25	3,804,774.90
Total	.....	2,808,044	$9.75	$27,372,277.20	$9.21	$25,865,001.73

During the year two 20-foot bowl classifiers were installed on the primary circuit. Grinding is done at about 50 per cent., —200 mesh at a dilution of 1.25 to 1. The pulp is passed direct to agitation from which the underflow is pumped to the bowl classifiers, and the overflow passes to the thickener and from there to a second agitation, thence to countercurrent decantation and filters.

The rake product from the bowls passes to a regrinding tube mill operating in closed circuit with a duplex Dorr classifier. The overflow from this circuit joins the pulp from the primary circuit and passes to the agitation tank which follows the grinding, and is kept in closed circuit until fine enough to overflow the bowl.

Pyrite in the ore from the primary circuit runs 8 per cent., the rake product from the bowls 16 per cent., and in the classifier regrind circuit, 32 per cent.

Three American filters, 8 by 6 feet, were also installed to follow the countercurrent decantation system. For these and necessary pumps and conveyor belts, an Ingersoll-Rand air compressor, 23 by 12 inches, and two Imperial type vacuum pumps, an addition, 36 by 110 feet, was made to the mill building.

MILLING COSTS

	Labour	Supplies	Repairs and maintenance	Power	Total	Cost per ton
Ball milling	$9,581.83	$26,328.30	$442.90	$14,226.58	$50,579.61	$0.1097
Tube milling	6,794.77	56,962.10	1,292.39	26,007.45	91,056.71	.1976
Classification	5,690.55	2,261.65	669.04	3,176.25	11,797.49	.0256
Pumping and elevating	7,315.21	6,765.29	650.05	4,484.65	19,215.20	.0417
Agitation	7,315.21	2,006.05	254.95	7,298.41	16,874.62	.0366
Thickening	7,315.21	4,004.92	965.02	1,793.88	14,079.03	.0305
Clarification	10,467.50	5,398.44	344.55	926.44	17,136.93	.0372
Precipitation	7,315.21	12,509.09	60.05	2,212.88	22,097.23	.0479
Reagents	.....	85,626.58	.....	.....	85,626.58	.1858
Filtration	3,751.61	2,327.02	384.40	1,522.80	7,985.83	.0173
Refining and assaying	13,854.60	7,242.48	266.37	507.90	21,871.35	.0475
Heating	.....	6,746.20	33.30	.....	6,779.50	.0147
Tailings disposal	.....	2,320.40	2,299.40	2,255.17	6,874.97	.0149
Mill alterations	4,607.96	6,962.62	.....	.....	11,570.58	.0252
Total	$84,009.66	$227,461.14	$7,662.42	$64,412.41	$383,545.63	$0.8322

OPERATING COSTS

Mining	Total	Per ton milled
Exploration	$30,417.63	$0.0660
Development	277,554.45	.6022
Breaking and stoping	1,102,663.61	2.3924
Examination of prospects	12,367.22	.0268
Total mining costs	$1,423,002.91	$3.0874
Crushing and transportation	66,117.41	.1435
Milling	383,545.63	.8322
Heating and maintenance—buildings and camps	52,560.68	.1140
Mercantile store and welfare expenses	6,792.70	.0147
Management, bullion marketing and general expense, mine office	79,831.67	.1732
Administration and general expense, head office	92,005.08	.1996
Insurance, general	17,466.46	.0379
Total	$2,121,322.54	$4.6025

The mining cost for 1924-25 was $3.1022 per ton milled.
The total operating cost for 1924-25 was $4.8156 per ton.

The average number of men employed during the year was: mine 525, mill 60, general 170; total, 755.

McMaster Syndicate

During 1925, the McMaster Syndicate operated their property near Rose Grove in Boston township, district of Timiskaming, with a force of six men. Harry McMaster is manager.

The shaft was continued to a depth of 270 feet, and a level was established at a depth of 250 feet.

McMillan Development Company

Working under option to purchase the Red Rock property of the Gold Nugget Mining and Development Company, in Scadding township, district of Sudbury, the McMillan Development Company ceased mining operations on the property about the end of August, 1925, at which time the work completed underground consisted of the sinking of the shaft to 160 feet and 1,140 feet of drifting and cross-cutting on the 100-foot level.

At the present the company is exploring by diamond-drilling a group of claims in Mackinnon township.

Ewen J. McMillan is in charge of the operations.

March Gold, Limited

The company is capitalized at $1,500,000, in shares of ten cents par value each. The officers of the company are: Henry Kobler, president; Bert C. Conderman, vice-president; J. C. Roche, vice-president and managing director; Frank J. C. Bull, treasurer. The directors are: Henry Kobler, J. C. Roche, Frank J. C. Bull, Charles Schmidt, Clarence Leo, Fred Goellner, and Peter Schabacker, all of Buffalo, N.Y.; and Bert C. Conderman, of Hornell, N.Y. Logan C. Ball was superintendent until June 23, 1926, when he was succeeded by E. S. McEwen, South Porcupine, Ont.

The head office of the company is 331 White Building, Buffalo, N.Y.

The company owned six claims in 1925 as follows: H.R. 823 (7,955), H.R. 833 (8,276), H.R. 844 (8,277), H.R. 845 (8,278), H.R. 899 (T.R.P. 917), and

H.R. 900 (1,387). Early in 1926, the purchase of the Maidens-McDonald claims H.R. 832 (T.R.S. 777) and H.R. 926 (6,150) from the Coniagas Mines, Limited, of Cobalt, Ont., was negotiated. All these claims are located centrally in the north portion of Deloro township, district of Cochrane.

An incline shaft started in December, 1924, near the northeast corner of claim H.R. 833, was sunk to a depth of 190 feet, with levels at 60 and 170 feet, vertically for prospecting a vein dipping to the north which had been located with diamond-drill. At the 60-foot level, 40 feet of drifting was done; and at the 170-foot level, 300 feet of drifting was done.

A vertical shaft was sunk from a point 40 feet southwest of the incline and at the end of the year had reached a depth of 240 feet. On January 28, 1926, the depth was 325 feet. Levels were made at 170- and 300-foot depths, and a connection was made with the incline shaft at the 170-foot level.

The vertical shaft has three compartments, two of which are 4 feet 6 inches by 4 feet 6 inches, and the other 4 feet by 4 feet 6 inches.

The plant used in sinking consisted largely of machinery moved from the shaft at claim H.R. 823. There were two 70 h.p. locomotive boilers, a 300 cubic foot air compressor, straight line, a 10- by 12-inch Lidgerwood hoist. A Canadian Ingersoll-Rand compressor, 18 by 11 by 14 inches, type PRE2, driven by a 200 h.p. synchronous motor, 550 volts, 300 r.p.m., was added to the plant. The boiler, hoist, and compressor are housed in a frame building, 35 by 63 feet.

A headframe 38 feet in height was erected and covered in a shaft-house, 15 by 32 feet.

Late in the fall of 1925, plans were made for the erection of a mill near the shaft, and construction was started during the winter of 1926.

An average of nine men was employed in the mine, but this number was increased towards the end of the year. At the time of construction 35 men were employed on the surface.

Night Hawk Peninsular Mines, Limited

This company is capitalized at $5,000,000, divided into shares of $1 par value each. At July 23, 1925, there were 4,450,000 shares issued.

The officers of the company are: James R. Dodsworth, chairman; William Thaw, president; Samuel Hollis, secretary; Samuel Grenet, treasurer; W. C. Adler, assistant treasurer; Walter E. Segsworth, Toronto, Ont., consulting engineer; and A. J. Keast, Connaught, Ont., superintendent. The directors of the company are: William Thaw, New York; James R. Dodsworth, J. Albert McKay, James Ward, Jr., Benno Janssen, Samuel J. Grenet, and Samuel Hollis, all of Pittsburgh, Pa.; W. C. Patterson, Jamestown, N.Y.; J. W. Callinan, George A. Grover, and John H. Black, all of Toronto.

The head office of the company was at 371 Bay Street, Toronto, and the executive offices at 87 Vandergrift Building, Pittsburgh, Pa.

The mine and mill, in Cody township, district of Cochrane, were operated continuously throughout the year 1925. There were 39,778 tons of ore treated in the mill.

The following is a statement of the development work done during the year:

	Feet
Drifting	2,283
Crosscutting	1,168
Sinking	104.5
Raising	895
Total	4,450.5

All ore from the 6th level was from development. Stopes were worked above the 5th and 4th levels.

The main shaft of the mine is sunk to a depth of 440 feet, with levels at the 80-, 180-, 300-, and 425-foot levels. The 5th and 6th levels at 525 and 625 feet, respectively, were worked from a winze which had been sunk at a point 240 feet southeast of the main shaft on the 4th level.

Operations at the property were suspended on May 31, 1926. The mill was closed, and arrangements were made to keep the mine clear of water.

The average number of men employed in 1925 was: mine 58, mill 9, surface 22; total 89. Walter Coleman was mine captain; Jas. Sullivan was mill superintendent until June 1, 1925, and was succeeded by E. P. Sawyer until November 15, 1925, when the work was taken over by S. C. Sterling.

Northland Gold Mines, Limited

The company operated their property in Gauthier township, district of Timiskaming, during the year with a working force of from 9 to 25 men. The holdings comprise 20 claims, totalling 771.6 acres. The company has an authorized capital of $2,000,000 in shares of $1 par value. The directors are: J. J. Byrne, president; J. B. Gibbons, H. P. Hermance, Toronto; W. A. Newell and Melvin J. Sterns, Ogdensburg, N.Y. The head office of the company is at Haileybury, Ont.

Work was carried on with a small force of men during the early part of the year. The following buildings were erected: power-house, 28 by 38 feet; shaft-house, 20 by 48 feet, with a 52-foot headframe; smithy and machine shop, 26 by 26 feet; and small buildings for thaw-house, boiler-house, root house, and transformer house.

The following plant was installed: 550 cubic foot Alley and MacLellan air compressor, electrically driven by a 100 h.p. motor; Rand hoist, 10 by 12 inches; and a 25 h.p. boiler for heating purposes.

Mining work was resumed early in November, and the No. 1 shaft was continued from a depth of 46 feet to 250 feet by the end of the year, and to a depth of 500 feet in the first quarter of 1926. In the early part of the year, 25 feet of drifting was done in No. 2 shaft situated on one of the easterly claims at a depth of 57 feet.

Ore Chimney Mining Company, Limited

The company dewatered the mine in the township of Barrie, Frontenac county, in July, 1925, and during the remainder of the year were drifting northeast from the shaft on the 400-foot level.

Electric power is supplied to the mine from the mining company's generating station on the Skootamatta river.

They employed an average of twelve men underground and eight on the surface.

The officers of the company were: president, A. E. Fletcher; secretary-treasurer, S. G. Both; manager, J. M. Wolchuck, Northbrook.

Porcupine Paymaster Mines, Limited

The company is capitalized at $2,000,000, divided into shares of $1 par value. These shares are assessable. The holdings of the company are in Deloro township, district of Cochrane, along the south boundary of Tisdale township.

The officers and directors of the company are: president, E. H. Walker, Boston, Mass.; vice-president and treasurer, A. S. Fuller, South Porcupine, Ont.; vice-president and managing director, J. A. Frohock, Boston; secretary, M. P. Van Der Voort, Toronto; director, Frank G. Wright, Boston; general manager, H. E. Clement, South Porcupine. W. G. Norrie-Lowenthal was superintendent and David McLeod mine captain until June 15, 1925, when the direction of the work was taken over by the general manager, with M. Donovan as mine captain. The Boston office of the company is located at 79 Milk Street.

Operations in the mine were carried on continuously throughout 1925 on all levels from the 100- to the 800-foot, excepting the 6th and the tunnel levels.

The following is a summary of the development work done during the year 1925:—

Level	Drifting	Crosscutting	Raising
	feet	feet	feet
100-foot	400	.....	25
200-foot	133	.....	28
300-foot	1,593	1,139	152
400-foot	276	18	.....
800-foot	18	88	.....
Total	1,839	1,245	205

During the year, plans for a mill to treat the ore were made, the design being that of B. D. Kelly, of Timmins, Ont. In the fall of 1925, foundations for the mill were laid 720 feet southwest of the main shaft. The mill comprises a crushing and a grinding and cyanidation plant, the crushing building and the grinding plant being connected with a belt conveyor runway, where a belt, 20 inches wide and 84 feet long, is operated at a slope of 19 degrees.

The crusher building is 28 by 52 feet, and the grinding and cyanide building 63 by 133 feet, with a wing at the southeast corner, 21 by 70 feet. The buildings are of frame construction with cedar sheeting covered with half-inch "Ceilotex" and "Ruboid." The plant is designed for a capacity of 400 tons per day.

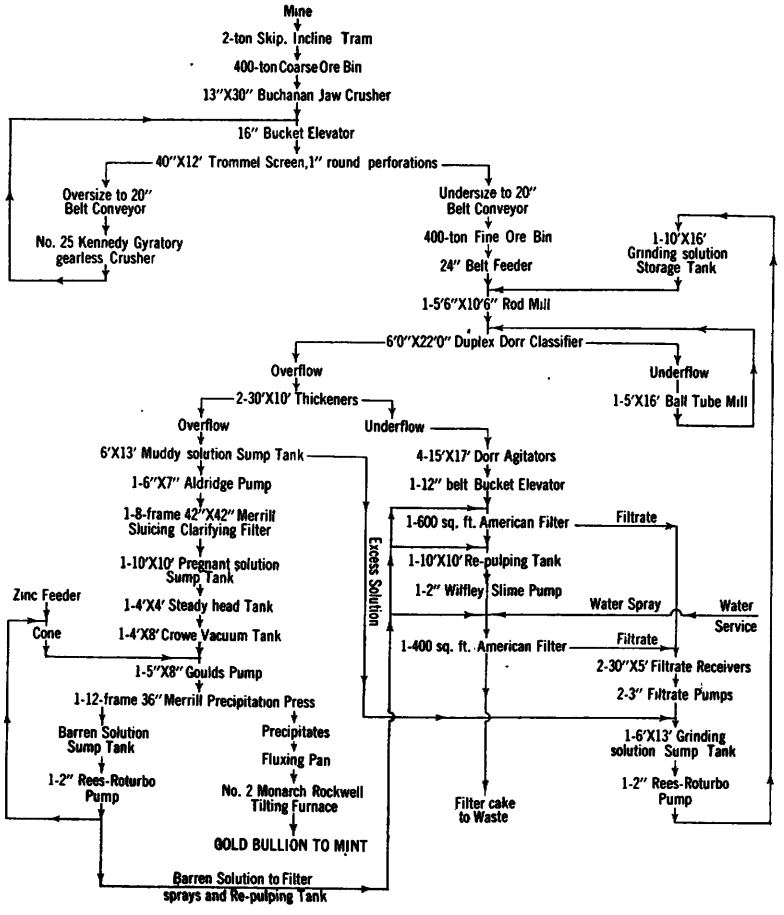
In the crushing plant, there is a 13- by 30-inch Buchanan jaw crusher, which is driven by a 30 h.p. motor, 750 r.p.m. The 40- by 12-inch trommel screen, with 1-inch diameter perforations is operated by a 10 h.p. motor, 750 r.p.m. Oversize from the trommel is passed to a No. 25 Kennedy gearless crusher, which is driven by a 25 h.p. motor, 750 r.p.m. The undersize from the trommel is carried to a 400-ton bin in the cyanide plant.

Fine grinding is done in a Marcy mill, 5 feet 6 inches by 10 feet 6 inches, which feeds to a 6- by 22-foot duplex Dorr classifier, the underflow from which passes to a 5- by 16-foot ball tube mill operating in closed circuit with the classifier. The rod mill is driven by a 100 h.p. motor, 1,450 r.p.m., reduced by gear to 168 r.p.m. The classifier is driven by a 15 h.p. motor, 750 r.p.m., and the tube mill by a 150 h.p. motor, 750 r.p.m.

Grinding is done in cyanide solution to 65 per cent.,—200-mesh. Instead of countercurrent decantation after grinding, the underflow from the thickened pulp is agitated and submitted to a double filtration. After the first filtration, all but the filtrate passes to a 10- by 10-foot repulping agitator and is then pumped by a slime pump to the second filter.

The pregnant solution is clarified in a Merrill sluicing clarifying filter, 8 leaves, 42 by 42 inches. The clarified solution is deoxidized by the Crowe process; precipitation is done with zinc dust and the precipitate refined direct.

The motor equipment in the agitation and filtering includes the following: 15 h.p. motor, 750 r.p.m., for agitators and thickeners; 5 h.p. motor, 750 r.p.m., clarification pump; 5 h.p. motor, 750 r.p.m., for precipitation pump; 1 h.p. motor, 750 r.p.m., for root blower; 1½ h.p. motor, 1,500 r.p.m., for first American filter; 2 h.p. motor, 750 r.p.m., for second American filter; 3 h.p. motor, 750



Flow Sheet of 350-ton Mill, Porcupine Paymaster Mines, Ltd., April, 1926.

r.p.m., for tailings disposal; two 5 h.p. motors, 1,500 r.p.m., for filtrate; 7½ h.p. motor, 1,500 r.p.m., for storage; 7½ h.p. motor, 1,500 r.p.m., for barren solution.

The plant also includes two Ingersoll-Rand vacuum pumps, 18 by 6 inches, each driven by a 15 h.p. motor, 750 r.p.m., and an Ingersoll-Rand air compressor for pressures up to 20 pounds, 14 by 8 inches, driven by a 40 h.p. motor, 750 r.p.m. The prevailing voltage is 550.

Heating in the mill is done by six No. 3 Aerofin Sturtevant heaters, each heater condensing 150 pounds of steam per hour and being operated by a one-quarter h.p. motor, 725 r.p.m.

From the mine the ore is carried to the crushing plant on a trestle rising from the shaft on a 3.33 per cent. grade. The car used is of 2-ton capacity and is pulled by a 15 h.p. motor, 725 r.p.m.

Milling operations were commenced on April 24, 1926.

On the surface the following additions were made during the year; 1,200-gallon wood stave tank, on steel frame; one-storey cottage, 22 by 28 feet; thaw-house for explosives, 18 by 10 feet; magazine for explosives, 12 by 16 feet; mill warehouse, 16 by 48 feet; refinery, 29 by 23 feet.

The average number of men employed was 36 in the mine, 8 in the mill, and during construction 33 men on the surface.

The mill construction was carried on under the direction of W. W. Hudson, who on the completion of the mill was appointed superintendent.

Power and Mines Syndicate

The syndicate has an operating contract to purchase the Grace mine in the Michipicoten area, district of Algoma, owned by the United Algoma Mines, Limited.

The syndicate proposes to do considerable diamond-drilling during 1926, dewater the workings, and continue underground operations, sinking to 500 feet. The present depth of the mine is reported to be 300 feet. Surface exploration will also be carried on.

Jacob A. Jacobs, Montreal, is syndicate manager; R. P. Teare, Michipicoten River, is the mine manager. The head office is at 604 Jacobs Building, Montreal.

Six men were on the property when visited early in May, 1926.

Queen Lebel Gold Mines, Limited

The company operated their property in Lebel township, district of Timiskaming, during the latter half of 1925 with a force of from 15 to 25 men, the latter number including wood-cutters in the winter months. The board of directors comprises: Harry Braniff, president; David Gross, vice-president; Victor Hattin, secretary; Alfred Wintermeyer, treasurer; K. T. Sass, E. B. Wood, John Swartz. The head office is at Kitchener, Ont. E. B. Wood is manager.

The mine was pumped out in June, and mining began in September. In the period between September, 1925, and April, 1926, a total of 700 feet of drifting and 250 feet of crosscutting was done on the 300-foot level. All but 100 feet of drifting was done in a southwesterly direction in extension of the former workings.

Shield Development Company, Limited

The Shield Development Company, Limited, of which Norman R. Fisher of Montreal is president and managing director, is installing a plant at the Huronian gold mine, Moss township, district of Thunder Bay, with the view of reopening the property in the summer of 1926.

A bunk-house, cookery, powder magazine, and stable have been erected. The following machinery was taken in during April, before the break-up, and work on its installation is being done at the time of writing: 125 h.p. return tubular boiler; Sullivan, WB2, straight-line compressor, 14 by 10 by 16 inches; 8- by 10-inch Jenckes hoist.

The old workings consist of a shaft, reported to be between 150 and 200 feet in depth, with a level opened up at 55 feet, on which 102 feet of drifting has been done in a southwest direction and 30 feet to the northeast.

James G. Harkness, Kashabowie, Ont., is the superintendent. During the erection of the plant a force of nine men is being employed.

Sylvanite Gold Mines, Limited

Sylvanite Gold Mines, Limited, township of Teck, district of Timiskaming, has an authorized capital of $3,000,000, in shares of $1 par value. Edward L. Koons, Buffalo, is president, C. E. Rodgers is manager, and 35 to 45 men are employed.

During 1925 the main shaft was sunk 456 feet to a depth of 1,526 feet, and stations were established at 1,250, 1,375, and 1,500 feet. Lateral development comprised 7,245 feet of drifts, 5,890 feet of crosscuts, 269 feet of raises, besides excavation amounting to 22,358 cubic feet in cutting the three stations.

Plans are being prepared for a mill to be erected on the property.

Teck-Hughes Gold Mines, Limited

Teck-Hughes Gold Mines, Limited, with property in Teck township, district of Timiskaming, has an authorized capital of $5,000,000 in $1 shares, of which 4,750,000 shares are issued. The officers of the company are: Charles L. Denison, president; Albert W. Johnston, vice-president; George C. Miller, secretary; William C. Himrod, treasurer; K. P. Emmons, assistant treasurer. The directors are: Charles L. Denison, Albert W. Johnston, and J. F. Thompson, New York; Robert W. Pomeroy, George C. Miller, Conrad E. Wettlaufer, and W. W. Reilley, Buffalo, N.Y. D. L. H. Forbes is general superintendent, and an average of 205 men is employed.

The following information is taken from the report of the general superintendent for the fiscal year ending August 31, 1925:—

During this period 48,718 dry tons of ore were treated, from which bullion amounting to $924,580.88 or $18.98 per ton, was recovered. The gross revenue was $950,979.71, or $19.52 per ton. The total direct operating cost was $530,129.47, or $10.88 per ton; while depreciation on fixed plant amounted to $43,157.78, or $0.89 per ton, making the total of direct and indirect charges come to $573,287.25, or $11.77 per ton. The net operating profit was $377,692.46, or $7.75 per ton. After setting up a reserve of $22,609.46 for federal taxes, the net surplus was $355,083.00.

Following is a statement of operating costs in detail:—

	Total cost	Cost per ton
Development and exploration	$160,244.36	$3.29
Mining	218,044.06	4.47
Milling	82,424.66	1.69
General expense	69,416.39	1.43
Total of direct charges	$530,129.47	$10.88
Depreciation on fixed plant	43,157.78	.89
Total of direct and indirect charges	$573,287.25	$11.77

Included in the charges under development and exploration is the sum of $106,653.04 spent on sinking, raising, and station-cutting for the central shaft.

A total of $152,851.20 was spent on new construction and charged to capital account. Of this amount, $147,438.35 was spent on mill enlargement and other additions to plant and $5,412.85 on dwelling-houses.

Development work amounted to 3,246.1 feet as follows—

	Feet
Drifting	1,126.5
Station-cutting	129.4
Crosscutting	758.2
Raising	144.1
Winzing	13.0
Shaft-sinking	1,074.9
Total	3,246.1

The mine workings at August 31 had a combined length of 31,190 feet, or 5.9 miles, classified as follows:—

	Feet
Drifts	17,148.6
Crosscuts	8,856.5
Raises	1,414.2
Winzes	1,092.9
Shafts	2,678.4
Total	31,190.6

Development work produced 1,667 tons of ore that was treated in the mill, 2,351 tons of low-grade that was stock-piled, and 29,204 tons of waste rock.

Small extensions were made to all of the levels from the 3rd to the 10th, and stations were cut at the new shaft on the 6th, 8th, 10th, 11th, and 12th levels. New ore bodies in the No. 3 vein system were found on the 6th, 7th, 8th, and 10th levels; while ore was also found in the No. 5 vein where cut by the new shaft between the 5th and 6th levels.

As effort was concentrated on development work connected with the new shaft, no great amount of drifting was done on the upper levels. Reserves of fully developed blocked ore above the 10th level decreased to some extent, but the broken ore reserve was increased, and the total fully developed ore reserves above the 10th level were but slightly less at the end than at the beginning of the fiscal year.

During the remaining four months of the year the central shaft was continued to a depth of 1,520 feet, and from 150 to 200 feet of lateral work was done on the 11th, 12th, and 13th levels, which resulted in the opening up of high-grade ore from 8 to 30 feet in width.

The mill was increased to a capacity of 240 tons, and some remodelling of buildings was done.

The building programme of 1926 includes: 10 new houses for the staff on the south part of the property and a new staff-house to supplement the present bunk-house.

The installation of a new Nordberg hoist for handling ore at the central shaft is under way. The drums are 7 feet in diameter with a 54-inch face. The clutches and brakes are hydraulically operated with oil under 150 pounds pressure. Each drum has an independent solenoid and a Lilly control.

Tough-Oakes Burnside Gold Mines, Limited

The capital of this company is $5,000,000 in shares of $1 par value. The directors are: F. H. Phippen, president; James Y. Murdock, vice-president; A. Burt, treasurer; Arnold M. Ivey, A. M. Stobie, and W. D. Wilson. M. Musselman is secretary, and the head office is at 217 Bay Street, Toronto. Alan Stuart is manager. The mine is in the township of Teck, district of Timiskaming.

The following information is taken from the report of the manager for the period January 1, 1924, to December 31, 1925:—

SUMMARY OF DEVELOPMENT, FOOTAGE AND DIAMOND-DRILLING

	1924			1925
	Jan. to April (incl.)	May to Dec. (incl.)	Total	
	feet	feet	feet	feet
Drifts and crosscuts	2,587	2,326	4,913	4,179
Raises	60	239	299	1,003
Winzes	22	146	168	650
Shafts	124	.....	124	56
Total footage	2,793	2,711	5,504	5,888
Diamond-drilling	564	.....	564	2,107

The figures for the period January to April, 1924, inclusive, were shown in the last annual report.

During 1925, the main points of attack have been:—

Tough-Oakes Section

No. 11 vein—level connections between 100-, 200-, and 300-foot levels, Tough-Oakes shaft

No. 2 vein—400- and 450-foot levels, Tough-Oakes shaft; 400- and 480-foot levels, Burnside shaft. The 400-foot level, Burnside shaft, makes connection with the 500-foot level, Tough-Oakes.

Burnside Section

Main vein system, west of diabase fault.

Vertical veins associated with so-called "main break" at the 400-, 550-, 675-, 800-, and 900-foot levels.

Flat veins lying to the south of the above at the 900-, 1,025-, and 1,100-foot levels.

Vein system, east of diabase dike, 900- and 1,025-foot levels.

Diamond-Drilling

Seven holes were drilled from the 1,025-foot level with a total of footage 2,107 feet. Four of these were drilled to the west of the north and south diabase fault, and the remainder to the east.

General.—The main shaft has been connected with the 1,100-foot level where a pump station, hoist-chamber for incline shaft, and rock-bin have been cut. An electric pumping plant has been installed. The underground pumping arrangements were reorganized, and a large capacity sump was created at the 400-foot Burnside level, making it possible to eliminate two pumping plants situated in the old Tough-Oakes mine. Fourteen rock-drills, new shaft cables, mine cars, and winze-sinking equipment, etc., were purchased during the year and charged to current expenditure.

Since January 1, 1925, all development operations which included shaft-sinking, permanent underground works, etc., formerly charged to capital account, have been charged direct to current working costs.

Milling Operations.—Normal milling operations were commenced on October 1, 1924.

Sources of Mill Ore

Drawn from	1924	1925	
	Oct. to Dec. (incl.)	1st half	2nd half
	tons	tons	tons
Surface dump	3,786	2,899	2,683
Shrinkage stopes taken over from K.L.P. Co., Ltd	.....	1,272	821
Stopes created by T.O.B. Co. in 1924	3,715	.....	392
Development rock	665	4,830	8,705
New stopes created during 1925	.....	3,700	5,236
Narrow stoping, No. 11 vein	272	3,513	101
Total	8,438	16,214	17,938

Production

Period	Tons milled	Total fine ounces gold	Total value of gold	Average recovery per ton
Oct. 1 to Dec. 31, 1924	8,438	2,280.81	$47,148.52	$5.588
Jan. 1 to June 30, 1925	16,214	5,579.95	115,347.77	7.181
July 1 to Dec. 31, 1925	17,938	7,044.61	145,624.98	8.11
Total, 1925	34,152	12,624.56	260,972.75	.....
Total to date	42,590	14,905.37	308,121.27	.....

Total value of gold produced	$308,121.27
Total value of silver produced	2,490.54
Total value of bullion produced	310,611.81
Mint charges	1,542.70
Net revenue	$309,069.11

Mining.—Total cost of development, diamond-drilling, stoping, tramming, hoisting and pumping, general mine expenses, and all other charges at mine, except those under heading of milling, were as follows:—

	1924		1925	
	1st half	2nd half	1st half	2nd half
Development footage	3,880	1,624	2,428	3,460
Diamond-drilling	564		1,163	944
Tons stoped	784	6,291	7,213	5,337
Cost	$115,909.22	$108,994.50	$107,789.19	$126,108.98
Milling		19,843.59	33,486.37	31,510.52
Total costs	$115,909.22	$128,838.09	$141,275.56	$157,529.50

The average number of men employed during the year 1925 was 95.

Vipond Consolidated Mines, Limited

This company is capitalized at $2,000,000, divided into 2,000,000 shares of the par value of $1 each. The officers of the company are: F. H. Hamilton, president; John H. Black, vice-president; J. Mackintosh Bell, managing director; R. S. Dening, secretary. The directors are: F. H. Hamilton and Edward Hooper, London, England; J. Mackintosh Bell and W. H. Stafford, Almonte, Ont.; James W. Bain and John H. Black, Toronto; and R. T. Shillington, Haileybury, Ont. R. E. Dye, Timmins, Ont., is general superintendent.

The mine and mill in Tisdale township, district of Cochrane, operated continuously throughout the year, and 64,522 tons of ore were treated.

The balance sheet for the year ending July 31, 1926, as taken from the fourth annual report of the company, shows the following:—

ASSETS

CAPITAL:		
Mining claims and properties as per balance sheet July 31, 1924	$1,432,442.84	
Mine, mill, camp and office building, plant, machinery, and equipment appraised July 31, 1924	301,240.87	
Additions at cost for year ending July 31, 1925	13,851.90	
Additions at cost for year ending July 31, 1926	85,624.94	
Shares in other companies	101,970.27	
		$1,935,130.82
CURRENT:		
Cash on hand and in banks	$25,152.79	
Provincial and railway bonds at cost (par value $100,000)	99,337.50	
Bullion en route and on hand	27,455.21	
Accounts and interest receivable	2,694.42	
Mining and milling supplies	37,867.99	
		$192,507.91
DEFERRED:		
Development expenditures undistributed	$92,600.12	
Insurance and other prepayments	9,473.71	
Sundry charges	1,096.51	
		$103,170.34
		$2,230,809.07

LIABILITIES

CAPITAL:		
Capital stock, authorized and issued (2,000,000 shares at $1 per share)	$2,000,000.00	
Surplus	58,070.49	
		$2,058,070.49
CURRENT:		
Accounts and wages payable	$46,788.43	
Accrued charges	3,469.23	
		$50,257.66
RESERVES:		
Reserve for depreciation of buildings, plant, machinery, etc.	$119,107.82	
Reserve for taxes	3,373.10	
		$122,480.92
		$2,230,809.07

The operating account shows the following:—

EXPENDITURE

Development	$152,068.44	
Mining, including hoisting	160,489.05	
Crushing, conveying, and milling	88,724.18	
Shipping and marketing bullion	5,046.14	
General camp maintenance	12,035.92	
Administration and general expense, mine	29,673.02	
Administration and general expense, Toronto office	6,157.40	
Transfer, legal, and directors' fees	17,807.94	
Insurance	17,158.31	
Provincial and municipal taxes	1,355.14	
Balance carried down	81,213.99	
		$571,729.53

REVENUE

Bullion proceeds, less exchange	$565,745.39	
Bond and bank interest earned	5,731.00	
Miscellaneous recoveries	253.14	
		$571,729.53

The profit and loss account shows the following:—

DEBIT

Redemption of pre-production development costs	$50,002.50	
Reserved for plant depreciation	31,509.24	
Surplus, July 31, 1926, carried to balance sheet	58,070.49	
		$139,582.23

CREDIT

Surplus, July 31, 1925	$58,368.24	
Balance brought down	81,213.99	
		$139,582.23

Summary of Underground Operations.—During the year ending July 31, 1926, the following underground operations were carried out:—

	Feet	Cost per foot
Drifting and crosscutting	7,643.5	$12.28
Raising	1,359	16.43
Sinking	39.5	146.12
Total footage	9,042	

Of the 64,676 tons of ore hoisted, 46,299 tons were taken from the stopes and the remainder from development. The cost of ore per ton delivered to the primary crushing plant was $2.48.

For the year, a total of 15,306 feet of diamond-drilling was done at a cost of $1.61 per foot.

Mill.—Towards the end of the fiscal year, extensive renovations and additions were made to the milling plant, and the daily capacity of the plant raised to 300 tons per day. The enlarged plant was in operation by July 1, 1926.

An addition, 60 by 34 feet, was made to the mill for the filter section, and another addition, 30 by 40 feet, for the tube mill and tables. The two small Hardinge ball mills were replaced by one 8-foot Hardinge mill, thereby doubling the ball-mill capacity. This new mill is driven by a 150 h.p. motor, 400 r.p.m. A tube mill, 5 by 18 feet, driven by a 75 h.p. motor, 400 r.p.m., was also added.

One thickener was converted to an agitator for additional agitation capacity. Formerly a four-step countercurrent decantation followed the agitators, but in the new scheme the increased capacity is obtained by using two tanks in parallel for primary thickeners and using the remaining two tanks in parallel for a single-step wash. This step is followed by a duplex, 8-foot, 10-disc, American filter on which the pulp is given a two-stage wash.

Six Deister, Plat-O, slime tables were installed, and in the new flow-sheet follow the agitators. The pyrite is separated and returned to the grinding circuit, and the tailings pass to the thickeners and filter.

During the year under review, the mill treated 64,522 tons of ore of an average value of $9.74 per ton, or a gross value of $628,247.72, from which bullion to the value of $565,995.60 was recovered. This represents a recovery of $8.77 per ton.

Ore Reserves.—The ore reserves at the mine were estimated at approximately 300,000 tons of a gross value of about $2,475,000. Of this amount approximately 55,000 tons of an estimated value of $520,000 were broken.

Cost of Production.—The costs of production for the year are as follows and are compared with those of the previous year:—

	1925-26	1924-25
Development	$2.36	$1.62
Ore extraction	2.48	3.06
Crushing, conveying, and milling	1.37	1.56
Shipping and marketing bullion	.08	.09
General camp maintenance	.19	.21
Administration at the mine	.46	.54
Head office expense	.09	.12
Corporate expense	.28	.34
Taxes	.02	.05
Insurance	.27	.25
Total	$7.60	$7.84

The increase in development charges is due to the fact that in 1925-26 the work underground amounted to 9,042 feet as compared with 4,989 feet in the year 1924-25; the diamond-drilling in 1925-26 was 15,306 feet, as compared with 12,880 in 1924-25.

The total production to the end of July 31, 1926, is as follows:—

From bullion produced during the year	$565,995.60
From bullion produced during former years	1,770,425.25
Total	$2,336,420.85

The average value per ton for 1925-26 was $9.74, as compared with $10.62 for 1924-25.

The average number of men employed during the year was: mine 100, mill 19, surface 35.

Walsh-Katrine Gold Mines, Limited

The authorized capital of this company is $3,000,000, in shares of $1 par value, of which about one-half are issued. The directors are: Hugh Walsh, president; D. M. Morin, vice-president; W. R. Lowery, second vice-president; W. O. Taylor, Cobalt, secretary-treasurer. The company operated its property in Katrine township, district of Timiskaming, with an average force of 24 men during the year.

A second 60 h.p. boiler and a 10- by 12-inch hoist were added to the plant; a new office building was erected, and a new bunk-house, 20 by 30 feet.

The shaft was continued from 267 to 515 feet, and levels were established at 375 and 500 feet. Up to the end of the first quarter of 1926, drifting and crosscutting amounting to 500 feet was done on the 250-foot level, 30 feet on the 375-foot level, and about 800 feet on the 500-foot level.

Western Ontario Mines, Limited

The directors and officers of this company remain as reported in the 34th Annual Report of the Department of Mines. The mine is near Schreiber, district of Thunder Bay.

The plant was shut down in September, 1925, and no work carried on until May, 1926, when operations were again started.

To date, in addition to the shaft which has reached a depth of 255 feet, the underground development consists of approximately 525 feet of crosscutting and 190 feet of drifting, all on the 240-foot level. Work at the present is confined to drifting on the "copper" vein.

Two men are employed underground, while the surface operations are all performed by Louis Fenning, the manager.

Wright-Hargreaves Mines, Limited

This company has a capital of $2,750,000 in shares of $1 par value. The board of directors comprises: Oliver Cabana, Jr., president; Edwin Lang Miller, vice-president and secretary; Gerard F. Miller, treasurer; Ralph Hochstetter, Charles G. Duffy, Oliver G. Donaldson, and Harcourt Ferguson. James E. Grant is general manager. The mine is in Teck township, district of Timiskaming. The mine office is at Kirkland Lake, and the executive offices at Liberty Bank Building, Buffalo, N.Y. An average of 200 men is employed.

The net profits for 1925 were $1,209,644.58, as compared with $535,049.77 in 1924. Dividends paid amounted to $687,500, as compared with $343,750. The surplus stands at $458,515, after providing $95,000 for taxes; preliminary development cost $30,342.48, and exhaustion of mine $114,725. This compares with the previous surplus of $172,635.60.

The following is the general manager's report:—

During the year 147,939 tons of ore were treated, and the bullion recovered therefrom amounted to $1,913,401.82, with an average value per ton of $12.93.

The mill operated 89.05 per cent. of its possible running time, and treated on an average of 402 tons per day, an increase of 172 tons per day over the same period of a year ago.

Analysis of operating costs, reproduced below, shows a total cost per ton milled, including the year's expenditure for exploration and development, of $5.008 per ton.

ANALYSIS OF OPERATING COSTS

Description	Total cost	Cost per ton milled
Development and exploration	$111,371.42	$0.753
Stoping	196,140.73	1.326
Transporting ore (hoisting, etc.)	93,357.42	.631
Milling charges	171,487.80	1.159
Marketing bullion	14,485.68	.098
General and undistributed charges (roads and general surface, storehouse, maintenance miscellaneous mine buildings, administration and management, property taxes, insurance, interest and exchange, legal expenses, donations, and miscellaneous)	74,667.36	.504
Depreciation plant and equipment	79,420.82	.537
Total	$740,931.23	$5.008

SUMMARY OF DEVELOPMENT AND EXPLORATION
December 31, 1925

	Drifting		Shaft-sinking	Crosscutting		Diamond-drilling	
	ft.	in.	ft.	ft.	in.	ft.	in.
December 31, 1924	13,821	0	1,756	2,431	6	2,516	6
Fiscal year	4,687	6	625	601	0	2,234	0
December 31, 1925	18,508	6	2,381	3,032	6	4,750	6

The summary of total bullion production, including the value per ton treated as well as actual tons milled, since the commencement of operations in 1921, is herewith shown:—

	Months	Tons milled	Value per ton	Bullion produced
May, 1921, to December, 1921	8	36,081	$13.00	$468,665.64
1922	11	66,181	11.52	762,752.84
1923	12	79,242	9.52	754,978.81
1924	12	84,487	12.89	1,088,725.53
1925	12	147,939	12.93	1,913,401.82
Total	.....	413,930	$12.05	$4,988,524.64

Mining and Development.—For practically the whole year, our mining and development was concentrated around No. 1 or North vein. A 500-foot crosscut was run on the 700-foot level, connecting No. 1 and No. 3 shafts. This makes three haulage-ways, between our No. 1 and No. 2 ore bodies. A fourth crosscut, connecting No. 1 and No. 3 shafts at the 1,250-foot level, is now under way.

During the year, No. 1 shaft was sunk from the 700-foot level to a depth of 1,271 feet. At this point the ore is in the shaft and is of a very good grade. During the development work on No. 1 vein, ore has been opened up on the 400-, 700-, 850-, and 1,125-foot levels.

The station at the 1,250-foot level has just recently been cut, and the small amount of drifting to date shows the same grade and quality of ore as that encountered in the upper levels. Further, a second body of ore, approximately 40 feet south of No. 1 vein, has been cut. While as yet no drifting has been done on this new vein, the assays taken were very satisfactory. As a whole, our development for the year has been very encouraging, inasmuch as the drifting done on No. 1 vein is almost entirely in ore, and the ore opened up has been the most continuous and consistent so far encountered on the property.

Construction.—During the latter part of November an additional compressor was installed' delivering 1,000 cubic feet of air per minute, at 100 pounds pressure; accordingly, during the month of December, we were enabled to add more machines underground, greatly increasing our development.

An electric hoist was also installed underground for shaft-sinking, having a hoisting capacity of 3,000 pounds at 300 feet per minute.

The second electric locomotive for hauling ore underground was ordered.

An addition to the power-house was completed to accommodate the new compressor. Also a suitable machine shop was constructed and equipment for same purchased.

Milling.—During the month of March our milling capacity was stepped up to 400 tons per day, as outlined in our plans of the latter part of the preceding year. This tonnage was consistently maintained throughout the year, with the result that the average tonnage per day treated for the year showed 172 tons per day greater than that of the preceding year. A concerted attempt to reduce our tailing loss was made, with some indications of success.

To sum up the result of our year's programme, the mining and development, including increased tonnage in connection with our milling operations, has been very favourable.

GRAPHITE

Black Donald Graphite Company, Limited

The mine and mill at Whitefish lake, Brougham township, Renfrew county, was operated all through 1925, except for three weeks at the beginning of the year. The mine is situated 14 miles from Calabogie, which is the post office of the company.

About 90 per cent. of the product goes to the United States. All the graphite is shipped as a finished product for the different uses to which each grade is adapted. Owing to the high carbon content, 96 per cent. of the higher grades of flake graphite, it is especially valuable as a lubricant flake. The semi-amorphous and crystalline are graded for the other uses, such as foundry facings, paints for iron and steel, and stove polish.

The capacity of the mill is 12 to 13 tons a day of finished product. During the year 1925, production amounted to 2,250 tons of all grades. A Sperry press, 30-inch frame, with 14 plates, was added to the mill to increase and improve the No. 5 plumbago, which formerly graded 63 to 65 per cent. carbon.

The officers of the company are: R. F. Bunting, president and treasurer; R. A. Telfer, Calabogie, Ont., secretary; C. N. Daly, superintendent. An average force of 34 men was employed, 10 of these being in the mine. During the year, 21 diamond-drill holes were put in, totalling a depth of 976 feet.

GYPSUM

Ontario Gypsum Company, Limited

The property at Caledonia was operated throughout the year, and the Lythmore plant till the end of May.

The mine at Caledonia, located on lots 9 and 10, range I, Seneca township, Haldimand county, was operated at full capacity. About 90 per cent. of the ore mined was obtained from the north and east workings and the balance from the west.

The gypsum block plant previously operated by the Ebsary Gypsum Company was acquired in August by the Ontario Gypsum Company, which continued the manufacturing of roof, floor, and partition tile. This plant has a capacity of about 7,000 square feet of tile per day.

The Mussen stones in the mill were replaced by Kent mills for raw grinding. New mixers and bins were also added.

The mine produced 89,173 tons of ore during the year, the greater part of which was marketed approximately as follows:—

	Tons
Crushed rock (used in the manufacturing of cement)	25,000
Hardwall plaster	25,000
Gypsum board and block	24,000
Stucco and finish	6,000

The mine and plants employed an average of 207 men.

The mine at Lythmore, located on lot 29, in concessions III and IV of Oneida township, produced 3,929 tons of gypsum, which was manufactured into hardwall plaster. The ore was mined from two levels in the new shaft.

On an average 33 men were employed.

The officers of the company were: W. G. Case, Buffalo, N.Y., president; R. E. Haire, Paris, Ont., secretary-treasurer; A. J. Parkhurst, Caledonia, Ont., general superintendent; L. V. Robinson, Caledonia, assistant general superintendent; J. C. F. McPherson, superintendent at Lythmore.

LEAD

Forbes Galena Mines, Limited

The Frontenac lead mine, situated in Loughborough township, Frontenac county, is a property of some 330 acres consisting of the south half of lot 16 and part of lot 15 in concession IX, and the south half of lot 14 in concession X. The arrangement of the lots is such that the property extends for a mile and a half along the course of the vein.

The Toronto-Ottawa main line of the Canadian National Railway crosses the south part of lot 16 within 200 feet of No. 1 shaft. The nearest station is Perth Road, which is about one mile from the mine.

The property was formerly owned by the North American Smelting Company, Limited, of Kingston. The mine has not operated since 1913, but with the increased price of lead and the fact that a similar deposit has been satisfactorily worked at Galetta, attention has again been given to the Frontenac lead mine, which was first worked as early as 1866.

In July, 1924, the No. 3 shaft was pumped out for Joseph Savage of Buffalo, N.Y., and examined by John E. Hardman of Montreal. In April, 1925, the No. 1 shaft was dewatered for Payne, Webber and Company of Boston, Mass., and examined by W. R. Wade, formerly of the Northern Zinc Company, Edwards, N.Y.

In 1926 the property was bought by John M. Forbes acting for a group of Ottawa valley people. Forbes Galena Mines, Limited, was incorporated January 15, 1926, with a capital of $150,000 preferred stock in shares having a value of $100 each, and $10,000 common stock of no par value.

Work of dewatering No. 1 shaft was carried out, and in May, 1926, the shaft had been repaired to the 100-foot level and the overhauling of the concentrating mill was being done.

The officers of the company are: J. S. Gillies, Braeside, Ont., president; C. M. Edwards, Ottawa, vice-president; P. B. German, Ottawa, secretary-treasurer; John M. Forbes, Ottawa, managing director; W. T. May, Perth Road, Ont., superintendent.

The head office of the company is at 36 Central Chambers, Ottawa. Thirty-one men were employed at the mine.

Kingdon Mining, Smelting and Manufacturing Company, Limited

The plants of this company at Galetta, in the township of Fitzroy, Carleton county, were in continuous operation throughout the year 1925.

The main shaft was sunk an additional 175 feet, from 900 to 1,075 feet, stations being cut at the 900- and 1,025-foot levels and locomotive sheds driven off both these stations.

Crosscutting totalling 402 feet was completed on each of the three lower levels as follows: 650-foot level, 33 feet; 900-foot level, 159 feet; 1,025-foot level, 210 feet.

A total of 4,441 feet of drifting was completed during 1925 as follows:—

Level	Drift	
	East	West
	feet	feet
650-foot	610	817
775-foot	550	824
900-foot	706	934

The bulk of the production for the year came from shrinkage stopes on the 650- and 775-foot levels, stoping on the 900-foot being confined solely to breast stoping, preparatory to placing the stulls and lagging.

A Worthington, triple-plunger pump, type VTSA, 7½ by 10 inches, rated at 300 gallons per minute, was installed on the 525-foot level, pumping to surface. The old pump of this same type, previously located on the 400-foot level, was moved to the 1,025-foot and discharges to the sump on the 525-foot. Both pumps are driven by 75 h.p. motors.

A third Atlas storage-battery locomotive was added to the mine equipment.

At the smelter, the Scotch hearth was in continuous operation, in addition to which the blast furnace, treating the grey slag from the hearth, was run for 11 days between October 26 and November 5.

The staff at the mine, concentrator, and smelter remains unchanged.

The working force, exclusive of the office staff, averages about 173 men, 136 of whom are employed underground, 13 in the smelter, and 24 in the mill and on surface work.

MICA

Loughborough Mining Company, Limited

This company operated the Lacey mine at Sydenham, Loughborough township, Frontenac county, throughout the year 1925.

The 6,000 pounds of rough-cobbed mica produced weekly came entirely from the open pit.

A prospect drift was run into the hill for a distance of 100 feet at the southwest side of the shaft.

An average of 18 men was employed.

The company has a capitalization of 100 shares, par value $100.

G. W. McNaughton, Sydenham, is manager, and R. Smith is superintendent.

S. Orser and D. J. Wilson

The mica deposit on lot 32, concession XV, Faraday township, Hastings county, produced about 200 tons of black mica during 1925. A deposit of dark amber mica was also uncovered on lot 31, concession XV, from which a small quantity was shipped.

Both properties, which are near Bancroft, have been optioned to a syndicate.

An average of five men was employed while the property was being worked.

NICKEL AND COPPER

International Nickel Company

This company owns all the capital stock of the International Nickel Company of Canada, Limited. The stock of the parent company consists of: common shares (par $25) $50,000,000 authorized, $41,834,600 outstanding; preferred 6 per cent., non-cumulative (par $100) $12,000,000 authorized, $8,912,600 outstanding. The officers of the parent company are: chairman of the board, Charles Hayden; president, Robert C. Stanley; vice-president, secretary, and treasurer, James L. Ashley. The executive committee consists of: chairman, Charles Hayden; William E. Corey, John Foster Dulles, Reg. Halladay, and Robert C. Stanley. The directors are: James L. Ashley, New York; Reg. Halladay, Cresskill, N.J.; W. J. Hutchinson and Seward Prosser, Englewood, N.J.; Andrew V. Stout, William E. Corey, William N. Cromwell, John Foster Dulles, New York; Charles Hayden and Robert C. Stanley, New York; William T. Graham, Greenwich, Conn.; J. L. Agnew, Copper Cliff, Ont.; Wm. W. Mein, San Francisco, Cal.; Thomas Morrison, Pittsburgh, Pa.; Britton Osler, Toronto.

The general offices of the parent company are located at Bayonne, N.J.; the executive and financial departments at 67 Wall Street, New York.

The head offices of the mining and smelting division are at Copper Cliff, Ont.

The following information is extracted from the twenty-fourth report of the company, dated March 1, 1926, and covers the nine month period, April 1 to December 31, 1925, the fiscal year having been changed at this time to onform to the calendar year:—

All of your plants ran continuously throughout the year. Uniform monthly sales materially aided your executives in efficiently conducting operations and maintaining low costs of production.

A competent and experienced technical staff is constantly endeavouring to improve metallurgical processes and to better the quality of products.

At the Port Colborne works, which since 1922 has refined all the nickel sold by your company, nickel of the highest purity (99.9 per cent.) is now being efficiently and economically produced in a temporary unit. Provision for an output of 6,000 tons per annum of this special grade of nickel will be made during 1926, which will enable your management to meet a growing demand for pure nickel. A further economy resulting from this process is the recovery of the platinum metals.

Mine development work, mentioned in previous reports, was continued during the year and has added materially to your ore reserves.

Diamond-drilling at the Frood mine, which is the largest of the company's ore deposits, has proved the existence of an extensive tonnage of high-grade ore at depth, which is similar in many

respects to Creighton ore. This development is particularly encouraging, and a new shaft will be started on this property as soon as the market demand for nickel calls for a substantial increase in mining operations.

The Huntington works has completed its third year of successful operation. During this period the mill, which was built to produce hot-rolled sheets and bars, has been gradually equipped to produce cold-rolled sheets, cold-drawn rods, and seamless tubes. A strip mill is being installed to produce cold-rolled strip, a form for which a market exists both in nickel and monel metal.

As stated in previous reports, the demand for sheets of high surface finish has been constantly growing, and monel metal and nickel in this form are well known and widely used. Prospects of a further increase in business of this character are so apparent that your management has ordered another cluster mill together with necessary finishing equipment. This installation will be completed during the year and will require but a comparatively small capital expenditure.

Additional natural gas reserves have been secured under satisfactory terms which should assure the company an adequate supply of this important fuel for the life of the gas field.

Capital Expenditures.—For the nine months ending December 31, 1925, there were expended and charged to capital account sums aggregating $3,995,476.53, as compared with $471,734.80 for the previous year. The distribution was as follows: Copper Cliff, including mining properties, $3,698,138.57; Port Colborne, $57,840.40; Huntington works, $231,926.19; and Bayonne works, $7,571.37.

The International Nickel Company of Canada, Limited, recently acquired ore lands and certain other assets from the Anglo-Canadian Mining and Refining Company, Limited. These lands are adjacent to your mines in the Sudbury district of Ontario and add materially to ore reserves. Payment was made by the delivery of the Canadian company's serial ten-year, five per cent. notes.

Financial.—The operating profit for nine months was $5,305,534.19, from which was deducted $672,708.65 for depreciation of plants, $307,137.18 for depletion of ore reserves, and $88,288.09 for other charges, leaving a net profit for nine months of $4,237,400.27, compared with a net profit of $2,924,057.94 for the preceding year (12 months). After deduction of three preferred dividends, amounting to $401,067.00, and two common dividends, amounting to $1,673,384.00, the surplus on December 31, 1925, was $15,302,092.71, an increase of $2,162,949.27.

Earnings applicable to the common stock were $3,836,333.27, equivalent to $2.29 per share for the nine months ending December 31, 1925, which is at the rate of $3.05 per share per year.

The balance sheet shows that the additions to property account, less recoveries, were $3,995,476.53, which includes $3,397,900.00 for acquisition of properties, and that $86,982.55 was written off for dismantlement and charged to reserve fund. The total property account, after deducting depreciation and depletion of ore reserves, is $53,060,026.98, as compared with $50,044,396.28 on March 31, 1925.

Net current assets of $15,055,134.35 are in excess of last year's figures by $919,370.72.

Dividends.—The company's business, as indicated by quarterly and annual earnings for the last two years, has shown a steady recovery from the demoralized condition existing in the metal industry during the period of deflation immediately following the war. Careful and intelligent research has replaced, with diversified industrial business, losses incurred by disarmament.

The price of nickel during 1923 and 1924 was subnormal; and while the price to-day is lower than it was in pre-war years and substantially less than during the war, the company has, nevertheless, been able to show increased earnings. Current profits plus a strong financial condition decided your directors to inaugurate dividends on the common stock on September 30, 1925, after a lapse of six years, the last dividend having been paid March 1, 1919.

Three dividends of $1.50 each on the preferred stock were paid during the period covered by this report. Distributions of 50 cents on the common stock were made on September 30, 1925, and December 31, 1925.

Shareholders.—The number of preferred shareholders was 1,472 on December 31, 1925, as compared with 1,509 on March 31, 1925. The number of common shareholders was 9,204 on December 31, 1925, as against 12,447 on March 31, 1925.

The total number of shareholders at the close of the calendar year was 10,334 compared with 13,558 on March 31, 1925.

Creighton Mine

Operations at the Creighton mine were continuous throughout the year.

The work of installing a third underground crusher at the 26th level with its attendant ore passes, ore pocket, and skip loading station was completed and put into operation during the year.

The bulk of the production was obtained from stopes and pillars between the 12th and 16th levels, with some additional stoping being done on the 20th and 23rd levels.

Development work consisting of drifting, crosscutting, raising, and box-holing was done throughout the mine. The main portion of this work was done on the 23rd and 26th levels with the addition of considerable drifting and raising above the 5th level in the vicinity of No. 2 shaft, where a considerable body of ore is being developed.

A large amount of diamond-drilling was done underground from several of the lower levels.

In the rock-house, experimental work in the use of a magnetic pulley to assist in ore sorting was successfully tried out, and during 1926 the rock-house is being equipped with four of these pulleys. The advantage claimed, besides economy in man power, is a cleaner separation than by sorting entirely by hand.

An average of 418 men was employed during 1925.

The staff at the mine includes: W. J. Rolfe, superintendent; Chas. Lively, mine foreman; J. E. Treasure, assistant mine foreman; John Symons, master mechanic; and Alex. McIntyre, chief electrician.

No. 3 Mine

In addition to extensive diamond-drilling, some mining was done at the No. 3 mine of the International Nickel Company during the months of June to October, 1925.

This work was mainly confined to stoping on the 3rd level, the ore being shipped to Copper Cliff for milling and smelting test purposes.

J. Brown was mine foreman in charge of this work and 28 men were employed during the five months of operation.

Copper Cliff Smelter

At Copper Cliff, three blast furnaces and three converters were in continuous operation throughout 1925; four Wedge furnaces and the reverberatory furnace also ran throughout this period.

The smelter force averaged 645 men, which figure also includes the force of O'Donnell roast yard, High Falls power plant, and the general offices.

Donald MacCaskill is the smelter superintendent, and J. W. Rawlins, metallurgist.

Mond Nickel Company, Limited

The Canadian officers and staff of the Mond Nickel Company remain unchanged.

Plants at Coniston

Throughout the year 1925 the Mond Nickel Company operated three blast furnaces and from three to four converters at the Coniston smelter.

A fourth 13- by 30-foot converter was installed, replacing another 10- by 26-foot shell and bringing the converter equipment up to four 13- by 30-foot and one 10- by 26-foot converters, all of the Pierce Smith type.

A second 16- by 200-foot stack for furnace and converter gases was built. No changes were made in the blast furnaces of furnace equipment.

During the year the company installed and put into operation two units of a "contact" sulphuric acid plant, having a combined capacity of roughly 25,000 tons of acid per year.

In this plant the gas is taken from the converter hoods and, after the usual purification and drying, passes through a heat interchange to the contact mass of platinized asbestos; from there it passes to absorption towers, from which

the sulphuric acid goes to the shipping tanks. An oleum system is installed where further sulphur trioxide is absorbed and oleum of any desired strength produced, as required.

Officials of the company state that the plant is working very satisfactorily and is making acid of an excellent quality.

The quartzite quarry at Coniston was worked throughout the year, producing 49,500 tons of quartzite for converter flux.

No changes were made in the sintering plant or the concentrator during the year.

The average force employed at the Coniston plants was 686.

Frood Extension Mine

Operations at the Frood Extension mine of the Mond Nickel Company during the year consisted chiefly of development work in the mine and construction of the surface plant.

Underground development, aside from shaft-sinking, was confined to the 1,400-foot or 8th level. Here 650 feet of drifting and 400 feet of crosscutting (at an angle of 45 degrees) was completed. Section-cutting, for the purpose of further defining the ore body, was done in four stopes: 8.1, 8.3, 8.2, and 8.4. These stopes when fully section-cut will have a width of 75 feet and a length determined by the width of the ore body, and will be separated from adjacent stopes by a 25-foot rib pillar.

The shaft was sunk 469 feet, from a depth of 1,267 to 1,736 feet; stations being cut at 1,300, 1,400, 1,550, and 1,700 feet. In addition to this sinking and station-cutting, the work of retimbering the upper portion of the shaft was completed.

This upper portion of the shaft as previously timbered was divided into four compartments and has now been changed to three compartments, allowing two hoisting compartments, 5 feet 4 inches long by 6 feet wide, between the guides, with a pipe and manway compartment, 5 feet 4 inches by 4 feet, in the clear.

The following buildings were erected on the surface:—

Dry-House.—A change-house, 106 by 32 feet, was built. This building also has a 12-foot lean-to, extending the entire length on one side, which provides accommodation for the shift-boss office and change, engineer's room, first-aid room, and showers and toilet. It also has a basement in one end housing the heating boiler for the entire plant.

Machine Shop and Blacksmith Shop.—This building is 121 by 32 feet, with a tool and foreman's room at one end. The principal equipment installed to date is a lathe, pipe-threading machine, and an Ingersoll-Rand, type 550, drill sharpener.

Office and Warehouse.—This building is 90 by 30 feet, one end of which is used as a warehouse, while the other end is partitioned off to accommodate the mine offices and draughting-rooms for the engineering staff.

Power-House.—An annex, 22 by 18 feet, was built to the power-house to provide for switchboard equipment.

All these buildings are of brick and steel construction with Robertson's process roofing and, with the exception of the blacksmith shop, have concrete floors.

Alterations were made to the rock-house, the ore bins being rebuilt and a picking belt and trommel installed.

A new air compressor was installed in the power-house. This machine is an Ingersoll-Rand, type PRE2, 30 by 20½ by 24 inches, rated at 3,300 cubic feet per minute, and driven by a direct-connected, 666 h.p. synchronous motor.

Ore was shipped throughout the year to the Coniston smelter, coming mainly from the development work in the drifts and crosscuts in addition to which ore was also broken in the shaft which was put down through the ore body in the early months of the year.

Shipments to the smelter were averaging about 2,000 tons per month at the end of the year.

A. D. Carmichael, Box 480, Sudbury, Ont., is the mine superintendent, and an average of 103 men was employed throughout the year.

Garson

The Garson mine of the Mond Nickel Company was operated steadily throughout the year under the superintendence of A. L. Sharp.

The shaft was sunk an additional 209 feet and a station cut at the 1,200-foot level. Other development to the extent of 2,498 feet, consisting of 1,505 feet of drifting and crosscutting with 993 feet of raising, was completed.

The total tonnage hoisted, including waste, was 322,059 tons.

A storage-battery locomotive was added to the mine equipment. This locomotive is being used for tramming on the 8th level, where the bulk of the present production is being obtained. This is a Goodman locomotive, class A, type 76-0-4-T, with a battery of 48 Exide cells, the chassis weighing 6,000 pounds and the battery 1,140 pounds.

An average force of 327 men was maintained.

Levack

In common with all the other nickel-copper mines of the area, the production at Levack was greater in 1925 than in 1924.

In 1925, the tonnage hoisted, ore and waste, at Levack was 411,561.

Development work completed comprised 5,003 feet of drifts and crosscuts in addition to 2,684 feet of raises. This development was chiefly carried on on the 7th level.

During the summer a magnetic sorting plant, working on the same principle as the plant erected at Garson in 1924, was built. The structure for this plant, the main building of which is 72 by 37 feet, is of brick and steel. The plant went into operation on October 28, 1925.

F. J. Eager, Levack, Ont., is superintendent; J. Lyons is the mine foreman.

An average force of 345 men was employed during 1925.

Worthington

During 1925, 190,320 tons of ore and waste were hoisted at the Worthington mine of the Mond Nickel Company.

Development work consisted of the following: 190 feet of shaft, part of which was raised above the 7th (1,000 feet, vertical depth) level and the balance sunk below this level; a winze sunk 200 feet from the 7th to the 8th (1,200 feet) level; drifts and crosscuts, totaling 1,068 feet, chiefly on the 7th and 8th levels; raises to the extent of 540 feet.

A galena vein was encountered in the shaft below the 7th level, which has persisted in the shaft to the present. The writer is informed that the galena carries very little or no silver.

Several small pockets of gas were encountered in the progress of sinking this portion of the shaft. Unfortunately, it has not been possible to get samples of this gas for analysis. However, two samples of gas obtained from diamond-drill holes at Garson and at Creighton were analysed by the Dominion Department of Mines. The similarity of the composition of these gases, although the proportions of the main constituents are practically reversed, leads to the assumption that the Worthington gas will probably have a somewhat similar composition. The determinations of these gases were as follows:—

Constituents	Gas from drill-hole at Garson mine	Gas from drill-hole at Creighton mine	
		No. 1	No. 2
	per cent.	per cent.	per cent.
Carbon dioxide (CO_2)	nil	nil	nil
Oxygen (O_2)	0.63	nil	0.43
Methane (CH_4)	62.70	38.03	41.25
Ethane (C_2H_6)	5.93	4.42	2.12
Hydrogen (H_2)	nil	nil	nil
Nitrogen (N_2)	30.44	57.55	56.20
Helium (He)	nil	Insufficient sample for test	

W. J. Mumford, Worthington, Ont., is the mine superintendent at Worthington and had employed throughout the year a force averaging 172 men.

SILVER

Beaver Auxiliary Mines, Limited

The shaft on this property in the township of James, district of Timiskaming, was pumped out in May. The company is a subsidiary of the Beaver Silver Mines and has a capital of $2,000,000 in shares of $1 par value. The head office of the company is in the Lumsden Building, Toronto. The board of directors comprises: F. L. Culver, president; F. C. Finkenstaedt, vice-president; W. H. Alderson; Robert Graham, secretary-treasurer. H. L. Donaldson is manager.

Mining operations were carried on during July and in the last quarter of the year when thirty men were employed. Development work during this period comprised 65 feet of drifts and 65 feet of crosscuts on the 200-foot level, 164 feet of drifts and a 40-foot crosscut on the 300-foot level.

In January, 1926, a start was made in the sinking of the shaft to the 800-foot level.

Brewer, Sullivan and Richardson

The Adanac property, in the township of Coleman, district of Timiskaming, was leased to Brewer, Sullivan and Richardson in September. The mine was pumped out and operations were begun on the winze level at a depth of 300 feet on October 12 and continued for a few weeks. No ore was shipped.

Canadian Lorrain Silver Mines, Limited

Operations were conducted during the year on the property in South Lorrain, district of Timiskaming, with an average working force of 30 men. The company is a subsidiary of the Huronian Belt Company. Dr. J. Macintosh Bell is consulting engineer, and Hugh MacMillan is manager.

During the fiscal year ending February 28, 1926, the total development work amounted to 2,247 feet of drifting, 909 feet of crosscuts, 188 feet of slashing, and 394 feet of raises and a 5-foot winze. Of this work, 240 feet of drifting was in No. 1 tunnel; 189 feet of drifting and the 14-foot crosscut on No. 2 level; 719 feet of drifting, 819 feet of crosscuts, and 291 feet of raises were on the 250-foot level; 1,099 feet of drifting, 76 feet of crosscuts, and a 108-foot raise was on the 350-foot level.

Commodious camp buildings were erected, and plans are being drawn for the erection of a 50-ton concentrating mill. These buildings comprise a cookery, 52 by 24 feet, with an annex 16 by 22 feet for cooks' quarters, and five 10-men huts, each 22 by 20 feet.

The major development during the year was the finding on the 350-foot level of a high-grade ore shoot, 109 feet long, of an average width of 11 inches of 750-ounce ore.

Capitol Silver Mines, Limited

Capitol Silver Mines, Limited, has an authorized capital of $4,000,000 in shares of $1 par value, of which $3,518,339 shares are issued. The officers of the company are: J. P. Bickell, president; Balmer Neilly, secretary-treasurer. The directors are: J. P. Bickell and Joseph Errington, Toronto; W. J. Sheppard, Waubaushene, Ont.; J. B. Tudhope, Orillia, Ont.; and D. H. McDougall, Stellarton, N.S. The head office of the company is in the Standard Bank Building, Toronto.

Mining operations were carried on in the early part of 1925 with a force of some 40 men, and in the latter part of the year and the first half of 1926 with a force of 20 to 25 men, trenching the surface and examining the most favourable ground for silver discovery on mining claims H.S. 363-65, 369, and 352, in Nicol and Haultain townships, district of Timiskaming. On claims H.S. 363 and 369, veins of great length containing cobalt and silver are being explored.

The expenditures on surface work for the fiscal year ending June 30, 1926, amounted to $5,680, and the total expenditures on development, including diamond-drilling, amounted to $27,090, bringing the development charges to date to $150,073.

The Keewatin diabase contact was located by diamond-drilling from the bottom level of the mine at a depth of about 1,020 feet.

W. J. Dobbins was manager during 1925, and H. G. Young succeeded him as manager in 1926.

Castle-Trethewey Mines, Limited

This company has an authorized capital of $2,000,000 in shares of $1 par value. The property is in Haultain township, district of Timiskaming. The officers of the company are: J. P. Bickell, president; J. B. Tudhope, vice-president; Balmer Neilly, secretary-treasurer. The other directors are: W. J. Sheppard, Waubaushene, Ont.; S. R. Wickett and Gordon Taylor, Toronto. The head office of the company is in the Standard Bank Building, Toronto.

R. J. Ennis is consulting engineer, and H. G. Young is mine manager, having succeeded Murray D. Kennedy at the end of 1925. The working force averaged 120 men during 1925.

The following is taken from the manager's report for the fiscal year ended June 30, 1926:—

The advent of electric power in March, 1926, made it possible to increase development from 400 feet to 1,000 feet per month. The nature of the ore deposits in this field makes it essential constantly to carry on a large development programme.

The principal development late in the year was the opening up of a rich ore body on the 625-foot level, the lowest level in the mine. A limited amount of development showed 250 lineal feet of 50- to 60-ounce ore over 5 feet.

Ore reserves were increased by 161,000 ounces to a total of 2,701,655 ounces of silver, contained in 86,615 tons of ore of an average grade of 31.2 ounces.

SUMMARY OF DEVELOPMENT

	Shafts	Drifts	Crosscuts	Raises	Winzes	Total
	feet	feet	feet	feet	feet	feet
No. 3 shaft	142	5,160	1,394	579	37	7,312
No. 2 shaft	.....	44	59	.....	.....	103
No. 4 shaft	50	.....	.....	.....	.....	50
Total	192	5,204	1,453	579	37	7,465

Total footage of drifts, raises, and winzes	5,820 lineal feet
Percentage of this footage in ore	24.6 per cent
Development, 6,564 tons of 31.6-ounce grade	207,619 ounces
Diamond-drilling	1,102 lineal feet

SOURCES OF ORE FROM MINE

Source	Tons	Grade, ounces	Total, ounces
Development	6,564	31.6	207,619
Stopes	33,970	24.4	928,955
Mill dumps	1,254	20.0	25,080
Total	41,788	27.8	1,161,654

PRODUCTION

Concentrates shipped, dry tons	323.25	
Ounces per ton	3,091.21	
Total fine ounces silver recovered	999,234.00	
Average price per ounce	$0.6789	
Revenue from sale of silver		$657,843.38
Cobalt produced, pounds	30,879	
Revenue from sale of cobalt		5,314.60
Total revenue		$663,157.98

PRODUCTION SINCE COMMENCEMENT OF OPERATIONS

Period	Period months	Tons milled	Ounces per ton recovered	Gross production, ounces	Gross value, silver and cobalt
Feb. 1, '22 to June 30, '22	5	Sorting	.....	40,000	$28,000.00
July 1, '22 to June 30, '23	12	Sorting	.....	62,811	41,146.80
July 1, '23 to June 30, '24	12	7,607	46.03	350,147	229,656.95
July 1, '24 to June 30, '25	12	30,273	30.62	927,088	637,712.10
July 1, '25 to June 30, '26	12	34,425	29.03	999,234	683,610.48
Total	.....	72,305	31.48	2,379,280	$1,620,117.33

MILLING

	Tons
Ore treated from mine	40,534
Ore treated from dumps	1,254
Total	41,788
Waste sorted from mill	7,363
Actual tons milled	34,225
	Ounces
Total production	999,234
Waste sorted from crusher	20,274
Tailings	110,332
Total	1,129,840

CONCENTRATES PRODUCED

	Pounds	Ounces
Jigs	199,398	493,383
Sands	346,428	489,903
Slimes	101,340	22,373

OPERATING COSTS

	Total cost	Cost per ton milled	Cost per ounce
Development	$145,210.89	$4.218	$0.145
Mining	72,896.11	2.117	.073
Tramming and hoisting	30,735.85	.893	.031
Milling	66,983.44	1.946	.067
Shipping	9,974.98	.290	.010
Smelting and refining	26,700.41	.776	.027
General expenses—mine	15,110.89	.439	.015
Corporate, legal transfer, and administration—head office expenses	18,812.44	.547	.019
General maintenance	5,621.48	.163	.006
Insurance and miscellaneous	4,907.87	.142	.005
Total	$396,954.36	$11.531	$0.398

Power and Construction.—Turning over the mine to Northern Canada Power of 25-cycle from 60-cycle cost during the year $22,094.75. New construction, consisting of machine shop, new dry-house, bunk-house, etc., cost $28,009.08, making a total of $50,103.83.

Clifton Consolidated Mines, Limited

The Provincial mine at Cobalt was operated by this company from December, 1924, to September, 1925, with an average working force of 30 men. Maurice E. Young was manager.

The development work comprised a total of 3,100 feet of drifts, crosscuts, and raises. No stoping was done, and no shipments were made.

Cobalt Contact Mines, Limited

Work was carried on continuously during 1925 at the Cobalt Contact mine in Bucke township, district of Timiskaming, with an average force of 18 men. Up to March 20 the work was under the direction and control of J. M. Aitken and Company of Toronto, and subsequently by the Cobalt Contact Mines, Limited, which company took over the option from that date.

The officers of the company are: J. M. Aitken, president; George F. Beaumont, vice-president; Alexander M. Hamilton; G. W. Adams; and James A. Stewart, secretary-treasurer. The head office of the company is at 8 Bloor Street East, Toronto. J. M. C. Dunlop is manager.

The shaft was deepened from the 115- to the 200-foot level during the year, and a total of 190 feet of raising and winzing and 1,400 feet of drifting was done.

In the latter half of the year an option was taken on the Law property, which lies north of the Contact mine and directly east of North Cobalt. Operations began on August 24 and continued until the end of the year. An average of 14 men was employed during this period, and 105 feet of sinking and 515 feet of drifting was done.

The Red Rock and Green-Meehan properties were leased from Edwards and Wright, Limited, and operations began at the Red Rock shaft on August 28 and were carried on intermittently until the first week in December, with an average force of 17 men. During this time 353 feet of drifting was done on the 110-foot level. The Green Meehan shaft was unwatered in October, and mining work was carried on in a small way until the end of the year. The work comprised 34 feet of raising and 50 feet of drifting. After the beginning of 1926, operations began on a larger scale.

During November and December, 1925, excavations were completed for a mill on the Green-Meehan property by the operating company.

The shaft on the Hunter property was unwatered in May. The shaft is 93 feet deep. No work was done.

Coleroy Gowganda Mines, Limited

This company operated their property at Leroy lake, in Nicol township, district of Timiskaming, in the first quarter and during the last five months of the year. The officials of the company are: John A. McAndrew, president; E. V. Nisbet, secretary-treasurer. The head office of the company is at 272 Bay Street, Toronto. John W. Shaw is manager, and from 17 to 25 men are employed.

During the first quarter of 1925, 228 feet of crosscuts and 166 feet of drifting was done on the 388-foot level. Upon resumption of operations in August, the shaft was sunk 100 feet and a new level established at 488 feet. An additional 50 feet of crosscutting and 189 feet of drifting was done on the 388-foot level. Up to the end of March, 1926, a total of 575 feet of drifts and 245 feet of crosscuts was driven on the bottom level.

A new bunk-house, 16 by 40 feet, and a shaft-house and 30-foot headframe were erected.

Colonial Mining Company

The Colonial property, in the town of Cobalt, Coleman township, district of Timiskaming, was operated under lease as in the two previous years by the Menago Mining Company, Limited. J. P. Hussey was manager, and the average number of men for the year was 58.

The development work done during 1925, including the Nipissing crosscut, amounted to 5,716 feet, as follows: Nipissing crosscut, 1,504 feet, of which 650 feet is on the Colonial mine; Colonial Silver Cliff Webb crosscut on the 1,130-foot level, 989 feet. Other drifting, 2,610 feet; raising, 471 feet; winzes, 34 feet; and box-holes, 108 feet.

The Cross Lake fault was encountered on the 1,130-foot level at a point about 400 feet east and 200 feet north of the southeast corner of the Violet property. The faulted zone is about 40 to 50 feet wide with an olivine diabase dike about 50 feet wide on the southwest side of the dike. The 1,080-foot level was continued in a southeasterly direction to the north boundary of the Watts claim.

The year's production consisted of 11.61 tons of high-grade and 7,589 tons of mill rock of an approximate silver content of 280,000 ounces.

The Nipissing crosscutting was continued during January, 1926, to a total length on that property of 1,005 feet. The Menago Mining Company returned the property to the Colonial Mining Company on March 31, 1926.

Coniagas Mines, Limited

Operations at the Cobalt property during the year were confined to cleaning up the mill site and disposing of stores and mechanical equipment carried on the company's books at the time of the fire in May, 1924, the principal operation being that of the Coniaurum Mines at Porcupine.

The company's capitalization and board of directors remains the same as last year, except that W. G. Watson of Toronto replaces R. P. Rogers as a director.

During the year five field parties were employed investigating, staking, and prospecting promising territory in the townships of Duprat, Boischatel, Dufresnoy, Montbray, and Rouyn in the province of Quebec, and a large number of claims were staked upon which assessment work will be carried on this summer. In the province of Ontario, certain claims in the Red Lake area and Kipling township were staked, and it is proposed to carry out a similar programme there. To date, on none of these properties in either province has sufficient work been done to justify any official statement.

Crescent Silver Cobalt Mining Company, Limited

Operations were carried on at the Trout lake property, in the southwest corner of Coleman township, district of Timiskaming, for part of the summer with a force of 15 men. Drifting was done from the adit at a point 550 feet from the entrance, and had proceeded by September 18 for a distance of 208 feet to the south and 85 feet to the north. The property closed down soon after. S. W. Barber, 19 Farquhar Street, Guelph, Ont., is president and manager. The head office of the company is at 100 McKinnon Building, Toronto.

Doherty-Easson Mining Syndicate, Limited

The Penn-Canadian mine, in Coleman township, district of Timiskaming, was operated under option by the Doherty-Easson Mining Syndicate during most of the year 1925. J. C. Houston is manager, and Richard Bandoe, mine captain. Twelve to fourteen men are employed except for the two summer months, when the mill was running and the working force was 40 to 45 men.

Considerable development work was done in the northwest corner of the property, as follows: 850 feet of crusscutting, 200 feet of drifting, and 40 feet of raising. Approximately 3,000 tons of ore was crushed between June 18 and August 7.

Genesee Mining Company, Limited

The property in Bucke township, district of Timiskaming, was closed down between April, 1925, and January 15, 1926, when work was resumed, with a force of 11 men, and a total of 424 feet of drifts and crosscuts and a 15-foot winze were driven on the 350-foot level. The property closed down on May 1, 1926.

Gowganda-Duggan Silver Mines, Limited

Operations were continued during the year on this property in Donovan township, district of Timiskaming, with a force of 15 men. James A. McVichie is superintendent.

A mining plant, comprising one 70 h.p. locomotive-type boiler, a 300 cubic foot, Rand, straight-line air compressor and a 6- by 8-inch hoist, was installed. In the last quarter of the year and the first two months of 1926, the main shaft was continued from 50 feet to a depth of 165 feet.

Gowganda Keora Silver Mines, Limited

This company has a capital of $3,000,000 in shares of $1 par value, of which 2,300,000 are issued. W. B. Gunton is president; George W. Mulholland, vice-president; and W. E. Smith, secretary-treasurer. The head office is at 1106 C.P.R. Building, Toronto.

In February, the company began installing plant, which comprised a 20 h.p. boiler, a two-drill air compressor driven by a 55 h.p. gasoline engine, and a 6- by 8-inch hoist, at the old Calcite Lake property in Lawson township, district of Timiskaming. The mine was pumped out in March, and drifting began on the 150-foot level on April 16.

The mining work accomplished from April 16 to January 31 comprised 70 feet of crosscuts and 100 feet of drifts on the 150-foot level, 100 feet of crosscuts and 400 feet of drifts on the 200-foot level, and 100 feet of drifting on the 275-foot level.

A 30-ton mill was erected which operated from September 1 to 15 and from October 26 to date, and milled 500 tons up to the end of January, 1926. Thomas Reilly is manager.

J. W. Hamilton

In May, J. W. Hamilton, of Cobalt, began surface work with 8 men on his property in Coleman township and Gillies limit, district of Timiskaming, about one mile south of Gillies Depot. Frank Clement was in charge of the working force, which was later increased to 15 men.

Cook and sleep camps, each about 15 by 30 feet, were erected, and a mining plant, consisting of a 40 h.p. boiler, a two-drill compressor, and a 6- by 8-inch Jenckes hoist was installed.

A 50-foot prospect shaft sunk three years ago was enlarged to two compartments and timbered. A 25-foot headframe was erected and the shaft continued to a depth of 72 feet by October 21 when operations were suspended. A power-house and a powder magazine were erected.

Haultain Mining Company, Limited

The property in Haultain township, district of Timiskaming, was operated during the latter half of the year. Work began on August 26 and was continued by Joe Melisek with a force of 16 men. The shaft was continued to a depth of 162 feet and a level established at 150 feet. Crosscuts were driven 26 feet east and 35 feet west, and drifts were driven 57 feet north and 55 feet south. Work was continued during December and January of 1926, with a force of 28 men under F. A. S. Carnegie as manager and Horace F. Strong as consulting engineer. The work done in this period comprised 130 feet of crosscuts and 180 feet of drifting on the 150-foot level, and 25 feet of drifting on the 125-foot level.

Hector Silver Mines, Limited

This company has a capital of $2,000,000 in shares of $1 par value. The officials are: R. A. Cartwright, president; Vernon F. Taylor, vice-president; C. C. Calvin, secretary; B. E. Taylor, treasurer. The head office is in the Excelsior Life Building, Toronto. The company operated their property at Bass lake, in the Gillies limit, district of Timiskaming, during most of the year 1925 and for the first five months of 1926. The work was under contract to Stewart Brothers, of Cobalt, who employed 12 to 18 men, and was under the supervision of W. J. Adair, of Haileybury.

A bunk-house, 17 by 35 feet, hoist-house, dry-house, and a headframe were erected, and the shaft was continued to a depth of 500 feet during the year. Preparatory to resuming sinking operations, a vertical diamond-drill hole was put down to a depth of 540 feet, intersecting the diabase conglomerate contact at about 460 feet. Levels were established at 60 feet, 150 feet, 255 feet, and 490 feet.

The following work was done on the various levels, mainly in the first five months of 1926: drifts 117 feet west and 134 feet east, a crosscut 30 feet south, and short drifts amounting to 169 feet, were driven on the 60-foot level; drifts 35 feet west and 20 feet east and a crosscut 20 feet south were driven on the 150-foot level; drifts 105 feet east and 105 feet west and a crosscut 20 feet south were driven on the 255-foot level; crosscuts 155 feet northeast, 150 feet south, and 55 feet southwest, also drifts totalling 98 feet were driven east on the 490-foot level.

Huronian Belt Company

Mining claim W.J. 9 in Nicol township, district of Timiskaming, was acquired by the Huronian Belt Company, and surface operations were begun in September. A two-compartment shaft was started with hand steel and sunk to a depth of 55 feet by the end of the year. Leonard Smith is superintendent, and 16 men are employed.

The following buildings were erected on the property: cook camp, 20 by 40 feet; bunk-house, 20 by 30 feet; office, 20 by 14 feet; smithy, icehouse, and stable, each 14 by 16 feet; magazine, 10 by 12 feet; power-house, 24 by 40 feet; and a 25-foot headframe.

Hylands-Gardiner-Johnston Claims

This group of seven claims, including R.S.C. 131-34, 140-42 in Nicol township, district of Timiskaming, were operated during the last quarter of the year under what is known as the H.J.G. option. C. L. Hershman was manager, and 33 men were employed.

Stripping began on November 11 and sinking on November 16. The shaft was continued by contract to a depth of 100 feet in February, 1926, when operations ceased. The following buildings were erected: office, 20 by 24 feet; cook camp, 28 by 50 feet; bunk-house, 20 by 40 feet; storehouse, 20 by 16 feet; stable, 16 by 12 feet; power-house, 24 by 30 feet; and smithy, 16 by 22 feet. A 25-foot headframe was also erected over the shaft.

Keeley Silver Mines, Limited

This company has a capital of $2,000,000 in shares of $1 par value. The board of directors comprises: F. H. Hamilton, president; J. Mackintosh Bell, managing director; E. Turk, John H. Black, James W. Bain, W. H. Stafford, and R. T. Shillington. R. S. Dening is secretary-treasurer, and the Toronto office is at 302 Bay Street.

The company operated its property at Silver Centre, South Lorrain, district of Timiskaming, with an average force of 125 men during the year 1925. M. C. H. Little is resident manager.

The report of the managing director for the fiscal year ending February 28, 1926, is as follows:—

During the period under review, the results obtained may be considered gratifying. The steady monthly production of approximately 125,000 ounces of silver has been maintained, and although the developed ore reserves have been reduced they are still substantial. The position in this respect gives no immediate cause for concern, and recent discoveries emphasize the fact that the speculative possibilities of the property are far from being exhausted.

Summary of Underground Operations.—During the year the following underground development has been carried out:—

	Feet	Cost per foot
Shaft-sinking (No. 5 shaft)	58	$52.14
Winze-sinking	170	82.55
Drifting and crosscutting No. 5 shaft	404	12.52
Drifting and crosscutting No. 3 shaft	6,795	14.07
Raising	641	18.95
Diamond-drilling, Keeley	485	4.37
Diamond-drilling (in conjunction with Mining Corporation of Canada)	600	2.55

Some 23,210 tons of ore were hoisted. Of this amount, 19,419 tons were taken from the stopes; the remainder came from development.

The cost per ton of ore delivered to the primary crusher averaged $4.

Results of Development.—The most interesting results obtained during the year were those in the zone occupied by veins Nos. 16 and 28 in the western part of the property, where a number of shoots of ore of varying richness were discovered at various horizons, and were in process of development at the end of the year. In this part of the property a new level is now being opened up at a depth of 820 feet. Recent developments in the right branch of Wood's vein, at a vertical depth of 620 feet, are no less promising, but this ore body has been developed since the close of the fiscal year, and only passing reference need be made to it in this report.

Mill Statistics.—During the year, 23,258 tons of ore were milled. Abbreviated statistics are as follows:—

Ore milled	23,258 tons
Heads, average	22.11 ounces
Tails, average	2.86 ounces
Extraction, average	87.50 per cent.
Average running time	72.60 per cent.

Production.—Production for the year (based on actual smelter returns) was as follows:—

	Pounds, net	Silver, ounces	Cobalt, pounds
Picked ore	499,061	1,064,517	68,998
Concentrates	1,578,487	449,890	112,056
Total	2,077,548	1,514,407	181,054

The corresponding figures for the silver and cobalt produced during the previous year are 1,880,352 ounces and 228,450 pounds, respectively.

PRODUCTION DURING PREVIOUS YEARS

Year	Pounds, net	Silver, ounces	Cobalt, pounds
1913	322	872.7	.....
1914	2,327.4	3,183.03	.....
1918	145,048	39,557.25	1,061
1919	31,766	4,565.82	3,160.3
1920	119,770	8,253.44	9,896.86
1921	676,411.5	313,230.88	60,566.72
1922 and 1st two months 1923	2,286,497	1,146,961.56	196,927
Fiscal year 1923-24	1,973,832.75	1,600,739.68	171,357
Fiscal year 1924-25	2,668,241.75	1,880,351.88	228,450
Total	7,904,216.4	4,997,716.24	671,418.88
Fiscal year 1925-26	2,077,548	1,514,407.48	181,054
Total production to February 28, 1926	9,981,764.4	6,512,123.72	852,472.88

COST OF PRODUCTION

(Based on 23,508 tons of ore treated, producing 1,514,407 ounces of silver.)

	Total cost	Per ton	Per ounce
Development	$137,900.81	$5.87	$0.091
Ore extraction	77,637.79	3.30	.051
Ore sorting	4,778.63	.20	.003
Milling	44,913.24	1.91	.030
Shipping and marketing	71,312.68	3.03	.047
General maintenance	34,920.52	1.49	.023
Administration at the mine	35,639.62	1.52	.024
Head office expense	9,493.25	.40	.006
Corporate expense	26,081.07	1.11	.017
Taxes	18,289.55	.78	.012
Total	$460,967.16	$19.61	$0.304

Ore Reserves.—The total ore reserves opened up in the mine, as at February 28, 1926, are estimated at approximately 25,000 tons, containing about 1,500,000 ounces of silver and 120,000 pounds of cobalt. Immediately prior to the date mentioned (as well as subsequent thereto) there were important discoveries of new ore, but their development had not progressed sufficiently far to permit of their inclusion in the above estimate.

Kerr Lake Mines, Limited

Besides maintaining their pumping plant in operation, this company did some surface work in open cuts and some sorting of ore from dumps at the property in Coleman township, district of Timiskaming. R. R. Brown is manager, and from 6 to 16 men were employed, the latter number for a short period when sorting No. 3 dump.

The following is taken from the manager's report for the fiscal year ending August 31, 1925:—

The production for the fiscal year amounted to 73,428 ounces of silver from 60,385 pounds of high-grade and concentrates. The sorting of ore from No. 3 dump was discontinued early in the summer after a production of 58,428 ounces had been recovered in the period. Surface exploration, consisting of trenching and open cuts, resulted in a production of 11,000 pounds high-grade, estimated to contain 15,000 ounces of silver. This came from No. 7 vein and parallel veins south of the main east vein. A limited amount of exploration was done in the area adjacent to No. 7 vein.

La Rose Mines, Limited

This company operated the Violet property, Coleman township, district of Timiskaming, during the year and leased the Princess and the Lawson mines. The company has a capital of $1,500,000 in shares of $1 par value. The board of directors is as follows: E. W. Nesbitt, Woodstock, Ont., president; H. H. Sutherland, 36 King Street East, Toronto; George Parent, Quebec; J. L. Counsell, Hamilton, Ont.; J. A. Cameron, Toronto; R. J. Purdy, Toronto; J. W. Lowden, Toronto; A. W. Cowles, Sewaren, N.J.; G. E. H. Booth, Cobalt. William Cameron is secretary, and the head office is at 36 King Street East, Toronto.

G. E. H. Booth is manager, and 36 men were employed.

The following summary is from the manager's report:—

SUMMARY OF WORK DONE DURING 1925

	Shafts	Stations	Drifts	Crosscuts	Raises	Stopes
	ft.	cu. yds.	ft.	ft.	ft.	cu. yds.
Violet	177	174	1,248.5	412.5	234	970

DISTRIBUTION OF PRODUCTION

	Dry tons	Ounces silver
Violet	23.32	100,045.52
Lawson	8.88	41,463.88
Mill rock from the Violet mine	7,044.08	156,448.03
Total	7,076.28	297,957.43

Violet Mine

This property was operated throughout the year and produced 23.32 tons of high-grade ore, assaying 4,290 ounces to the ton, together with 7,044 tons of mill ore, assaying 22.21 ounces to the ton, a total production of 7,076.32 tons containing 256,494 ounces of silver. The greater part of this production came from the new discovery made in January on the 800-foot level of the winze in the southeast part of the property. The winze was deepened to the 930-foot level, proving the ore to be 130 feet in depth. Levels were established at 830 feet, 880 feet, and 930 feet, and a limited amount of lateral development accomplished where the ore shoot was found to be very irregular in extent and value, although from this small area 240,000 ounces of silver were produced. As commercial ore exists in the winze below the 930-foot level in favourable geological conditions, the discovery of ore shoots similar in extent and value may be expected, with the exploration of this area.

On the 635-foot level some prospecting of the northern section of the property was done in the sedimentary formation underlying the diabase sill. Two small occurrences of commercial ore were found which merit further development. The old workings adjoining the O'Brien mine were dewatered latterly and a tonnage of mill ore produced therefrom. Several promising blocks of ground remain to be developed between the old levels.

Princess Mine

This mine was worked throughout the year under lease by the McKinley-Darragh-Savage Mines of Cobalt, who did some prospecting on the lower levels and produced 6,229 tons of low-grade mill ore on which a royalty was paid to the company. This lease has been renewed for a further term.

Lawson Mine

During the latter half of the year, this property was operated under a short-term lease with a measure of success. Two small but rich shoots of high-grade ore were found from which 8.88 tons containing 41,464 ounces were produced. This mine has still considerable prospective value since additional discoveries of ore will no doubt result from the further exploration of the old workings.

Prospecting

During the summer season, prospectors were again sent to the claims held by the company in northwest Quebec. Sufficient work was accomplished to hold the claims and to indicate the occurrence of encouraging copper-gold values in geology identical with that in Rouyn township, where profitable mines have been established.

Summary

During the year there was made a profit on production of $33,768, compared with a loss of $90,370 in 1924. The average grade of mill ore shipped was 22.27 ounces per ton, against 16.44 ounces in 1924. The average price received for silver was 69.96 cents, as compared with 66.1 cents in 1924.

The future prospects of the Violet mine as a result of the year's development are quite favourable. Since the ore occurrences are very erratic as to size and value, no estimate of ore reserves can be made. Commercial ore is known to exist not only on the upper levels, but also below the 930-foot or lower level of the mine. A considerable section of the mine, particularly No. 4 vein, remains to be prospected where geological and structural conditions are favourable for the discovery of other valuable ore shoots.

Lorrain Consolidated Mines, Limited

This company operated their property in South Lorrain, district of Timiskaming, during the year with an average force of 23 men. The company has a capital of $3,000,000 in shares of $1 par value. The head office is at 42 Broadway, New York. L. L. Steindler is president; Horace F. Strong, Haileybury, Ont., is consulting engineer.

The work done on the property during 1925 comprised 960 feet of drifts, 385 feet of crosscuts, 360 feet of raises and winzes, and approximately 800 cubic yards of stoping, besides the sinking of No. 3 shaft to a depth of 50 feet. The distribution of the work was as follows: on the 50-foot level, 65 feet of drifting; on the 100-foot level, 125 feet of drifting, 100 feet of raising, and 70 feet of winzing; on the 134-foot level, 65 feet of drifting, a 20-foot crosscut, and an incline drift of 55 feet; on the 175-foot level, 580 feet of drifting, 305 feet of crosscutting, and 105 feet of raising; on the 250-foot level, 70 feet of raising; in No. 3 shaft, 45 feet in drifting; on the 140-foot level in No. 3 shaft area, 60 feet of crosscuts, 65 feet of drifts, and a 15-foot raise.

McKinley-Darragh-Savage Mines of Cobalt, Limited

This company has a capital of $2,500,000 in shares of $1 par value. The mine and head office are at Cobalt, Coleman township, district of Timiskaming. The directors are: R. Home Smith, president; J. R. L. Starr, F. H. Phippen, Manning Doherty, Robert Bryce, J. Homer Black, and John O'Connor, Toronto;

Milton W. Tichenor and Quincy W. Beese, New York; James C. Haight, Waterloo, Ont. C. H. Pelling is secretary-treasurer, and the general office is at 330 Bay Street, Toronto.

H. C. McCloskey is manager, and 95 men are employed.

The silver recovered during 1925 from 55,378 tons of ore hoisted amounted to 416,564 ounces, and the silver recovered to date to 21,108,610 ounces.

The following summary for 1925 is from the manager's report:—

GENERAL STATEMENT OF OPERATIONS

	Tons
Ore removed from the mine and dumps	55,378
Ore milled	55,363
	Ounces
Silver on hand January 1, 1925	55,357
Silver recovered during the year 1925	416,564
Silver shipped during the year 1925	432,937
Silver on hand January 1, 1926	38,984

COSTS

Operations		Total	Per ton of ore mined	Per ounce recovered
Mining		120,726.36	$2.180	$0.2898
Milling		88,848.25	1.604	.2133
Operating		14,276.38	.258	.0343
Sampling and assaying		3,925.55	.071	.0094
Bagging and shipping		3,571.23	.065	.0086
Surface work, roads, etc		2,613.85	.047	.0063
Repairs to plant		450.64	.008	.0011
Fire protection		1,502.92	.027	.0036
Prospecting		158.13	.003	.0004
Savage—pumping and caretaking		3,386.43	.061	.0081
Administration	$12,997.88			
Less—interest and exchange	7,245.47			
		5,752.41	.104	.0138
Marketing	$34,617.97			
Less—cobalt and copper	9,414.84			
		25,203.13	.455	.0605
Total costs		$270,415.28	$4.883	$0.6492

The silver recovered was distributed in the following classes of product:—

Classification	Product, tons	Silver, ounces	Percentage of total	Average ounces per ton
Metallics	0.036	735	0.18	20,417
Below 550 ounces per ton	4.422	1,141	.27	258
550 to 1,000 ounces per ton	1.021	901	.22	882
1,000 to 2,000 ounces per ton	12.762	17,965	4.31	1,408
Over 2,000 ounces per ton	1.971	13,440	3.22	6,819
Sand concentrates	232.715	219,402	52.67	943
Flotation concentrates	368.903	162,980	39.13	442
Total	621.830	416,564	100	669.9

DISTRIBUTION OF UNDERGROUND WORK DURING 1925

Levels	Drifts	Crosscuts	Raises	Stopes
	feet	feet	feet	tons
McKinley:				
75-foot	.....	.....	45	7,157
150-foot	.....	160	.....	11,102
200-foot	.....	39	.....	4,918
250-foot	.....	.....	.....	2,509
300-foot	453	560	70	5,949
350-foot	525	557	25	8,943
400-foot	264	127	.....	4,357
Princess	40	132	.....	2,319
Total	1,282	1,575	140	47,254

McKinley-Darragh

Development work during the year was confined principally to the lower levels, the 300-, 350-, and 400-foot, from which approximately 40 per cent. of the tonnage was obtained, while the balance came from stoping operations on the upper levels from the 75- to the 250-foot on the old ore bodies and branches.

Vein No. 92, discovered early in the year on the 300-foot level, has been opened up on the 350-foot level for a length of 190 feet and for 130 feet on the 400-foot level, with a stoping width of from 7 to 25 feet of fair milling values.

Vein No. 102 was picked up about 30 feet north of No. 92 on the 350-foot level; it does not show values on the 300-foot, but has been opened up on the 400-foot level. Very little stoping has been done on this ore body.

Vein No. 104 was picked up near the Princess line on the 300-foot level, and is the downward extension of an inclined ore body on the Princess which had been worked to within about 50 feet of our line. Values are confined to a height of about 25 feet by the quartzite above and the Keewatin underneath. Width of milling values is from 10 to 25 feet. A further extension may be found between the 300- and 400-foot levels.

While our mining costs show a considerable increase over the previous year, more development was accomplished than for any year since 1918, and results have justified the additional expenditure.

Savage

A small amount of exploration work was carried on with one machine for a few months, but nothing of importance was discovered. A block of ground below the 140-foot level will be drilled during the present year.

Princess Lease

The greater part of the work carried on was investigating old stopes from which 5,241 tons was obtained.

Milling

The concentrator treated 55,363 tons, which is a slight decrease from the previous year. Costs were somewhat higher due to additional repairs made during the last week of the year. Mill heads were 8.196 ounces, and extraction was 85.07 per cent. as compared with 7.25 ounce heads and extraction of 82.54 per cent. for the previous year.

John H. McLeod

The Foster mine, in Coleman township, district of Timiskaming, was operated under lease by John H. McLeod with one or two men during part of the year. A shipment of two and a quarter tons of ore, taken from the back of the southwest stope at No. 6 shaft, was made to the Timiskaming Testing Laboratory.

Millcrest Mining Company, Limited

Surface work began on October 15, on mining claim No.330 in Haultain township, district of Timiskaming, half a mile east of the Castle-Trethewey mine. The company owns a group of claims comprising Nos. 328-32. The capitalization

of the company is $2,000,000 in shares of $1 par value. Sir Henry Pellatt is president, and C. H. Manaton secretary. The head office is at 420 Bank of Hamilton Building, Toronto. W. H. Fairburn is superintendent, and 8 men were employed.

Camp buildings and smithy were erected. The camp buildings comprise: a cook camp, 16 by 26 feet; and two camps, 14 by 16 feet.

A 70-foot shaft was sunk in the first quarter of 1926 by hand with a force of 16 men, and a mining plant, consisting of a 330 cubic foot air compressor and a 7- by 10-inch cylinder hoist, was installed.

Mining Corporation of Canada, Limited

This company has an issued capital of $8,300,250 in shares of $5 par value. The directors and officers of the company are: J. P. Watson, president; W. R. P. Parker, first vice-president; G. M. Clark, second vice-president; E. H. Rose, J. G. Watson, A. B. Stodart, and C. E. Trafford, directors; M. F. Fairlie, mine manager; G. C. Ames, secretary. The head office is at 1512 Bank of Hamilton Building, Toronto. The company operates mines at Cobalt and South Lorrain, district of Timiskaming, and has holdings outside the province.

The average number of men employed at Cobalt is 190, of whom 55 are employed in the mill of the Cobalt Reduction Company, a subsidiary of the corporation. The working force in South Lorrain was again increased by about 30 men during the year, and averaged 170, including those employed in Lorrain Trout Lake Mines which are partly owned by and under the management of the Mining Corporation.

Under date of November 11, the corporation granted an option on part of its holdings in the Flinflon property and neighbouring properties in Manitoba to Roscoe H. Channing, Jr., representing very strong American financial and mining interests, under terms which are considered advantageous to the corporation. The Flinflon ores are being tested on a large scale by the option-holder. If the option be exercised the corporation will retain a 15 per cent. interest in the company which will be formed to operate the property.

The following is from the resident manager's report for 1925:—

Satisfactory developments during the year at the Cobalt and South Lorrain properties of the corporation resulted in important increases in tonnage and grade of mill ore and in silver content of high-grade ore.

Silver production from all classes of ore was 2,032,105 ounces, as compared with 1,373,158 ounces for the previous year.

The completion of the railroad to South Lorrain permitted regular shipments of mill ore from the Frontier and Crompton properties. A total of 55,050 tons of mill ore and fines from the corporation's mines was treated during the year. In addition, 30,531 tons of mill ore was purchased under contract from Lorrain Trout Lake Mines, Limited, and other local producers—this being sufficient to keep the Cobalt Reduction mill at full capacity during the year.

PRODUCTION IN 1925

	Tons treated	Ounces produced
Cobalt properties	41,468	898,008
South Lorrain properties	15,042	1,134,097
Total	56,510	2,032,105

Of the above production, 297.81 tons of high-grade ore, containing 820,671.17 ounces of silver, were treated in the high-grade plant of the Cobalt Reduction Company. An additional tonnage of low-silver, high-cobalt ore, amounting to 1,162.63 tons containing 47,952.08 ounces of

silver, was shipped direct to the smelter. The balance, including 71.12 tons of fines containing 31,468.71 ounces, was treated in the low-grade plants of the Cobalt Reduction Company.

The cobalt metal content in all classes of ore, except mill ore, for which settlement was made, amounted to 293,324 pounds.

The details of tonnage treated, production, etc., from mill ore are given in the table below:—

Tons of mill ore treated	54,979
Assay value, ounces per ton	24.02
Ounces contained	1,320,853.97
Ounces returned by Reduction Company	1,132,012.99
Percentage returned under contract	85.7

The table below gives the production by years from the mines of the corporation. The aggregate amounted to 40,372,203 fine ounces at December 31, 1925.

PRODUCTION IN FINE OUNCES TO DECEMBER 31, 1925

Period	Cobalt mines	South Lorrain mines	Total
Prior to 1908	118,616		118,616
Year ended Dec. 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
Jan. 1, 1914, to Mar. 31, 1914	866,622		866,622
April 1, 1914, to Dec. 31, 1914	3,185,124		3,185,124
Year ended Dec. 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
Total	37,382,894	2,989,309	40,372,203

Mining Operations

Cobalt.—A total of 41,468 tons with head assay of 25.29 ounces per ton and a silver content of 1,048,697.43 ounces was produced and milled during the year from the Cobalt properties. By far the largest proportion of this ore came from Cobalt Lake where developments were as follows:—

No. 16 vein has been drifted upon for a total length of 325 feet north and south of No. 6 vein. There is the possibility of the further extension of this vein in both directions. The average grade of ore over a six-foot stoping width is more than 30 ounces.

No. 11 vein has been developed for a total length of 165 feet on each of two levels. Both north and south faces are still in commercial ore. The average value shown in stoping is over 30 ounces per ton.

Other development drifts on one level only, include the following veins and footages:—

No. 14.....57 feet to the west from vein 16.
No. 15.....52 feet to the west from vein 16.
No. 21.....33 feet to the west from vein 16.
No. 22.....25 feet to the southeast from vein 6.
No. 23.....65 feet on the 2nd level.
No. 25.....100 feet on 2nd level.

As practically no stoping has been done on these veins and as all drift faces are still in ore, the possibilities for future development are good.

A crosscut from No. 5 winze tapped No. 4 vein on the 4th level, and the vein was developed for 180 feet in length.

During the coming year, No. 4 vein and other veins of the No. 2 vein system will be developed on the 5th level.

On the Townsite, stoping was carried out on No. 6, No. 8, and G veins. On the City of Cobalt and Townsite Extension, stoping continued on Nos. 34, 17, and 31 veins.

South Lorrain.—From the Frontier and Crompton properties, the following shipments of ore were made during the year:—

13,511 tons of mill ore with head assay of 20.14 ounces, and silver content of 272,156.54 ounces.

71.12 tons of fines assaying 442.47 ounces and containing 31,468.71 ounces.

1,162.63 tons of cobalt ore assaying 41.24 ounces and containing 47,952.08 ounces.

297.81 tons of high-grade ore assaying 2,755.69 ounces and containing 820,671.17 ounces.

The total silver content of all classes of ore was 1,172,248.50 ounces.

The unusual tonnage of cobalt ore included above was mined and marketed under a contract favourable to the corporation. Although a large quantity of this material has been developed, it is doubtful if a satisfactory market will be found during the coming year. Should this condition change, production can be resumed immediately.

On the Frontier and Crompton properties, the total footage of drifts, crosscuts, and raises was 8,094 feet during 1925.

Developments for the year on the three producing veins were as follows:—

Watson Vein.—On the 5th level a shoot of high-grade ore, 53 feet long and with widths up to 18 inches, was opened up. On this level a large tonnage of cobalt ore was mined and shipped direct to the smelter. Above the 4th level a short shoot of high-grade ore, 8 to 10 inches in width, was developed by raise. On the 3rd level cobalt ore was stoped. On the 2nd level the high-grade ore shoot developed in the previous year was extended to a total length of 105 feet. Production of both mill-grade and cobalt ore came from this level.

On the 150-foot level a shoot of exceptionally high-grade ore, 50 feet in length and with widths up to 18 inches, was exposed. From this level a raise was put up 50 feet and a sublevel established. On this sublevel a shoot of ore, 77 feet long and averaging 10 to 12 inches in width, of very high-grade ore was developed on the main vein; and on a branch vein, a shoot, 65 feet long and 5 to 15 inches in width, of 3,000-ounce ore was also exposed. No further development work has been done on the latter vein, but on the main vein a raise of 42 feet in height showed high-grade ore practically to the surface.

Wood's Vein.—On the 6th level cobalt ore was mined and shipped. On the 5th level a short shoot of high-grade ore was developed and a large tonnage of cobalt ore was stoped from this level as well as from the 4th and 3rd. Above the 3rd level two stopes of mill-grade ore gave a regular production of this grade of material. On the 75-foot level two shoots of high-grade ore, 25 and 35 feet in length, showed widths of 5 to 12 inches of 2,000-ounce ore.

No. 1 Vein.—Mill-grade ore was stoped on both the 3rd and 2nd levels. A short shoot of high-grade ore, 4 inches wide, of 4,000-ounce ore was exposed in drifting north on the 2nd level. This awaits further development. In addition, some mill-grade ore was put in sight on the 2nd level.

General.—On the 8th level, the crosscut from No. 3 shaft has been advanced a total of 1,100 feet to the west in the direction of Beaver lake. No high-grade was developed in drifting on No. 8 vein, which was exposed in this crosscut and which showed leaf silver in the early work.

Crosscutting is now in progress on the 150-foot level, east from the Watson vein.

In conjunction with the Keeley Silver Mines, the corporation is at present diamond-drilling at the Keeley-Crompton boundary. The object of this work is to establish the exact depth of the lower diabase-Keewatin contact. Upon this information future plans for work at much greater depth may depend.

Operations on Other Claims

On the Little Keeley claim a total of 1,352 feet of drifting, raising, and crosscutting was done during the year from the Frontier workings on the 4th level. In the northeastern part of the property, 224 feet of drifting was completed on No. 2 vein. The only commercial ore developed in the above work is cobalt ore in widths up to 12 inches but with low silver values.

On the Forneri claim a shaft was sunk by hand to 73 feet on a cobalt vein with low silver values. This vein merits further work at a lower horizon.

Peterson Lake Lease.—Work in the Cart Lake section of this property was discontinued in March. The old workings under Peterson lake were then unwatered and a thorough examination was made. Although this area holds fair promise for successful development, it was decided to concentrate work on the South Lorrain properties of the corporation, and the lease was dropped in July.

Cryderman Property.—During the year Russell Cryderman, acting for the corporation, staked 35 claims in Manitoba close to the Ontario boundary and west of the Red Lake area.

Surface trenching has so far disclosed two veins, roughly parallel and with a northwesterly strike. The occurrence is in Keewatin, the main vein being a shear zone in andesite with widths of quartz up to 32 feet. A quartz porphyry dike parallels the vein in the hanging wall. A total

length of 1,500 feet has been proven with native gold showings in many places. Where stripped for 538 feet in length, the main vein shows an average width of 12 feet. In the sinking of a 43-foot shaft by hand, channel samples taken at 5-foot intervals over a width of six feet showed ore averaging well above commercial grade, with much visible gold.

To the northeast and roughly parallel to the main vein is the Discovery vein, 50 to 120 feet away. The small amount of stripping done on this vein shows an average width of seven feet with native gold showings throughout its length and with slightly higher values than the main vein.

A steam plant and compressor are being installed, and a vertical two-compartment shaft will be sunk 250 feet starting in the hanging wall to cut both veins. Development will be carried out on the 125- and 250-foot levels.

By the end of the coming year definite information will be available on this promising property.

Ore Reserves

Cobalt.—In accordance with our previous practice, it is possible this year to estimate the ore reserves in our Cobalt properties. During the year considerable bodies of milling ore were developed on various veins. Of this, there remain at the end of the year approximately 50,000 tons containing not less than 1,250,000 ounces of silver.

South Lorrain.—Following our settled policy, for reasons previously given, no effort has been made to estimate the ore reserves in our South Lorrain properties.

The Cobalt Reduction Company, Limited

Concentrating Plant.—This plant ran 362 days during the year.

Seventy-five stamps ran 609,363 out of a possible 651,600 stamp-hours, or 93.52 per cent. of the possible running time.

The tonnage of mill ore treated in the low-grade plant was 85,581 against 81,508 tons in 1924.

This tonnage was shipped by:—

	Tons
The Cobalt mines of the Mining Corporation of Canada, Limited	41,468
The South Lorrain mines of the Mining Corporation of Canada, Limited	13,582
Lorrain Trout Lake Mines, Limited	12,813
Sundry	17,718
Total	85,581

Comparative details of concentration treatment for 1925 and 1924 follow:—

	1925	1924
Tons treated	85,581	81,508
Average assay	24.71	19.26
Ounces contained	2,115,084.49	1,569,646.11
Tons concentrate produced	1,048.38	699.17
Average assay	1,108.83	1,462.33
Ounces contained	1,162,478.67	1,022,415.84
Percentage of extraction by table concentration	54.96	65.14

Flotation Plant.—All the slime produced by crushing and grinding, and the table-tailing (after regrinding in tube mills) was treated by flotation.

Details of tonnage, extraction, etc., are given below:—

	1925	1924
Tons of slime treated	84,532.56	59,690.50
Average assay	11.27	8.17
Ounces contained	952,605.82	487,845.03
Tons of flotation concentrate produced	1,418.79	672.43
Average assay	542.45	542.33
Ounces contained	769,617.48	364,676.98
Percentage of extraction	80.79	74.75

SUMMARY OF MILLING OPERATIONS

	1925		1924	
	Total	Extraction	Total	Extraction
		per cent		per cent
Tons of ore mill	85,581	.....	81,508	.....
Average assay, 5 ounces per ton	24.71	.....	19.26	.....
Ounces contained	2,115,084.49	.....	1,569,646.11	.....
Table concentrate produced, ounces	1,162,478.67	54.96	1,022,415.84	65.14
Flotation concentrate produced, ounces	769,617.48	80.79	364,676.98	23.23
Total ounces produced	1,932,096.15	91.35	1,387,092.82	88.37

High-Grade Plant.—There were treated in this plant 1,388.83 tons of high-grade ore and concentrate, including 328.38 tons of purchased ore, against 1,106.45 tons in 1924. The refinery produced 2,253,367.15 ounces of refined bullion.

Residues carried over from 1924 and part of the 1925 production, amounting to 834 tons, were shipped during the year.

Owing to conditions which have arisen in the market for the by-products of the high-grade plant, it was found toward the end of the year that it would not, for some time to come, be profitable to continue to operate this plant. It was, therefore, after over nine years of successful operation, closed down at the end of the year. The machinery and equipment will be kept in place and, should conditions change, it will be possible to resume operations on short notice.

The cost of the high-grade plant, $40,241.70, was written off in the two years following completion.

A contract has been arranged under which the products of the mine and mill, heretofore treated in the high-grade plant, will, for the next two years, be shipped to the smelter.

General Costs.—The total cost of operations was $380,207.99, against $314,508.97 in 1924. The higher operating cost is due to the cost of marketing the largely increased tonnage of flotation concentrate produced, and to the cost of treating in the high-grade plant the larger production of table concentrate. The increase in administration and general costs is largely due to municipal taxation on 1924 profits.

The cost of marketing the flotation concentrate produced, including freight, smelter treatment and refining charges, value of smelter deduction, etc., is included under "operation" in the table below and amounted to $82,482.41 in 1925, or 96.4 cents per ton of ore treated, against 53.6 cents in 1924.

TOTAL COST OF OPERATION

	Labour	Material	Other	Total	Per ton
Administration and general	$6,333.72	$994.44	$9,287.87	$16,616.03	$0.194
Operation	81,993.79	117,264.32	151,050.93	350,309.04	4.093
Head office	.....	.....	13,282.92	13,282.92	.155
Total cost of operation	$88,327.51	$118,258.76	$173,621.72	$380,207.99	$4.442

Included in the above is the cost of treating, in the high-grade plant, 328.38 tons of purchased ore.

Earnings.—The gross earnings were made up of customs charges to the Mining Corporation of Canada, Limited, and subsidiaries and treatment charges on purchased ore, etc.

The operating profit was:—

By earnings		$438,113.35
Less total cost		380,207.99
Profit at plant		$57,905.36

There were no capital expenditures during the year.

Net Profit.—The net profit was:—

By profit at plant		$57,905.36
Less federal taxes	$6,648.42	
Written off plant	34,600.80	
		$41,249.22
		$16,656.14

The above amount was paid out in dividends to the Mining Corporation of Canada, Limited.

Frontier and Crompton

The Frontier and Crompton properties were operated during the year 1925 by the Mining Corporation of Canada with an average working force of 135 men. Details of operation and production are given under Mining Corporation.

Lorrain Trout Lake Mines, Limited

This company has a capital of $1,500,000 in shares of $1 par value, one-third of which are owned by the Mining Corporation of Canada. The board and management are the same as for the latter company. The working force was increased during the year from 20 to 45 men.

The following is from the resident engineer's report for 1925:—

Operations.—At No. 1 shaft on claim H. R. 103, work during the year was largely centred on the production of mill ore and high-grade ore. This work retarded new exploration owing to the limited capacity of the inclined shaft.

A well-equipped, vertical, two-compartment shaft, No. 2, was sunk in 1925 to 365 feet on claim H. R. 107, and from this shaft exploration of the company's property can be carried out much more advantageously.

A total of 2,922 feet of drifting, crosscutting, raising, and sinking was completed in the year at both shafts. Of this total, 442 feet was shaft-sinking.

Development.—No. 1 shaft on the Wood's vein was completed to a depth of 475 feet, at which horizon drifting exposed a vein much stronger than on the level above and with consistent cobalt ore showings. Exploration at greater depth is called for but may require to be done eventually from No. 2 shaft.

Stopes were opened for production of ore as follows: on the Wood's vein on the 240-foot level south of the shaft, on the 175-foot level both north and south of the shaft, and on the 100-foot level both north and south of the shaft; on the northeast branch vein, stoping was carried out on both the 175- and 100-foot levels.

Development during the year included an additional length of over 200 feet of mill-grade ore on the 175-foot level. Above this level north of the shaft, a high-grade ore shoot was developed, from which regular shipments were made.

In December a shoot of high-grade ore was developed on a branch vein south of the shaft on the 175-foot level. This shoot is exposed for a length of 30 feet in the drift and shows widths of 3 to 15 inches and average values of 4,000 ounces per ton.

From No. 2 shaft, which was completed in September, drifting has been carried out on two veins on the 350-foot level.

On No. 1 vein, which may be a branch of the Wood's vein, cobalt ore carrying values of 150 ounces over four inches in width has been exposed.

On No. 2 vein, which has a north-south strike, considerable cobalt ore with low silver values gives great promise for future developments at lower depth. A diamond-drill hole put down near the shaft shows the diabase contact to be 450 feet below the 350-foot level at that point. Exploration work to the south will be closer to this contact.

A lower horizon, which will shortly be reached by winze, should prove more favourable for the development of the above-mentioned veins.

Production.—Shipments of mill ore were made by rail to the plant of the Cobalt Reduction Company at the rate of approximately 50 tons per day. The total tonnage of this material for the year was 12,813 tons with an average assay of 22.26 ounces and silver content of 285,173 ounces. The production from this ore was 248,720 ounces.

In addition, 124.97 tons of high-grade ore containing 187,582 ounces was sacked and shipped direct to the smelter.

The total silver production for the year was 436,302 ounces, as compared with 263,912 ounces for the previous year.

Costs.—Included with "mining costs" in the table below is the total cost of sinking No. 2 shaft.

The unit costs are based on a production of 12,938 tons of ore and 436,302 ounces of silver.

	Total cost	Per ton	Per ounce
			cents
Mining costs	$131,898.58	$10.19	30.23
Freight and realization (including sampling, selling, and smelter charges)	33,083.76	2.57	7.58
Milling and reduction	44,845.33	3.46	10.28
Administration and general	11,027.45	.85	2.53
	$220,855.12	$17.07	50.62
Head office	23,089.39	1.78	5.29
Written off plant	989.88	.08	0.23
Reserve for taxes	5,953.90	.46	1.36
Total	$250,888.29	$19.39	57.5

INCOME AND PROFIT

	Total cost	Per ton	Per ounce
			cents
By value of production	$307,021.88	$23.73	70.37
Interest	4,193.40	.32	.96
Gross income	311,215.28	24.05	71.33
To total cost	250,888.29	19.39	57.50
Net profit	$60,326.99	$4.66	13.83

Conclusion.—A large area of hitherto unexplored ground awaits development during the coming year from the new shaft. The limited amount of work so far accomplished has proven the existence of most promising veins. The presence of cobalt ore, in shoots of good length and width and carrying silver values, encourages the belief that high-grade ore will be uncovered at lower horizons.

At No. 1 shaft, development work and production will be continued, and crosscutting into new territory to the east will be started early in the year.

Newton Lorrain Syndicate

This syndicate began operations on their property in South Lorrain, district of Timiskaming, in April. William Newton, of Cobalt, is manager, and Andrew McGarry, superintendent. A dozen men were employed.

A two-compartment shaft was sunk to a depth of 63 feet by hand, and continued to a depth of 180 feet after the installation of a 25 h.p. boiler and a small hoist.

Early in 1926 a transmission line was built to the property, a distance of two and a half miles, and a 720 cubic foot Alley and MacLennan air compressor and a 125 h.p. motor were installed. Sinking operations were resumed May 10.

Nipissing Mining Company, Limited

Nipissing Mines Company, Limited, has a capital of $6,000,000 in shares of $5 par value. The officers of the company are: E. P. Earle, president and treasurer; Alexander Fasken, secretary. The directors are: E. P. Earle, Richard T. Greene, and August Heckscher, New York; Alexander Fasken, David Fasken, and John H. Black, Toronto. The head office of the company is in the Excelsior Life Building, Toronto, and the New York office is at 165 Broadway.

The operating company is the Nipissing Mining Company, Limited, with a capital of $250,000 in shares of $100 par value. The officers are David Fasken,

president; E. P. Earle, vice-president and treasurer; Alexander Fasken, secretary. The directors are: E. P. Earle, Richard T. Greene, David Fasken, and John H. Black. The operating officials are: Hugh Park, general manager; E. V. Neelands, manager; J. M. Carter, mill manager; Cyril W. Knight, geologist. The property is in Coleman township, district of Timiskaming.

The company's production of silver up to the end of 1925 has reached a total of 74,170,451 ounces of a net value of $48,655,115. A total of $27,600,000 has been paid in dividends since 1906. This is equivalent to 460 per cent., or $23 per share. The operating company's surplus stands at $4,405,000.

The following summary is taken from the general manager's report:—

LOW-GRADE MILL

	Tons	Assay, ounces	Ounces contained
Ore treated	91,044	25.78	2,347,531
Recovered in products:			
Precipitate	33	23,946	781,492
Coarse concentrate	536	2,553	1,368,138
Fine concentrate	133	737	98,002
Total recovery	.....	.....	2,247,632

Average tailing 1.09 ounces; recovery 95.74 per cent.

Forty stamps ran 329 days, 14 hours, or 90.30 per cent. of possible running time. They crushed 276.22 tons per day, or 6.90 tons per stamp per day.

The cost per ton was the lowest yet obtained, being $2.781, or 68 cents less than in 1924.

SUMMARY OF UNDERGROUND WORK, 1925

Shaft	Drifting	Crosscutting	Raising	Sinking	Total	Stoping
No.	feet	feet	feet	feet	feet	cu. yds.
19	.....	.....	.....	.....	.....	358
26	238	178	60	.....	476	679
49	.....	.....	62	.....	62	601
63	1,321	411	120	.....	1,852	15,294
73	1,197	3,894	361	.....	5,452	7,795
177	149	661	.....	291	1,101	.....
405	.....	1,522	.....	.....	1,522	.....
407	346	1,812	30	300	2,488	.....
Total	3,251	8,478	633	591	12,953	24,727

Diamond-drilling, 1,784 feet.

Development

Underground work was carried on at eight shafts in various parts of the property. The total advance was 3,000 feet more than in 1924. The tons stoped also showed an increase due to larger tonnage milled. Exploration and development faces numbered 201; the stopes 22.

A number of veins were found, but there were no discoveries of any considerable importance. Attention is being paid to some of the older shafts which produced large quantities of silver years ago but which have been idle for some time. There are possibilities of extending old stopes, and in some cases the adjacent areas warrant closer exploration for other veins or branches.

Shaft No. 19.—Summer operations in open cuts on veins Nos. 6 and 130 produced a small tonnage of mill rock of fair grade.

Shaft No. 26.—Exploration of an area of the lower diabase contact discovered a number of veins containing high-grade ore over widths of from one to five inches. The ore shoots, however, were comparatively short and the values erratic. As the possibilities of the immediate area had been reasonably prospected without profitable results, the shaft was closed during the early part of the year.

Shaft No. 49.—The main vein at this shaft was a large and spectacular producer during the first few years of the company's operations. It was reopened during the latter part of 1925. Production from present operations is being obtained from extensions of the old stopes. Occasional amounts of high-grade ore are found, the total tons of all ore hoisted being better than average grade. There are other old producers in the immediate vicinity of this shaft, and their further development will be undertaken as soon as some necessary connections have been completed.

Shaft No. 63.—Most of the tons treated during the year were obtained from a number of veins being worked through this shaft. It is now the main source of present production. Exploration discovered several veins of fair importance; development and stoping operations on some of the older veins exceeded expectations. A large part of the tonnage hoisted was obtained from vein No. 86, where stoping was commenced during the year. The ore is mainly mill-rock grade.

Shaft No. 64.—A small production was mined from a few branch veins. There is now no reserve at this shaft except some blocks of cobalt ore of low silver content.

Shaft No. 73.—The older veins were completely stoped during the year and future production now rests on a number of small veins of no great importance. Operations at the Fourth of July shaft consisted largely in removing pillars and bottoms. There is still some work of this nature to be done. Exploration found four new veins which produced a fair amount of both high and low grade ore. One of them was found late in the year and will probably contribute a large part of the tonnage to be hoisted at shaft No. 73 during 1926.

Shaft No. 177.—Development of a group of claims at South Lorrain was started in July. Initial work progressed at two levels in a 300-foot shaft and consisted largely of exploration in the search for veins. A number were found, but the limited amount of development done during the year disclosed no ore of profitable grade. Most of the work consisted of exploration in Keewatin, below the lower diabase contact.

Shaft No. 405.—Exploration of a lower diabase contact area in R.L. 405, adjacent to a similar area developed by shaft No. 26, was carried on by means of a crosscut driven from the 960-foot level of a shaft owned by a neighbouring company. A few calcite veins of fair width were found, but no development was done on them. Due to the closing down of the shaft by its owners, with consequent stoppage of the crosscut, the possibilities of R.L. 405 may be considered as only partly determined.

Shaft No. 407.—The shaft required for the exploration of a diabase conglomerate area in R.L. 407 was completed in April. A level, in the conglomerate just above the Keewatin, was established at 310 feet. Exploration found six veins, the largest being one and a half inches wide, assaying 1,200 ounces over a length of 60 feet. Further work is continuing and something better is hoped for.

Summary of Results

Production of silver for the year was 2,212,000 ounces, about 800,000 ounces less than in 1924. Due to the decrease in ounces produced and to the increase in amount of underground work, the cost per ounce was 46 cents, up 9 cents from the previous year. The cost per ton of ore was $11.14, a decrease of $1.88.

Shipments of Nipissing silver contained 2,414,000 fine ounces. The average New York official price for the year was 69.07 cents per ounce, an increase of 2.29 cents over 1924. Quotations were fairly steady, the high and low daily variation being 6⅜ cents for the entire year.

Notwithstanding a general increase in the amount of underground work, no substantial discoveries of new veins were made during the year. However, the possibilities of the lower diabase contact have only been partly determined. Results obtained to date from recent exploration of this horizon, of which there are several hundred acres, can be considered as interesting but not thus far important from the viewpoint of steady and profitable production. Closer exploration of the sediments resulted in the discovery of a number of veins of minor importance.

Known ore reserves at the end of the year were 34,028 tons, containing 1,006,344 ounces, of which 60 per cent. was unbroken. The tons show no material decrease from the previous year; the ounces are 500,000 less. In the absence of important new discoveries during 1926, a similar comparison a year hence is improbable.

Results from first exploration at the South Lorrain claims have been encouraging, but sufficient work has not been done to form a definite opinion of the value of the property. A number of veins have been found which show from one to ten inches of cobalt and other minerals usually associated with silver. Occasional visible silver has been noted, but nothing of any commercial value has been found by the limited amount of work done to date. Active development of the veins found so far has been delayed until crosscutting the area in the immediate vicinity of the shaft has reached certain limits.

Many properties were examined during the year. An option was taken on a group of claims in Montbray township, Quebec, which has a number of outcrops showing encouraging values in copper and gold. Some surface work was done towards the end of the year, preparatory to development by diamond-drilling.

The company had several prospecting parties in the field and staked a large number of claims n various promising districts.

Northern Extension Cobalt Mines, Limited

Installation of machinery was begun at the end of August, on the Agaunico property, in the township of Bucke, district of Timiskaming. The mine was pumped out in September, and development work was carried on on the 100- and 200-foot levels during the last quarter of the year with a force of 17 men under T. R. Buchanan.

The company has a capital of $2,000,000 in shares of $1 par value. D. L. Jemmett, of Cobalt, is president.

A camp building, 30 by 36 feet, and an office building, 26 by 26 feet, were rebuilt. A hoist-house, 20 by 16 feet, and a transformer house, 12 by 14 feet, were erected. A 375 cubic foot Sullivan air compressor and an Ottumwa hoist, both electrically driven, were installed.

Development work during the last quarter totalled 632 feet and comprised 532 feet of drifting, 48 feet of crosscuts, and 55 feet of raises.

M. J. O'Brien, Limited

Miller Lake O'Brien

The Miller Lake O'Brien mine, township of Nicol, district of Timiskaming, is owned and operated by M. J. O'Brien, Limited. J. G. Dickenson, Cobalt, is general manager, and H. G. Kennedy, is resident superintendent. On an average, 68 men were employed during the year.

Development work during the year totalled 2,147 feet of drifting and crosscutting, mainly on the 525- and 645-foot levels. Sinking amounted to nine feet. Tonnage stoped amounted to 9,922 and tonnage milled to 9,937 tons during the year.

Early in the new year the mill was shut down for alteration and enlargement. It is planned to change it over from a stamp to a ball mill.

O'Brien

The O'Brien mine, township of Coleman, district of Timiskaming, which is owned and operated by M. J. O'Brien, Limited, carried on operations during the year with a working force of 163 men, exclusive of 15 employed in Quebec on outside exploration. J. G. Dickenson is general manager, and A. D. Campbell, manager.

Underground development comprised 1,439 feet of drifting and crosscutting, and 237 feet of sinking and raising. Stoping amounted to 57,069 tons, of which 56,006 tons were milled, yielding a silver production of 730,689 shipping ounces.

Ontario Solid Silver Mines, Limited

The property in Cane township, was operated from April 14 to July 8, 1925, six men being employed by a contractor. On the 75-foot level, 166 feet of drift was driven in a westerly direction. James A. McRae is manager.

Carl Reinhardt

The Crown Reserve mine, in Coleman township, district of Timiskaming, was operated under lease during 1925 by Carl Reinhardt with an average force of seven men.

At the beginning of the year, stoping of mill rock was in progress on the 50-foot level in vein No. 13, which parallels the Carson vein to the south. Exploratory drifting and raising was also being done at the 50- and 100-foot levels at the west end of the Victoria vein, and continued without finding ore during February and March.

An air lift was installed in March in the winze on the Carson vein between the 300- and 500-foot levels to reduce pumping costs, and in June a new 6-inch pipe line on trestles was put in place on the surface to carry the mine water direct to the lake outlet.

In April a raise put up from the 200-foot level on No. 12B vein, which lies about the centre of the property, struck high-grade ore and mill rock, and in July another raise from the 150-foot level on vein No. 44, near the Kerr Lake boundary, also struck high-grade and mill ore. From September to November stoping was done at the east end of vein No. 13 above the 50-foot level, and in December a crosscut was driven on the 200-foot level for about 60 feet northwest from the Gear vein.

A total of 1,324 tons of ore, with a silver content of 43,632 ounces, was shipped during the year to the plant of the Cobalt Reduction Company.

John W. Shaw

The Hudson Bay mines was operated under lease by John W. Shaw during the last half of 1925 and the first seven months of 1926. The partners in the lease are: Joseph Gaynor, Alfred Lash, and John McDonald. Two shipments of high-grade ore were made in 1925 and three shipments in 1926, one of the latter, made in May, being from the Trethewey property, in Coleman township, district of Timiskaming. The shipments were as follows: 9,000 pounds, running over 2,000 ounces; and 4,200 pounds of 4,000-ounce ore in 1925; 9,000 pounds of 2,300-ounce ore on January 15, 1926; 4,200 pounds of 3,000-ounce ore in May; and the final shipment of 9,500 pounds of high-grade silver ore in July, 1926.

Silver Bullion Mines, Limited

Operations were resumed on the property at Leroy lake in Nicol township, district of Timiskaming, on July 18, after a six months' shut-down, and continued until the end of November with a force of 12 men under John Hughes as contractor. Horace F. Strong, of Haileybury, is consulting engineer. The head office of the company is at 804 Royal Bank Building, Toronto.

The work done during the period consisted of: 100 feet of shaft-sinking, the shaft being continued from 200 to 300 feet; 20 feet of drifting at the 40-foot level; 517 feet of drifting on the 200-foot level, and 70 feet on the 275-foot level.

Silver Sill Mining Company, Limited

This company operated their property in Auld township, district of Timiskaming, seven miles from Kenabeek, during the first four months of the year, when 285 feet of drifts and crosscuts were driven on the 250-foot level.

Horace F. Strong, of Haileybury, was consulting engineer, and Harold Binch, contractor. Ten men were employed.

Tonopah Canadian Mines Company

Mining operations were continued throughout the year on the Walsh property and during the last half of the year on the Morrison property, which Tonopah Canadian Mines hold under option, with a working force which was

increased from 30 to 60 men. The company is a subsidiary of the Tonopah Canadian Mines Company. The officials are: Charles R. Miller, president; W. L. Haehnlen, vice-president; J. H. Whiteman, chairman of the board; P. S. Bickmore, secretary-treasurer. The head office of the company is at 572 Bullitt Building, Philadelphia. Ernest Craig is manager. The properties are in Nicol township, district of Timiskaming.

The following buildings were erected on the Walsh property: power-house, 43 by 33 feet; boiler-house, 37 by 36 feet; two-storey bunk-house, 26 by 60 feet; office and store the same size; cook-house, 26 by 60 feet; residence, 24 by 26 feet; and the old cook camp remodelled into a manager's residence; smithy, 28 by 18 feet; ore-house, 16 by 30 feet; 52-foot headframe; shaft-house, 24 by 75 feet. This, together with the installation of a 740 cubic foot Ingersoll-Rand air compressor and a 10- by 12-inch hoist, represents an expenditure of $47,000.

At the Morrison property, the Canadian Gowganda camps were remodelled and a power-house and a 28-foot headframe erected. This, together with the installation of a portable air compressor, a gasoline engine, and a small hoist, represents an expenditure for equipment of $9,000. A shaft was sent to a depth of 268 feet, and 1,063 feet of driving was done on the 250-foot level.

Development work on the Walsh for a 14-month period to the end of 1925 represents a total of 4,078 feet as follows: drifts, 2,874 feet, crosscuts 780 feet, raises 126 feet, winzes 84 feet, shaft-sinking 214 feet. The shaft has been continued to a depth of 400 feet, and levels have been established at 330 and 400 feet. The work has resulted in finding about 400 feet of ore-bearing veins on these levels.

Trainmen Silver Mining Company, Limited

Surface work was begun on the McAndrew claims Nos. 1,355 and 1,227 in Gillies limit, district of Timiskaming, on June 11 with a force of six men, and the sinking of a shaft was commenced on July 14. This shaft had reached a depth of 78 feet when the property closed down on October 9.

The company has a capital of $500,000 in $1 shares. The head office is at Cobalt, Ont. John J. McAndrew is president; Edward Burns, vice-president; Richard H. Kingsdorf, John Sainio, James A. Gillis, directors.

Victory Silver Mines, Limited

This company operated their property in southeast Coleman township, district of Timiskaming, during most of 1925 with a force of six men. W. D. Taylor is superintendent. The officials of the company are: A. Patterson, president; A. K. Masterson, vice-president; F. E. Hetherington, secretary-treasurer. The office of the company is at 75 St. Paul Street, St. Catharines, Ont.

The shaft was pumped out in January, and 158 feet of diamond-drilling was done in June. Shaft-sinking began in September at a depth of 392 feet and had reached a depth of 485 feet by the end of January, 1926. Work has been done in past years on levels at 40, 100, 185, 300, and 392 feet. A bottom level has been established at 477 feet.

Wigwam Silver Mines, Limited

The property in Haultain township, district of Timiskaming, was operated during the first half of the year with a working force of from 12 to 22 men. John W. Sanderson is manager and Horace F. Strong, consulting engineer.

The work comprised 65 feet of crosscuts and 250 feet of drifting on the 100-foot or adit level, and 135 feet of drifting on the 290-foot level. The shaft was deepened from 260 to 300 feet.

SOAPSTONE

Grace Mining Company, Limited

During 1925 three cars of sawn soapstone blocks, for Kraft paper mill linings, were shipped by the Grace Mining Company from their quarry on Eagle lake in Kenora district.

The equipment at the quarry now consists of two boilers, Ingersoll-Rand compressor, Sullivan channeler, Ingersoll-Rand hoist, three Pollard gang saws, derrick, barge, and tug boat.

The buildings on the property are: bunk-house, 18 by 30 feet; cook-house, 18 by 30 feet; office, 18 by 30 feet; manager's house, 18 by 20 feet; and mill building, 48 by 60 feet.

W. J. Richards, Kenora, is manager.

The capitalization and personnel of the directorate remain as reported in the 34th Annual Report of the Department of Mines.

H. H. Wood

No work was done during 1925 by H. H. Wood on his soapstone deposit on Turtle lake near Mine Centre, in the Rainy River district.

When the property was visited on May 26, 1926, work preparatory to making a 30-ton shipment to the Lava Corporation of America, Chattanooga, Tenn., was under way, but was halted owing to the drowning of Mr. Wood, who was in charge of the work, employing three men.

TALC

Asbestos Pulp Company, Limited

The mine and mill of the Asbestos Pulp Company, near Madoc, in Hastings county, were operated throughout the year.

The shaft was completed to the 5th level, at a depth of 325 feet. The ore was taken from the stopes on the 4th level.

During the year, 3,952 tons were mined and milled, an average working force of 20 men being employed.

Henry Taylor, Belleville, Ont., is president; and Roy Taylor, Madoc, Ont., is manager.

Geo. H. Gillespie Company, Limited

The Henderson mine and the talc mill near Madoc, in Hastings county, were operated continuously during 1925.

The ore was mined from stopes east and west of the new shaft on the 310-foot level. The new stope on the west side of the shaft has a width of from 30 to 35 feet.

A total of about 600 feet of drifting and crosscutting was done during the year on the lower level. The drift was extended about 300 feet west and 200 feet east.

During the year 10,143 tons of ore were mined and treated in the mill. On an average, 17 men were employed in the mill and 9 at the mine. Geo. H. Gillespie is president, and M. H. Ludwig is secretary-treasurer.

METALLURGICAL WORKS

Algoma Steel Corporation

In 1925, the blast furnaces of the Algoma Steel Corporation at Sault Ste. Marie, were on blast as follows: No. 1 furnace, operating all year; No. 2 furnace, from February 20 to June 9, and from September 28 to November 16.

The total production was 183,624 tons of p'g iron.

Jas. H. Bell is the blast furnace superintendent, and Jas. Dale is assistant superintendent.

Deloro Smelting and Refining Company, Limited

During the year 1925 the silver plant was operated at normal capacity but with a restricted production of arsenic, on account of the continued bad market conditions governing that product.

The cobalt oxide plant operated continuously throughout the year at normal full capacity with improved metallurgical efficiency as a result of the additional equipment installed during the previous year. With the entry of the Belgian Congo product into the market, the output of Ontario cobalt has had to be curtailed, but it is hoped to develop an increased demand for this metal among the manufacturers of alloy steels. The production of cobalt salts was increased during the year, and investigations along this line are being continued.

The metals department was operated at normal capacity in producing cobalt metal and stellite.

The insecticide plant was operated for a limited period only, due to market conditions. The company is now concentrating on the production of calcium arsenate, this being the cheapest and most efficient arsenical insecticide.

The average number of men employed during the year, including staff, was 350. The head office and works are at Deloro, in Hastings county.

The officials 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, general manager; R. A. Elliott, superintendent.

International Nickel Company of Canada, Limited

The refinery at Port Colborne was operated continuously throughout the year, as noted on page 136.

Steel Company of Canada, Limited

This company, located at Hamilton, operated "B" furnace during the whole year and "A" furnace during the last three months, and produced 191,314 tons of basic, malleable, and foundry pig iron.

The ores were all obtained from the Lake Superior region. Production, by furnaces, was: "A" furnace, 26,025 tons; "B" furnace, 165,289 tons.

The company employed 85 men during the first nine months and 145 men for the remainder of the year.

The officers of the company were: president, R. H. McMaster; vice-president and works manager, R. G. Wells; vice-president and treasurer, H. H. Champ; secretary, H. S. Alexander; and superintendent of blast furnace, H. G. Hilton.

INDEX, PART I

PAGE

A

Abitibi r., waterpower. *See* Island falls.
Abitibi Development Synd. 59
Abitibi Mines, Ltd. 8
Abitibi Power and Paper Co. 9
Abrasives. *See* Corundum; garnet; quartz pebbles.
Accidents, mining. 67-72
Acme g. m. 14, 15
Aconda Mines, Ltd. 59
Actinolite statistics. 2, 3, 31
Actinolite Mining Co. 31
Adair, W. J. 148
Adams, G. W. 145
Adanac s. m. 141
Addoms, Hallett. 104
Adelaide tp., gravel pit. 49
Aeroplanes for Red L. prospecting. 6
Agaunico s. m. 23, 164
Agaunico Cobalt Mines, Ltd. 59
Agnew, J. L. 136
Aitken, J. M. 89, 145
Aitken and Co., J. M. 145
Alabastine Co. of Paris. 48
Aladdin s. m. 23
Aladdin Cobalt Co. 21
Alberta Tar Sand Products, Ltd. 59
Aldershot. 44
Alderson, W. H. 141
Alexander, Adam. 49
Alexander, H. S. 168
Alfred, peat bog. 36
Algoma dist., mg. revenue. 55
Algoma Exploration Co. 59
Algoma Power Co. 96
Algoma Steel Corp'n.
  Blast furnaces. 28, 29, 168
  Coking plant. 29
  Silica brick producers. 39, 40
Allan Bros., sand and gravel. 49
Alvinston Brick and Tile Co. 45
Amabel tp., limestone. 54
American Cyanamid Co. 48
Ames, G. C. 155
Amherstburg. 41, 48
Ammonium sulphate, production. 29
Analyses.
  Gas from Sudbury nickel mines. 45
Anderdon tp. 48, 54
Anderson, Gus. 104
Anderson, J. G. 32, 40
Anglo-Canadian Mg. and Rfg. Co. 137
Angus, D. H. 102
Ankerite gold m.
  Flow sheet; report. 84-87
  Mill being constructed. 8
Ankerite Gold Mines, Ltd. 84, 85
Anthraxolite. 82
Archambault, Wilfred. 87
Argonaut g. m. 7, 87
Argonaut Consolidated Mines, Ltd. 7
Argonaut Gold, Ltd. 7, 35
Armstrong Supply Co. 49
Arnprior. 30, 45

PAGE

Arsenic statistics. 2, 3, 18
Asbestos statistics. 2, 3, 31
Asbestos Pulp Co. 77, 167
Ashley, James L. 136
Ashton, Thomas. 49
Assay office, report. 61, 62
Atikokan Iron Co. 29
Atkinson, S. 71, 72
Auld tp. *See* Silver Sill m.
Austin, Louis. 35
Australia. 10
Automobile industry. *See* Motor industry.
Axford, J. B. 49

B

Babst, Frank L. 94
Bache, Jules S. 97
Bain, James W. 128, 149
Baker, Geo. E. 45
Baker, Richard L. 94
Balfour tp., anthraxolite. 82
Ball clay. 44
Bandoe, Richard. 147
Bapty, F. A. 168
Barber, S. W. 75, 146
Barite statistics; uses. 1-3, 31
Barney, W. G. 90
Barnhardt, W. H. 45
Barrett, F. L. 82
Barrie tp.
  Gold. *See* Ore Chimney g. m.
Barry-Hollinger g. m. 7, 8, 88
Barton tp., lime and limestone. 48, 54
Bartonville Pressed Brick Co. 45
Batchelor, Samuel. 45
Bathurst tp.,
  Feldspar. 32, 83
  Quartz. 40
Beachville, lime and limestone. 48, 54
Beachville White Lime Co. 48, 54
Beatty tp.
  Gold. *See* Blue Quartz g. m.
Beaumont, Geo. F. 89, 145
Beaver Auxiliary Mines, Ltd. 141
Beaver Consolidated Mines, Ltd. 21
Beaverton. 46
Bedford tp.
  feldspar. 32
  mica. 35
Beese, Quincy W. 153
Beilby, C. J. 104
Beilby, J. W. 104
Belgian Congo, cobalt. 168
Bell, J. Mackintosh. 95, 96, 128, 142, 149
Bell, James H. 77, 168
Bell, Wilson. 104
Bellellen Lorrain Mines, Ltd. 59
Belleville, cement. 47
Bellew, H. C. 31
Bellyou, N. E. 49
Belmont, brick and tile. *See* McCredie, Wilson.

PAGE

Belmont tp., trap quarry 53
Bennet, J. 88
Bennett, H. V. 35
Bennett, W. F. 88
Bennett Mg. Co. 88
Benson and Patterson 49
Benzine statistics 37
Bertie tp., limestone 54
Bianchi, Chas. J. 90
Bickel, E. Edward 103
Bickel, J. P. 113, 114, 142
Bickmore, P. S. 166
Biederman, Albert G. 48
Billedeau, Godfrey 71
Binch, Harold 165
Bishop, A. L. 91
Black, J. Homer 152
Black, John H. 128, 149
Black Donald graphite m. 33, 133
Blake, E. H. 96
Blartner Mines, Ltd. 59
Blast furnaces 28, 29
Blenheim 45
Blue Quartz g. m. 8, 88
Bluevale, brick and tile. *See* Elliott, Chas.
Boischatel tp., prospecting 146
Bolender Bros. 54
Bonanza United Mines, Ltd. 59
Bonuses. *See* Dividends.
Booth, G. E. H. 76, 151
Booth Brick and Lumber Co. 45
Boring permits, revenue 55
Borthwick, W. 35
Bosquet g. m. 89
Boston Creek. *See* Barry Hollinger g. m.
Both, S. G. 121
Bothwell oil field 36
Bourgie, J. B. 54
Bowmanville 45
Brampton Pressed Brick Co. 45
Braniff, Harry 124
Brantford, brick and tile 45
gravel and sand 49
Brent, Charles 90
Brewer, Sullivan and Richardson 75, 141
Brick, operators and statistics 2, 3, 43-46
Brigham, A. F. 104
British Allied Estates, Ltd. 60
British America Mines Operating Co. 59
British American Nickel Co. 24, 25
British American Oil Refineries, Ltd. 37
British Canadian Mines, Ltd. 8, 89
British Colonial Coal Mines of Canada, Ltd. 59, 82
British Sulphides Smelting Co. 60
Broadwell and Son, B. 45
Brockville, limestone 54
Brodeur, A. 87
Brougham tp., graphite. *See* Black Donald gr. m.
Brown, A. C. 53
Brown, J. 138
Brown, R. R. 76, 151
Brown, Samuel 49
Brown and Fahey 35
Brownsville, tile 45
Bruce, Dr. E. L. 6
Bruce county, operators, gravel and sand pits 49

PAGE

Brule and Sons, E. D. 54
Brunner Mond, Canada, Ltd. 41, 48, 54
Brunton (magistrate) 71
Bryce, Robert 152
Buchanan, T. R. 76, 164
Buck, Geo. S. 90
Bucke tp. *See* Genesee s. m.
Green-Meehan s. m.
Buffalo, U.S.
Gas brought from, for Ont. 17
Buffalo s. m. 20
Buffalo Mines, Ltd. 21
Building permits, value (1920-25) 42
Bunting, R. F. 133
Burgess, A. L. 96
Burgess N. tp., barite 31
graphite 33
mica 35
Burns, Edward 166
Burrows, John 49
Burt, A. 126
Butler, granite 53
Byrne, J. J. 121

C

Cabana, Oliver, Jr. 131
Cables, nickel for 5
Cabrera & Co., Ltd., Chas. T. 59
Cadwell Dredging Co. 51
Calcite Lake s. m. 147
Caledonia.
Gypsum. *See* Ontario Gypsum Co.
Caledon Brick Co. 52
Caledon Mountain Shale Products, Ltd. 45
Caledonia tp. 35
Caledonia Springs Co. 35
California, gold production 10
Calvin, C. C. 97, 148
Calvin tp., feldspar 83
Cameron, Chas. M. 49
Cameron, J. A. 151
Cameron, W. M. 48
Cameron Gold Syndicate, Ltd. 59
Campbell, A. D. 164
Campbell, C. A. 56, 65
Campbell, J. H. 71
Campbell, Neil F. 45
Campbell and Lattimore 53
Camsell, Chas. 64
Canada.
Business improvement 5
Gold production 10
Canada Cement Co. 47
Canada Crushed Stone Co. 54
Canada Lime Co. 48
Canada Mines Synd. 90
Canada Night Hawk Mines, Ltd. 31
Canada Sand-Lime Pressed Brick Co. 52
Canada Gold, Ltd. 8
Canadian Associated Goldfields, Ltd. 89, 90
Canadian Copper Co. 27
Canadian Dredging Co. 51
Canadian Fireclay Products, Ltd. 45
Canadian Furnace Co. 29
Canadian Lorrain s. m. 23, 162, 142
Canadian Oil Refineries, Ltd. 37
Canadian Pressed Brick Co. 45
Canadian Salt Co. 41
Canadian Steel Corp'n. 29
Canadian Tiles, Ltd. 59

PAGE
Candler, statistics....37-39
Capitol s. m....23, 142
Caradoc tp., sand and gravel.... 49
Carfrae, A. J. J.... 82
Carleton co.
Operating limestone quarry.... 54
Carleton Place.
Brick plant.... 45
Lead near.... 30
Lime kilns.... 48
Carmichael, A. D.... 140
Carnegie, F. A. S....76, 148
Carpenter, N.... 88
Carroll, Sylvester.... 71
Carroll Bros.... 49
Carter, J. M.... 162
Cartwright, R. A.... 148
Case, W. G.... 134
Casey tp., silver.... 19
Casey Cobalt Silver Mg. Co.... 21
Castle-Trethewey s. m....17, 20, 143, 144
Castle-Trethewey Mines, Ltd....21, 58, 142
Cement, Portland, statistics....23, 47
Ceylon, graphite.... 33
Chalmers Lime Works.... 48
Champ, H. H.... 168
Champion g. m.... 89
Champion Gold Mines, Ltd.... 90
Channing, Roscoe H., Jr.... 155
Chapleau, prospecting classes.... 65
Chapman, John....45, 46
Chatham....45, 46, 48
Chatham Sand and Gravel Co.... 51
Chatham, Wallaceburg and Lake Erie R'y.... 49
Checkley, H. R....32, 83
Cheeseman, Peter.... 45
Chelmsford, lead and zinc near.... 30
China clay.... 44
Christie, Henderson & Co.... 48
Circurca, Nick.... 49
City of Cobalt s. m.... 157
City of Cobalt Mg. Co.... 21
Clark, G. M.... 155
Classes for prospectors....64, 65
Clay products, statistics....2-4, 43-46
Clement, Frank.... 147
Clement, H. E....74, 122
Clifford Gold Mines, Ltd.... 8
Clifton g. m.... 12
Clifton Consolidated Mines, Ltd.... 125
Cline, J. W. *See* next ref.
Clines Canadian Gold Mines, Ltd....90, 91
Cloutier and Grenon.... 54
Clydach, Wales.... 26
Coal. *See* Anthraxolite.
Coatsworth, brick and tile.... 45
Cobalt (mineral).
Belgian Congo.... 168
Industry and statistics....2-5, 16-24
Cobalt, Ont.... 5
Cobalt silver area.... 19
Cobalt Argyros Mines, Ltd.... 59
Cobalt Central Mines Co.... 21
Cobalt Comet Mines, Ltd.... 21
Cobalt Contact s. m.... 71
Operations....16, 145
Producing.... 20
Cobalt Contact Mines, Ltd....59, 145
Cobalt Lake s. m....20, 156
PAGE
Cobalt Lake Mg. Co.... 22
Cobalt Reduction Co.
Operating....23, 24
Report....158, 159
Cobalt Silver Queen, Ltd.... 21
Cobalt Townsite Mining Co.... 22
Coboconk, brick.... 48
Cobourg, brick.... 46
Cochrane, prospecting classes.... 65
Cochrane dist., mg. revenue.... 55
Cockshutt, Hon. Henry.... [i]
Cody tp., gold.... 7
Coehill.... 53
Coking industry.... 29
Cole, A. A.... 63
Cole, Geo. E.
See Accidents, Mines of Ontario.
Coleman, Walter.... 121
Coleman, brick.... 45
Coleman tp. *See* Cobalt s. area.
Coleman mg. div., revenue....56, 57
Coleroy Gowganda s. m....23, 145
College du Sacré Coeur.... 49
Colonial s. m....20, 146
Comber, brick and tile.... 45
Company incorporations....58-60
Conderman, Bert C.... 119
Conestogo, brick and tile.... 46
Congo, Belgian. *See* Belgian Congo.
Coniagas s. m....20, 146
Coniagas Mines, Ltd.
Dividends (to 1924).... 21
Maidens-McDonald claims sold by.... 120
Newray m. optioned to.... 91
Prospects, western Que.... 146
Coniagas Reduction Co....23, 24
Coniaurum g. m....8, 91
Coniaurum Mines, Ltd....91-94
Coniston smelter.... 138
Conlin and Johnson.... 49
Considine-Reid, Ltd.... 51
Consolidated West Dome g. m....94, 95
Contact vein, Blue Quartz g. m.... 88
Contact Bay Mines, Ltd.... 8
Cook and Son, J. S.... 54
Cooksville Shale Brick Co.... 45
Cooper, Alfred.... 65
Cooper, James.... 96
Cooper, W. H.... 45
Cooper g. m....95, 96
Copper, mining reports....136-141
statistics....2-5, 18, 26
Copper Cliff smelter.... 138
Cordingley, J.... 65
Corey, William E.... 136
Corley, Ernest.... 49
Cornwall, England, clays.... 44
Correspondence, departmental.... 63
Counsell, J. L.... 151
Courtright, salt.... 41
Cowan, W. S.... 72
Cowles, A. W.... 151
Craig, Ernest....76, 166
Craig, T. H.... 32, 82
Crang, Jethro.... 45
Crawford, J. E.... 65
Crawford Bros.... 45
Crediton, brick and tile.... 45

PAGE

Creighton nickel m.
Gas, analysis ... 141
Production ... 24
Report ... 137, 138
Crerar, feldspar ... 84
Crescent Silver Cobalt Mg. Co. ... 146
Crompton s. m. ... 157, 160
Cromwell, William N. ... 136
Crookston, limestone ... 54
Cross Lake fault ... 146
Crosthwaite, F. ... 49
Crowe, H. C. ... 88
Crowe, J. H. W. ... 88
Crown Reserve g. m. ... 96
Crown Reserve s. m. ... 20, 97, 164, 165
Crown Reserve Mg. Co.
See also Crown Reserve g. m.
Crown Reserve s. m.
Dividends ... 21
Employees, number of ... 8
Prospecting in Gillies limit ... 97
Cryderman, Russell ... 157
Cryderman g. claims, Man. ... 157, 158
Crystal-Comstock Gold Mines, Ltd. ... 59
Crystallite Stone Products ... 82
Cudmore, Alice.
Sand pit. *See* Usborne tp.
Cudmore, J. Walter ... 49
Culhane, John ... 71
Culver, F. L. ... 111, 141
Curran, J. W. ... 65
Curtin, Frank ... 45
Curtis Bros. ... 45

D

Dale, James ... 168
Daly, C. N. ... 133
Davidson g. m. ... 12
Davis and Son, John ... 44
Dawn oil field ... 36
Day, J. E. ... 91
De Laplante, J. E. and Co. ... 45
Deller, Albert E. ... 45
Deller, Wm. H. ... 45
Deller Bros. ... 45
Deloro ... 19, 24
Deloro tp.
Asbestos. *See* McKay l.
Gold. *See* Ankerite g. m.
Deloro Smelting and Refining Co. ... 168
Deneault, L. ... 35
Denfield, brick and tile ... 46
Dening, R. S. ... 96, 128, 149
Denison, Charles L. ... 125
Dennison, Alex. ... 88
Dennison, J. A. ... 111
De Pencier, H. P. ... 74, 97, 99
Dereham tp., gravel pit ... 50
Deroche tp., quartz quarry ... 39, 40
Deschênes smelter ... 25
Deseronto blast furnace ... 29
Dickenson, J. G. ... 76, 164
Dill tp., feldspar ... 32, 82, 83
Dingman, E. ... 50
Dividends.
Gold and silver mines ... 14-16, 21, 22
Dobbins, W. J. ... 75, 142
Dodds, Thos. ... 50
Doelle, H. E. ... 85
Doherty, Manning ... 152

PAGE

Doherty-Easson Mg. Synd. ... 20, 147
Dolan, John ... 45
Dolly Varden, lime ... 48
Dome g. m., production ... 7, 12
report ... 97-102
Dome Extension g. m., production ... 99
Domes Mines Co. ... 14, 15, 98
Dome Mines, Ltd.
Capital; officers ... 97
Dividends ... 14, 15
Profit tax ... 58
Dominion Concrete Co. ... 50
Dominion Mines and Quarries, Ltd. ... 40
Dominion Salt Co. ... 41
Dominion Sewer Pipe and Clay Industries, Ltd. ... 59
Dominion Sugar Co. ... 48
Donaghue, W. A. ... 56
Donaldson, H. L. ... 110, 131
Donaldson, S. E. ... 45
Donovan, M. ... 122
Donovan tp.
See Gowganda-Duggan s. m.
Don Valley Brick Works ... 45, 52
Dorchester station ... 45
Dorfman, André ... 86
Douglas and Turner ... 45
Dover, W., tp., oil ... 36
Dowsett, C. W. ... 97
Drain tile. *See* Tile.
Dresden, brick and tile ... 25, 46
Drummond tp., quartz quarry ... 40
Dryden tp., feldspar ... 32
Dublin, brick and tile ... 46
Duffy, Charles G. ... 131
Dufresnoy tp., Que. ... 146
Dulles, John Foster ... 136
Dumfries N. tp., limestone ... 54
Dundas co.
Operating limestone quarry, Finch tp. 54
Dundas Quarries, Ltd. ... 59
Dunham, J. H. ... 50
Dunite in S. Africa ... 26
Dunlop, J. M. C. ... 75, 145
Dunn, James A. ... 88
Dunwich tp., oil ... 36
Duprat tp., Que. ... 146
Dupré, L. H. ... 87
Duquette, Wilfrid ... 87
Durham Stone and Sand Co. ... 50
Dutton, brick and tile ... 45, 46
Dutton tp., oil ... 36
Dye, R. E. ... 128

E

Eagle l., Ken., soapstone ... 41, 167
Eager, F. J. ... 140
East Neebish island, quartz quarry ... 39, 40
East Toronto, brick ... 52
Eau Claire, feldspar ... 32, 83
Ebsary Gypsum Co. ... 134
Edwards, C. M. ... 135
Edwards, W. S. ... 97
Edwards and Wright ... 125
Elarton Salt Works ... 41
Elgin co.
Operating gravel and sand pit ... 50
Elizabeth Feldspar Mines, Ltd.
Capital and date of charter ... 59
Operations ... 32, 82, 83

PAGE

Elliott, Charles ... 45
Elliott, James, Jr. ... 45
Elliott, R. A. ... 168
Elliott, William ... 45
Elmsley S. tp., mica ... 35
Elora, lime ... 48
Elzevir tp., actinolite ... 31
Emerald Lake Gold Mines, Ltd. ... 8
Emmons, K. P. ... 125
Empey, W. F. ... 112
Empire Limestone Co. ... 50
Englehart, prospectors' classes ... 65
Ennis, R. J. ... 114, 143
Enniskillen tp., oil ... 36
Enright, Owen ... 76
Erenhous, Leo ... 111
Errington, Joseph ... 114, 142
Essex, tile ... 45
Evered, N. J. ... 96
Exchange premium ... 13
Exeter Salt Works Co. ... 41
Explosives. *See* Accidents, mining.
Eyre, Reginald ... 60

F

Fairburn, W. H. ... 76, 155
Fairlie, M. F. ... 76
Faraday tp., mica ... 35, 136
Farmer, Geo., and Sons ... 54
Farr, Mrs. L. G. ... 54
Farrell, A. R. ... 102
Farris, Chas. S. ... 50
Fasken, Alex ... 97
Faulds, Morley ... 50
Feldspar.
  Industry and statistics ... 2, 3, 32
  Mining reports ... 82-84
Feldspar Mines Corp'n ... 32
Feldspars, Ltd. ... 32
Fennell, Robt ... 88
Fenning, Louis ... 74, 131
Fenning gold m. ... 131
Fergus, limestone ... 54
Ferguson, Harcourt ... 131
Finch tp., limestone ... 54
Finkenstaedt, F. C. ... 141
Fisher, Norman R. ... 124
Fisher Quebec Prospecting Syndicate, Ltd. ... 59
Fitch, C. R. ... 89
Fitzroy tp.
  Lead. *See* Kingdon Mg., Smelting and Mfg. Co.
Fletcher, A. E. ... 121
Flinflon g. m. ... 155
Flower pots production ... 44
Flower Station, iron pyrites ... 34
Fluorspar ... 2, 3, 33
Foley g. m. ... 89
Forbes, D. L. H. ... 125
Forbes, John M. *See* Forbes Galena Mines, Ltd.
Forbes Galena Mines, Ltd. ... 134, 135
Forester Falls, lime ... 48
Forneri s. m. ... 157
Fort William, brick and tile ... 45, 46
  classes for prospectors ... 64, 65
  trap quarry ... 53
Fort William Brick and Tile Co. ... 45, 46
Foster, Albert ... 103

PAGE

Foster, R. R. ... 50, 54
Foster s. m. ... 20, 154
Foster Cobalt Mg. Co. ... 21
Foster Pottery Co. ... 44
Fox, Geo. J. ... 45
Foxboro, tile ... 46
Frank, Carl ... 94
Franz, prospecting classes ... 65
Fraser (magistrate) ... 71
Frid Bros. ... 45
Frohock, J. A. ... 122
Frontenac co., feldspar ... 32, 82
  quarries ... 78
Frontenac lead m. ... 30, 134
Frontier s. m. ... 157
Frontier Lorrain s. m. ... 16, 17, 20
Frontier (Lorrain) Mines, Ltd. ... 59
Frood nickel m. *See* Mond Nickel Co.
Frood Extension nickel m. ... 139
Fuller, A. S. ... 122
Fuller Gravel Co. ... 50
Furness Gold Mines, Ltd. ... 59

G

Galena.
  See also Lead.
  Worthington nickel m. ... 30
Galetta, lead mg. ... 30, 135
  Limestone ... 54
  Prospectors' classes ... 65
Gallagher Lime and Stone Co. ... 48, 54
Galt, limestone ... 54
Gamebridge Limestone Products, Ltd. ... 59
Gammage, C. R. ... 45
Gananoque ... 53
Garafraxa W. tp ... 51
Gardiner, William ... 45
Gardiner Feldspar Co. ... 40
Garnet Abrasive Corp. ... 59
Garson nickel m.
  Gas, analysis ... 141
  Operations ... 140
  Production ... 24
Gas, natural.
  Statistics ... 36
  Sudbury nickel mines, analyses ... 141
Gasoline, statistics ... 38, 39
Gauthier tp. *See* Argonaut g. m.
Gaynor, Joseph ... 76, 165
Gear, H. ... 50
Gear, William I. ... 96
Genesee s. m. ... 20, 147
Genesee Feldspar Co ... 32
Geneva l. ... 30
Georgetown, porcelain ... 44
German, P. B. ... 135
Gibb, J. A. P. ... 111
Gibbons, J. B. ... 121
Gillespie, Geo. H. ... 41, 77, 167
  See also Henderson talc m.
Gillies, J. S. ... 135
Gillies limit.
  Prospecting in ... 97
  Silver mg. *See* Hamilton, J. W. McAndrew s. m.
Gillis, James A. ... 166
Ginn, H. G. ... 56, 65
Glenannan, brick and tile ... 45
Glenelg tp., lime ... 48
Glen William, sandstone ... 53

PAGE

Glengarry co.
Operating limestone quarry, Finch tp. 54
Gloucester tp., limestone 54
sandstone 49
Goderich, brick and tile 45
salt 41
Goderich Mineral Water Co 35
Goderich Salt Co 41
Godfrey and Co., Thos 45
Godson Contracting Co 50
Goetz, E. P 97
Gold.
Mining reports 84-133
Profit tax 58
Statistics 2-16
Goldale g. m 91
Goldfields American Development Co. 84, 85
Gold Hill g. m 8, 102
Gold Hill Mines, Ltd 59, 102
Gold Hill Mining Co 102
Gold Nugget Mining and Development Co 119
Goodwin, W. L 64
Gordon, M. B. R 113
Gordon, Murray 88
Gordon Granite Co., D. J 53
Gosselin, P 102
Gosselin g. m 102
Goudreau g. m 102, 103
Gow, James 49
Gowganda mg. div., revenue 56, 57
Gowganda s. area 17, 19
Gowganda-Duggan s. m 23, 76, 147
Gowganda Keora s. m 23, 76, 147
Grace g. m. (Michipicoten) 124
Grace Lake Gold Mines, Ltd 59
Grace Mining Co 41, 167
Graham, Robt 111, 141
Graham, William T 136
Grainger, J. H 65
Granite quarries, operators 53
Grant, James E 131
Grantham tp., limestone 54
Graphite.
Industry and statistics 2, 3, 33
Mining 133
Graphite Refining Co 33
Grasselli Chemical Co 34
Gratton, Louis 87
Graves, T. A 90
Grease statistics 37, 38
Great Britain.
See also Cornwall.
Gold standard 9
Great Eastern Ore & Mining Corp 59
Great Lakes Oil Co 37
Great Northern Power Co 9
Green, George 35
Greene, E. H 88
Green-Meehan s. m 75, 145
Greenock, brick and tile 46
Grenville Crushed Rock Co 54
Grey co., limestone operators 78
Grimsby Brick and Tile Co 45
Gross, David 124
Guelph 48, 50
Guelph tp., limestone 54
Gull-Kirk Gold Mines, Ltd 59
Gunton, W. B 147
Gurd & Co., Chas 35

PAGE

Gypsum.
Industry and statistics 2, 3, 33, 34
Mining. *See* Ontario Gypsum Co.

H

Haehnlen, W. L 166
Hagersville, limestone 54
Hagersville Contracting Co 54
Hagersville Quarries, Ltd 54, 71
Haight, James C 153
Haileybury, limestone 54
Haire, R. E 134
Haldimand co., stone quarries 78
Haliburton, limestone 54
Hall, R. Reece 53
Halladay, Reg 136
Hallatt Clay Products 45
Hallatt and Son, H 45
Halliday, Fred 54
Halpenny, Louis E 50
Halton co., clay operators 81
quarries 78
Halton Brick Co 45
Hamilton, F. H 128
Hamilton.
Blast Furnace. *See* Steel Co. of Canada.
Coking operations 29
Tile and brick plants 45, 46
Pottery 44
Sand pit 49
Halton Brick Co 45
Hamilton, A. S 96
Hamilton, Alexander M 145
Hamilton, F. H 149
Hamilton, J. W 147
Hamilton and Toronto Sewer Pipe Co 44
Hamilton Pressed Brick Co 45
Hammel, J 103
Hannah, W. A 83
Hanover Portland Cement Co 47
Harbour Brick Co 51, 52
Hardman, John E 134
Harker g. m 103
Harkness, H 103
Harkness-Hays Gold Mg. Co 59, 103
Harkness, James G 74, 124
Harkness, R. B 36
Harpell, R. E 50
Harriston, tile. *See* Donaldson, S. E.
Hartington, quartz quarry 40
Harvey, E., Ltd 48
Harvey-Kirkland Mines, Ltd 8, 104
Harwich tp., gravel and sand 50
Hatmaker, B. J 90
Hattin, Victor 124
Haultain s. m 148
Haultain tp 142, 148
Hawkshaw (magistrate) 71
Hayden, Charles 136
Hayden Gold Mines, Co 8
Hays, W. D. *See* Harkness-Hays Gold Mg. Co.
Hazel Silver Mines, Ltd 59
Hazelton Porcupine Gold Mines, Ltd 59
Hector Silver Mines, Ltd 148
Henderson, F. D 83
Henderson talc mine 40, 167
Hermance, H. P 121

PAGE

Herschell tp., dolomite. *See* Carfrae, A. J. J.
Hershmann, C. L. 76, 149
Hespeler, lime 48
Hess tp., lead 30
Hibbard, H. 88
Highlands-Gardiner-Johnston. Silver claims 149
Hill, Aaron 45
Hill, A. W. 45
Hilton, H. G. 77, 168
Himrod, William C. 125
Hinde Bros. 52
Hircock Bros 45
Hitch, D. A. 45
Hitch, Thos 45
Hochstetter, Ralph 131
Hodder, J. H. 45
Hoffman, Jas. 50
Hogs Back, Ottawa 54
Holden, John B. 104
Holditch, E. 83
Holland, H. E. 56
Hollinger, J. J. 88
Hollinger g. m. 8, 9
  Production 7, 8, 12
  Report 104-110
  Waterpower for 9
  Wright-Hargreaves m. compared with 9
Hollinger Consolidated Gold Mines, Ltd.
  Capital; officers 104
  Dividends 9, 14, 15
  Profit tax 58
Holmes and Webster 50
Homegardner Sand Co. 51
Hooper, Edward 128
Hopkins, Judge 71
Horne, William 53
Hortonolite 26
Hough, J. Atwell 65
Houston, J. C. 147
Houston, James 88
Houston Company, Ltd 45
Howey Red Lake Synd. 56
Howlett, Fred, and Sons 5
Howry Creek g. area 89
H.R. 823, 833, 899 gold locs. *See* March g.m.
H.S. 363-365, 369, 352 gold locs. *See* Capitol s. m.
Huddlestone, G. 7
Hudson, W. W. 124
Hudson Bay Mines, Ltd 21
Hughes, Dan 102
Hughes, John 165
Humberstone tp.
  Limestone quarry 54
  Sand pit 49
Hunter s. m. 145
Hunton Kirkland Gold Mines, Ltd. 8, 111
Huntsville Brick and Tile Works 45
Huron co.
  Operating gravel and sand pit 50
Huronian g. mine 124
Huronian Belt Co.
  Silver mg., Nicol tp 148
  See also Canadian Lorrain s. m.
Hussey, J. P. 75, 146
Hutchings, W. N. 89
Hutchinson, F. L. 94
Hutchinson, W. J. 136

PAGE

Hutchison, R. A. 113
Huycke, G. M 103
Hybla, feldspar 32
  quartz quarry 40
Hydrated lime, plants 48
Hydro-Electric Power Commission 54
Hylands-Gardiner-Johnston s. claims 149

I

Illuminating oil, statistics 37, 39
Imperial Oil Refineries, Ltd 37
Independent Concrete Pipe Co 50
India, gold production 10
Industrial Minerals Corpn 32, 40
Infection, relation to accidents 71
Ingersoll, brick and tile 46
Inglewood, bricks 46
Innerkip stone quarry 54
Innis, P. Allan 97
Insulex 33
Insull Power Co 96
International Alumina Co 59
International Nickel Co.
  Anglo-Canadian claims bought by 137
  Financial statement 136-138
  dividends 25, 27
  Murray m. bought by 24
  Production 24
  Profit tax 58
International Sand Co 50
Interprovincial Brick Co 45
Iridium, production 45
Iron and steel, industry and statistics 3, 5, 28
Iron pyrites, industry and statistics 2, 3, 34
Iroquois Exploration Synd 59
Iroquois Falls 9
Island falls 9
Irwin, Geo 20
Ivey, Arnold M 126

J

Jackfish, quartz pebbles 31
Jackson, W. B. 45
Jacobs, Jacob A. 124
James tp., silver mg 141
Jamieson, J. M. 48
Janes, D. A. 45
Jasperson Brick and Tile Co 45
Jervis, W. J. 45
Johnson, Felix, quartz quarry. *See* Hybla.
Johnson, Jas., Snr. 45
Johnson, R. C. 103
Johnston, Albert W. 125
Johnston, G. F. 50
Jury Gold Mine Development Co. 59

K

Kaladar tp., actinolite 31
Kaslin. *See* China clay.
Katrine tp., gold mg 131
Kearney, E. W. 102
Keast, A. J. 74, 120
Keeley s. m.
  Producing 17, 20
  Report 149, 150
  Rich find 16

PAGE

Keeley Silver Mines, Ltd.
Capital; officers ... 149
Dividends ... 21
Profit tax ... 58
Keeling, Jas ... 54
Kelly, D. B ... 122
Kelso, lime ... 48
Kennedy, H. G ... 76, 164
Kennedy, Murray D ... 143
Kenora mg. div., revenue ... 55-57
Kent Bros ... 35
Kent co.
Operating gravel and sand pits ... 50
Keora s. m. *See* Gowganda Keora s. m.
Kerosene statistics ... 38, 39
Kerr, Chas ... 45
Kerr, Fred ... 45
Kerr Lake s. m ... 20, 151
Kerr Lake Mg. Co ... 21
Kerwood, brick and tile ... 46
Keyes, S. W ... 50
Kilbourne, H. & Son ... 50
Killarney quartz quarry ... 39, 40
Kilmer and Barber, Ltd ... 51
Kincardine Salt Co ... 41
Kinch, William H ... 94
Kingdon lead m. *See* Galetta.
Kingdon Mg., Smelting and Refining Co.
Lead mg ... 30, 135
Limestone quarrying ... 54
Kingsdorf, Richard H ... 166
Kingston, limestone ... 54
Kingston penitentiary ... 54
Kingston Sand and Gravel Co ... 50
Kingsville, brick and tile ... 45, 46
Kipling tp., gold prospecting ... 146
Kirk g. m ... 111
Kirkfield Crushed Stone, Ltd ... 54
Kirk Gold Mines, Ltd ... 8, 110
Kirkland, J. C ... 96
Kirkland-Hunton g. m. *See* Hunton-Kirkland g. m.
Kirkland Lake ... 65
Kirkland Lake g. area ... 6, 7, 11
Kirkland Lake g. m ... 8, 13, 111, 112
Kirkland Lake Gold Mg. Co ... 111
Kirkland Rand g. m ... 112
Kirkpatrick, S. F ... 168
Kitchener, brick and tile ... 46
Knapp, E. B ... 112
Knechtel, J. S ... 110
Knight, Cyril W ... 162
Knox, John ... 104
Kobler, Henry ... 119
Koebel, Bros ... 46
Koons, Edward L ... 125
Kowkash mining div., revenue ... 56, 57
Kruse Bros ... 46

L

Labelle, F. A ... 87
Labey and Son, Geo. A ... 46
Lacey mica m ... 135, 136
Lake Erie Sand Co ... 51
Lakefield Lime Products, Ltd ... 59
Lake Ontario, gravel and sand ... 51
Lake Shore g. m.
Mill enlargement ... 8
Production ... 7, 13
Report ... 112, 113

PAGE

Lake Shore Mines, Ltd.
Dividends ... 14, 15, 112
Profit tax ... 58
Lakeside Lorrain s. m ... 76
Lake Superior, gravel and sand ... 51
Lambton co.
Operating gravel and sand pits ... 50
Lanark co., feldspar mines ... 32, 83
Langford Quarry Co ... 54
Langmuir tp., barite ... 31
Langton, Thos ... 54
Langworthy, W. F ... 104
Lapish and Small ... 51
Larder Lake.
Gold mg ... 89
Prospectors' classes ... 65
See also Crown Reserve g. m.
Larder Lake mg. div., revenue ... 56, 57
La Rose s. m ... 17, 20, 151
La Rose Mines, Ltd ... 151
Lash, Alfred ... 165
Law Construction Co ... 54
Lawson s. m ... 151, 152
Lead mining ... 134, 135
statistics ... 2-5, 18, 30
Lebel tp.
Gold. *See* Harvey-Kirkland g. m.
Kirk g. m.
Lee, Dwight B ... 97
Lee, W. W ... 35
Leeds co., granite quarries ... 53, 79
Leonard, R. W ... 91
Leonard Silver Mines, Ltd ... 59
Leroy co ... 145
Levack nickel m ... 24, 140
Leviness, J. E ... 50
Lime, statistics ... 2, 3, 47, 48
Limestone operators ... 54, 78-80
Lincoln Gas Co ... 59
Lindsay ... 45, 46
Liskeard. *See* New Liskeard.
Little, M. C. H ... 149
Little Keeley s. m ... 157
Lively, Chas ... 138
Lock, Thos ... 20
London, gravel and sand. *See* Quick, Chas. R.
tile ... 46
Long rapids, Mattagami r ... 44
Longmore, E. L ... 65
Longwell, Alexander ... 91
Lorrain S. tp. *See* South Lorrain tp.
Lorrain Consolidated s. m ... 16, 20
Lorrain Operating Co. *See* Frontier Lorrain.
Lorrain Trout Lake s. m.
Producing ... 20
Report ... 160, 161
Rich find ... 16
Lorrain Trout Lake Silver Mines, Ltd.
Capital ... 160
Dividends ... 21
Profit tax ... 58
Loudon, W. E ... 65
Loughborough tp.
Feldspar ... 32, 82
Lead. *See* Frontenac l. m.
Mica. *See* Lacey mica m.
Loughborough Mg. Co ... 35, 135
Loughrin tp., mica ... 83, 84
Lovelace, Edwin J ... 50
Lowden, J. W ... 151

PAGE
Lowery, W. R. . . . 131
Lowes Bros. . . . 46
Lubricating oil, statistics. . . . 37, 38
Lucknow, brick and tile. *See* Phillips & Son, Thos.
Ludwig, M. H. . . . 167
Luther W. tp., sand and gravel. . . . 51
Lydenburg dist., S. Africa, platinum. . . . 26
Lynch, C. D. . . . 20
Lyons, J. . . . 140
Lythmore, gypsum. . . . 133, 144

M

McAndrew, John A. . . . 145
McAndrew, John J. . . . 76, 166
McAndrew s. claims. . . . 166
McArthur Engineering and Construction Co. . . . 50
McCannell, A. N. . . . 50
McCarthy, D. J. . . . 113
McCarthy-Webb Goudreau Mines, Ltd. 59, 113
McCaskill, Donald. . . . 77, 138
McCaul, W. E. . . . 71
McCloskey, H. C. . . . 153
McColl Bros. . . . 37
McCoomb, Chester. . . . 46
McCormick Bros. . . . 46
McCrea, Chas. . . . [i]
McCrea, J. H. . . . 65
McCredie, Wilson. . . . 46
McDonald, A. R. . . . 103
MacDonald, Geo. F. . . . 103
McDonald, John. . . . 165
McDonell, Diblee and Covey. . . . 54
McDougald, Wilfred L. . . . 104
McDougall, D. H. . . . 142
McGarry, Andrew. . . . 161
McGregor, J. G. . . . 88
McIntyre, Alex. . . . 138
McIntyre-Porcupine g. m.
Depth. . . . 8
Production. . . . 7, 12
Report. . . . 113, 119
McIntyre-Porcupine Gold Mines, Ltd.
Dividends. . . . 14, 15
Profit tax. . . . 58
McIvor Bros. . . . 46
MacKay, Dr. . . . 89
McKay, W. D. . . . 89
McKay l., asbestos. . . . 31
McKelvie, Angus A. . . . 94
McKenzie Gold Mines, Ltd. . . . 59
McKessock, J. S. . . . 83
McKinley-Darragh-Savage s. m.
Production. . . . 17, 20
Report. . . . 152-154
McKinley-Darragh-Savage Mines of Cobalt, Ltd.
Capital; directors. . . . 152
Dividends. . . . 21
McLean, A. . . . 104
McLean, A. B., & Sons. . . . 51
McLeod, David. . . . 122
McLeod, J. H. . . . 20, 76, 154
McMahon, Robert. . . . 46
McMaster, Harry. *See* McMaster Synd.
McMaster, R. H. . . . 168
McMaster Syndicate. . . . 8, 74, 119

PAGE
McMillan, Ewan J. *See* McMillan Development Co.
McMillan, Hugh. . . . 75, 142
McMillan, J. G.
Part author of reports on Accidents, mg; and Mines of Ontario, *which see.*
McMillan Development Co. . . . 119
McNab tp., limestone. . . . 54
McNaughton, A. . . . 65
McNaughton, G. W. . . . 75, 136
McNeill, W. K. . . . 60-62
McPhail, Duncan. . . . 94
McPhee, John. . . . 111
McPherson, J. C. F. . . . 134
McPherson, W. D. . . . 111
McQuigge, J. R. . . . 54
McQuire-Robinson Radium and By-Products Co. . . . 32
McRae, James A. . . . 76, 164
McVichie, James A. . . . 76, 147
McVittie tp.
Gold. *See* Canadian Assoc'd. Goldfields Ltd.
Madagascar, graphite. . . . 33
Madoc, talc. *See* Asbestos Pulp Co. Gillespie, Geo. H.
Mahon Bros. . . . 35
Maidens-McDonald g. claims. . . . 120
Maisonville tp. *See* Bennett Mg. Co.
Malahide tp., sand and gravel. . . . 50
Maloney, M. J. . . . 40
Manaton, C. H. . . . 94, 155
Map, sketch, Northern Ont. . . . 1
Maple Sand, Gravel and Brick Co. . . . 50
Marat, Miss A. V. . . . 88
Marchand, Louis A. . . . 87
Marsh Gold, Ltd. . . . 8, 119
Markus, William, Ltd. . . . 54
Marmora tp., quartz quarry. . . . 40
Marsden, F. V. . . . 76
Marshall, James. . . . 48
Martin, A. G. . . . 35
Martin, E. L. . . . 83
Martin, Ernest. . . . 112
Martin, Thos. E. . . . 46
Martin Lorrain Silver Mines, Ltd. . . . 59
Maryborough tp., sand and gravel. . . . 51
Massie (magistrate). . . . 71
Masterson, A. K. . . . 166
Matheson, prospectors' classes. . . . 65
Mattagami r., kaolin. . . . 44
Mattawan tp., feldspar. . . . 83
Maynard, Douglas. . . . 103
Medonte tp., limestone. . . . 54
Mein, Wm. W. . . . 136
Menago s. m., production. . . . 20
Menago Mining Co.
Operating Colonial s. m. . . . 20
Provincial s. m. . . . 146
Profit tax. . . . 58
Merensky Reef platinum deposit, S. Africa. . . . 26
Merkley's, Ltd. . . . 46
Merlo, Merlo and Ray, Ltd. . . . 51
Messecar, C. L. . . . 110
Metallurgical works. . . . 168
Methuen tp., trap. . . . 53
Mexico, gold production. . . . 10

PAGE

Mica.
Industry and statistics....35. 75
Mining reports....135, 136
Michael Syndicate, Ltd.... 59
Michipicoten area, gold.... 95
Michipicoten falls.... 96
Mickle Syndicate, Ltd.... 59
Middlesex co.
Operating sand and gravel pit.... 50
Middleton, Chas.... 46
Midland, blast furnace idle.... 29
Millcrest s. m....23, 155
Millcrest Mining Co....154, 155
Miller, Charles R.... 166
Miller, Edwin Lang.... 131
Miller, G. C....97, 125
Miller, Gerard F.... 131
Miller, James A.... 50
Miller, N. J.... 114
Miller, W. N....56, 65
Miller Lake O'Brien s. m....17, 20, 164
Milton Pressed Brick Co.... 46
Mimico, sewer-pipe.... 44
Mine Centre.
Soapstone near. *See* Wood, H. H.
Miner, M. F.... 46
Mineral statistics. *See* Statistical review.
Mineral water statistics....2, 3, 35
Miners' licenses, revenue.... 55
Mines of Ontario.
Report by inspectors....73-168
Mining accidents, report....67-72
Mining areas.
Northern Ont., sketch map.... 1
Mining companies incorporated, list...58-60
Mining Corporation of Canada.
Capital; directors.... 155
Dividends.... 21
Mines owned by.... 22
Profit tax.... 58
Report....155-161
Silver production.... 17
Mining revenue....55-58
Mint. *See* Royal Mint, Ottawa.
Minto g. m.... 96
Minto Exploration Co.... 59
Mohawk Sand and Gravel Co.... 50
Moir, A.... 110
Molybdenite statistics.... 5
Mond Nickel Co.
Dividends.... 27
Production.... 24
Profit tax.... 58
Quartz quarry.... 40
Report....139, 140
Rhodium production.... 27
Sulphuric acid plant.... 26
Trap quarry.... 53
Montbray tp., Que., prospecting.... 146
Monteagle tp., feldspar.... 32
Montreal r., waterpower. *See* Great Northern Power Co.
Montreal River mg. div., revenue....56, 57
Moore tp., oil.... 36
Morden, J. A.... 110
Morgan, J. W.... 56
Mosa tp., gravel and sand.... 49
oil.... 36
Moscow Brick and Tile Works.... 46
Moss tp., gold. *See* Huronian g. m.
Motor industry, nickel for.... 5

PAGE

Mount Brydges, brick and tile.... 45
Morgan, M. R.... 56
Morin, D. M.... 131
Morrison, Bruce L.... 55
Morrison, Thomas.... 136
Morrison, William.... 53
Morrison, s. m.... 166
Morston, R. C.... 65
Mount Dennis Vitrified Claywares, Ltd. 59
Mulholland, George W.... 147
Mumford, W. J.... 141
Murdock, J. Y....91, 126
Murray, John A.... 94
Murray nickel m.... 24
Murray tp., gravel and sand.... 49
Musselman, M.... 126

N

Nakina, prospectors' classes.... 65
Napanee, brick and tile....45, 46
Napanee Brick and Tile Works.... 46
Naphtha, statistics.... 57
Nassagaweya tp.
Gravel.... 49
Lime.... 48
Limestone.... 54
Sandstone.... 53
National Feldspar Co.... 59
National Fire Proofing Co.... 46
National Sand and Material Co.... 51
Natural gas, statistics.... 2, 3
Naud, J. A.... 87
Neelands, E. V.... 162
Neelon tp., quartzite.... 40
Neilly, Balmer.... 113
Nesbitt, E. W.... 151
Nesbitt, Wallace.... 97
Newell, W. A.... 121
New Liskeard, prospectors' classes.... 65
Newray g. mine.... 12
See also Coniaurum.
Newton, William....76, 161
Newton Lorrain Synd.... 161
New Toronto, brick.... 45
Niagara tp., limestone.... 54
Niagara Falls, lime.... 48
porcelain.... 44
Nickel.
Industry and statistics....2-5, 18, 24-27
New uses for.... 5
Profit tax.... 58
Reports, mining....136-141
Nicol tp., silver.... 142
Night Hawk Peninsular g. m....7, 12, 120
Night Hawk Peninsular Mines, Ltd.... 120
Nipissing mg. div., revenue.... 55
Nipissing s. m....17, 162, 163
Nipissing Mines Co....22, 23, 161
Nipissing Mining Co....22, 58, 161, 162
Nisbet, E. V.... 145
No. 3 nickel m.... 138
Norbay Lorrain Silver Mines, Ltd.... 59
Norbec Mining Corpn.... 59
Norite, S. Africa.... 26
Norrie-Lowenthal, W. G.... 122
Norsworthy, H. A.... 85
North America Smelting Co.... 134
North Bay, brick.... 46
Northcrown g. m.... 12
Northern Canada Power Co....9, 17

PAGE
Northern Extension Cobalt Mines, Ltd. 164
Northern Feldspar Mines, Ltd..... 83
Northern Gold Belt Mining Co..... 59
Northern Ont.
Metal mg. areas, sketch map..... 1
Northern Silver Lode Corp'n., Ltd 59
Northland g. m.....8, 121
Norwich, brick and tile. *See* Deller Bros.

O

Oakes, Harry..... 112
Oakes, Louis..... 112
O'Brien, J. A..... 168
O'Brien and Fowler, Ltd..... 83
O'Brien, M. J., Ltd.....164, 168
O'Brien s. m.....17, 20, 164
O'Connor, John..... 152
O'Dell and Sons, Wm..... 46
Oil & Turpentine Co. of Canada..... 59
Oil. *See* Petroleum.
Oil Springs oil field..... 36
Ojibway, blast furnace..... 29
Oleum, term explained..... 26
Oliver Rogers Stone Co..... 54
Ollman Bros..... 46
Oneida tp., gypsum. *See* Lythmore.
Onondaga tp., oil..... 36
Ontario Denison Tile Co..... 46
Ontario Gypsum Co..... 33
Ontario Kirkland g. m..... 13
Ontario Pipe and Clay Products, Ltd... 44
Ontario Potteries Co..... 44
Ontario Rock Co..... 53
Ontario Sewer Pipe and Clay Products, Ltd..... 44
Ontario Solid Silver Mines, Ltd. *See* Solid Silver s. m.
Ontario Stone Corpn..... 54
Ops tp., sand and gravel..... 49
Ore Chimney g. m.....8, 121
O'Reilly, T. E..... 46
Orillia, limestone..... 54
O'Rourke, M. F..... 56
Orser, C. E..... 83
Orser, S..... 75
Orser and Wilson mica m.....35, 75, 136
Orser-Kraft Feldspar Co..... 40
Osborne, W. R..... 112
Osgoode tp., sand and gravel..... 49
Osisko Lake Mines, Ltd..... 59
Osler, Britton..... 136
Osmium production..... 27
Ostrom Gold Mines, Ltd..... 59
Ottawa, brick and tile..... 46
limestone quarry..... 54
See also Royal Mint.
Ottawa Brick Mfg. Co..... 46
Ott Brick and Tile Mfg. Co..... 46
Owen Sound, brick..... 46
lime..... 48
limestone..... 54
Owen Sound Brick tp..... 46
Oxford tp., limestone..... 54
Oxford W. tp., gravel and sand..... 50
Oxford-Cobalt s. m..... 23

P

Pacaud tp., gold. *See* Barry-Hollinger.
Paddock, George..... 83
Paisley, tile..... 46

PAGE
Palladium.....26, 27
Paraffin wax, statistics.....37, 39
Paragon-Hitchcock s. m..... 23
Parent, Geo..... 151
Park, Hugh.....76, 162
Park, John S..... 50
Parker, W. R. P..... 155
Parkhill, brick and tile..... 46
Parkhurst, A. J..... 134
Parks, H. W..... 46
Parry Sound Iron Co..... 29
Parsons, C. S..... 64
Patricia g. m..... 13
See also Barry-Hollinger.
Patterson, A..... 166
Paxton, Fred. R..... 46
Paxton, Norman.....113
Paymaster g. m. *See* Porcupine Paymaster g. m.
Payne, Webster & Co..... 134
Peat Fuels, Limited..... 36
Peat statistics.....2, 3, 36
Peel co., clay pits, list..... 81
Pellatt, Sir Henry M.....94, 155
Pelling, C. H..... 153
Pembroke, brick.....45, 46
Pembroke tp., limestone..... 54
Pembroke Brick Co..... 46
Penly Silver Mines, Ltd..... 59
Penn-Canadian s. m..... 147
Penn-Canadian Mines, Ltd..... 22
Penn-Central Cobalt Mines, Ltd..... 59
Perth Feldspar Mg. Co..... 32
Perth Road, lead. *See* Frontenac lead m.
Peterborough.
Brick and tile. *See* Curtis Bros.
Gravel pit..... 50
Insulator plant..... 44
Peterson Lake s. m.....20, 157
Peterson Lake Silver-Cobalt Mg. Co.... 22
Petroleum statistics.....2, 3, 36-39
Petrolia.
Brick and tile..... 45
Oil refinery. *See* Canadian Oil Refineries, Ltd.
Oil statistics..... 36
Phillips and Son, Thos..... 46
Phinn Bros..... 46
Phippen, F. H.....126, 152
Piggott & Co., Geo..... 46
Pine Lake-Lorrain Silver Mines, Ltd... 60
Pioneer Prospectors Association, Ltd... 60
Pirson, John..... 54
Pitch statistics..... 38
Pittsburgh tp., silica sand..... 39
Platinum, notes and statistics....2-5, 26, 27
Plympton tp., oil..... 36
Poitevin, E..... 64
Pomeroy, Robert W.....97, 125
Ponsford, A. E..... 50
Porcelain. *See* Pottery.
Porcupine g. area, production.....6, 7, 11
Porcupine mg. div., revenue.....55-57
Porcupine Crown g. m..... 12
Porcupine Crown Mines, Ltd.....14, 15
Porcupine Goldfields Development and Finance Co.....8, 84
Porcupine Pet g. m..... 12
Porcupine Paymaster g. m.....8, 17, 122
Porphyry Hill g. m..... 12
Port Arthur.....29, 65

PAGE

Port Arthur mg. div., revenue....56, 57
Port Colborne, blast furnace.... 29
cement.... 47
nickel refinery.... 25
Port Elmsley, graphite refinery.... 33
Portland tp., feldspar....32, 82
Port Rowan Brick and Tile Co.... 46
Pote and Rogers.... 50
Pottery, industry and statistics....23, 43, 44
Powell, O. P.... 91
Power. *See* Waterpower.
Power and Mines, Synd.... 124
Preston, sand and gravel.... 49
Preston, g. m.... 12
Price and Cumming.... 46
Price and Smith.... 46
Princess s. m.... 152
Profit tax.... 58
Prosecutions....71, 72
Prosser, Seward.... 136
Proton, brick and tile. *See* Batchelor, Smith.
Provincial assay office....60-62
Provincial s. m.... 145
Provincial Secretary, Dept. of
Limestone quarry, Guelph tp.... 54
Purdy, George.... 83
Purdy, R. J.... 151
Puslinch, lime.... 48
Pyrite. *See* Iron pyrites.

Q

Quarries, stone, list of....78-80
See also Limestone; Quartz; Sandstone, etc.
Quartz, industry and statistics...2, 3, 39, 40
pebbles, Jackfish.... 31
Queen Lebel g. m....8, 124
Queenston Quarries, Ltd.... 54
Quick, Chas. R.... 50
Quicklime. *See* Lime.
Quigley, B. C.... 50
Quinlan, Robertson and Janin.... 54
Quinn and Wilson.... 50
Quinte Gold Mines, Ltd.... 60
Quinton and Brundige.... 54
Quinze r., Que., waterpower.... 9

R

Rainham tp., limestone.... 54
Rainville, J. H.... 87
Raleigh tp., gravel and sand.... 49
oil.... 36
Rama tp., limestone.... 54
Ratcliffe, Ltd., E. B.... 50
Rawlins, J. W.... 138
Raymond, Avile.... 87
Rayner, G. W.... 40
Rea g. m....12-15
Recording fees, revenue.... 55
Red lake, Pat., gold.... 6
Reddy, H. L.... 87
Redington, John.... 91
Red Lake g. area.... 146
Red Rock g. m.... 119
Red Rock s. m....75, 145
Regan and Blackburn.... 50
Reid, Fraser D.... 91
Reilley, W. W.... 125

PAGE

Reilly, Thomas.... 76
Reinhardt, Carl....20, 76, 96, 164
Renfrew, brick and tile.... 45
lead near.... 30
lime.... 48
Rhodesia, gold.... 10
Rhodium, production.... 27
Richards, W. J.... 76
Richardson and Son, James.... 46
Richmond, limestone.... 54
Ridgetown, brick and tile.... 45
Right of Way Mines, Ltd.... 22
Right of Way Mining Co.... 22
Riselay Brick Co.... 46
Robertson & Co., D....48, 53, 54
Robillard & Son, H....54
Robinson, John B.... 97
Robinson, L. V.... 134
Rock Lake Mica Mg. Co.... 35
Rock Products Co....32, 83
Rockwood, lime.... 48
Roddy, J. M.... 54
Rodgers, C. E.... 125
Rogers, R. P.... 146
Rogers, W. R.
Statistical review by, and Young....1-63
Rogers and Co., F.... 53
Rolfe, W. F.... 138
Romney tp., oil.... 36
Rose, R. R.... 65
Rose Grove, gold mg near.... 119
Ross, James G.... 96
Rothwell, T. E.... 60
Rouyn tp., Que....9, 146
Royalties on sand and gravel.... 55
Royal Mint, Ottawa.
Bullion, marketing method....9, 10
Russell, Jos.... 46
Russell tp., limestone.... 54
Russia, gold.... 10
platinum.... 27
Ruthenium, production.... 27
Rutledge, J. W.... 51

S

Sacred Heart College, Sudbury.... 51
Sadler, Frederick L.... 46
Sainio, John.... 166
St. Catharines, brick.... 46
St. Charles, W. P.... 112
St. Clair r., sand and gravel.... 51
St. Clements, brick and tile.... 46
St. Marys, limestone.... 54
St. Marys Cement Co.... 47
St. Thomas, brick and tile.... 45
Sales tax.
Effect on cement industry.... 47
Salt, industry and statistics....2, 3, 40, 41
Saltfleet tp., limestone.... 54
Sand and gravel.
Industry and statistics....2, 3, 48-51
Royalties.... 55
Sand and Supplies, Ltd.... 51
Sanderson, John W....76, 166
Sandstone quarries.... 53
Sandwich, salt.... 41
Sanitaris, Ltd.... 35
Sarjeant Co.... 50
Sarnia, oil.... 36
salt.... 41

PAGE
Sarnia Gravel Co. . . . 60
Saskatchewan, clay . . . 44
Sass, K. F . . . 124
Sault Ste. Marie.
Blast furnace . . . 29
Brick. *See* Elliott, Jas., Jr.
Prospectors' classes . . . 65
Sault Ste. Marie. mg. div., revenue . . . 56, 57
Savage, Joseph . . . 134
Savage s. m. *See* McKinley-Darragh-Savage.
Sawyer, E. P . . . 121
Scarboro, sand and gravel . . . 49
sand-lime brick . . . 121
Schreiber, gold near. *See* Harkness-Hays g. m., Fenning g. m.
Schumacher g. m . . . 12, 14
Seaforth, brick and tile . . . 46
Seamen, A. G . . . 89
Seebach, Edward . . . 50
Selkirk, A. V. J . . . 65, 103
Seneca Silver Mines, Ltd . . . 60
Seneca-Superior Silver Mines, Ltd . . . 22
Serra S. Bruno Mining Co . . . 60
Sewer-pipe, industry and statistics 2, 3, 43, 44
Shale Products, Ltd . . . 46
Sharp, A. L . . . 140
Shaw, John W . . . 75, 145, 165
Sheppard, W. J . . . 113, 114, 142
Sherbrooke S. tp., quartz quarry . . . 40
Sherrill, Charles L . . . 94
Shield Development Co . . . 124
Shillington, R. T . . . 128, 149
Shirk, G. M . . . 50
Siddall, John P . . . 51
Sieling, A . . . 110
Silica brick, industry . . . 39, 40
Silica Sand Co . . . 39, 40
Silver.
Industry and statistics . . . 2-5, 16-24
Mining reports . . . 141-167
Profit tax . . . 58
Silver mt., limestone . . . 54
Silver Bullion s. m . . . 165
Silver Centre. *See* Keeley s. m.
Silver Queen s. m . . . 20
Sinclair, D. G
Author (pt.) of Mines of Ont. and Mg. accidents . . . 67, 73
Sioux Lookout, prospectors' classes . . . 65
Sixt, William . . . 74, 111
Skinner, R . . . 50
Skootamatta r., waterpower . . . 121
Slade, A . . . 82
Sludge, statistics . . . 38
Smith, Clifford E. C . . . 85, 89
Smith, Home . . . 152
Smith, L. B . . . 88
Smith, Leonard . . . 76, 148
Smith, R . . . 136
Smith, W. E . . . 147
Smith, W. W . . . 7
Smith and Son, Alex . . . 46
Smith-Labine g. m . . . 88
Smythe, C., Ltd . . . 50
Snelgrove, A . . . 46
Soapstone.
See Grace Mg. Co.
Wood, H. H.
Solid Silver m . . . 164
PAGE
Solvay process. *See* Hamilton, coke.
South Africa, platinum . . . 19
Southern Production Co . . . 60
South Lorrain tp., silver . . . 16, 19
See also Keeley s. m.
Soviet Government. *See* Russia.
Splane, M. J . . . 64
Sproat, Wm. M . . . 46
S. S. M. gold locs., Alg.
See Cooper g. m.
McCarthy-Webb g. m.
Minto g. m.
Stafford, W. H . . . 95, 96, 128, 149
Stamford tp.
Limestone operators . . .
Sand pit operators . . . 54
Standard Brick Co . . . 50
Standard Chemical Co . . . 46
Standard Iron Co . . . 48
Standard White Lime Co . . . 48, 29
Stanley, Robt C . . . 154
Starke, Robt . . . 36
Starr, J. R. L . . . 187
Steel Company of Canada . . . 28, 29, 152
Steele, Edwin . . . 68
Steenman, L. F . . . 46
Steindler, L. L . . . 176
Stellite . . . 1652
Sterling, S. C . . . 1218
Sterling Lumber Co . . . 60
Stern, Morton F . . . 97
Sterns, Melvin J . . . 121
Stevens, Frank G . . . 94
Stewart, James A . . . 145
Stewart, R. J . . . 83
Stewart, Robt . . . 60
Stobie, A. M . . . 126
Stodart, A. B . . . 155
Stormont co.
Operating limestone quarry . . . 54
Storrington tp., mica . . . 35
Stout, Andrew V . . . 136
Stratford Brick Tile and Lumber Co . . . 46
Streets and O'Brien . . . 53, 79
Streetsville Brick Co . . . 46
Stroh, M. C . . . 46
Strong, Horace F . . . 76, 148, 152, 165, 166
Strong-Bow Gold Mines, Ltd . . . 91
Stuart, Alan . . . 74, 126
Sudbury, prospectors' classes . . . 65
Sudbury dist., mg. revenue . . . 55
Sudbury mg. div., revenue . . . 56, 57
Sullivan, James. *See* Brewer, Sullivan and Richardson.
Sulphuric acid industry . . . 26
Superior Brick and Tile Co . . . 46
Surrey, H. G . . . 86
Sutherland, H. H . . . 151
Sutherland, T. F . . . 26, 67, 73
Sutherland, W. A . . . 46
Swansea, brick . . . 52
sewer-pipe . . . 44
Swartz, John . . . 124
Swift, Frank R . . . 90
Switzer, W . . . 104
Sydenham, mica mg . . . 35, 135, 136
Sylvanite g. m . . . 8, 125
Symons, John . . . 138

PAGE

T

Tack, Henry 50
Talc, mining 167
statistics 2, 3, 41
Tar, statistics 29, 37, 38
Taylor, B. S 148
Taylor, Gordon 142
Taylor, Henry 77, 167
Taylor, Roy 77, 167
Taylor, Vernon F 148
Taylor, W. D 166
Taylor, W. O 131
T. B. 3327 and 3354 gold locs., E. of Schreiber. *See* Harkness-Hays g. m.
Teal, William G 71
Teare, R. P 74, 124
Teck-Hughes g. m.
Mill enlargement proposed 8
Production 13
Report 125, 126
Teck-Hughes Gold Mines, Ltd 58, 125
Teeswater, lime 48
Telfer, R. A 133
Temiscamingue dist., Que 146
Temiskaming and Hudson Bay Mining Co 22
Temiskaming Mining Co 22
Terry, Stuart D 113
Thames r., gravel and sand 51
Thames Quarry Co 54
Thamesville, brick and tile 46
oil 36
Thomas, D. R 87
Thompson, Geo 50
Thompson, J. F 125
Thompson, W. G 54
Thorndale, brick and tile 45
Thornton, W. H 71
Thunder bay, gravel and sand 51
Thunder Bay dist., mg. revenue 55
Tichenor, Milton W 153
Tilbury E. tp., oil 36
Timagami 5
Timiskaming dist., mg. revenue 55
Timiskaming mg. div., revenue 56, 57
Timiskaming Testing Laboratories 55, 63
Timmins, Jules R 104
Timmins, Les. H 104
Timmins, Noah A 104
Timmins, W 89
Timmins, prospectors' classes 65
Timmins Graphite Mines, Ltd 33
Tionaga, barite 31
Todmorden, brick 52
Tommy Burns g. m 12
Tonopah Canadian Mines Co 20, 60, 165
Tope, Richard (Estate) 46
Toronto.
Brick and tile operators 45, 46
Pottery plant 44
Sand-lime brick 52
Oil refinery 37
Toronto Brick Co 46, 48
Toronto Lime Co 48
Toronto Sewer Pipe Co 44
Tory Hill Mica Mining Co 35
Tough, Geo 102
Tough-Oakes Burnside g. m.
Production 7, 13
Report 126-128

PAGE

Tough-Oakes Burnside Gold Mines, Ltd. 126
Tough-Oakes Gold Mines, Ltd 14, 15
Townsend tp., gravel and sand 51
Townsite s. m 20, 157
Townsite Extension s. m 157
Trafford, C. E 155
Trainmen Silver Mg. Co 166
Transvaal, gold 10
Treasure, J. E 138
Trap rock, quarries 53
Trethewey-Ossiam Mines, Ltd 60
Trethewey Silver Cobalt Mines, Ltd 22
Trout Lake s. m 146
T.R.P. 917 gold loc. *See* March g.m.
Tuck, Jas. A 88
Tudhope, J. B 114, 142
Tuer, C. F 107
Turk, E 149
Turtle l., near Mine Centre.
Soapstone. *See* Wood, H. H.
Tweed, brick 45
Tyrrell, J. B 111

U

United Algoma Mines, Ltd 60, 124
United States, gold production 10
Ural mtns., platinum 27
Usborne tp., sand pit 50

V

Van Der Voort, M.P 94, 103, 113, 122
Vankleek Hill, brick 46
Van Luven, A. J 82
Vaughn, A. C 65
Verona Quarries, Ltd 60
Victoria co., limestone quarries 79
Victoria No. 1 nickel m. *See* Mond n. m.
Victory s. m 166
Violet s. m 151, 152
Vipond g. m.
Mill enlargement proposed 8
Production 7, 12
Report 128-131
Vipond Consolidated Mines, Ltd.
Financial statement 128, 129
Profit tax 58
Vogan, Samuel 48

W

Wabigoon l., soapstone 41
Wabigoon Soapstone Co 41
Wagstaff, Albert H 46
Wagstaff, Charles 46
Walker, E. H 122
Walker Bros 54, 71
Walker Silver Mines, Ltd 60
Wallace and Son, R 46
Wallaceburg, lime 48
oil refinery 37
Wallaceburg Sand and Gravel Co 51
Walpole tp., limestone 54
Walsh, Hugh 131
Walsh s. m 20
Walsh-Katrine g. m 131
Walton, W. S 85
Wanapitei, feldspar 32
Wanup, feldspar 32, 83
quartz quarries 40

PAGE

Ward, James, Jr. 120
Warwick, salt 41
Weekes, F. R. 85
Weeks, H 65
Wehman, John 54
Wein, Aaron 46
Weisman, A 83
Wellington co., gravel and sand 50
limestone 54
quarries 79, 80
Waterberg dist., S. Africa 26
Waterloo, brick 45
Waterpower, Northern Ontario, notes . . . 9
Watford, brick and tile 45
Watson, J. R 155
Watson, W. G 91, 146
Watson vein 157
Wells, R. G 168
Wende, Albert 112
Wendover, limestone 54
Wentworth, clay pits 81
limestone 54
quarries 80
Wentworth Quarries, Ltd 54
Weppler, Henry 48
West Australia, gold 10
Western Canada Flour Mills Co 41
West Dome Lake g. m 7, 12, 94, 95
Western Ontario Mines, Ltd 41
Western Salt Co 41
West Lake Brick and Products Co 52
West Lorne, brick and tile 45
Wettlaufer, Conrad E 125
Wettlaufer Lorrain Silver Mines, Ltd . . . 22
White, G. L 65
Whitehead, J. H. W 88
Whiteman, J. H 166
Whiting, from England 44
Wiarton, lime 48
Wickett, S. R 142
Widdifield tp., sand and gravel 49
Wigwam s. m 23, 166
Wilkesport, tile 45
Wilks, Geo 51
Willcox, H 51
Willcox Lake Brick Co 52
Wilson, A 82
Wilson, D. J. *See* Orser and Wilson.
Wilson, M 51

PAGE

Wilson, W. D 126
Winch, Bros 46
Windmill Point Crushed Stone Co 54
Windsor Brick and Tile Co 46
Windsor Sand and Gravel Co 51
Wingham Salt Works 41
Winnipeg Roofing Co 54
Wintermeyer, Alfred 124
W. J. Nine s. m 148
W. J. Nine Silver Mines, Ltd 60
Wood, E. B 74, 124
Wood, H. H 76, 127
Wood-Croesus Gold Mines, Ltd 60
Wood's vein 157
Woodslee Brick and Tile Co 46
Woolchuck, J. M 121
Workmen's compensation rates 67, 68
World's gold output 10
Worthington nickel m 24, 30, 140
Wright, S. B 77, 168
Wright, William H 35, 112
Wright and Co 40, 51
Wright and Sons, Geo 46
Wright, Frank G 122
Wright-Hargreaves g. m.
Compared with Hollinger g. m 9
Production 7, 11, 13
Report 131
Wright-Hargreaves Mines, Ltd.
Finance details 9, 14, 15, 58, 131, 132
Wyoming, tile. *See* Middleton, Chas.

Y

Yarmouth tp., gravel and sand 49, 51
York co., clay pits, list 81
York tp., sand pit 50
York Sandstone Brick Co 52
Young, A. C.
Statistical review by, and Rogers 1-63
Young, Horace G 103, 142, 143
Young, Maurice E 75, 145
Yukon, gold output 11

Z

Zinc, industry and statistics 2-5, 30
Zorra E. tp., limestone 54
Zorra W. tp., sand and gravel 50

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CONTENTS

Vol. XXXV, Part 2

Sault Ste. Marie Area

	PAGE
Introduction	1
Previous work	1
Map	1
General character of the area	2
Topography	2
Waterways	3
Lakes	3
Forests	3
General Geology	4
Introduction	4
Table of formations	4
Pre-Huronian	5
Basement series	5
Distribution	5
General character	5
Conglomerates	7
Quartzites	8
Lavas	8
Schists	9
Diabase	10
Age relationship	10
Granite gneiss (Algoman?)	10
General character	11
Age relationships	11
Huronian	12
Soo series	12
Driving Creek formation	13
Distribution	13
General character	13
Structure	13
Duncan greenstone	14
Structure	15
Aweres formation	16
Rocks	16
Quartzites	18
Structure	18
Stratigraphical relationship	19
Bruce series	20
Mississagi quartzite	20
General character	21
Stratigraphical relationship	22
Bruce limestone	22
Cobalt series	23
Lower Cobalt	23
Distribution	23
Rocks	24
Upper Cobalt	27
Rocks	27
Structure and stratigraphical relationship	29
Cobalt boulder conglomerates	30
Origin	30
Character of Matrix	32
Distribution	33
Underlying surface	33
Striated boulders	34
Keweenawan	35
Effusives	35
Intrusives	36
Olivine diabase	37
Age relationship	38
Younger granite	38
Distribution	38
General character	38
Age relationship	39
Cambrian	40
Lake Superior sandstones	40
Distribution	40
Rocks	40
Structure and age	42
Pleistocene and recent	42
Boulder clay	42
Fluvio-glacial deposits	42
Outwash deposits	43
Lake deposits	43
Algonquin stage	43
Nipissing stage	44
Recent deposits	44
Economic Geology	44
Mines and prospects	44
Victoria mine	45
Cascade mine	45
Rankin mine	46
Lucinda mine	46
Other properties	46
Iron prospects	47
Structural Materials, Quarries, etc	48
Limestone	48
Building stone	48
Clays	49
Silicia	49
Artesian waters	50
Addenda	51
Lead-zinc ore near Searchmont	51

Batchawana Area

	PAGE
Introduction	53
Previous work in the area	54
Topography	55
Micrometer surveys	57
Flora and Fauna	58
General Geology	59
Batchawana series	59
Mamainse diabase	60
Algoman?	61
Keweenawan system	63
Lower Keweenawan	64
Middle Keweenawan	65
Character and distribution	65
Section between Mica and Pancake bays	67
Conglomerate and sandstone	69
Igneous rocks	71
Upper Keweenawan	73
Dikes of olivine diabase and quartz-porphyry	74
Pleistocene	75

PAGE

Structural Geology 76
Economic Geology 76
Iron formation 77
Batchawana (Batchewanung) mine. 77
Vulcan and Mammoth locations... 78
Copper deposits 81
Mamainse mine 81
Nipigon Mining Company's property 82
Begley location 84
Quartz veins 85

SAHKATAWICH LAKE SECTION, WOMAN RIVER IRON RANGE

PAGE

Introduction 86
Location and accessibility of the property 86
Surface features of the region 87
General Geology 87
Iron formation 89
Economic Geology 90
Iron deposits 90
Claims W.D. 1,736 to 1,731 90
Claims W.D. 1,730, etc 91
Claims W.D. 720 to 715 92
Utilization of the iron ore 94
Lead-Zinc deposit 94

ILLUSTRATIONS

PAGE

Conglomerates, Basement series, south of Maple lake, Deroche township 7
Conglomerates, Aweres formation, in rock cut southwest of Bellevue station 17
Aweres formation (conglomerate) overlying granite, east of Bellevue 19
Upper Cobalt quartzite, Bellevue ridge 29
Cobalt conglomerates resting on schists of the Basement series, Midge lake 34
Prominent hill due to Keweenawan dike, looking north across Mitchell lake 55
Rugged shoreline of interbedded Middle Keweenawan lavas and conglomerates, Mica bay .. 56
Falls over diabase on the Batchawana river 57
Wharf at Batchawana village, Batchawana bay 58
Lower Keweenawan porphyritic diabase cutting granite at the first falls on Harmony river .. 62
Mica bay, east shore of Lake Superior, Keweenawan amygdaloidal basalt in foreground 63
Lower Keweenawan diabase dike forming prominent hill opposite M. 81, A.C. Ry 64
Algoman granite ridge with Upper Keweenawan sediments and Lower Keweenawan lavas .. 67
Large granite boulder in Middle Keweenawan conglomerate 70
Middle Keweenawan conglomerate showing boulders and pebbles 71
Olivine diabase dike cutting granite, Mica bay. Note the spheroidal weathering in the dike. 74
Varved clay on Harmony river above first falls and rapids 75
Test pit in iron formation on edge of a beaver pond in southwest corner of the Mammoth location 80
Mamainse mine from the lake. Conglomerate overlain by amygdaloid in the foreground .. 82
Conglomerate with native copper at shaft on Copper Creek vein 84
Vein of galena and sphalerite in the shaft on claim W.D. 717 95

SKETCH MAPS AND DIAGRAMS

Fig. 1—Generalized section across the central portion of the Soo series 12
Fig. 2— " " " " Driving Creek formation 13
Fig. 3—Section showing basal beds, Lower Cobalt series, Rankin location 25
Fig. 4—General section of southwestern slope, King mountain, Vankoughnet township 27
Fig. 5—Key map showing position of the Batchawana area 53
Fig. 6—Generalized section showing the structure of the formations between Mica bay and Coppermine point 66
Fig. 7—Index map showing location of routes to the Sahkatawich (Rush) Lake section of the Woman River iron range 87

INSERT AND COLOURED GEOLOGICAL MAPS

Geological map (uncoloured) of the Sahkatawich (Rush) Lake section of the Woman River Iron Range, scale ½ mile to the inch ..... *Insert facing* 88
Map No. 35*a*—Sault Ste. Marie Area, District of Algoma, scale 2 miles to the inch ..... *In pocket*
Map No. 35*b*—Batchawana Area, District of Algoma, scale 2 miles to the inch ..... *In pocket*

SAULT STE. MARIE AREA, DISTRICT OF ALGOMA

By R. G. McConnell

Introduction

The present report deals with the geology of an area in the vicinity of Sault Ste. Marie, Ont., extending from the St. Mary river northward to Batchawana bay, and from Lake Superior eastward to and including the Garden River Indian Reserve, Duncan township, and portions of Anderson and Deroche townships.

Previous Work

This district was explored and partly mapped by Alexander Murray in the early days of the Geological Survey of Canada, and a brief description of the geology is published in the 1863 report. Since then it has been visited at various times by numerous geologists interested in the structure of the Huronian group of formations and other problems bearing on pre-Cambrian geology; but these visits were all for some special purpose, and no general detailed work was carried out. Murray's outline of the geology of the area is still copied with little or no alteration on all general maps.

The work of the early explorers was confined largely to navigable streams, lake shores, and points easily accessible from these. In the Sault Ste. Marie area the interior was not examined in detail, but the mapping of a strip along the St. Mary river and northward along the coast of Lake Superior proved to be remarkably accurate. The limestone band, now known as the Bruce limestone, was considered to be an important horizon marker, and a painstaking search was evidently made for exposures. The country was heavily forested at the time, but was nevertheless combed so thoroughly that all the small scattered occurrences were found and mapped.

While the Sault Ste. Marie area itself has been largely neglected, an intensive study of various pre-Cambrian areas to the east, along the north shore of Lake Huron, has been carried out in recent years by Dr. W. H. Collins, Director of the Geological Survey of Canada, with highly important results, especially in regard to the structure and sequence of the various Huronian formations and their stratigraphical relationship to each other and to older series.[1] This work was of great assistance in unravelling the tangled stratigraphy of the Sault Ste. Marie area. Other recent work in the vicinity of the area mapped includes an examination of Deroche, Hodgins, Shields, and Gaudette townships, by Sir Stopford Brunton in 1921.[2]

Map

The geological map, No. 35*a*, accompanying this report is based largely on township plans. The surveys for these were made many years ago, and the lines were difficult, in some instances impossible, to follow, as all markings had disappeared and posts had rotted away. In the absence of other means, positions were fixed as closely as possible by paced traverses from the nearest fixed point. The traverses were usually short, but some error in the laying down of geological boundaries by this method is unavoidable.

A small section in the southeastern part of the area is copied from Dr. Collins' map of the Bruce Mines area.

During the progress of the work the writer was visited in the field by the late Dr. W. G. Miller, A. G. Burrows, and Cyril W. Knight, of the Ontario

[1]Geol. Surv. Can., Mem. No. 143, 1925.
[2]Geol. Surv. Can., Sum. Rept., 1921, pt. D., pp. 27-33.

Department of Mines, and Dr. Collins, of the Geological Survey of Canada, and received helpful suggestions from them.

General Character of the Area

Topography

The Sault Ste. Marie area, with the exception of a terraced strip north of the St. Mary river, a wide flat along the lower portion of Goulais river, and Kars and Ley townships bordering Lake Superior, is a region of rough forested ridges and broken plateaus, plentifully sprinkled with picturesque lakes. The general elevation increases to the north and reaches its highest point in King mountain in Vankoughnet township.

The drift-covered strip north of the St. Mary river extends across the area with a width of from one to five miles. In the central and western portion, it rises toward the north in a succession of clay, sand, and gravel terraces, the highest being 420 feet.

The terraced lowlands are of composite origin. They are largely built of lake deposits, clay and silt below, and sand and gravel above, but in places an underlying boulder clay has been exposed by erosion. Alluvial flats occur along the lower reaches of Garden river and Root river and are still being added to. The lake deposits are also overlain along the granite escarpment that borders them on the north by occasional small fan-shaped areas of stream gravels.

The Goulais river lowlands are less conspicuously terraced than those along the St. Mary river. Clay and sand flats of lacustrine origin occur toward the eastern end, but over most of the area the lake deposits have been partially or wholly removed by the meandering Goulais river. For some distance east of Goulais bay, the plain is low and swampy and largely surfaced with coarse sand and gravel. Only occasional patches have any agricultural value.

In section 9, Fenwick township, a wide ridge extends southward from the bordering schist escarpment on the north into the Goulais river flats for a distance of over a mile. The ridge where crossed by the road has a height of 150 feet above the lake. It is built of drift and may be of morainic origin, but exposures in the thickly wooded slopes and summit of the ridge are too small and infrequent to show its character definitely.

Kars and Ley townships fronting Lake Superior at the northwest corner of the area mapped are drift covered everywhere, with the exception of a few rock exposures along the lake shore and a low quartzite ridge in section 12, Kars township. The drift includes lake clays and sand and boulder clay. The southern part of Kars township is a flat sandy plain, but toward the north the drift is piled up in a wide ridge rising to a height of 175 feet above the lake. The surface is generally sandy, and the soil in both townships is of little value for agricultural purposes.

The rock ridges and broken plateaus of the area are all partially drift covered, and the topography varies with the character of the underlying rocks. Schist areas are usually surfaced with a succession of ridges, many of them with steep, cliffy, southern slopes and an easy inclination to the north. Gneissic areas have the same general character, but the ridges are shorter and less regular. The younger granite weathers into a hummocky surface; the quartzite areas, where the beds have a low inclination, into cliff-bordered irregular plateaus; and where steeply tilted into narrow ridges, such as Bellevue ridge. Diabase areas often exhibit strong relief. The long sill in Vankoughnet township is bordered on the south by a series of imposing cliffs rising in places to a height of 700 feet,

and conspicuous hills and ridges of diabase rise high above the general level in the eastern part of Duncan township north of Garden river.

King mountain in Vankoughnet township, with an elevation of approximately 1,400 feet above Lake Superior, is the highest point in the area. It forms part of a broken upland, three to four square miles in extent, capped with the massive quartzite of the Upper Cobalt. The slopes to the north are easy but elsewhere are steep and interrupted by numerous cliffs. West of King mountain a range of rugged granite hills, some of them approaching 1,000 feet in height, extends northwestward to Havilland bay. Other prominent elevations are Bellevue ridge; a schist ridge in Havilland township, the highest point of which is known locally by the inappropriate name of Pikes peak; and Green mountain, south of Driving lake. Ordinarily the uplands of the area are flanked by steep escarpments from 300 to 500 feet in height. The surface, while rough and hilly and broken by numerous ravines, preserves a fairly uniform height, few of the elevations rising much above the general level.

Waterways

The principal streams of the area are the St. Mary river, connecting Lake Superior with Lake Huron; Goulais river, which crosses the area from east to west; and Garden river, a tributary of the St. Mary. In addition to these a multitude of smaller streams, usually heading in lakes, wind across the broken uplands towards the main waterways and Lake Superior. The most important of these are Root river, the two Carp rivers, and Driving, Shepherd, Stokely, Cranberry, and Robertson creeks. Few of the smaller streams have graded channels, except in their lower reaches, and the numerous falls and cascades bear witness to the usual disorganization of the drainage system during the glacial period. The east branch of Root river and Carp river both cascade down the escarpment bordering the St. Mary river lowlands on the north in a series of picturesque falls.

Goulais and Garden rivers, unlike the smaller streams, are enclosed except near their mouths in great valleys of pre-glacial origin. Both valleys were filled with drift during the glacial period. This has since been largely removed in places down to the old bed rock. Some of the smaller streams, notably lower Shepherd creek and Stokely and Driving creeks, in part also occupy scoured-out pre-glacial depressions.

Lakes

The numerous clear lakes of the area, often enclosed in rocky basins and surrounded in most cases by still unburned forest, are one of its most attractive features. Island lake and Trout lake in Aweres township and Robertson lake in Vankoughnet township are well-known summer resorts, but other lakes equally beautiful but less accessible occur in practically every part of the area except the sandy lowlands. The lakes are small, seldom exceeding three miles in length, and owe their existence, as in other glaciated regions, largely to blocked drainage channels.

Forests

The area was originally heavily forested throughout mostly with hardwood trees on the uplands and coniferous varieties in the flats and lower slopes. Lumbering operations have been carried on for many years, and while extensive hardwood forests still remain, few groves of pine or large spruce have escaped. Forest fires have aided to some extent in their destruction, but the area has suffered less in this respect than is ordinarily the case.

The sugar maple is the most abundant of the hardwoods and is prominent everywhere in the unburned uplands. Other common varieties are white and

yellow birches and soft maple. The forest also included a few oaks of fair size on the highlands, and scattered elms and ashes along some of the streams.

The common soft woods are the white and black spruce, white pine, hemlock, balsam fir, cedar, tamarac, and smooth and rough bark poplars.

General Geology

Introduction

The rock formations of the area range from pre-Huronian to Cambrian. The oldest series consists of steeply tilted schists, largely of clastic origin, but including a few bands derived from basic and acid lavas and tuffs. This series is called the Basement series in this report as it differs in some respects from both the Timiskaming and Keewatin and cannot be definitely correlated with either. It is intruded by granite and diabases, also pre-Huronian in age.

The hard rock formations of the area are mantled and in places deeply buried over considerable areas beneath a covering of drift made up of boulder clays, sands, and gravels, overlain by lake clays, silts, sands, and gravels. The latter cover the lowlands and extend up the slopes to a height of over 400 feet.

Table of Formations

QUATERNARY		
Pleistocene:		Lake clays, sands and gravels, boulder clays.
	Unconformity	
PALEOZOIC		
Cambrian:		Lake Superior sandstones, shales and conglomerates.
	Great unconformity	
PRE-CAMBRIAN		
Keweenawan:		Olivine diabase dikes. Younger granite. Quartz diabase. Basic and acid lavas.
	Unconformity and intrusive contact	
Huronian:	Cobalt series:	Upper Cobalt quartzites. Lower Cobalt greywackés, quartzites, and conglomerates.
	Unconformity	
	Bruce series:	Bruce limestone. Mississagi quartzites.
	Probable unconformity	
	Soo series:	Aweres quartzites, conglomerates and greywackés. Duncan greenstone. Driving Creek quartzites and conglomerates.
	Great unconformity	
Pre-Huronian:	Algoman (?):	Granite and granite gneiss batholiths.
	Intrusive contact	
	Basement series:	Hornblende and chlorite schists, lavas, conglomerates, greywackés and quartzites, cut by pre-Huronian diabases and granites.

The Basement series and associated intrusives are overlain unconformably by a number of Huronian formations divisible in ascending order into three series: Soo, Bruce, and Cobalt. The two latter are well-known groups, and their occurrences along the north shore of Lake Huron, east of the Sault Ste. Marie area, are described in detail by Dr. Collins in a recent publication. The Bruce series, in the area reported on by Dr. Collins, rests generally on rocks assigned to the pre-Huronian, but in places overlies the Sudbury series, the age of which

is still in doubt. In the Sault Ste. Marie area, the Bruce series is underlain by an older group of Huronian formation for which the name Soo series is proposed.

The Soo series consists of two sedimentary formations, largely conglomerates and quartzites, separated by a wide band of basic lavas. Its contact with the Bruce is probably an unconformable one, although the field evidence on this point is not altogether satisfactory. The rocks of the two series show diverging dips where they approach each other, amounting in places to over 30 degrees, but no close contacts were found. The junction is everywhere concealed by a few feet of drift or debris.

The Huronian group of formations is followed by basic and acid intrusives and lavas referred to the Keweenawan. The lavas have a limited distribution and are confined to the immediate coast of Lake Superior. Intrusives considered to belong to the same age include an extensive development of quartz diabase sills and dikes, a younger set of olivine diabase dikes, and granitic dikes and batholiths.

The Keweenawan lavas are overlain unconformably by the Lake Superior sandstone. This formation is placed in the Cambrian. It is unfossiliferous, and its exact position in the geological scale is uncertain.

PRE-HURONIAN

Basement Series

The oldest rocks of the area consist mainly of a series of green and grey schists, derived mostly from clastics but in places representing crushed massive rocks. Associated with these are conglomerates, quartzites, unschisted or only lightly schisted greywackés, massive and sheared lavas, both basic and acid, tuffs, and occasionally small bands of iron formation. This assemblage of rocks resembles in some respects those of the Keewatin and in others those of the Timiskaming, but cannot be definitely assigned to either of these pre-Huronian formations. It was considered inadvisable to apply a new name to them, and they will be referred to in this report simply as the Basement series.

Distribution

The Basement series outcrops in a number of disconnected areas extending from Garden river northwestward across the area mapped to Batchawana bay on Lake Superior. A triangular-shaped area covers the eastern portion of Duncan township and is traceable northwards through Anderson township to Midge lake in Deroche township. The schists in this area are bordered on the south by the Mississagi quartzites of the Bruce series, on the west by the younger granites, and on the east by the older granites intruded in places by the younger. From Midge lake to Northland on the Algoma Central railway, the schists have been largely destroyed by granitic intrusions, but schist inclusions in the granite are numerous. West of Northland they reappear and extend westward in a wide band cut by the deep valley of Goulais river to Sill lake in Vankoughnet township where they disappear beneath the greywackés of the Lower Cobalt. Farther west, irregular-shaped areas outcrop in Fenwick and Havilland townships; and the southern part of Tupper, mapped as granite, is partially underlain by small included schist areas.

General Character

The rocks of the Basement series differ considerably in character in the various areas, the proportion of schist derived from sediments increasing markedly towards the west.

In the southwestern area, extending from Garden river northwards to Midge lake, the rocks are mostly of igneous origin, largely greenstone schists, striking north and dipping steadily to the east across the area at angles of from 50 to 80 degrees, or more. The schists of sedimentary origin are apparently strictly conformable in dip and strike to those derived from massive and fragmental igneous rocks. The planes of schistosity are everywhere remarkably regular, seldom showing any crinkling or contortion, even along the granite contacts.

The principal rock varieties in the southern part of the area from west to east, and in ascending order according to the dip, are chlorite and hornblende schists, followed in the vicinity of Driving lake by alternating bands of quartz porphyry, feldspar porphyry, and chlorite schists. From Driving lake chlorite and hornblende schists, cut by several areas of quartz diabase, extend eastward to near the granite contact where they are overlain by a band of tuffs. In addition to the rocks mentioned, altered but uncrushed basic lavas occur in an isolated ridge south of Driving creek and also in a small area south of the west end of Driving lake, where they are faulted up through the Mississagi quartzites. The succession is apparently continuous, no evidence of a repetition of any of the bands being observed.

The tuffs, the highest rocks of the series, outcrop in a band about a quarter of a mile wide, bordering the granite and dip steeply toward it. They are hard, dark-green, highly altered, but only slightly schisted rocks. Their clastic character is evidenced by an alternation of layers differing in texture and hardness. On weathered surfaces, the harder layers usually project in a series of narrow ribs.

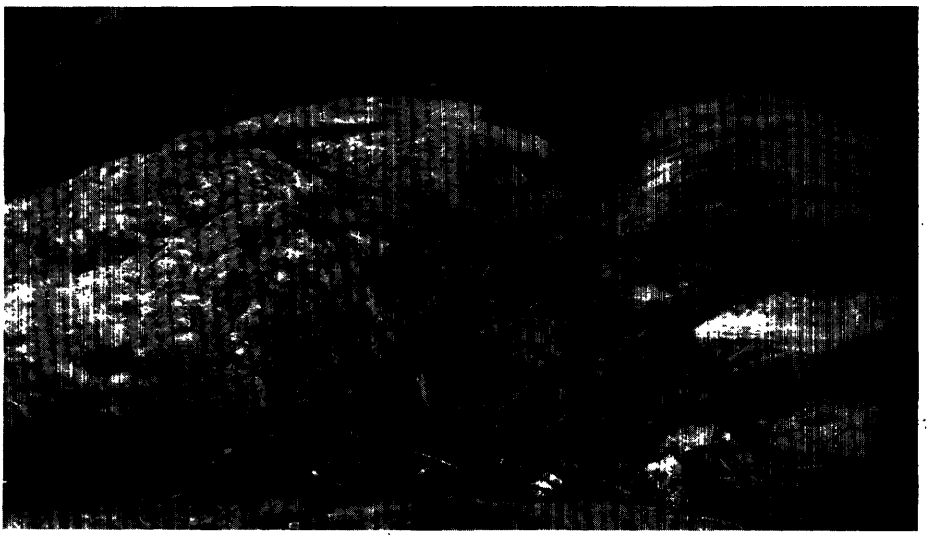
The greenstone schists occur in a highly fissile condition in some bands and in others are only lightly sheared. The thinly foliated varieties represent in part at least altered greywackés, while the coarsely sheared varieties are largely crushed igneous rocks. Owing to the intense alteration of the rocks, the original character is not always evident even in thin sections.

Feldspar porphyry-schists are well exposed in a band about half a mile wide along the eastern part of the north shore of Driving lake. They are hard, greyish, flaggy rocks separating easily along the shearing plane into plates an inch or more in thickness. Thin sections of this rock show cloudy feldspar individuals, porphyritically distributed through a fine-grained base, partially altered into sericite. The feldspar phenocrysts have not been flattened or broken and are easily recognizable in hand specimens. Other smaller bands of light-coloured acid schist, often closely resembling massive quartzites, occur at the west end of Driving lake and northwestward along the valley of the main feeder of the lake. These are largely quartz porphyry-schists, thin sections showing both corroded quartz and feldspar phenocrysts, usually intact but occasionally crushed into angular fragments.

Farther north, south of the Duncan-Anderson boundary, a second section across the same area of the Basement series shows a nearly similar succession. The underlying rocks bordering the granite on the west are mostly greywackés in various stages of alteration. These are followed by chlorite and hornblende schists, alternating in places with narrow bands of quartz porphyry-schist and overlain by tuffs near the granite contact on the east. The tuffs here and for some distance northwards hold occasional short, narrow bands of the peculiar black and white striped siliceous rock known as iron formation. The black layers, usually less than an inch in width, are rich in magnetite, and the same mineral also occurs in places disseminated through the bordering schists. Many

attempts have been made to locate a commercial deposit in the iron-bearing zone, but so far without success.

North of the Duncan-Anderson boundary, the schist area gradually narrows, and at one point south of the north boundary of Anderson the width between the enclosing granites is less than a quarter of a mile. North of the boundary, it widens again, and at Midge lake where it terminates has a width of about a mile. The principal variety here is a medium-grained, green hornblende schist. The moderate dips of the schist along the west boundary, and the even bedding all across the area, suggest a sedimentary origin, but the alteration has been so complete that no trace of clastic structure remains.



Conglomerates, Basement series, south of Maple lake, Deroche township.

The rocks of the Basement series in the area extending from Northland westward along the Goulais river for six miles differ considerably in character from those in the Garden River area. In both areas hornblende and chlorite schists variously derived and in various stages of alteration constitute the greater part of the series, but the proportion of those manifestly derived from clastics, largely greywackés, is greater in the northern than in the southern area, and the alteration on the whole is less. Also the schists in the northern area are associated with conglomerates in considerable amount, occasional beds and bands of quartzites, and at two points with small bands of crushed pillow lava. The direction of the strike also changes from north and south to nearly east and west, and the dips are everywhere to the north.

Conglomerates

The conglomerates have a very irregular and bunchy distribution. They resemble very closely in places the conglomerates of the Lower Cobalt, and the possibility arose of their being infolds of these. A detailed examination showed plainly that they alternated conformably with the other members of the Basement series and formed part of it.

In the Goulais River area the Basement series terminates on the south in a steep rocky escarpment, usually from 200 to 300 feet in height. Conglomerates

alternating with quartzites, greywackés, lavas, and at one point iron formation, outcrop in the face of the escarpment from Pothole lake, in lot 10, concession II, Deroche township, westward to the outlet of Deer lake, a distance of a mile and a half. They form the exposed base of the series in the escarpment but are not confined to this position, as they occur at two horizons higher up, alternating with greenstone schists.

The greatest development of conglomerates in the Basement series occurred at the west boundary of the Goulais River area south of Goulais river. Here the whole series is made up of alternating bands of conglomerates, quartzites, and greywackés for a distance across the strike of over a mile. As the dips are steep, varying from 60 degrees to nearly vertical, and are uniformly northward, the conglomerate and associated beds must have a thickness of fully 3,500 feet. Traced eastward along the strike, the pebbles and boulders disappear, usually at distances of less than a mile, and the succession of sedimentaries gradually passes into schists. The alteration increases toward the east, but the schists, even near the granite, usually retain some traces of the original clastic structure.

The pebbles and boulders of the Basement series conglomerate represent a number of rock types. Red granite, in pebbles and rounded and angular boulders up to three feet in length, is conspicuous in most of the sections. Other varieties usually present include grey granite, gneiss, greenstone schist, quartz, and quartzite. The pebbles and smaller boulders are usually well rounded, while the larger ones have angular outlines. Boulders distorted and fractured by pressure are occasionally found, but ordinarily they still retain their original shapes. The coarse material of the conglomerates shows little evidence of sorting, except in the case of a few small, lenticular, pebble beds. Ordinarily pebbles and boulders are intermingled in the irregular manner characteristic of the Cobalt boulder conglomerates.

The matrix of the conglomerate is usually a medium-grained greywacké of arkose made up largely of angular grains of quartz, feldspar, and small rock fragments. Chlorite is always present and in some instances has developed in sufficient quantities to give the rock a schistose character. In one extreme case, a bed carrying a few scattered pebbles and boulders consisted almost entirely of a finely fissile, glossy chlorite schist.

Quartzites

The quartzites of the Basement series have a limited distribution and are mostly confined to the basal portion. They occur in occasional beds and bands, sometimes as much as fifty feet or more in thickness, alternating with greywackés and conglomerates and infrequently with schist. The beds and bands are usually quite massive, seldom showing any distinct intermediate lines of bedding or parting planes of any kind. The ordinary variety is a hard, light-greyish, medium to fine grained rock, made up of a base of small angular quartz and feldspar grains enclosing a variable proportion of larger ones. Feldspar is much less abundant than quartz but in the sections examined is always present in some quantity. Other constituents include chlorite, iron oxide, and less frequently sericite.

Lavas

Lavas alternating with the conglomerates, quartzites, and schists of the Basement series occur north of Pothole lake and on lots 10 and 11, range II, Deroche township, and also west of Deer lake in sections 25 and 26, Vankoughnet township. The succession at the former point in ascending order consists of conglomerates of unknown thickness at the base of the escarpment, followed by a band of dark blocky lava 90 feet in width, a second band of conglomerates

about 80 feet in width, and 30 feet of iron formation. The latter is overlain by a second lava band partially drift covered, but probably a hundred yards at least in width. North of this, after a concealed interval, are schists of sedimentary origin. The lava in the second band has the ellipsoidal markings of pillow lava. It is a greenish, coarsely sheared rock, the shearing planes coinciding in dip and strike with the bedding planes of the accompanying sedimentaries. Thin sections show that it consists mainly of hornblende and cloudy striated feldspar, with some magnetite and occasionally a few grains of quartz.

The lava occurrence west of Deer lake has a width of about a quarter of a mile and is traceable westward along the escarpment which here limits the Basement series on the south for a distance of over a mile. Along most of its course it is the lowest exposed rock of the series, but towards its west termination it is underlain, apparently conformably, by conglomerates. The overlying rocks are conglomerates and hard greenstone schists. The spheroidal markings of the lava have been flattened and the whole band squeezed and altered into a hornblende schist, but traces of the original structure can still be detected in thin sections. The principal constituents are hornblende, chlorite, and cloudy feldspar.

Schists

The schist of the Basement series in the Goulais River area resembles in a general way the schists of the Garden River area previously described. South of the Goulais river they are mainly greywackés and impure quartzites in various stages of alteration into hornblende and chlorite schist. North of Goulais river, the schists of clastic origin alternate at several points with bands of hornblende schist derived from crushed, massive igneous rocks and in one instance with a greyish sericitic schist probably representing an acid lava.

The schists and accompanying rocks in this area have a width along the Deroche-Vankoughnet boundary of three and a half miles. The dips are uniformly northward at angles of from 60 degrees to nearly vertical. No repetition of the various members of the series by faulting or overturn folds was observed, but as the region is forested except along the escarpment and as exposures are scattered, these could easily be overlooked. The thickness of the series is therefore uncertain but probably exceeds 10,000 feet.

West of the Goulais River area, the Basement series is concealed for several miles, partly by drift and partly by the greywackés and quartzites of the Lower Cobalt. It reappears farther west in the northern part of Fenwick township and spreads northward in two irregular areas, separated by a band of Lower Cobalt rocks, into Havilland township.

The Basement series in these western areas is made up mostly of medium-grained hornblende and chlorite schists, usually showing in thin sections evidences of its clastic origin. Lavas are absent or are so schisted as to be unrecognizable. Conglomerates occur at the base of the series in section 12, Havilland township, and occasional small, blunt lenses, a few feet in length, are interbanded with the schists for 500 feet above the exposed base. An isolated exposure of conglomerates also outcrops near the east boundary of section 33, Havilland township.

The conglomerates show the same bunchy distribution as in the Goulais River area, and their general character is similar. They extend along the escarpment for a distance of about a third of a mile, with a width of from 100 to 300 feet. At the east end they are replaced so abruptly by schists that faulting was suspected, but no evidence of this was found. The associated rocks are greywackés, passing into schists and hard, close-textured quartzites. The boulders of the conglomerate, mostly red and grey granite, quartz, quartzite,

and schist, are small, seldom exceeding six inches in diameter, and are usually well rolled.

A feature of the Basement series in sections 11 and 12, Vankoughnet township, is a low inclination of the exposed basal beds ranging from 15 to 25 degrees. The dips are everywhere to the north and, except near the base, are usually steep, often 70 degrees or over. The outcrop of conglomerates referred to above as occurring in section 33, Havilland township, near the north boundary of the formation, may possibly be a repetition of those exposed along the south boundary, but as the exposure is isolated, this is uncertain.

In addition to the areas of the Basement series of rocks described, a number of smaller areas, mostly made up of hornblende schists, extend from the eastern portion of Havilland township eastward across Tupper township. These alternate with granite and diabase and are cut by numerous granitic dikes. They no doubt represent a once continuous band partially destroyed by intrusives.

Diabase

The schists and other members of the Basement series are cut by numerous dikes and small, irregular-shaped areas of a pre-Huronian diabase. In the field this older diabase can usually be distinguished from the younger Nipissing diabase by its older, more altered appearance. It is also occasionally roughly schisted in the same general direction as the schists it cuts. North of Goulais river, bands of schists derived from diabase alternate in places with the schists of clastic origin. The principal constituents of the older diabase are hornblende and a basic striated feldspar, chlorite, and in some sections a few grains of quartz. Augite is occasionally present, but as a rule the alteration of this mineral to hornblende is complete. Epidote and iron oxide in scattered grains are common secondary minerals.

In thin sections the pre-Huronian diabase is distinguished from the Nipissing diabase by its greater alteration, less siliceous character, and by the absence of intergrowths of quartz and feldspar, a common feature of the latter.

Age Relationship

The schists of the Basement series are cut by both the older and younger granites, and at points where they are found in close contact with the Huronian formations, their inferior position and unconformable relationship to them is unmistakable. At the southeast corner of Midge lake in Deroche township, Lower Cobalt conglomerates rest on the Basement series schists at discordant angles, and near Bellevue they are overlain at several points by the conglomerates and quartzites of the Aweres formation. They are plainly the oldest rocks of the area and may possibly represent the Keewatin, but if so they include a much larger proportion of rocks of sedimentary origin than is ordinarily the case.

Granite Gneiss (Algoman?)

Granite and granite gneiss considered to be of Algoman age occupy two sections in the area. The largest of these extends from Gros Cap on Lake Superior eastward to Surette lake, in the Garden River Indian Reserve, a distance of 20 miles, and where crossed by the Goulais Bay road has a width of over seven miles. The second area is situated along the east boundary of the area mapped, from Garden river northwards.

The Gros Cap area forms a wide, rugged ridge with an elevation of from 400 to 600 feet above Lake Superior, bordered on the north by the Goulais river flats and on the south by the St. Mary river lowlands. On the east the granite

sinks below Huronian sediments and on the west terminates in a series of high bluffs fronting Lake Superior. At various points along its south, north, and west boundaries, it is overlain by disconnected exposures of Lake Superior sandstone and north of Gros Cap is in contact for a short distance with Keweenawan lavas. The younger formations rest against the base of the granite ridge in such a manner as to suggest that even in Huronian and Keweenawan times it possessed considerable relief.

General Character

The Gros Cap granitic batholith varies greatly in character in different areas. The batholith apparently had its centre in Prince township. The granite here is massive or only slightly schistose, over a considerable area, and contains few inclusions. To the east it gradually passes into a complex made up of several red and light-grey, granitic, gneissic, and aplitic varieties, the later cutting the older, interbanded, grey and dark micaceous schists and numerous irregular-shaped inclusions of greenish hornblende schists, evidently metamorphosed fragments of the Basement series. The complex is cut by a number of wide quartz diabase dikes and by occasional reddish porphyritic dikes considered to be genetically related to the younger granite.

The numerous granitic and schistose types along the eastern peripheral portion of the batholith were not studied in detail. They represent several intrusions, and the great variability in character is no doubt due partly to magmatic differentiation and partly to the more or less complete assimilation of portions of the covering sediments.

The massive, in places lightly, gneissic variety in Prince township and neighbourhood is usually a rather coarse-grained rock, red-coloured in some areas and greyish and greenish in others. It is syenitic in character, consisting essentially of hornblende orthoclase and albite with occasional small quartz grains, but passes frequently with an increase in the quantity of quartz present and the addition of microline into a hornblende granite. Other minerals commonly present include chlorite, epidote, sphene, and magnetite. The granite gneisses of the area are seldom strongly foliated, and the banded structure common in other regions is nowhere conspicuous.

Age Relationships

The Gros Cap granite gneissic area is in contact along its east border with Aweres formation, the upper member of the Soo series of the Huronian formations, and the field conditions show conclusively that it underlies the Huronian sediments unconformably. It is nowhere intrusive into them, and in one section near the south end of Lower Island lake a gradual passage from granite into an overlying pebble conglomerate was noted. Also, east of Bellevue, a coarse conglomerate at the base of the Aweres formation rests directly on granite. Other sections examined were less plain, owing to the separation of the two formations by a narrow concealed interval.

The relationship of the granite gneiss to the Basement series schists on the other hand is plainly an intrusive one. The granite holds inclusions of the schists, and in Duncan and Anderson townships granite dikes from the eastern, granite gneissic batholith cutting the schists are frequent. Also in Fenwick township, the schists are traversed by a band of granite gneisses.

The granite gneisses are, therefore, older than the Huronian sediments and younger than the schists of the Basement series. They were probably intruded into the schists after the latter were folded and also after the intrusion of the older diabase.

HURONIAN

The Huronian in the Sault Ste. Marie area is divisible into three series, for which the names Cobalt, Bruce, and Soo series are used in this report. The Cobalt series, the upper and most widely distributed member, was defined and named by Dr. Miller from occurrences in the Lake Timiskaming area. In that area, the Cobalt rests on pre-Huronian rocks. Farther west the Cobalt is underlain unconformably by an older group of Huronian formations. These have been described by Dr. Collins under the name of the Bruce series. The Soo series, the lowest member, has not been definitely recognized, up to the present, east of the Sault Ste. Marie area.

Soo Series

The name Soo series is applied to a group of three, hitherto unmapped, Huronian formations extending from the Garden River Indian Reserve northward to Bellevue on the Algoma Central railway. It is bordered on the west by a pre-Huronian granite complex, and on the east by a post-Huronian granite, holding inclusions of the older granite. The group is made up in descending order of the Aweres formation, Duncan greenstone, and the Driving Creek

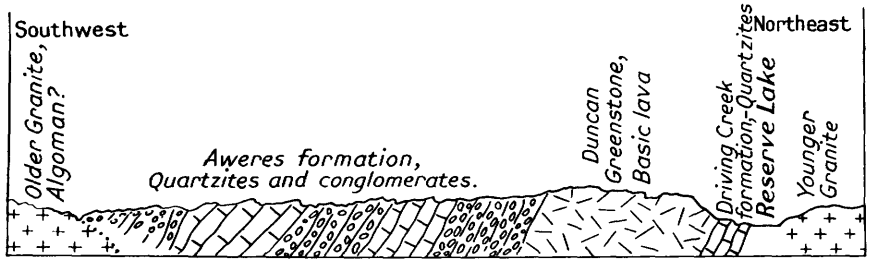


Fig. 1.—Generalized section across the central portion of the Soo series, Trout lake to Reserve lake, Aweres and Jarvis townships. Horizontal scale 1¼ miles to the inch.

formation. The Aweres formation consists of a succession of conglomerates and quartzites, with some greywackés, resembling in a general way the Lower Cobalt; while the Driving Creek formation, mostly grey quartzites passing below into conglomerates, is not unlike the Mississagi. The greenstone separating the two formations—a basaltic lava—is disturbed in places and probably faulted at its contact with the underlying Driving Creek quartzites, and the first determination reached in regard to the position of the members of the series was that the intermediate lava band represented a strip of pre-Huronian lavas faulted up over the Mississagi and overlain by the Lower Cobalt. As work progressed, this determination proved to be untenable. The field evidence, while nowhere absolutely conclusive, indicated that the Soo series was older than the Bruce series and probably underlaid it unconformably. The resemblance of the Aweres formation to the Lower Cobalt is more superficial than real. The rock types are the same, but the relative proportions of these and their distribution through the formations are quite different. The Duncan greenstone also is much finer grained and less altered than the basic lavas of the Basement series in neighbouring areas, and the conglomerates at the base of the Driving Creek formation differ markedly in character from those at the base of the Mississagi. The enclosures are more rounded and consist largely of grey granite and quartzite. Red granite pebbles and boulders, common in all the other Huronian conglom-

erates, are seldom present. The general strike of the members of the Soo series is also nearly transverse to that of the Bruce and Cobalt formations, a condition not readily explainable except by earlier folding.

DRIVING CREEK FORMATION

Distribution

The Driving Creek formation, the lowest member of the Soo series, has a very limited distribution. It occurs in a number of small disconnected areas, scattered along the east border of the Duncan greenstone, aggregating altogether less than three square miles. Two areas, each about a square mile in extent, separated by a spur from the main Duncan greenstone band, occur in Duncan township just north of the Indian Reserve line, and smaller areas occur west of Reserve creek, on Reserve lake, and northwards to near the northwest corner of Jarvis township. The present fragmentary distribution of the formation is due to its being partly buried beneath the Duncan greenstone and partly destroyed by the younger granites, which adjoin and intrude it on the east. An outlier, a quarter of a mile long, enclosed in granite, outcrops in section 5, Duncan township.

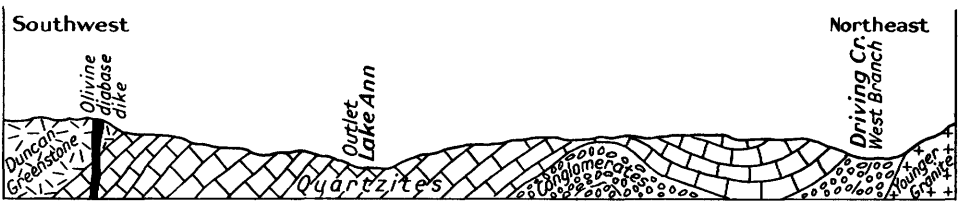


Fig. 2.—Generalized section across the Driving Creek formation, section 6, Duncan township. Horizontal scale, 1,500 feet to the inch.

General Character

The Driving Creek formation is made up of quartzites passing downward into conglomerates. The quartzites are ordinarily medium-grained, light-greyish to white rocks, very similar in appearance to the quartzites of the Mississagi formation. In places they are iron stained, and towards the north they assume a marked bluish coloration. The bedding is heavy where recognizable, but in many of the sections the original partings have been obscured and in the absence of textural differences are difficult to determine. No interbanding with greywackés was noted.

The quartzites are made up of angular quartz and feldspar grains, some sericite, chlorite, and a few grains of iron oxide, usually altered to leucoxene. The feldspars are quite fresh as a rule, and the quantity varies in sections examined from occasional grains to about one-quarter of the mass of rock. Unlike the other quartzites of the area, with the exception of the Upper Cobalt, sericite is much more abundant than chlorite in the groundmass. In some instances, the quartz grains and the few feldspar grains present are rimmed with sericite.

The quartzites of the formation pass downward into conglomerates, interbanded with coarse greywackés. The conglomerates have been largely destroyed by the younger granite, but isolated areas occur on the lower part of Maud creek, at the northern end of Maud lake, west of Elizabeth lake, and on a hill west of the forks of Driving creek. At the latter point, the beds are arched up by an anticline, and the conglomerates alternating with coarse greywackés and impure felspathic quartzites are well exposed in the steep eastern face of the hill. They

are made up of pebbles and boulders of grey granite, quartzite, quartz, and greenstone up to two feet in length, distributed irregularly through a coarse greywacké matrix. Distinguishing features of the conglomerate are the well-rounded condition of the pebbles and boulders and the absence of red granite boulders. In the exposures along Maud creek, while most of the boulders are fairly well rounded, a few angular ones are also present.

An area of conglomerate enclosed in granite, considered to be an outlier of the Driving Creek conglomerates, cut off by the intrusion of the younger granite, occurs near the Clergue road in the northeast quarter of section 5, Duncan township. The area is about 400 yards long and 150 in width. The conglomerate here, while similar in its general characteristics to the ordinary variety, differs from it in holding an occasional red granite boulder.

The matrix of the Driving Creek conglomerate, as shown in two thin sections, is made up of coarse angular quartz and feldspar grains, with some granitic fragments lying in a base of smaller grains. Sericite is the principal alteration product. The source of the grey granite boulders so abundant in the Driving Creek conglomerate is not evident. It is unlikely that they were derived from the older granites of the immediate area, as these while greyish in places have a prevailing reddish coloration.

Structure

The Driving Creek beds in most of the surviving fragments have a general southwesterly dip, ranging from 40 to 75 degrees, away from the younger granite and toward the Duncan greenstone. The largest area mapped occurs in and covers most of section 6, Duncan township. In this area the usual southwesterly dip is interrupted at one point by an anticlinal fold broken near the axis by a small downthrow fault. The thickness of the quartzites here was estimated at 2,000 feet and the conglomerates at 400 feet.

DUNCAN GREENSTONE

The name Duncan greenstone is applied to a band of lavas constituting the intermediate member of the Soo series. The Duncan greenstone outcrops in a band, averaging about a mile in width, extending in a direction a few degrees west of north from the north boundary of the Garden River Indian Reserve to Bellevue on the Algoma Central railway, a distance of nine and a half miles. On the west the lavas are overlain by the conglomerates of the Aweres formation, except at the extreme southern point where they come in contact for a short distance with the Mississagi quartzite. On the east they overlaid the quartzites of the Driving Creek formation along the greater portion of their course, but south of Reserve lake and again north of Legge lake they are bordered by the younger granite.

The west boundary of the lava band is fairly regular and at several points is marked by lakes lying parallel to its course. Close contacts between the lavas and the overlying conglomerates are seldom seen but were observed at two points, one east of the north end of Island lake and the other on the Algoma Central railway. In both places the conglomerates and associated beds rest on the roughened surface of the lava band, and the evidence of their superposition is plain. The conglomerates west of the contact dip away from the lavas at steep angles, in places exceeding 70 degrees.

The east boundary of the lava band is more uneven than the west one, due to invasions of the younger granite at a couple of points and to erosion irregularities. Near the south end of the band a spur, either an erosion remnant or a branch flow, extends in a northeasterly direction towards Maud lake for a dis-

tance of a mile and a half. A second pronounced spur projecting northwards occurs at the north end of Reserve lake.

Close contacts of the Duncan greenstone with the underlying quartzites of the Driving Creek formation were observed at two points, one in section 27, Duncan township, and the other in the Garden River Indian Reserve, a short distance south of section 6, Duncan. At the latter point the lava band terminates in a line of steep cliffs, fully 300 feet high in places, overlooking the valley of Driving creek. The contact line, rising at an angle of about 40 degrees, is easily traceable from the bottom to the top of the escarpment, except at one point where it is broken through by a wide olivine diabase dike. The quartzites dip regularly under the lavas and have an apparent conformity with them. The lavas, on the other hand, are lightly sheared at the point of contact and for some distance above, and show signs of disturbance. In places the two formations are separated by a thin carbonate band. Some faulting has evidently occurred along the line of contact, but probably only on a minor scale.

In section 27, Duncan, where a second close contact occurs in an escarpment west of the stream draining Reserve lake, the quartzites also dip regularly under the lavas at angles of from 35 to 40 degrees. The lavas near the contact are altered into a schist for a few feet and also show some brecciation. The superior position of the lavas, relative to the Driving Creek quartzites, is also shown in exposures on the east shore of Maud lake at the tip of the spur of greenstone mentioned above as extending in that direction from the main band. The lavas here are fresh looking, massive amygdaloids, free from any signs of disturbance.

The Duncan greenstone is ordinarily a hard, massive, fine-grained, dark-green almost black rock apparently entirely made up of lavas. No fragmental volcanics were observed. At the south end and in a few places along the east boundary, it is lightly sheared, but the shearing appears to be due to local causes and not to any general regional movement. It is strongly jointed and weathers into steep cliffs, often banked below by huge talus heaps of angular blocks. It is usually sparingly vesicular and in a few places passes into typical amygdaloids. The vesicles as a rule are filled with white quartz, usually with a chlorite lining. In some exposures lenticular quartz fillings, occasionally two inches or more in length, give the rock the appearnace of a pebble conglomerate. Chloritic and carbonate fillings also occur but are much less common than quartz. The greenstone is usually so fine grained that the constituent minerals cannot be distinguished by the naked eye or by an ordinary field lens. In one section only was a porphyritic phase observed. This occurs near the base of the greenstone west of Elizabeth lake. The lava at this point holds star-shaped feldspar phenocrysts scattered through a dark, fine-grained base.

The Duncan greenstone, while fine grained, is holocrystalline. In thin sections it is seen to consist of numerous small, basic feldspar laths lying in all directions in a base of hornblende, or of hornblende and chlorite, and is classed as a basalt. Some augite is occasionally present and rarely a few grains of quartz, possibly of secondary origin. A tendency to an ophitic structure is often noticeable. This is especially pronounced in a section of the porphyritic variety noted above. Epidote and iron oxide are common secondary minerals. A feature of the Duncan greenstone which distinguishes it from the lavas of the Basement series is the preservation practically everywhere of the original structure.

Structure

The region underlain by the Duncan greenstone is everywhere thickly wooded except on the steep escarpments. Exposures are isolated, and little

information was obtained in regard to the thickness of the greenstone or its division, if any, into separate flows. Highly vesicular phases of the greenstone in narrow tilted bands were noted at a few points, usually near the upper or lower margins of the formation, but none of these were traceable for any distance.

On the west, the greenstone plunges beneath the sediments of the Aweres formation at a high angle and probably formed a steep westward-facing ridge before the deposition of the latter. On the east, the conditions are different. The main lava band at the two points, where it is found in close contact with the underlying quartzites of the Driving Creek formation, overlies them apparently conformably and at moderate angles, while the long spur from the main band extending in a northeasterly direction toward Maud lake rests on the upturned edges of the quartzites and associated conglomerate beds. The thickness of the lavas in this spur where cut by the outlet of Maud lake cannot exceed 450 feet. The spur is sunk in the quartzite and may possibly represent a branch flow from the main lava mass. The reason for the apparent conformity of the Driving Creek beds to the main band of the Duncan greenstone, and their unconformable relationship to a spur from this band, is still an unsolved problem.

AWERES FORMATION

The Aweres formation, the highest member of the Soo series, outcrops in a crescent-shaped area, mostly in Aweres township, but extending north into Vankoughnet and southward across the southeast corner of Duncan into the Garden River Indian Reserve. It covers altogether an area of about 25 square miles. On the east it overlies the Duncan greenstone and on the west rests on the granite gneisses of the Gros Cap batholith. On the north it is in contact for short distances with the Basement series schists and the Upper Cobalt quartzites, and on the southeast with the Mississagi quartzites of the Bruce series.

Rocks

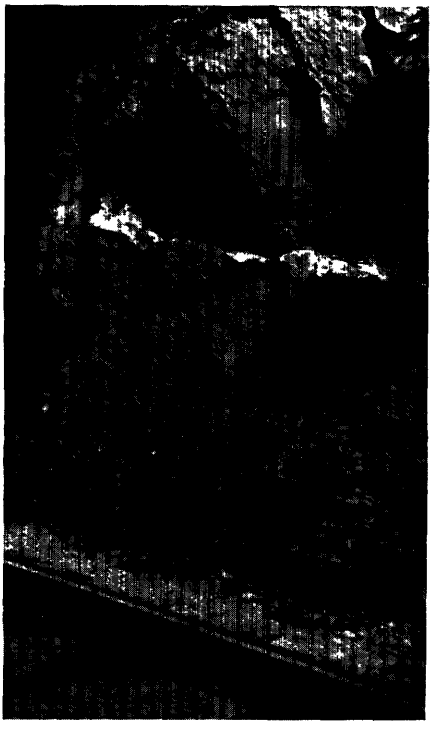
The rocks of the Aweres formation consist mainly of conglomerates and quartzites, with in places some greywackés and arkose, free from pebbles. The conglomerates occur in three zones varying in character from east to west. On the east, where they overlie the Duncan greenstone, a band in places half a mile in width is made up largely of fragments from that formation imbedded in a greenish greywacké or arkose matrix. The greenstone fragments occur in angular elongated slabs or blocks up to three or four feet in length, usually lying parallel, or nearly so, to the bedding. With these are a few granitic, quartzite, and quartz pebbles and boulders differing from the greenstone in being all fairly well rounded. East of Surette lake, the greenstone conglomerates have been strongly squeezed and are altered in places into schists. The fragments are flattened, are softer than the enclosing matrix, and weather into shallow pits. In some exposures the rock surface is covered with an irregular network of projecting ridges, due to differential weathering.

The matrix of the conglomerate is usually a medium-grained greywacké passing in places into a siliceous arkose. In the more altered varieties, chlorite is usually present.

Along the western margin of the formation, where it rests on the rocks of the Gros Cap batholith, granitic pebbles and boulders replace greenstone as the predominant constituent of the conglomerates. Greenstone, quartzite, and quartz pebbles and boulders occur in subordinate quantities, and occasionally a conglomerate boulder, probably derived from the Basement series. The granitic conglomerates have an irregular distribution, alternate with bands of

quartzite and arkose, and at Island lake and for some distance north and south along the west border of the formation are largely replaced by quartzites, holding in places a few scattered pebbles and boulders.

The pebbles and boulders of the Aweres granitic conglomerates are not sorted into beds and bands of approximately uniform size; but irregularities in size and in distribution of the fragments through the matrix, except in a few sections, is less marked than in the boulder conglomerates of the Lower Cobalt. South of the Aweres lake, where the conglomerates are well developed, few of the boulders exceed a foot in diameter and most of them are under six inches. The smaller granitic and quartzite boulders are all fairly well rounded, while



Conglomerates, Aweres formation, in rock cut southwest of Bellevue station, Algoma Central railway.

the larger ones are usually subangular in shape. The matrix is a siliceous greywacké or impure quartzite, and small and large pebbles and boulders are distributed through it with little regard to size. In a few instances small lenses occur made up of pebbles crowded closely together, but as a rule the matrix occupies more space in a section than the included coarse material. Near Bellevue, south of the Bellevue ridge, the Aweres granitic conglomerates differ in some sections from the ordinary type. They hold numerous angular granitic and greenstone fragments, often two feet or more in length, imbedded with numerous smaller ones of varying sizes in a hard siliceous matrix. An angular granite mass, fifteen feet in length and about six feet in width, occurs in one exposure. This coarse angular type of conglomerate, very similar to the coarse boulder conglomerate of the Lower Cobalt, has a limited and somewhat sporadic

distribution. It alternates with and soon passes along the strike into the ordinary variety.

A central, wide band of conglomerate east of Trout lake, overlain and underlain by quartzites, is made up of almost equal amounts of small to medium sized greenstone fragments, usually angular in shape, and pebbles and boulders of granite, quartzite and quartz, all more or less rounded. The matrix is a green siliceous greywacké, imperfectly schisted in places.

Quartzites.—The quartzites of the Aweres formation are well exposed along the north shore and on the islands of Trout lake, and also around Island and St. Joe lakes. They are light-greyish to whitish, medium-grained rocks, occasionally stained yellowish by iron. They are always more or less feldspathic and in places pass into an arkose. Small, rounded to angular pebbles of quartz and quartzites are common in the upper portion of the band on Island lake.

The quartzites occur in two bands, each about 2,000 feet thick, separated by conglomerates. The upper band passes into an arkose toward the top, and a considerable portion of it carries scattered pebbles of quartz and quartzites. The bedding is coarse, the parting planes being usually two to three feet and occasionally farther apart. Cross-bedding is much less common than in the Bruce quartzites. The dips are moderate, ranging from about 25 to 50 degrees, and are mostly to the southwest.

In addition to the two wide quartzite bands, forming the central part of the formation, narrow bands of greyish and light-reddish feldspathic quartzites occur interbanded with both the greenstone and granitic conglomerates.

In thin sections the Aweres quartzite shows a field of very angular quartz and feldspar grains, separated by lines and areas of smaller grains of the same minerals. Chlorite is usually present, and occasionally some sericite and iron oxide. One section from Trout lake was made up entirely of quartz and sericite, both feldspar and chlorite being absent, while in others the feldspar grains equal the quartz in numbers. The grains show little or no rounding in any of the sections.

Greywackés, free from pebbles or boulders, have a limited distribution in the Aweres formation. A fine-grained green variety, difficult to distinguish in hand specimens from the Duncan greenstone from which it was derived, is exposed along the Bellevue road west of Bellevue, and occasional narrow bands of a coarser, more siliceous variety occur in places with the conglomerates.

Structure

The bed of the Aweres formation on the south has a strike for a short distance of W. 30° N. It then bends to the north and follows the Duncan greenstone in a direction a few degrees west of north to near Bellevue. West of Bellevue it turns to the east around the north end of the Duncan greenstone and continues in an easterly direction as far as exposed. On the east the strike conforms generally with the direction of the greenstone, while on the west, where the beds are in contact with the Gros Cap batholith, it strikes towards it, in places at a considerable angle. The dips, except for short distances on the north and south where the beds follow around the north and south terminations of the Duncan greenstone band, are generally to the southwest away from the greenstone and toward the granite, the two enclosing formations. Occasional reversals of this dip occur near the granite contact, but only on a minor scale, and no evidence was found of any important repetition of the beds due to folding.

The dips near the greenstone are steep, often 70 degrees or more, and toward the southern termination of the formation they become vertical or nearly

so. West from the greenstone on Trout and Island lakes, the angle of dip decreases in places to 30 degrees or less.

The peculiar structure of the Aweres formation, its limited distribution, and the general monoclinic dip of the beds is difficult to explain except on the assumption that the existing beds are merely a remnant of a once extensive formation largely destroyed by erosion. They apparently represent a portion of the western limb of a domed anticline.

Stratigraphical Relationship

The Aweres formation on the east rests on the Duncan greenstone, usually at a high angle, and on the south, west, and north is bordered at various points



Aweres formation (conglomerate) overlying granite, east of Bellevue, with the author in the foreground.

by the Mississagi quartzite of the Bruce series, the granite gneisses and included schists of the Gros Cap batholith, the Upper Cobalt quartzites, and the schists of the Basement series.

The relationship of the formation to the granite gneisses and associated rocks and to the schists of the Basement series is clearly an unconformable one. The basal beds in an escarpment north of Bellevue rest at several points at discordant angles on the highly tilted schists of the Basement series; and near the southern end of Lower Island lake, a small granitic ridge projecting through the drift shows a gradual passage from an altered granite at the west end to arkose holding well-rolled pebbles at the east end. Other well-exposed contacts of the Aweres beds with the granites occur a short distance east of Bellevue ridge, where a small patch of basal conglomerates rests directly on granite, and in section 28, Aweres township. At the latter point, a marked change occurs in the granite complex as the contact is approached. The boundaries of the various members of the complex, usually well defined, become so indistinct as to be

barely recognizable. It is probable that the older rock was deeply weathered before the deposition of the sediments, and afterwards recemented and hardened.

Direct field evidence of the inferior position of the Aweres formation and other members of the Soo series relative to the Bruce series is less satisfactory. The Driving Creek beds, the lowest member of the Soo series, are nowhere exposed in contact with the Bruce and only at one point with the Duncan greenstone, the intermediate member. The Aweres formation, the highest member, adjoins the Mississagi quartzites of the Bruce series near its south termination on the north boundary of the Garden River Indian Reserve. At this point two wedge-shaped areas of Mississagi quartzite, one half a mile and the other 100 yards in length, project into the conglomerates of the Aweres formation. The exact contact is nowhere seen, but the two formations are often exposed within a few feet of each other. The strikes are similar, but the dips are divergent. The conglomerates have a nearly vertical attitude, while the quartzites of the larger wedge dip to the north at angles of from 40 to 60 degrees and in the smaller wedge at an angle of about 80 degrees. No pebbles or boulders of conglomerates occur in the quartzite. This may possibly indicate a faulted contact, but if so, the usual evidences of faulting have been obscured. Farther east, where the Mississagi quartzites come against the Basement schists, they are also free from schist fragments.

The Aweres formation, except at its north and south terminations, and the other members of the Soo series have general north-northwest strikes as compared to the nearly east strikes of the Cobalt and Bruce series. This apparently means that they escaped serious deformation during the disturbances of Keweenawan time, as the only severe foldings of these rocks in the area were along two narrow parallel east and west belts, one represented now by Bellevue ridge and the other situated a few miles to the south. The Aweres formation extends from one of these disturbed belts to the other in a direction nearly at right angles to their course; but as these belts are approached, the strike of the beds turns suddenly to the east. The two tips of the formation were evidently included in the folding, while the central portion was not affected.

Bruce Series

The term Bruce series was introduced by Dr. Collins as a substitute for the name Lower Huronian, previously used as a designation for the lower part of the Huronian as developed along the north shore of Lake Huron. The change was made in order to avoid the confusion frequently arising from the application locally of such terms as "Upper" and "Lower" to a group of formations before their distribution and range are fully known. The Bruce series includes the lower slate conglomerate of the early geologists and the associated quartzites and limestones. It underlies uncomformably the old Upper Huronian, now known as the Cobalt series.

The Bruce series in the Sault Ste. Marie area is made up of the Mississagi quartzite and the overlying Bruce limestone. The Espanola greywackés and limestone and the serpent quartzite described by Collins as forming the upper part of the series farther to the east are absent, probably destroyed by erosion, and the Bruce conglomerate in its extension westward is reduced to a few layers of greywackés carrying an occasional quartz pebble. It was only definitely recognized in one exposure.

MISSISSAGI QUARTZITE

The Mississagi quartzites are well exposed in the southeastern portion of the Sault Ste. Marie area. They cross the eastern boundary of the map area with a

width of four miles and extend westward in a triangular-shaped area to Garden river. West of Garden river they outcrop in a series of broken plateaus, ridges, and hills, separated by drift-covered stretches extending from Driving lake westward to a point half a mile west of the Lake Elizabeth trail, where they terminate against the conglomerates of the Aweres formation. Altogether they underlie an area of approximately 17 square miles, including the drift-covered portion.

An outlier of quartzites mapped as Mississagi but possibly belonging to the Driving Creek formation occurs resting on and sunk in the schists of the Basement group in the southeast quarter of section 19, Duncan township. The outlier is from 200 to 300 yards in width and is traceable for a distance of half a mile in a northwesterly direction divergent from the strike of the schists. No outcrops of Mississagi quartzites were recognized in the northern or western portions of the area.

General Character

The Mississagi in the Sault Ste. Marie area is an almost wholly quartzite formation. The quartzites very rarely hold a few small quartz pebbles; except at one point, where the reference is doubtful, no heavy conglomerate beds comparable to those described by Collins as forming the base of the formation farther to the east are present, and no accumulation of pebbles extensive enough to be called a conglomerate alternate with the upper beds.

In the Garden River Indian Reserve, south of Driving lake, a small area of lavas referred to the Basement group are faulted up through the Mississagi quartzites. The fault follows the northern boundary of the uplifted lava block and cuts typical Mississagi quartzites. On their southern boundary, the lavas are overlain at one point by a band of conglomerates associated with some greywackés and quartzites, about 200 feet in thickness. The Mississagi quartzite is well exposed a short distance to the south, dipping away from the lava, and when first found the conglomerates were mapped as the basal member of the formation. A subsequent examination failed to confirm fully this reference. The conglomerates are made up largely of greenstone fragments, seldom over six inches in length, with some rounded granite and quartz pebbles all enclosed in a rather coarse, greenish greywacké matrix. They are steeply tilted and somewhat altered, and closely resemble the conglomerates of the Aweres formation found elsewhere apparently underlying the Mississagi, to which they may possibly belong. The field evidence, owing to gaps in the section, is inconclusive.

The Mississagi quartzite is usually more or less feldspathic in character. The normal variety is a greyish to light-greenish, medium-grained rock made up in the sections examined of angular and subangular quartz and feldspar grains in a base of small angular grains of the same mineral. Other common constituents are shreds of chlorite, colourless mica, and grains of iron ore. The proportion of feldspar grains occasionally exceeds 30 per cent. In one specimen from the head of Driving creek, a well-cemented vitreous variety, feldspar was entirely absent. The general character of the quartzite, aside from the varying proportion of feldspar, some differences in degree of cementation, and slight textural changes, is uniform throughout. Coarse-grained beds, in one instance approaching a grit in texture, are occasionally found alternating with the normal variety, and in a few sections thin sheets of schisted greywackés occur along the bedding planes of the quartzites, but only in insignificant quantities.

A prominent feature of the Mississagi quartzite is its heavy bedding. Ordinarily the planes are from two to three feet or more apart, and in some exposures partings are absent altogether and the rock appears quite massive. The massive

variety usually shows faint white lines marking textural differences. Cross-bedding is common, and ripple marks were observed at a few points. The principal partings in some areas are strong, regular joint planes. These simulate bedding planes very closely and in such even textured rocks are often difficult to distinguish from them.

Numerous gaps in the outcrops of the Mississagi quartzites in the area made it impossible to construct a general section showing the structure. The observed dips indicate at least two easy folds trending in a nearly easterly direction. The beds, except towards the western termination of the formation and near faults, are inclined at moderate angles, seldom exceeding 35 degrees. The minimum thickness of the formation is estimated at 1,500 feet. The formation has been partially destroyed, and only incomplete sections are available for measurement.

Stratigraphical Relationship

The Mississagi quartzites are bordered along most of their north boundaries by the steeply tilted schists of the Basement series. The contact between the two formations is usually concealed by drift, but the marked differences in strike and dip furnish conclusive evidence of a nonconformable relationship. Basal conglomerates are absent; and on Ranson creek, where the quartzites have been crushed against the schists, the contact beds consist of a hard, close-textured, almost vitreous variety. It is possible that the contact at this point is a faulted one, and in that case the altered quartzites may not represent the basal beds. Normal granular quartzites outcrop a short distance south of the contact.

West of Driving creek, the Mississagi quartzites are in contact for some distance with the Duncan greenstone and Aweres formations of the Soo series. Their relationship to these formations is described in a previous section.

In the Sault Ste. Marie area, the upper members of the Bruce series, with the exception of a few patches of Bruce limestone, are absent, and the Mississagi quartzites are overlain unconformably along their south boundary by the conglomerates and associated rocks of the Lower Cobalt. Outliers of Lower Cobalt rocks also occur east of Meniss lake, resting directly on the quartzites.

BRUCE LIMESTONE

The Bruce limestone has a very limited distribution in the Sault Ste. Marie area, as only a few small areas survived the prolonged erosional interval separating the Bruce and Cobalt epochs. An area less than a mile in length and 300 to 400 yards wide outcrops south of Meniss lake, and a similar-sized area forms the southern face of an isolated ridge north of Garden River P.O. Other small bands occur in a ridge south of the west end of Boss lake, and in a hill north of Root river near the western boundary of the Garden River Indian Reserve.

The general character of the Bruce limestone in the different areas is uniform. It is a whitish to light-bluish, finely crystalline dolomitic rock, well stratified in beds ranging from six inches to four feet or more in thickness. It is very impure and is made up of layers of limestone seldom more than a few inches thick, alternating with thin parallel lines of irregularly spaced siliceous impurities arranged either singly or in groups. When weathered, the limestone has a dull-grey or brownish colour, and the lines of impurities project in a series of tiny ridges. South of Meniss lake, the Bruce limestone is separated from the underlying Mississagi quartzite by a few feet of pebble-bearing greywackés. These beds, seen in only one exposure, no doubt represent the Bruce conglomerates.

The fragment of Bruce limestone south of Meniss lake is a nearly flat-lying erosional remnant, less than 100 feet thick, resting in its normal position on the

underlying members of the series. The other occurrences in the area are along lines of strong disturbances accompanied by faulting. The tilted block a mile north of Garden River P.O. has been thrust up over the Lower Cobalt conglomerate at an angle of 40 degrees. South of the fault the limestone beds are sharply folded for some distance, and north of it the greywacké bands of the Lower Cobalt have been altered in places into schists, the planes of schistosity crossing the bedding at a small angle. Two miles west of this faulted block and apparently in the same line of disturbance, limestones are again encountered under somewhat puzzling conditions. They outcrop in a narrow band, seldom more than a hundred feet in width, traceable part way across a rounded hill built of Lower Cobalt rocks near Root river. The limestone beds are strongly contorted and have a general northerly dip of from 70 degrees to nearly vertical. They are underlain and overlain by Lower Cobalt boulder conglomerates, dipping in approximately the same direction. Traced eastward the limestone band, less than half a mile in length, disappears before reaching the brow of the hill and is replaced by a disturbed zone of altered greywackés and quartzites carrying numerous eyes and veinlets of quartz. The west termination is concealed. The identification of the limestone as Bruce is based on the fact that it is similar in all respects to occurrences of that formation elsewhere, and no other limestone has been recognized in the area. It therefore normally underlies the Cobalt, and its present position as an apparently interbanded member of that formation is only explainable by severe faulting.

The striped Bruce limestone on fresh surfaces is an attractive rock, and a marble quarry was opened up at one time in the face of a limestone bluff north of Garden River P.O., but the enterprise was short lived. The beds are all more or less fissured, and the cessation of work was probably due to the difficulty in obtaining large blocks free from rifts, and to the further drawback that the limestone, owing to the iron and other impurities it contains, soon loses its bright appearance on exposure. This would make it unsuitable for monumental or other outside work.

Cobalt Series

The Cobalt series, the highest member of the Huronian group of formations, is represented in the area by a number of disconnected sections of varying sizes. It is separable into two divisions quite conformable, but differing in lithological character. The lowest of these is called the Gowganda series by Collins, and the upper the Lorrain quartzites. The terms Upper and Lower Cobalt are used in this report.

LOWER COBALT

Distribution

In the southeastern part of the area, east of Garden river, a band of Lower Cobalt rocks, a mile in width in places, borders the Mississagi quartzites on the south for a distance of four miles. They terminate to the south in an escarpment, 300 to 400 feet in height, facing the St. Mary river lowlands. West of Garden river a continuation of the same band forms a prominent isolated ridge a mile and a quarter in length, and farther west, after a concealed interval, three small areas of Lower Cobalt rocks occur in the Rankin concession clinging to the granitic escarpment. No exposures were recognized west of this point in the southern part of the area.

A second band, broken into a number of disconnected areas by various causes, extends in a north-northwesterly direction from Midge lake in the southeast corner of Deroche township to Horseshoe bay in Ley township, a distance

of over 20 miles. The older Huronian formations are absent from the northern part of the area, and the Cobalt rests directly on the Basement series.

Rocks

The rocks of the Lower Cobalt series have a totally different character in the southern part of the area from what they have in the band crossing the northern. In the former, they consist of an irregular succession of conglomerates, greywackés, and red and grey quartzites, the sequence and relative importance of which vary from section to section. In the latter, conglomerates are rarely present, and greywackés, interbanded with quartzites, are the chief constituents.

An admirable description of the rocks of the Lower Cobalt by Dr. Collins, based on field work in the adjoining region to the east, has recently been published.[1] Dr. Collins' description would apply almost word for word to the occurrences of the formation in the Garden River Indian Reserve, except that the limestone reported by him is absent.

A complete section of the formation is nowhere available for study. East of Garden river, the beds in the outer escarpment are bent into an anticline, the southerly limb dipping to the south at a high angle under the drift. The highest beds exposed consist of greyish quartzites, possibly belonging to the base of the Upper Cobalt, alternating below with hard greywackés and dark argillites. Under these the disconnected exposures show a succession of greywackés, quartzites, and conglomerates extending across the band.

Good examples of both the coarse boulder conglomerates and thinly bedded greywacké conglomerate, described by Collins in the report referred to above, are present. Conglomerates consisting of scattered pebbles and imperfectly rounded boulders, usually less than a foot in diameter and enclosed in a fine-grained, thinly bedded greywacké matrix, occur in the outer range; lower down in the series, the coarser boulder conglomerates make their appearance. These rocks are quite unlike ordinary conglomerates, and their origin is still a matter of dispute. The matrix is a rather coarse greywacké, seldom well bedded but nearly always in the Sault Ste. Marie area showing some signs of stratification. Through this, rounded pebbles and angular and subangular boulders up to three feet or more in length are distributed in an exceedingly irregular manner. The enclosures are not sorted and do not follow the bedding planes of the matrix. In one exposure, a thin lens of irregular-sized boulders crossed the stratification at an angle of 30 degrees. The quantity of boulders present also varies from point to point, the rock in places passing into a greywacké almost free from them. The two types of congomerates, while quite different in appearance and possibly in origin in their extreme phases, are linked by rocks of an intermediate character. A variety made up of coarse but distinctly bedded greywackés, carrying scattered subangular boulders up to a foot in diameter, was not uncommon. A band of this character occurs in the isolated ridge west of Garden river. This ridge terminates on the east in a line of bare cliffs about 800 feet long, affording excellent exposures across the strike. The beds dip to the west at a high angle and are divisible into three zones. The upper zone consists of bedded, slightly schistose, coarse greywackés enclosing moderate-sized granitic and schist boulders rather sparingly distributed. Under this is a band of greywackés carrying numerous conspicuously white quartz and quartzite pebbles and only an occasional granitic one. The lower beds are coarse greywackés free from enclosures except for an occasional quartz pebble. The division of the beds into

[1]W. H. Collins, Geol. Surv. Can., Mem. No. 143, 1925.

three zones characterized by differences in the enclosures is purely of local significance, as farther north along the strike, boulder conglomerates persist across the ridge. This easy and rapid gradation from one rock type to another is very characteristic of the formation.

The basal beds of the Lower Cobalt series, as exhibited in a small area in the Rankin concession fringing the granite escarpment, consist of a band of boulder conglomerates below, 130 feet in width, followed by 200 feet of fine-grained, slaty greywackés. The greywackés are overlain by a second wide band of conglomerates, and this by red and grey quartzites. The beds have been forced into a vertical attitude against the granite, but no evidence of faulting along the contact was recognized.

The boulders of the conglomerates are largely derived from the older granite gneisses, schists, and greenstones of the area. Other less common varieties present include quartzites from the older Huronian formations, vein quartz, and

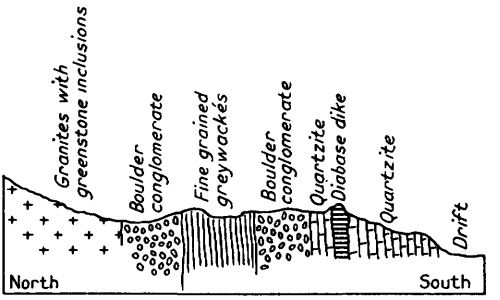


Fig. 3—Section showing basal beds, Lower Cobalt series, Rankin location. Horizontal scale, 500 feet to the inch.

rarely fragments of Bruce limestone. A quartzite boulder from the ridge west of Garden river proved to be different from the known types. A thin section showed it to consist largely of well-rounded quartz grains, only an occasional one showing angularity. A few feldspar grains are also present. The grains are separated by fine material, mostly quartz with some colourless mica. No quartzite of this character has been found in the area or has been reported from neighbouring areas.

The quartzites of the Lower Cobalt occur in heavy bands, up to 100 feet or more in thickness, and in thin beds and lenses alternating with the greywackés. They are always more or less feldspathic in character and pass in places into siliceous greywackés. The grains occasionally show some rounding but are usually angular or subangular in shape. The rounding of the grains in the sections examined is more noticeable than in the quartzites of the older Huronian formations. The base is ordinarily a fine-grained mixture of quartz and feldspar, usually accompanied by some chlorite and sericite.

The larger bands of quartzite alternate regularly with the greywackés and conglomerates. The behaviour of the thin beds and lenses is often quite different. They frequently widen suddenly and dip downwards into the greywackés, often cutting across several beds. Branching beds and beds apparently traversing the greywacké layers at a low angle are not uncommon. In one exposure several quartzite dikes, two to four inches in width, projected in ribs above the surface. This irregularity in the deposition of the sands, and the filling by them of ruts

and cracks in old surfaces, leaves little doubt in regard to the subaerial origin of at least a portion of the formation.

The above description applied to the Lower Cobalt as developed in the Garden River Indian Reserve agrees very closely with the general character of the formation along the north shore of Lake Huron and eastward to Lake Timiskaming as described by various authors.

In the Sault Ste. Marie area, an abrupt change in the character of the formation takes place a few miles north of Garden river. A number of areas, portions of a once continuous band, extend across Deroche, Vankoughnet, and Havilland townships. In these, the predominant constituents of the formation are greywackés of various kinds, alternating in places with red and grey quartzites and only rarely enclosing boulders.

Thin conglomerate beds occur at the base of the formation at the only two points where it was seen. Near the southeast corner of Midge lake, a thin sheet of coarse siliceous greywackés, enclosing scattered pebbles and small boulders, rests unconformably on a rough surface of the Basement series schists and older diabase. Conglomerates alternating with and passing upwards into greywackés also occur farther north along the lake some distance above the base. At West point on Havilland bay, a pebble bed, eight to ten feet thick, occurs at the base resting on granite. The pebble bed is overlain by greywackés, carrying occasional well-rounded pebbles for a few feet, above which they disappear. Higher up in the formation, the greywackés enclose a few scattered boulders in King mountain plateau and in an exposure on Stokely creek west of Goulais Bay road; but the great conglomerate bands, so characteristic of the formation elsewhere, are entirely absent.

The greywackés are of the ordinary kind. They are fine to medium grained, light to dark grey and green rocks, largely derived from broken-down volcanics. In thin sections they usually show a dark base holding numerous small angular quartz and feldspar grains. In the coarser varieties, the quartz grains are visible to the naked eye, and minute rock fragments are also usually present.

The fine-grained greywackés are always thinly bedded and often show a striped appearance due to textural differences. Slaty cleavage is not uncommon but is always local and is not characteristic of the formation as a whole. The coarse varieties are usually more heavily bedded, and slaty cleavage is absent.

The quartzites interbanded with the greywackés are similar to those in the southern band. They occur throughout the formation in beds and bands up to 50 feet or more in thickness, but their total volume is relatively small compared to the greywackés.

The total thickness of the Lower Cobalt is unknown, as a complete section is nowhere available for measurement. In the southern slope of King mountain plateau and southward from the base of the slope, it is exposed at intervals in a direction at right angles to the strike for a distance of nearly three miles. The dips throughout are northward at angles varying from 60 degrees on the south to 25 degrees in the upper part of the formation. This would indicate a thickness for the rocks in this area, disregarding some possible repetition of the beds by faulting and folding, of over 5,000 feet. In Bellevue ridge, north of Goulais bay, and in other areas, the exposed thicknesses seldom exceed 1,000 feet.

The correlation of the almost boulderless greywackés of the northern band with the succession of heavy conglomerates, greywackés, and quartzites that make up the formation in the Garden River Indian Reserve a few miles farther south and in other places, admits of little doubt. In King mountain, in Bellevue ridge, and in an area north of Goulais bay, the greywackés of the Lower Cobalt

alternate above with an increasing proportion of quartzite and pass regularly upwards into the easily recognizable, massive, white and reddish quartzites and jasper and quartz pebble conglomerates typical of the Upper Cobalt practically everywhere.

UPPER COBALT

The Upper Cobalt is well represented in the northern band of the Cobalt formation crossing the Sault Ste. Marie area, but with the possible exception of some impure quartzites found at one point overlying greywackés and conglomerates, is absent from the southern band. It consists largely of hard, white quartzites. These are the most resistant rocks in the area and weather into prominent elevations. Bellevue ridge and several small ridges north of Goulais bay are formed of them, and in King mountain plateau they spread over an area about two square miles in extent. A narrow isolated ridge of white quartzite,

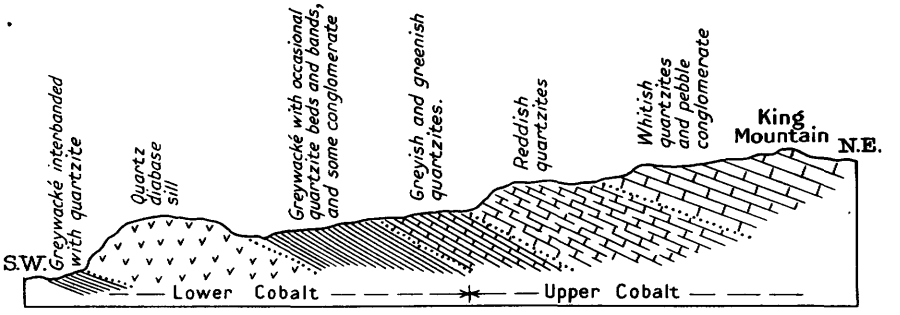


Fig. 4.—General section of southwestern slope, King mountain, Vankoughnet township. Horizontal scale, 1,500 feet to the inch.

considered to be of the same age, also occurs north of Bone lake sunk in the younger granite. At Midge lake and in two areas of Lower Cobalt in Havilland township, the Upper Cobalt is missing.

Rocks

The Upper Cobalt in the Sault Ste. Marie area, with the exception of a few small pebble beds, is a quartzite formation throughout. In King mountain, it has a thickness of approximately 1,800 feet, made up of 400 feet of greyish and greenish quartzites below, an intermediate band of reddish quartzite 700 feet thick, and an upper band 700 feet thick of white quartzite occasionally tinged reddish. The quartzites rest conformably on the greywackés and interbanded quartzites of the Lower Cobalt and dip northward at angles varying from 30 degrees at the base to 10 degrees towards the summit. They are heavily bedded, in some exposures almost massive, with obscure parting planes, eight to ten feet apart. This is especially marked in the upper white quartzites. Cross-bedding is a common feature. The base of the Upper Cobalt merely indicates the point at which a partially quartzitic formation is replaced by a wholly quartzitic one. The lower beds are feldspathic and resemble those alternating with the greywackés of the Lower Cobalt. Higher up, the feldspar and other more perishable constituents disappear and the rock consists almost entirely of a residue of cemented quartz grains. This passage upwards from an impure to a clean quartz rock is stated by Collins[1] to be generally characteristic of the formation along the

[1]Op. cit., p. 68.

north shore of Lake Huron. Thin sections of the white quartzites of King mountain show a field of very even sized, angular quartz grains surrounded by narrow rims of colourless mica.

The white quartzites of the Upper Cobalt, and less frequently the reddish variety, enclose pebbles in a few places and pass into conglomerates. The pebbles occur in small lenses and lines or are scattered sparingly through the beds. They are small, seldom exceeding two to three inches in length, and consist entirely of hard rocks, mostly white quartzites, brown and red jasper, and an occasional pebble derived from a hard siliceous schist.

The long narrow belt of Upper Cobalt quartzites in Bellevue ridge, unlike those on King mountain, have been strongly deformed. In the central part of the ridge they have been pressed into a sharp, unsymmetrical syncline, the southern limb dipping to the north at angles of 45 to 50 degrees and the northern limb dipping to the south at an angle of 80 degrees and over. Towards the north end of the ridge, the syncline is probably overturned slightly to the south, as the beds have a uniform, steep northerly dip. The Lower Cobalt rocks exposed in Beaverbrook valley, a short distance to the north, also dip in the same direction. In addition to severe folding, the quartzites in Bellevue ridge have also been faulted along the western portion of the south boundary, the fault bringing the Lake Superior sandstone, the Aweres formation, and the schists of the Basement series, successively against them in a distance of less than a mile. They have also been intruded in places by the younger granite, and the eastern portion of the belt has been split into two parts by a wide diabase dike. The quartzites, as a result of the intrusions and disturbances, have been altered, except in a few places, from a granular rock into a thoroughly cemented, hard, glassy variety difficult to distinguish in hand specimens from quartz. Thin sections show a mosaic of angular, interlocking quartz grains with occasional shreds of mica and grains of dark iron ore. Quartz and jasper pebble conglomerates, similar to those in King mountain, occur also in a few exposures in the central part of Bellevue ridge.

A mile west of Bellevue ridge, a small ridge of white shattered quartzites, considered to be of Upper Cobalt age, occurs along the south boundary of section 24, Vankoughnet township. The quartzites adjoin the schists of the Basement series and are probably in faulted contact with them. Farther west they occur in two short ridges north of Goulais bay, one east and the other west of Kars creek. In the eastern ridge both Upper and Lower Cobalt are present, the section consisting of 1,200 feet of greywackés and red quartzites below, overlain by about 1,000 feet of hard white quartzites and jasper conglomerates, all dipping northward at angles of from 60 to 70 degrees. The white quartzites are followed on the north by the schists of the Basement series. The contact of the two formations is concealed by drift, but their relationship is only explainable by faulting. The quartzites near the contacts have been wholly or partially replaced by rusty dolomites, the dolomitized zone ranging from 50 to 150 feet in width. The evidence of replacement is unmistakable. Veins and veinlets of dolomite penetrate the quartzites along the margin of the altered zone, and in the more altered portions cores of quartzite completely enclosed in dolomites are common. The schists north of the contact have been similarly affected but to a less extent, the alteration being nowhere complete. The cause of the dolomitization is obscure, but its occurrence along a line of faulting suggests solutions rising through the fractured zone as a possible explanation.

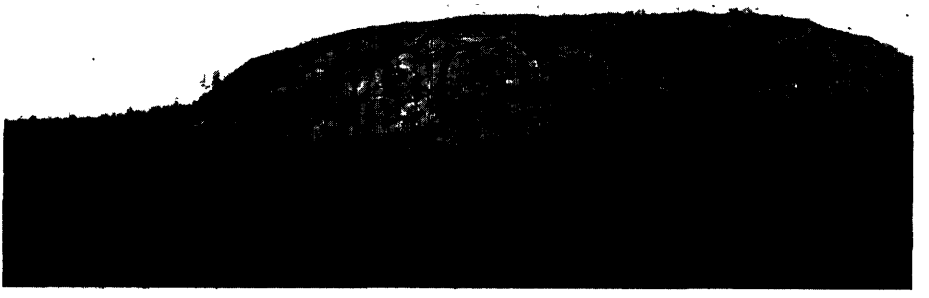
North of King mountain plateau in lots 4 and 5, range II, Tupper township, a ridge of Upper Cobalt quartzites, from 200 to 400 yards in width and somewhat

less than a mile in length, occurs in a granite area and sunk in the granite floor. The quartzites here evidently represent an outlier of the King mountain area isolated by the invasion of the younger granite. They are hard, glassy, completely cemented rocks similar to those in the more altered portions of Bellevue ridge.

Structure and Stratigraphical Relationship

The Cobalt series in the Sault Ste. Marie area has been largely destroyed by erosion, and the fragments remaining, often separated by a concealed interval and in many cases merely monoclinic blocks, can only be pieced together in a very conjectural way.

On the south in the Garden River Indian Reserve east of Garden river, the formation has a general anticlinal attitude. The southern limb dips steeply southward. The northern limb has a much lower general inclination northward



Upper Cobalt quartzite, Bellevue ridge.

and is deformed by a number of minor folds. West of Garden river, the isolated blocks which here represent the formation show steep southerly dips except towards the west termination of the line of exposure, where the beds become nearly vertical. The most easterly of the blocks is bounded on the south by a strong fault along which the Bruce limestone has been forced up over the Cobalt.

In the central part of the area, a synclinal structure is traceable along Bellevue ridge but is not evident farther west in exposures in the same line north of Goulais bay. The dips here are steadily northward. The beds preserved may possibly represent a portion of the southern limb of the Bellevue ridge syncline. On the north in King mountain plateau and in the area near Horseshoe bay, the strata have a uniform northerly inclination, usually at moderate or low angles. They constitute a portion of the southern limb of a flat syncline. The northern limb of this syncline in the King mountain area has been largely destroyed by the younger granite invasion, and in the Horseshoe Bay area it is concealed by the lake. The principal foldings of the formation occur along three main lines, all trending approximately east and west. The folding along the southern and central lines was much more severe than along the northern one and was also accompanied by considerable faulting.

The Cobalt foldings have the same general trend as those of the Bruce but are nearly at right angles to those of the Soo series. The general strike in the latter, except near the north and south terminations where the beds bend to the

the east, is a few degrees west of north. This is also the strike of the Basement schists in the Garden River area to the east.

The Cobalt series has been definitely proved by Dr. Collins to overlie the Bruce series unconformably along the north shore of Lake Huron. This unconformable relationship extends westward into the Sault Ste. Marie area. The Cobalt beds here were found resting on both the Bruce limestone and the underlying Mississagi quartzites, clear evidence of the separation of the two formations by a considerable time interval during which erosional agents were active. The Bruce limestone in this interval was largely eroded away, only small patches surviving, and the underlying Mississagi quartzites were also partially removed. In the northern part of the area, the Cobalt overlaps the older Huronian formations and rests directly on the upturned schists of the Basement series.

The Cobalt is the highest member of the Huronian group of formations in the area. It is followed in ascending order by Keweenawan lavas and the Lake Superior sandstones. The Keweenawan lavas east of Horseshoe bay are in contact with the tilted greywackés and quartzites of the Lower Cobalt. The time interval separating the two formations was sufficiently prolonged to allow of the removal by erosion of the whole of the Upper and a portion of the Lower Cobalt. Intrusives cutting the Cobalt include quartz diabase sills and dikes of Keweenawan age, and olivine diabase dikes and stocks of the younger granite. The latter are younger than the quartz diabases but are considered to belong to a later stage of the same age.

COBALT BOULDER CONGLOMERATES

Origin

The Cobalt boulder conglomerates are quite unlike the familiar variety in later formations, and all students of the pre-Cambrian agree that they must have had a different origin. Amongst the various theories put forward to account for them, the one that has obtained the widest acceptance is the theory of deposition by glaciers followed by torrential stream deposition and creepage.

The Cobalt conglomerates, as developed along the north shore of Lake Huron, where they have been studied by Collins,[1] and in the Sault Ste. Marie area, consist of two main varieties: a greywacké water-laid conglomerate made up of fine-grained, evenly bedded, usually striped greywackés, carrying pebbles and moderate-sized boulders distributed irregularly and in varying numbers through the matrix, and a boulder conglomerate usually quite different in appearance. The latter consists of the same materials as the greywacké conglomerate, but both the matrix and included fragments are coarser. Its chief characteristics are the great variability in size and in degree of abrasion of the included fragments, the disorderly manner in which they are distributed through the matrix, the number of intermingled rock types present, the absence of any definite sorting except in the case of a few small pebbles, lenses, and the slight stratification of the matrix, a feature sometimes absent altogether.

Judging from its appearance alone, a deposit of this kind might be formed by any of the agents mentioned above.

Serious discussion of the problem commenced in 1905. In that year Dr. Miller,[2] in the Cobalt area, and Dr. Coleman,[3] at Ramsay lake near Sudbury, both noted the resemblance of Huronian conglomerates to glacial deposits. Miller professed inability to offer a satisfactory explanation but suggested as a possible solution that "desert conditions prevailed in this region at the time

[1]Op. cit.
[2]Ont. Bur. Mines, Vol. XIV, pt. 2, 1905, p. 47.
[3]Ibid, pt. 3, p. 124.

some of the middle Huronian rocks, at least, were formed." Coleman on the other hand adopted at once the theory of a glacial origin and later published several papers advocating it.[1] In 1907, Miller,[2] after further work in the Cobalt area stated that the following facts were difficult to reconcile with a glacial origin of the conglomerate:—

(1) A good deal of the material has originated practically *in situ.*

(2) The underlying surface of the rock does not show striations.

(3) There has been no boulder clay recognized.

(4) Striations on boulders may be produced by faulting—there are numerous small faults in the Huronian rocks.

(5) Boulders resembling those which are usually considered to be characteristic of glacial origin are said to be found in deposits of undoubted non-glacial origin.

(6) No unconformity has been found between the underlying greywacké slate and felspathic quartzite series and the overlying conglomerates.

In 1913, Miller[3] again affirms that the evidence produced in favour of a glacial origin of the conglomerate is not conclusive and instances certain conglomerates in the Torridonian of the northwest Highlands of Scotland for which a glacial origin was at first suggested, but was subsequently discarded in favour of deposition by torrential streams.

In the same year an important contribution to the discussion was furnished by M. E. Wilson[4] based on his studies in the eastern part of the Cobalt belt. Wilson concludes that the conglomerates must have been deposited either by glaciers or by torrential streams and decides in favour of the former. The principal reason given is the absence at the time of sufficient grades to produce torrential streams. In addition some scratched and soled boulders were found. Wilson considers that the climate at the time was probably humid and cold.

In 1920, W. H. Whitehead[5] expressed his belief that the deposits "were of normal stream origin."

In 1922, H. C. Cooke[6] working in the same region as Wilson came to practically the same conclusion in regard to the origin of the conglomerates. The discovery of two small scratched and grooved surfaces under the conglomerates, the first found, is also announced.

In 1925, W. H. Collins,[7] as a result of his work on the north shore of Lake Huron, states that: "Coleman's hypothesis, though not yet conclusively established, is the only one yet advanced which offers an acceptable explanation of all the observed phenomena."

The writer working farther west in the Sault Ste. Marie area failed to find satisfactory evidence of direct of glacial deposition of the Huronian boulder conglomerates and agrees with Miller and Collins in considering that this glacial origin is not yet established.

An important point, not heretofore considered in connection with the problem, is the fact that conglomerates with practically the same characteristics as the Cobalt type occur at several horizons in the older Huronian formations. At Cobalt and for some distance east and west, the Huronian is represented by

[1]Amer. Jour. Sci., Vol. 23, pp. 187-92; Bull. Geol. Soc. Amer., Vol. 19, pp. 347-66; Jour. Geol., Vol. 16, pp. 149-58.
[2]Ont. Bur. Mines, Vol. XVI, pt. 2, 1907, p. 38.
[3]Ibid, Vol. XXII, pt. 2, 1913, p. 36.
[4]Geol. Surv. Can., Mem. No. 39, pp. 88-93.
[5]Econ. Geol., Vol. XV, p. 105.
[6]Geol. Surv. Can., Sum. Rept., 1922, pt. D, pp. 62-64.
[7]Op. cit.

the Cobalt series only. Farther west the Cobalt series has been shown by Collins to be underlain uncomformably by an older group of Huronian formations called by him the Bruce series, and still farther west the Bruce series is underlain by a third group called by the writer the Soo series. The Bruce series contains two great conglomerate members, one at the base of the Mississagi quartzite, the basal formation, and the other higher up at the base of the Bruce limestone. Collins[1] remarks in his description of the Bruce series on the close similarity in appearance of both these conglomerates to the boulder conglomerate of the Gowganda, the Lower Cobalt of this report. The first mention by Coleman of the possible glacial origin of some of the Huronian conglomerates was suggested by the resemblance to glacial deposits of conglomerates at Ramsay lake, since placed in the Bruce series.

In the Soo series, the Aweres formation, the highest member, consists largely of alternating bands of conglomerates and quartzites. The conglomerates vary in character, but in places the constituent fragments rival in size and have the same disorderly arrangement as the Cobalt conglomerates and simulate glacial deposits quite as closely.

Similar conglomerates also occur associated with the schists of the Basement series, a pre-Huronian formation probably nearly equivalent in age to the Timiskaming. In their coarser phases these conglomerates hold subangular granite fragments up to three feet in length and resemble the Cobalt boulder type so closely that for some time they were considered to be infolds of Cobalt in the schists. Later work proved conclusively that they were an integral part of the schist formation.

A development of conglomerates of the Cobalt type occurs, therefore, at two horizons in the Bruce series in the upper member of the Soo series and lower down associated with pre-Huronian schists and lavas. Assuming a glacial origin for all these conglomerates would mean that Huronian times were largely glacial and that intermittent glacial conditions continued down into the Timiskaming.

A comparison of the Cobalt boulder conglomerates with the well-studied Pleistocene boulder clays shows at once serious discrepancies in general character difficult to explain if their origins were similar.

Character of Matrix

Boulder clay as the name implies is a clayey mixture, the proportion of clay present varying with the character of the rocks from which it was derived. In exceptional cases it consists almost entirely of clay, but usually holds in addition varying amounts of gravel, sand, and rock flour. Merrill quoting Crosby states that the boulder clays in the vicinity of Boston, excluding the large boulders, are made up of 25 per cent. gravel, 20 per cent. sand, 40 to 45 per cent. of rock flour, essentially quartz, and less than 12 per cent. clay.[2] This example is, of course, not typical of boulder clays everywhere, as the relative importance of the various constituents change rapidly from point to point. The presence of a considerable percentage of rock flour is, however, a very characteristic feature. The greywacké matrix of the boulder conglomerate is quite different. It consists mainly of irregular-sized angular and subangular grains of quartz feldspar and minute rock fragments, usually accompanied by some chlorite and a small amount of fine, indeterminate material, and seems plainly the product of ordinary rock disintegration.

[1]Op. cit., pp. 32, 45.
[2]Geo. P. Merrill, Rocks, Rock Weathering and Soils, p. 353.

Distribution

In the eastern part of the Cobalt belt, Wilson describes the formation at one point as consisting of two boulder conglomerates separated by a band of greywackés, arkoses, and other bedded rocks assumed to be the product of an interglacial period. This succession, similar to that which obtains in places in the Pleistocene deposits, is assumed to indicate a similar glacial origin. In the western parts of the Cobalt belt, the conditions are entirely different. The same rock types are present, but their distribution through the formation is marked by extreme irregularity. The boulder conglomerate occurs at different horizons in sections not far apart and in places is absent altogether. In four sections published by Collins,[1] it forms the base of the formation in only one. It holds beds and bands of quartzite and boulder-free greywackés, and traced horizontally passes into other rock types, usually greywackés more or less distinctly bedded. In vertical sections, the junction of the boulder conglomerates with the other constituents of the formation is ill-defined, gradual in some instances and in others sharp and regular. No marked uncomformities or wavy contacts, such as commonly occur in the Pleistocene where boulder clays are overlain by interglacial or post-glacial bedded deposits, were noted. In the southeastern part of the Sault Ste. Marie area, typical boulder conglomerates in heavy bands and masses form an important part of the Lower Cobalt formation. A few miles away in Vankoughnet and Havilland townships the formation, here some thousands of feet thick, aside from a thin pebble bed at the base and rarely a few scattered boulders higher up, consists entirely of bedded greywackés and interbanded quartzites from top to bottom. Conditions such as these are inexplicable from the point of view of an orderly succession of glacial and interglacial periods.

Underlying Surface

One of the outstanding features of the ground moraine of the Pleistocene is its sharp contact with the underlying rocks where these are hard. Pre-glacial debris and decomposed rocks have been swept away, and the boulder clay rests, as a rule, on a hard, fresh surface, usually striated and grooved in the direction the glacier was moving. The base of the Cobalt series is in places well marked, while in others it is quite indefinite due to a gradual passage into the underlying rocks. The basal beds frequently consist of stratified greywacké and pebble conglomerate, not boulder conglomerate, and only one instance of a striated contact surface has been recorded among the hundreds examined.

In the Sault Ste. Marie area, excellent contacts of the Cobalt rocks with the underlying formations occur at several points, notably at Midge lake and Havilland bay. At Midge lake, a thin blanket of rather coarse greywacké, carrying scattered pebbles and boulders up to a foot in diameter, rests on the upturned edges of the hornblende schists of the Basement series. The contact is sharp and clearly traceable along the face of the exposure. The rough, in places angular, schist surface shows no trace of glacial smoothing. At Havilland bay, a pebble bed at the base of the Cobalt rests on a similar rough granite surface.

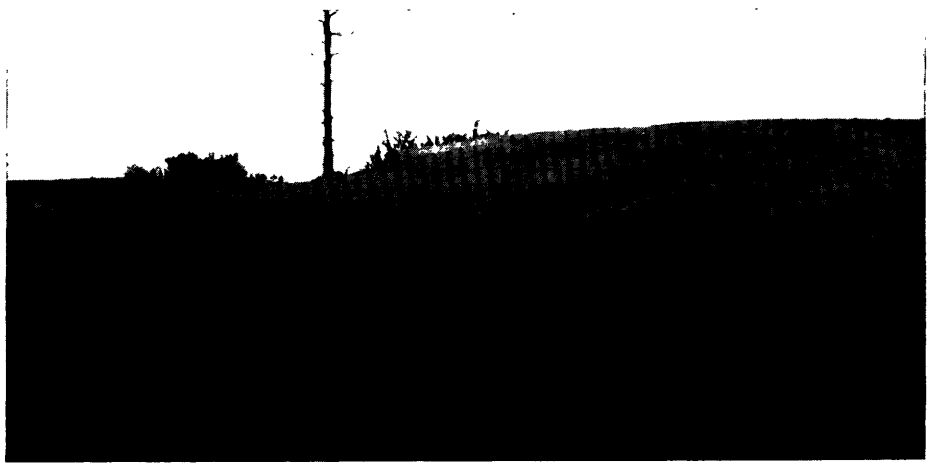
The marked absence of striated surfaces is explained by Coleman as follows: "Near the edge of a glaciated area where the thickness of ice is not great, the ice-sheet often moves for many miles on loose material without even reaching the rock surface beneath." This is no doubt true, but the argument implies that only the fringe of the deposits of Huronian times has been preserved. The

[1]Op. cit., p. 6.

wide distribution of the Huronian sediments makes this improbable. Also in the Pleistocene, where glacial deposits rest on loose material, the exact contact is usually easily recognizable. In the Huronian conglomerates, gradational changes at the base, from hard rock, through angular broken material, into rolled sediments with no sharp break anywhere, are common.

Striated Boulders

A few scratched boulders and a larger number of so-called soled boulders have been found in the Cobalt boulder conglomerate. This can hardly be considered conclusive evidence of glacial origin, as scratched boulders are not exclusively the product of glaciation and soled boulders have their counterpart in stream deposits. In the Pleistocene, neither scratched boulders nor striated



Cobalt conglomerates resting on schists of the Basement series, Midge lake, Deroche township.

surfaces have to be hunted for. They are present everywhere. They ought to be as numerous or nearly so in the Huronian boulder conglomerate if it is of direct glacial origin. The boulders have been sealed up practically since deposition and when freshly exposed have hard usually smooth surfaces showing no signs of decay. Heavy scratches, if originally present, could have been obliterated only by rolling. Even if the glacial origin of the few scratched boulders found is admitted, this need not imply continental glaciation. The climate at the time, according to most observers, was cold and humid, and a development of local glaciers on a considerable scale in favourable situations is very probable. Collins has shown that the striped matrix of the lacustrine greywacké conglomerate has the varved character now considered to indicate deposition from glacial streams and also that some of the boulders were carried out into the lakes, presumedly by floating ice, and dropped.

In Wilson's discussion of the origin of the Cobalt conglomerate, the conclusion is reached on good grounds that they must have been laid down either by glaciers or torrential streams. He admits the close resemblance of the deposits in all respects to the product of short torrential streams but decides in favour of the former. The assumed absence of steep-graded streams at the time is given as the principal reason. The writer on the other hand, for various reasons given

above, is unable to accept as conclusive the evidences of glacial origin so far formulated and considers that ordinary and torrential stream deposition, aided to some extent by floating ice and probably by local glaciers, offers a more plausible explanation and is more in accordance with the field conditions along the whole belt as described by various authors.

The question of grades is a difficult one and cannot be satisfactorily answered with present knowledge. There is no doubt that a long period of erosion preceded the deposition of the first Huronian sediments and that the surface on which they were laid down was in an advanced stage of peneplanation. Notwithstanding this, some relief existed. Emmons states, in regard to the pre-Bruce surface in Otter township, "that there was a considerable amount of relief to the granite surface of erosion"[1]; farther west, steep contacts of Huronian rocks with pre-Huronian granites and schists were noted by the writer at a number of points. The possibility of earth movements counteracting to some extent the effect of erosion must also be taken into account. The Bruce series was deformed by small earth movements before the deposition of the Cobalt sediments, and these movements may have continued on into Cobalt times. The Huronian series of formations have an aggregate thickness of over 30,000 feet and consist largely, possibly altogether, of a succession of land and lacustrine deposits. The crust no doubt sank under this great, gradually accumulating load, and bordering, correlative elevatory movements may have provided the necessary grades.

Evidence that moderate grades, at least, existed is afforded by the bedded greywacké conglomerates. These are lake deposits carrying pebbles and boulders up to six and eight inches in diameter. The streams feeding the lakes required considerable force to roll down drift of this size. The present surface of the Canadian shield is often compared with the pre-Huronian surface, yet in Pleistocene times, the grades in the Sault Ste. Marie area were sufficient to enable the streams to build up fluvial glacial deposits quite as coarse as the boulder conglomerates of the Cobalt and other Huronian formations and similar to them in other respects.

Neither the presence nor absence of steep-graded streams in Huronian times can be definitely proved or disproved. The records of the precise physical conditions that obtained in that far-off age have become too obscure. Evidence that they did exist rests altogether on the character of the deposits themselves.

KEWEENAWAN

Keweenawan rocks are represented in the area by three small isolated areas of lavas distributed along the coast of Lake Superior and by numerous dikes, sills, and bosses of diabase, intrusive into all the older formations. No sediments of this age were recognized.

Effusives

At Gros Cap the granites are fringed along the coast by a narrow band of volcanics for a distance of about half a mile. A second coastal strip a mile in length occurs a little farther north in section 30, Prince township. Jackson island lying off the coast is also built of lavas.

The volcanics include both basic and acid lava flows, the former predominating. Acid lavas occur at Gros Cap and northward along the coast for a few hundred yards. They are hard, red-coloured, moderately coarse porphyritic rocks, very strongly and evenly jointed in places. Thin sections show corroded

[1]W. H. Collins, op. cit., p. 33.

quartz individuals and a few unstriated feldspars, porphyritically distributed through a fine-grained base of the same minerals.

The basic lavas include both vesicular and massive types and are probably younger than the red acid lavas, as they enclose fragments of a similar rock. The bands are tilted to the southwest at angles up to 65 degrees. The ordinary massive variety is a medium-grained, dark-coloured rock, weathering on exposed surfaces to a rusty colour. It is a holocrystalline rock consisting of fairly fresh augite and basic feldspars, some hornblende, chlorite, and dark iron ore. Quartz occurs in occasional grains and rarely in intergrowths with feldspar. A tendency to an ophitic structure is often noticeable. A green variety proved to be similar to the black, lithologically, except that the alteration was more advanced and uralized augite and chlorite more abundant.

The contact between the lavas and the granite in the high bluffs extending north from Gros Cap show some peculiar features. Sharp contacts were found only at a few points, but in these the contact line was either vertical or inclined eastward under the granite at an angle of about 75 degrees. This apparent evidence of the younger age of the granite was supported by the fact that it holds inclusions of a basic volcanic rock. On the other hand, the granite near the contact is coarse grained, the lavas show little or no alteration, and no granitic dikes were found cutting them. The peculiar relationship of the two formations may possibly be due to faulting, although all ordinary indications of faulting, such as brecciation and shattering of the rocks along the fracture plane, are absent.

In addition to the areas mentioned, a narrow band of Keweenawan lava follows the west shore of Horseshoe bay in Ley township for a distance of nearly a mile. On the south shore, the lavas are overlain unconformably by the Lake Superior sandstone, and on the north are separated from the same formation by a fault. On the east, they are in contact at one point with Lower Cobalt rocks. The lava here is dark, basic, highly vesicular rock. The vesicles, in some instances two inches or more in length, are filled with chalcedonic varieties of quartz.

Intrusives

Sills, dikes, and bosses of diabase considered to be of Keweenawan age are common throughout the area. A large sill outcropping in a crescent-shaped band, about half a mile in width and several miles in length, crosses the northern part of Vankoughnet township. It has weathered along most of its course into a prominent ridge, usually with easy slopes to the north but facing south in a series of steep, imposing cliffs, 700 feet high in places. Its thickness in the central portion is approximately 900 feet. On the west it penetrates the greywackés and quartzites of the Lower Cobalt and, near its east termination, the schists of the Basement series. The inclination of the sill is northward at low angles, practically the same as those of the enclosing greywackés.

The diabase in the Vankoughnet sill is a massive, medium-grained rock, ordinarily light-greyish in colour but becoming dark grey towards the eastern termination of the sill. It is a quartz diabase made up largely of striated feldspars and augite in well-marked ophitic relationship to each other. Other minerals present include grains of dark iron ore, quartz in grains and in granophyric intergrowths with feldspar and occasionally hornblende and epidote. The dark variety differs from the light grey in the larger proportion of augite and in the absence of quartz-feldspar intergrowths. The intrusion of this great sill produced remarkably little effect on the beds penetrated. The latter are nowhere crumpled or broken and are not noticeably altered along the margins.

An area of light-greyish diabase, about half a mile in length, very similar to that in the Vankoughnet sill both in appearance and lithologically, forms a prominent craggy ridge faced on the south with high cliffs in section 20, Duncan township. The diabase here probably intrudes the greenstones of the Basement series in the form of a stock, as the long diameter of the area crosses the foliation. It is a medium to moderately coarse-grained grey rock free from shearing planes. It is traversed by occasional small dikelike bodies made up largely of dark columnar augite and quartz with some feldspar. These bodies have more the appearance of segregations than dikes and are probably genetically connected with the diabase.

A parallel ridge on the south is built of a medium to coarse grained, dark basic rock resembling gabbro in hand specimens. The coarser areas are deeply weathered. A thin section from a moderately coarse exposure showed the ophitic structure of a diabase. In the east end of this ridge, reddish aplitic or syenitic differentiates, a common feature of the Nipissing diabases, are extensively developed. The dark intrusive is separated from the grey by a narrow concealed area and may possibly form part of the same mass.

With the exception of the Vankoughnet sill and the area in section 20, Duncan township, the Keweenawan diabases of the area are dark-coloured rocks, usually weathering to a dark green. Rounded, stocklike masses are widely distributed but are all small, seldom exceeeding a third of a mile in diameter. Only a few of the larger ones have been mapped. A good example of the stock occurs in the Garden River Indian Reserve, three miles east of Garden River Crossing, and north of the old main road. The diabase here outcrops in an oblong block about 700 yards in length and 400 in width and, owing to its superior resistance to erosion, forms a short, steep-sided ridge, 250 feet in height. It cuts through the greywackés and quartzites of the Lower Cobalt series here dipping to the south at moderate angles. The beds show little disturbance or alteration as a result of the intrusion. The diabase is coarser grained than that in the Vankoughnet sill and in the dikes, but is similar lithologically. It is a quartz diabase made up essentially of augite and labradorite with quartz in grains and in intergrowths with feldspar. Near the centre of the mass a reddish irregular band of an acidic differentiate crosses the ridge.

Quartz diabase in dike form is a very common intrusive in all the older rocks, both igneous and sedimentary, up to the Lake Superior sandstone. The dikes occur in all sizes, occasionally attaining a width of from 200 to 300 feet and a length of a mile or more. They cut the rocks in all directions, no general trend being noticeable, and their attitude seldom varies much from the vertical. The texture, except in very small examples and along chilled edges, is always distinctly granular and in places becomes quite coarse. In the thin sections examined, quartz, either in grains or in intergrowths with feldspar, was always present.

The largest dike encountered, and the only one mapped, occurs in the east end of the Bellevue ridge. It is traceable in a direction a few degrees south of east for a distance of two and a half miles and has a width in places of 300 feet. It cuts along its exposed course the hard quartzites of the Upper Cobalt. It is a typical quartz diabase but holds in places, in addition to the ordinary minerals, scattered red plagioclase crystals. Hornblende, probably derived from augite, is also present in some sections.

Olivine Diabase

In addition to quartz diabases, occasional quartz-free diabase dikes, usually characterized by the presence of olivine, occur throughout the area. A vertical dike of this class, fully 75 feet in width, breaks through the Driving creek quartz-

ites and the overlying Duncan volcanics at their junction a short distance south of section 6, Duncan township. The dike is fine grained along the margins but becomes fairly coarse towards the centre, and in places shows a feeble spheroidal structure. It is made up of labradorite, augite, and olivine, with some hornblende chlorite, apatite, and dark iron ore. A rounded area of olivine diabase along the south border of section 12, Aweres township, probably represents a small stock. In this occurrence, the diabase is a dark-coloured, medium-grained, remarkably fresh rock, with a very pronounced ophitic structure. The constituent minerals, mainly labradorite, augite, and olivine, show little or no sign of alteration.

The quartz diabases are cut in places by narrow, fine-grained dikes of a basaltic type, probably belonging to the same period of intrusion as the olivine diabase. These dikes are made up of small fresh phenocrysts of labradorite and augite distributed through a dark base often holding feldspar microlites.

Age Relationship

The quartz diabases were intruded in post-Huronian times and before the deposition of the Lake Superior sandstone. They are placed in the Keweenawan, although no direct proof of this was obtained. The quartz-free diabases, although much younger, probably belong to the same period. They intrude both the quartz diabases and the younger granite.

Younger Granite

Post-Huronian granites have a considerable development in the area. They are similar in appearance to certain phases of the pre-Huronian variety and cannot always be distinguished from them in the field with certainty.

Distribution

An area of granite in Duncan, Jarvis, and Deroche townships, extending from Driving creek northward to Bellevue ridge, consists mostly of the younger variety but contains inclusions of the older. It is bordered on the west and north by Huronian formations and on the east by the schists of the Basement series. The granites in the southern part of Tupper township and the hilly ridge extending westward to Havilland bay are also largely but not altogether of post-Huronian age. Inclusions of pre-Huronian granite quartz are common in places. Farther west a small stock outcrops near Horseshoe bay in the western part of Havilland township. This occurrence was examined by Alexander Murray in 1857 and its post-Huronian age recognized. It is described by him as a syenite dike.

General Character

The younger granite is ordinarily a medium-grained, unsheared red rock made up largely of feldspar. In the central part of the Duncan-Jarvis batholith, the grain becomes quite coarse in places, and in a few exposures the development of large feldspar crystals gives the rock a distinct porphyritic appearance. The common constituents of the granite in the thin sections examined are microcline, oligoclase, orthoclase, variable but usually small quantities of quartz, and a few flakes of biotite, chlorite, and colourless mica. Pyrite and epidote in disseminated grains are also occasionally present. Fresh microcline is the most abundant constituent of the rock. In normal varieties the quartz content is small, but in a few small peripheral areas, the granite becomes highly siliceous, due no doubt to the absorption of siliceous sedimentary rock.

The distinguishing feature of the younger granite in the Soo area as compared with the pre-Huronian variety in its massive character, and aside from differences in grain, is uniformity. The peripheral portions of the older granite batholith usually consist of an intricate complex of schist inclusions cut by a succession of granitic dikes and masses ranging from aplites to coarse granites. This marginal complexity, while present to some extent along the contact of the younger granite batholiths with the schists of the Basement series, is almost wholly absent where the contact is with Huronian sediments. This junction is usually a clear-cut line with few inclusions in the granite and few dikes penetrating the sediments for any distance.

The metamorphic effects of the granite intrusions on the sediments of the Huronian formations, probably explainable by the small size of the batholiths, are remarkably slight. Well-exposed contacts of the granite with the greywackés of the Lower Cobalt occur on lot 2, concession I, Deroche township. The granite holds small inclusions of partially absorbed greywacké near the contact, but the bordering greywackés have undergone little alteration, aside from an increase in the amount of chlorite present. They are nowhere altered into schists. Direct contacts of the younger granite with Cobalt greywackés may also be observed at several points along the northern and western borders of the Havilland Bay stock. The greywackés near the granite assume a green coloration due to the development of chlorite, but otherwise are not noticeably altered. The Upper Cobalt quartzites of Bellevue ridge are altered into a hard, completely cemented rock wherein contact along their southern border with the Duncan-Jarvis batholith, but this is probably due to dynamic action. Similar glassy quartzites occur elsewhere, notably north of Goulais bay, in disturbed areas free from granites, while the nearly flat-lying King mountain quartzites, where cut by granites, still retain their granular character.

A feature of the younger granite batholiths of the area is the presence of numerous dikes which they sent out into the schists of the Basement series and the comparative rarity of dikes along contacts with Huronian greywackés and quartzites. The Duncan-Jarvis batholith is in contact with Huronian rocks along its western border for a distance of nine miles, and in this stretch only one large dike and a few small dikelets are directly traceable from the granites into the sediments. The small stock at Havilland bay is fringed along its south boundary, where in contact with the older schists, with dikes and small satellitic granitic masses, while on the north boundary evidence of intrusion into the Lower Cobalt rocks is limited to an occasional small granitic stringer penetrating the greywackés for a few feet or inches.

Acidic dikes and masses, no doubt genetically connected with the younger granites, occur in a few places in the interior of the Huronian areas. On Trout lake the quartzites and conglomerates of the Aweres formation are cut by a number of short, blunt quartz porphyry dikes and small masses, and in the Garden River Indian Reserve south of section 7, Duncan township, the Duncan volcanics are traversed by small granite dikes. A granitic mass, about 400 yards in length, intrusive into the quartzite of the Driving Creek formation, also occurs in section 27, Duncan township.

Age Relationship

The post-Huronian age of the younger granites in the Sault Ste. Marie area is quite clear. The field evidence of their intrusion into all the Huronian formations, up to and including the Upper Cobalt quartzites, the highest member, is unmistakable. They are also, in part at least, younger than

Keweenawan quartz diabases, but probably older than the later intrusion of olivine diabase. Granite dikes were noted at a number of points cutting the quartz diabases, and on Driving creek a small dike of the olivine diabase series intrudes the granite. The Lake Superior sandstone, a Cambrian formation, overlying uncomformably both the Keweenawan lavas and the Huronian sediments, are free from dikes of any kind. The evidence is fairly clear that the younger granite is of Keweenawan age and was intruded either after or during the closing period of the quartz diabase invasion, and before the irruption of the later set of olivine diabase dikes. It is very similar in composition, general character, and also in age relationship, to the Killarney granite as described by Collins,[1] and can with confidence be correlated with it.

CAMBRIAN

Lake Superior Sandstones

The sandstone and shales of the Lake Superior sandstone, the youngest hard rock formation in the area examined, are exposed at a number of points in the usually drift-covered lowlands of the area, bordering the St. Mary river and Lake Superior. They rest unconformably in different areas on the schists of the Basement series, the Cobalt quartzites, and the Keweenawan lavas, and are overlain directly by glacial and recent deposits.

Distribution

The terraced strip of country bordering the St. Mary river on the north is heavily drift covered, and while probably underlain throughout by Lake Superior sandstones, exposures of these rocks are found only in the central part in the vicinity of Sault Ste. Marie and on Root river near the limiting granite gneiss escarpment on the north. Following the shore line o Lake Superior northward, occasional outcrops are found on the beach in Dennis and Pennefather townships. The wide flat occupied by the lower reaches of Goulais river, originally an arm of the lake, is also floored with Lake Superior sandstone. Outcrops are infrequent but occur at intervals along the bases of the bordering hills, and at one or two points project through the drift-covering of the plain. They extend westward to the west end of Bellevue ridge, a distance of ten miles from the present lake shore. North of Goulais bay, exposures of sandstones occur at intervals along the lake shore, north to Rudder Head point, and eastward along the south shore of Batchawana bay to near the mouth of the Harmony river, where the examination ended. While exposures are confined to the coast, it is probable that the sandstones underlie the drift over the greater part of Kars and Ley townships. The elevations in both these townships are low, the contours are even, and except at one point projecting ridges of the older rocks so prominent elsewhere are absent.

Parisian island in Whitefish bay, eight miles west of Goulais point, and Maple island, lying off section 4, Ley township, consist of reefs of Lake Superior sandstone covered with beach sands and gravels. The exposed west and north coasts of Parisian island are lined with low sea-cliffs built of sandstone, dipping gently to the north. The sheltered east coast is a succession of sand and gravel beaches.

Rocks

The Lake Superior sandstones, while covering considerable parts of the area, occur everywhere in disconnected sections, and it was impossible to follow

[1]Op cit., p. 85.

the sequence of the beds or to form even an approximate estimate of their volume. Bore-holes put down in a search for water have penetrated them to varying depths up to 710 feet. As the dips, except near faults, are low, seldom exceeding 10 degrees, this gives a minimum thickness.

The lower beds of the formation where exposed consist of coarse conglomerates. These are overlain by reddish, mottled, and greyish sandstones interbanded in places with red and grey shales and infrequently with thin beds of pebble conglomerate.

The basal beds are well exposed along the east shore of Horseshoe bay for a distance of about half a mile. They consist here of coarse conglomerates made up largely of well-rounded pebbles and boulders of Upper Cobalt quartzite up to 20 inches or more in diameter, enclosed in a matrix of coarse-grained ferruginous sandstone, occasionally alternating with thin lenticular beds of red sandstone. Other rock varieties in the conglomerate include Lower Cobalt greywackés and red quartzites, and greyish and reddish gneisses and granites. The granite boulders, unlike those in the Huronian formations, have been much softened by decay. At their north termination, the conglomerates overlie a band of Keweenawan lavas and near the contact hold, in addition to the usual varieties, numerous angular fragments of lava. Basal conglomerates, somewhat similar in character, also occur resting on the schists of the Basement series in section 6, Havilland township, and project through the drift at one point in section 35, Deroche township.

An unusual type of the conglomerate outcrops in section 11, Kars township, at the base of a low ridge of Upper Cobalt quartzite. The sandstone here is a reddish, rather fine-grained, shaly variety, and dips away from the quartzite at a low angle. Near the contact the sandstones become coarser and enclose a number of angular and imperfectly rounded fragments of quartzite, evidently debris from the quartzite ridge, while a few yards away from the contact the same beds are quite free from boulders. The boulders occur, not at the base of the formation, but at the ends of beds, some distance above the base, where they terminate against the ridge. A rock of this kind might be termed a marginal conglomerate.

Above the basal conglomerate, the most prominent variety is a medium to rather coarse grained, moderately hard sandstone, usually reddish in colour, but often blotched and streaked irregularly with grey. It occurs in heavy beds, up to four or five feet in thickness, and in bands made up of a succession of thin beds. Strong cross-bedding and ripple-marked surfaces are common features. The sandstone is made up largely of angular quartz grains, but also holds some feldspars. It is often porous, and has been bored at several points for water, with varying success. The more massive beds furnish an excellent building-stone, but unfortunately these are interbanded with so much unsuitable material that production costs are high. No quarries are now in operation.

The coarse, reddish sandstone is interbanded with fine-grained, shaly sandstone usually reddish in colour, but occasionally grey or spotted with grey, and with reddish shales. A hard, fine-grained, grey sandstone also occurs in the series at a few points apparently near the top of the local section. A thin section of this showed it to consist of small, angular quartz grains with a few cloudy feldspars, some colourless mica, and dark iron oxide. Thin, non-persistent pebble beds and sandstone beds surfaced with scattered pebbles occur sparingly throughout the formation. The common pebbles in these are quartz, quartzite, schist, and granite. Small, angular fragments of hematite were found at one point in sandstone on Parisian island.

Structure and Age

The Lake Superior sandstones, unlike the other formations of the area, are characterized everywhere, except along faulted zones, by low dips; and in places their attitude is horizontal or nearly so. In the lowlands north of St. Mary river, the general dip is from the escarpment southward toward the river. The artesian character of some of the wells of the region is due to this southward inclination of the beds. Along the shore of Lake Superior, light folds were noted at a number of points, but the long concealed intervals made it impossible to construct a connected section. The trend of the folds is usually east and west. Faulting on a small scale is common in the beds of the formation, and a strong east and west fault has tilted them on end and brought them against the quartzites of the Upper Cobalt, south of the west end of Bellevue ridge. A second considerable fault is probably indicated by a vertical zone of sandstones bordering the Keweenawan lavas on the north, in Horseshoe bay.

The Lake Superior sandstones and shales are a strictly sedimentary series. No interbanding with volcanic, either effusive or pyroclastic, was observed, and no dikes of any kind were found cutting them. They are placed in the upper Cambrian at about the horizon of the Potsdam sandstone by the Michigan Geological Survey.

On the Canadian side of the St. Mary river, means for determining their age are lacking. They definitely overlie unconformably all the older formations up to and including the Keweenawan lavas, but are unfossiliferous and are not overlain by younger hard rock formations.

PLEISTOCENE AND RECENT

In glacial times, the Sault Ste. Marie area was overridden by a lobe of the Labrador glacier advancing from the north. Smoothed, striated, and grooved surfaces, marks of heavy glaciation, are common at all elevations up to and including King mountain, the highest point in the area. The striae have a general but by no means uniform southerly trend, as the rough topography prevented the free flow of the ice southward. Variations in direction of the striae up to 50 degrees were noted, due to the ice moving around obstructions in its path. The glacier carried away all loose material and smoothed and rounded the hills and ridges to some extent but otherwise, except for stream diversions, effected little change in the general topography. Some of the ridges show the steep cliffy faces on southern exposures, generally attributed to ice plucking.

The deposits of the Pleistocene consist of boulder clays and associated fluvio-glacial and outwash gravels, overlain by lake clays, silts, sands, and gravels of the Lake Algonquin period.

Boulder Clay

The boulder clays have a very sporadic distribution and in many places on the highlands are absent altogether. A ridge, possibly a terminal moraine, projects through the lake clays north of the town of Sault Ste. Marie, and a somewhat similar ridge occurs in section 9, Fenwick township. Other disconnected occurrences were noted in cuttings along the Algoma Central railway and in the northern slopes of some of the ridges. No general blanketing of the surface with this material apparently ever took place.

Fluvio-Glacial Deposits

A typical fluvio-glacial deposit is exposed in the southern face of a drift ridge a mile north of Garden River P.O. It consists of sand, gravel, and boulders, up

to four feet or more in length, with here and there a little clay. The uneven-sized boulders are distributed very irregularly through the sand and gravel beds, and the deposit as a whole resembles in general appearance the boulder conglomerates of the Lower Cobalt and suggests at once a like origin. The matrix is different, as it consists largely of coarse, siliceous sand and gravel with little fine material. Similar coarse drift deposits extend northward for a distance of nearly a mile following a depression north of Quarry ridge.

Outwash Deposits

In lots 10 and 11, concession II, Deroche township, a wide depression in the older rocks north of Bellevue ridge is levelled up to a height of approximately 500 feet above Lake Superior with gravels and sand laid down by streams issuing from the retreating glacier. The gravelly plain has a width of over half a mile and is pitted at several points by deep rounded hollows or kettles. The largest of these, a quarter of a mile or more across, contains a small lake. These peculiar depressions according to current opinion owe their development to the melting of masses of ice left behind by the retreating glacier and subsequently buried in stream wash. As the ice melts, the gravels slump down into a rounded, kettle-shaped hollow.

Lake Deposits

Algonquin Stage

During the retreat of the great glacier northward, the basin of Lake Superior, or portions of it, was occupied by a succession of lakes held in by the ice and draining in various directions, depending on the changing levels and the facilities offered. The lake deposits forming the lowland in the Sault Ste. Marie area were laid down in one of the latest of these predecessors of Lake Superior, known as Lake Algonquin. In the Lake Algonquin stage, the water for a while stood at a height of about 420 feet above the present elevation of Lake Superior. Arms of the lake at this period extended up Goulais and Garden River valleys for many miles.

The deposits of the Lake Algonquin stage consist of clays and silts, with some interbanded sand below and sands and gravels above. A thin gravel bed is recorded in some well-borings at the base, underlying clay. The upper limit of the lake beds is well marked at Granite Siding, on the Algoma Central railway, by a small gravel plain at an elevation of 1,022 feet above the sea, and also by a sandy terrace farther west at about the same elevation on the Goulais Bay road. Below the high level, stages in the lowering of the lake are marked by a number of terraces, the most prominent one occurring at an elevation of approximately 700 feet.

The lake deposits have been partially destroyed and occur in disconnected areas, the largest situated north of St. Mary river from Root river westward. Other areas occur in sheltered western slopes in Pennefather township, in Kars and Ley townships, and in the valleys of Goulais and Garden rivers.

In the St. Mary river valley, the lake deposits were laid down on an uneven sandstone and boulder clay surface, and on account of this vary greatly in thickness. In the vicinity of the town of Sault Ste. Marie, the old sandstone surface rises in places above the river-level, while to the east and west it sinks out of sight beneath the drift. On Carp river, a bore-hole put down to a depth of 443 feet failed to reach bed rock. The sediments penetrated consisted of: clay, 160 feet; sand, 15 feet; clay, 66 feet; sand, one foot; and silty clays, 201 feet. As about 300 feet of lake beds occur above the top of the bore-hole, a

minimum thickness here of approximately 750 feet is indicated. In other sections examined, the thicknesses were much less.

Nipissing Stage

At the Nipissing stage, the water in the Lake Superior basin at Sault Ste. Marie stood for some time at an elevation of about 49 feet above the present level and drained through the Ottawa river into the lower St. Lawrence. No deposits comparable to those of the Algonquin were laid down at this stage, but considerable changes were effected in the topography at low levels. The long, winding clay escarpment north of the St. Mary river, extending from Carp river to Root river, was cut back by lake waves during this period. Steep shore lines of the Nipissing period occur also in Prince, Kars, and Ley townships, and a low terrace north of Quarry ridge near Garden river is probably of the same age.

Recent Deposits

The numerous small lakes of the area originated largely by the damming of streams with drift during the glacial period. At the present time, these lake basins are being gradually filled up by sediments brought into them by their feeders. In the case of some of the smaller ones, the process has been completed and the lake has been replaced by a small plain bisected by a meandering stream. Sand plains are also in course of formation at the mouths of the principal streams. Goulais river brings down an enormous amount of sediment year by year, and Goulais bay into which it empties will eventually disappear. At the present time, the northern portion of the bay is covered by only a few inches of water. Root river and Garden river have also built up in recent time at their mouths long sand points projecting into the St. Mary river.

Economic Geology

Mines and Prospects

The Sault Ste. Marie area is disappointing from a mineral standpoint. It has been fairly well prospected for iron and other minerals, and numerous showings have been found and tested; but with the possible exception of the Victoria mine, none of these proved to be of much economic importance. The geological conditions are not unfavourable, as the older formations of the area have been crushed and broken by earth movements and repeatedly intruded by igneous rocks, mostly granites and diabases. In Vankoughnet township, the conditions at the famous Cobalt silver camp are seemingly almost exactly paralleled. A great diabase sill traverses for miles the rocks of the Cobalt formation, but unlike the Cobalt sill had apparently little effect in either fracturing or mineralizing the intruded rocks. A few small quartz veins have developed in places along the sill, and in some instances these carry negligible quantities of galena and other metallic minerals. No workable veins have so far been opened up. Discoveries of native silver have been reported from several points in the area. There is nothing inherently improbable in such discoveries, but the writer was unable to verify them. The surface of the country is largely drift covered, even in the uplands, and only a comparatively small proportion is open for ordinary prospecting.

The showings of galena, chalcopyrite, and other non-ferrous minerals found up to the present occur mostly in schist inclusions in the granite areas. No discoveries of any importance have been made in either the Huronian group of formations or in the schists of the Basement series.

Victoria Mine

The Victoria mine is situated near the north boundary of section 26, Duncan township. It was opened up in 1875, but has been idle for many years, and the workings are now filled with water. A brief description of this mine, the only one in the area from which any considerable shipments of ore have been made, is given in the report of the Royal Commission on the "Mineral Resources of Ontario, 1890," page 29, and further information in regard to the workings and assays is published in Volume XXIV, part 1, of the Ontario Bureau of Mines, 1915, page 238. As the workings are inaccessible at present, little additional information was obtained.

The ore body occurs in a small area of greenstone schists, about 150 feet in width and a few hundred yards in length, enclosed in a pinkish, medium-grained granite, probably of Keweenawan age. The following section was measured across the schist belt just north of the main working shaft:—

	Feet
Granite	...
Green schists	17
Green schists, crushed and sparingly mineralized, cut by small quartz veins	18
Quartz vein	1
Schists, well mineralized with galena, zinc blende, etc.	3
Dike	1
Partially schisted greenstone	12
Concealed	90
Granite	...

The main shaft was sunk on the central, well-mineralized zone and was continued down to a depth of 410 feet, with drifts along the lead at intervals of about 50 feet. No record of production is obtainable. The ore is argentiferous galena distributed somewhat irregularly through the crushed schists in stringers and small bunches. The silver content of the ore ranges from 10 to 30 ounces per ton. Besides the galena, sphalerite occurs in the ore body in considerable quantity, also some copper and iron pyrites.

A second shaft was sunk in granite 200 feet south of the main shaft near a granite schist contact. The schists along the contact are crushed and silicified for a few feet and carry some galena and sphalerite but not in sufficient quantity to constitute a commercial ore.

The Victoria mine is connected with Garden River station on the Canadian Pacific railway, the shipping point, by a wagon road about ten miles in length. The original road followed the east shore of Elizabeth lake. The portion along the lake has been destroyed in places by fire, but the mine can be reached by a road passing the lake on the west.

Cascade Mine

The Cascade mine is situated in Jarvis township about half a mile directly north of the Victoria mine. The country rock here is a granite carrying occasional greenstone schist inclusions. The showing occurs in one of these inclusions about ten feet in width, outcropping in the valley of Weashkog creek. The narrow schist belt follows a line of strong disturbance; the schists and to some extent the bordering granite have been crushed and in places brecciated. The crushed schists carry some sphalerite, argentiferous galena, and copper and iron pyrites in disseminated grains, but the showing is not an impressive one. A shaft was sunk near the northern tip of the schist inclusion and some drifting done. The search for a commercial ore body proved unsuccessful, and a mill put up somewhat prematurely is now dismantled.

Rankin Mine

The Rankin mine is situated in the northern part of the Rankin concession, a few yards north of the Huronian granite contact. The granite here, as at the Victoria and Cascade mines, holds small greenstone schist inclusions. The schist areas are cut by a number of irregular quartz veins and lenses, some of them carrying considerable quantities of chalcopyrite in grains and bunches. The workings consist of three pits sunk on the most promising veins. Some good ore was taken out, but the veins proved to be too irregular and non-persistent for successful exploitation.

Lucinda Mine

This property is situated near the southwest corner of section 2, Fenwick township, in an area of the Basement series schists. The country rocks are hornblende and chlorite schists, cut by wide diabase dikes. The workings consist of a shaft 50 feet or so in depth, judging by the dump. The reason for the shaft is not apparent. It does not follow any well-defined vein or fissure, and the rocks penetrated, aside from a few scattered grains of iron pyrites, are not mineralized. Work was discontinued some years ago and the equipment removed.

Other Properties

A number of other properties in the area have been opened up by shafts, pits, and small tunnels. Considerable work has been done on a prospect in the Garden River Indian Reserve, situated on a ridge about a quarter of a mile south of the west end of Boss lake. The workings consist of a shaft, reported to be 100 feet or more in depth, and three pits. The shaft penetrates the conglomerates of the Lower Cobalt for a few feet, then enters and continues downwards in the Bruce limestone. The limestone is lightly mineralized with zinc blende, galena, specularite, and iron pyrites in disseminated grains. No commercial ore body was found.

A number of claims have been staked east of Bellevue on the northern part of lot 11, concession VI, Jarvis township. The country rock is a granite holding greenstone schist inclusions. One of these inclusions is traversed by a well-defined shear zone sparingly mineralized with zinc blende, galena, and chalcopyrite. It has been opened up by several surface cuts. A short distance south of this showing, some work has been done on a large vein cutting across both schists and granite in an easterly direction and dipping steeply to the south. The vein is peculiar in having a quartz filling in its eastern extension and a calcite filling in the western portion. The calcite in one place carries small values in galena over a width of ten feet. A second calcite vein occurs near the south boundary of lot 11, concession I, Deroche township, but proved to be quite barren.

South of Trout lake, a number of small veins have been found and opened up in the granite schist complex near the Huronian contact. They carry some chalcopyrite but nowhere in quantity. Metalliferous prospects, worked to some extent but now idle, also occur in the plateau east of Gros Cap, on the lake shore in section 18, Prince township, on Ranson creek in section 2, Duncan township, along the diabase sill east of Sill lake, and at numerous other points. Notwithstanding the frequent disappointments in the search for deposits of value, prospecting is still active and some development work is in progress. A showing in the southeastern corner of section 1, range II, Tupper township, staked in 1919 by J. W. Robertson, has recently been opened up by a small cut. The showing occurs in a sheared greenstone schist inclusion in granite. The sheared zone has a width of about ten feet and is silicified and rather heavily

mineralized along the southeast wall, over a width of four feet, with chalcopyrite, some bornite, and iron pyrites. The ore, in addition to a considerable copper content, is reported to carry a small quantity of gold and also to assay for nickel. The ore body is only exposed at one point and its extent is unknown.

Iron Prospects

Occurrences of iron ore have been found at numerous points in the area, but unfortunately the development work carried on up to the present has failed to indicate any deposits of commercial value. The iron-bearing formations are the schists of the Basement series, the quartzites of the Upper Cobalt, and the greywackés of the Lower Cobalt.

Typical striped iron formation in narrow disconnected bands, associated with tuffs, occurs at the summit of the Basement series in sections 21 and 22, Duncan township, and extends northwards into Anderson township for a distance of over a mile. This range was carefully examined by a company a few years ago with little result. The schists in places carry magnetite in disseminated grains, but nowhere so far as known in sufficient quantity to constitute a commercial ore.

A large number of iron claims have been staked on the Basement series rocks in Deroche township in the vicinity of Maple lake. The only indications of ore in this section are a few feeble impregnations and an occasional small stringer in the schists. Development work consists of one bore-hole and a few pits.

In addition to the iron oxides, bunches and lenses of iron pyrites have developed in places in the schists. The largest outcrop of pyritic ore seen occurs in section 25, Vankoughnet township. It is owned by Chas. Legge and was opened up by a few surface cuts during the war. Its full extent has not been determined.

Iron deposits in the Lower Cobalt include those worked at the Breitung and Williams mines, and a series of small showings in the vicinity of Midge lake, Deroche township.

Descriptions of the Breitung and Williams mines by Sir Stopford Brunton are published in the Summary Report of the Geological Survey of Canada, 1922, page 310. Both mines have been idle for years.

The Breitung mine, owned by the Breitung Iron Mining Company, Marquette, Mich., is situated on Loon lake, in lot 4, concession I, Deroche township, at the east end of the long Bellevue quartzite ridge. The country rock consists of greywackés, occasionally interbanded with quartzites, invaded and cut off sharply a short distance south of the mine by the younger granite. The highly disturbed and in places shattered condition of the greywackés is probably due to the granitic intrusion, also the mineralization with quartz and hematite. Small quartz veins are seldom absent, and in some areas the greywackés are conspicuously ribbed with a succession of narrow veins following the stratification. The distribution of the hematite is more limited and is confined to a small area in the vicinity of the mine. It occurs in impregnation and in a few places where the mineralization of the greywackés was complete, or nearly so, in irregular lenses. No large ore body was encountered, and the total production of the mine was inconsiderable. The principal workings consist of two short tunnels driven into the steep hillside rising up from the lake.

The Williams mine is situated close to the southeastern corner of lot 1, concession I, Deroche township, at the south end of a narrow outlier of Lower

Cobalt rocks. These consist largely of greywackés, with some conglomerates near the base and an occasional quartzite bed higher up. They rest unconformably on the schists of the Basement series on the east, and on the west are in contact with and intruded by the younger granite.

A shaft was sunk on the Williams mine property to a reported depth of over 200 feet, and the property was explored by boring to a further depth of 300 feet. The shaft was located on a drift-covered, terraced slope, with no rock outcrops in the immediate vicinity, and is now filled with water. It evidently penetrated a crushed zone, as the dump material, largely chloritized greywackés, often show slickensided surfaces. The total production of the mine is reported at 500 tons.

The belt of Lower Cobalt rocks on which the Williams mine is situated is traceable in a north-northwesterly direction from the mine for a distance of a mile and a half. The northern part of the belt in the vicinity of Midge lake is covered with iron claims, and considerable trenching and stripping has been done. The surface work has shown a rather widespread mineralization of the greywackés with hematite, but only in small, usually veinlike forms. No workable deposits have been uncovered. Some stripping and trenching has also been done in the granite schist complex, north of Midge lake, and a 510-foot bore-hole was drilled at one point. The mineralization here consists of a few small quartz veins, occasionally carrying minute quantities of iron oxide.

The Lower Cobalt rocks on the northern slope of Bellevue ridge have also been explored for iron. A drill-hole was bored some years ago on what is known as the Hawkshaw-Derrer property in lots 6 and 7, concession II, Deroche township, to a reported depth of nearly 500 feet. The drill-hole penetrated alternating beds and bands of quartzite and fine-grained greywackés similar to the surface outcrops. No iron ore in significant quantities was encountered.

The presence of iron oxide, usually hematite, in veins, veinlike forms, uneven bunches, and impregnations is a characteristic feature of the quartzites of the Upper Cobalt and has led to extensive staking. Numerous deposits of this kind, all too small to merit much attention, have been found and staked on the northern slope of Bellevue ridge east of the Algoma Central railway. Outcrops of iron ore in the form of small veins and impregnations also occur in the northern portion of Bellevue ridge. Exploratory work here includes a bore-hole put down on section 36, Vankoughnet township, to a reported depth of over 1,600 feet. The quartzites penetrated were practically barren.

Structural Materials, Quarries, Etc.

Limestone

The crystalline Bruce limestone is the only limestone in the area. An attempt was made some years ago to utilize it for marble without success. A quarry was opened up in an occurrence a mile north of Garden River P.O., and a spur since removed was built to it from the Canadian Pacific railway. The light-greyish, striped limestone at the quarry is an attractive rock when freshly broken, but soon tarnishes and is also rather badly fractured. A close search of the limestone ridge might possibly result in a discovery of areas free from these defects.

Building Stone

The sandstones of the Lake Superior formation have been used in the construction of a number of the larger buildings in the town of Sault Ste. Marie.

The variety used is a medium-grained rock, mottled and striped with light greys and reds. The rich colouring and durability of the sandstone make it an exceedingly satisfactory building stone, but for some reason, probably the cost, very little of it has been used for structural purposes in the area in recent years. The hard, mottled variety is usually interbanded with shale and other unsuitable material, and this makes quarrying expensive. Small quarries have been opened up at Root river near the Algoma Central railway crossing and at other points, but these are now idle.

The granites of the area, while not very accessible at present, are worth attention. The Younger granites have a wide distribution in Duncan and Jarvis townships. The ordinary variety is a medium-grained, even-textured, reddish-coloured, unsheared rock, but coarser grained, in places porphyritic phases are not uncommon. It is traversed by strong joints. spaced very evenly in some exposures. The even-grained, massive varieties in selected areas would furnish material eminently suitable for monumental and similar work, as well as for ordinary structural purposes.

The older granites, except in the central part of the batholiths, have a gneissic structure and are filled with schist inclusions. The centre of the batholith extending from the Algoma Central railway westward to Gros Cap on Lake Superior, is in Prince township. The granite here over a considerable area is quite massive and not unlike the younger granite in appearance. It is somewhat coarser grained, and the prevailing red coloration is occasionally replaced by grey patches and bands.

Clays

Lake clays of Pleistocene age are widely distributed in the lowlands of the area. In the plain north of the St. Mary river, they have been eaten back to varying distances from the shore and now outcrop in a long winding terrace from a few feet to sixty feet or more in height, traceable from Carp river eastward to the east branch of Root river. The clays are finely laminated, greyish, light-bluish, or reddish in colour and usually free from pebbles and boulders. In some sections, thin red and grey layers alternate throughout. They are highly plastic as a rule, but pass in places into a silty variety occasionally interbanded with sand. Small calcareous concretions are frequently present. The clays and associated silts and sands rest either on boulder clays or on the Lake Superior sandstone and are overlain by stratified sands and gravel.

The lake clays mixed with a varying amount of sand, usually about 25 per cent., are well adapted for the manufacture of ordinary brick and tile. At James Elliott's brickyard, near Sault Ste. Marie, a natural mixture is used. The wash from the clay and sand terraces has built up at the foot of the escarpment a deposit about 12 feet thick, mixed in the right proportion. Two kilns, each with a capacity of 90,000 bricks, were in operation at this yard at the time of my visit. Both plain and rugger brick are manufactured.

The expansion of the brick industry is dependent only on the market. Raw materials conveniently situated are available in practically unlimited quantities.

Silica

The quartzites of the Upper Cobalt, especially the upper portion in Bellevue ridge and other places, are almost purely siliceous in character. They are made up of angular, usually interlocking quartz grains, free from impurities with the exception of an occasional shred of chlorite and minute quantities of iron. The silica content ranges from 95 to 99 per cent.

The Algoma Steel Corporation obtains supplies of silica needed by them from a quarry opened up in Bellevue ridge immediately west of the tracks of the Algoma Central railway at mileage 19.80, and connected with them by a short gravity tram. The quartzites in the quarry dip steeply to the north, have a reddish tinge in places, and are cut at one point by a diabase dike. The material is shipped as quarried, practically no selection being necessary, and in carload lots is stated to average about 97 per cent silica.

Thoroughly cemented quartzites, similar to those at the Bellevue ridge quarry, also occur in areas west of the Breitung mine, north of Goulais bay, and in lots 4 and 5, concession II, Tupper township. The King mountain quartzites, although of the same age, have not been infiltrated by silica to the same extent and are less pure.

Artesian Waters

A report by Mr. R. O. Wynne-Roberts, consulting engineer, Toronto, prepared in 1917 in connection with water-supply schemes for the town of Sault Ste. Marie, contains an interesting account of the artesian and other wells of the area. Mr. Wynne-Roberts collected data in regard to 39 wells, all situated in the drift-covered, terraced lowlands north of the St. Mary river, most of them in Korah township. Of these, six had an artesian character, two were dry, and in the remainder the water rose to varying levels.

The artesian wells derive their supply in some instances from the porous sandstone of the Lake Superior formation, and in others from sands either underlying or interbanded with the lake clays.

Steelton before its union with Sault Ste. Marie obtained its water supply from three neighbouring artesian wells, bored inside the limits of the municipality, and it is still partially supplied from this source. The three 6-inch bore-holes penetrated 65 feet of clay, 2 feet of sand, and 7 feet of gravel before reaching the sandstone bed rock. They were continued down into the sandstone, and a flow of good water was struck at a distance of four feet. The water rises to a height of 14 feet above the surface, and the aggregate capacity of the three wells is given at 600 gallons per minute.

A number of other wells sunk in the sandstone inside the city limits, with one exception, failed to overflow. A hole, 360 feet deep, mostly in sandstone, was put down by the city in Trelawn avenue, and one 710 feet deep by the Soo Falls Brewing Company, near the corner of Spring and Bay streets. In the latter, a small supply of fresh water came in at 110 feet. At 700 feet, the water seeping in became salty.

The Lake Superior sandstone has a small general dip, from the granitic escarpment bordering it on the north, southward towards the St. Mary river, but apparently its porosity is insufficient to allow of the easy seepage of water through it, except in limited channels.

At West Korah school-house, near the southeastern corner of section 21, Korah, a small supply of artesian water is obtained from sands underlying 140 feet of clay. Overflowing wells, deriving their supply from sands underlying clays, also occur at Yates, in section 27, and at Everett, in section 28, Korah. At other wells in Korah and Tarentorus townships sunk in the superficial deposits, water is usually found but not under sufficient pressure to force it to the surface.

The lake clays and sands like the underlying sandstone have a slight slope to the south, and the absence of artesian water conditions except at a few points is attributed by Mr. Wynne-Roberts to the uneven ridgy character of the sandstone bed rock. Ridges and hummocks of sandstone, as shown by the borings,

project up into them to varying heights and check the flow of water. The continuity of the clay bed is also interrupted at several points by boulder clay ridges, probably of morainal origin.

ADDENDA[1]

Lead-Zinc Ore near Searchmont Station

Lead-zinc ore showing some promise has been found in the west central part of township 23, range X, district of Algoma, eight miles northeast of Searchmont station on the Algoma Central railway. It can be reached by automobile from either Searchmont or Sault Ste. Marie.

The discovery was made along an east branch of the Goulais river, the vein being exposed in the creek bed. Fred Vacheresse, the discoverer, staked his first claim in May, 1926, and has since staked some forty claims. He found traces of galena while panning the small stream. According to report, the vein, which strikes northeast and averages six feet in width for a distance of 1,680 feet, on the surface, appears to be of the fissure type. A portion of the vein, 125 feet long, has been stripped and opened up to a depth of 12 to 15 feet in places.

Specimens were furnished by J. E. Gimby, of Sault Ste. Marie, showing the wall rock, the nearest intrusive, and vein matter. The wall of the vein is an altered basic rock with a large carbonate content, and the intrusive is a pink granite gneiss. The carbonized wall rock shows patches and veins of white carbonate, which in places is replaced by lead and zinc sulphides. A specimen of the vein about 10 inches wide shows walls of fairly fine grained pyrite. On the pyrite has been deposited a comb-structured quartz layer, and next to the quartz was laid down carbonate and sphalerite rich in iron. Later than the sphalerite and nearer the centre of the vein is a mixture of fairly coarse galena, quartz, a buff-coloured carbonate, together with a few small masses of chalcopyrite. Another specimen shows a mixture of dark sphalerite, pyrite, and carbonate, to the exclusion of galena. Nearly pure massive galena also occurs.

Through the kindness of G. W. MacLeod, mining engineer of Sault Ste. Marie, the following description of the deposit found by Vacheresse is added:—

> The original discovery was made in the western part of claim A. C. 1,737, and consists of a quartz and calcite vein, containing considerable massive zinc blende, pyrite, and galena. A sample taken across five feet at this point gave an assay of 12 per cent. zinc. A sample taken across a rich streak in this vein, two feet wide, gave the following results: zinc, 20 per cent.; lead, 3.5 per cent.; silver, 40 ounces; gold, none.
>
> Four channel samples, at what appeared to be average points in the vein, gave from two to four per cent. zinc, across six feet, together with smaller amounts of lead, and from one to three ounces of silver with no gold.
>
> The vein has been stripped over a length of 125 feet, but is indicated by pits and trenches at intervals for 1,700 feet. It is quite possible that further work, which is now in progress, might show the discovery to be important.

From a standpoint of economic geology, the highly carbonatized wall rock is a favourable locus for the deposition of lead and zinc sulphides. These

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[1]Since Dr. McConnell returned from the field a discovery of lead-zinc ores has been made near Searchmont station on the Algoma Central railway, in an area outside of his map-sheet. The following note on the discovery and rocks of this area are furnished by T. L. Gledhill of the geological staff of the Ontario Department of Mines.

sulphides, the world over, show a preference, in their replacing of wall rock of veins, for limestone and other common carbonate-bearing rocks.

An assay (No. 1) of a sample from the above deposit made by W. K. McNeill, Provincial Assayer, is given below.

Assay No. 2 was of a seam of pyrite contained in the sample, which it was thought might carry gold.

	No. 1	No. 2
Gold	none	$0.40 per ton
Silver	0.4 ozs. per ton	none
Lead	8.35 per cent.	.....
Zinc	12.55 per cent.	.....

A later discovery of galena was made by a prospector, Angus Bussineau, in township 3 H, Mississagi Forest Reserve, 12 or 13 miles east of the zinc-lead find in township 23. An assay of the sample said to have come from the claim was made by Mr. McNeill, and is as follows: silver, 127.2 ounces per ton; lead, 42.47 per cent.

BATCHAWANA AREA, DISTRICT OF ALGOMA

By E. S. Moore

INTRODUCTION

The Batchawana area, as described in this report, includes the territory adjacent to the north side of Batchawana bay and to the lower portion of the Batchawana river (Fig. 5). Batchawana is a large bay in the east shore of Lake Superior. In the earlier reports and on old maps it was known as Batchewahnung bay; and this apparently was the old Indian name for the bay and the river flowing into it. The area is a continuation southwestward of the area

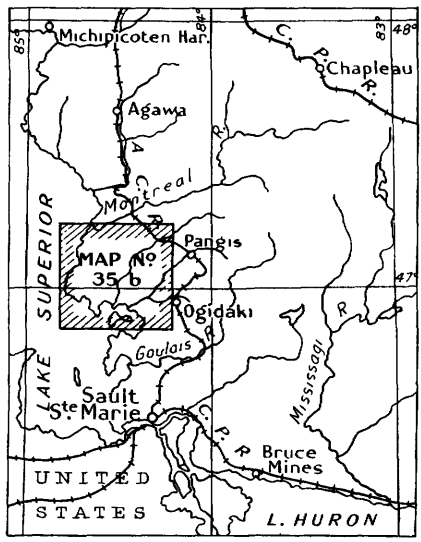


Fig. 5.—Key map, scale 50 miles to the inch, showing position of the Batchawana area covered by map No. 35*b*.

described by the writer, under the title "Mississagi Reserve and Goulais River Iron Ranges," in the last annual report of the Department of Mines. Many of the geological formations found in that area extend into this one, and a further study of some of these has thrown fresh light upon their relationships. Iron formation similar to that in the Forest Reserve and on the Goulais river occurs north of Batchawana bay, and it will be described herein under the Batchawana iron formation.

In addition to the iron formation, which furnished one of the objects for an investigation of this region, there are a number of old copper mines, which in the past have created much interest in mining circles, although few of them have been productive. During the latter part of the field season, a trip was made to Michipicoten island for the purpose of examining a recent discovery of native copper. The formations in which this copper occurs are very similar to those on the east shore of Lake Superior, where native copper has been found in a number of places.

During the field season the writer had as assistants, G. B. Tribble, D. K. Griffin, A. D. Dickson, and J. Dick, to whom he is much indebted for very

efficient and faithful service. Mr. Tribble served as first assistant on the party and took care of the micrometer survey work.

As in the previous summer, much assistance and various courtesies were received from a number of men in Sault Ste. Marie and other places visited by the party while the field work was in progress. In this connection the writer wishes to mention specially R. S. McCormick, General Superintendent and Chief Engineer of the Algoma Central and Hudson Bay Railway; C. H. E. Rounthwaite, of the same company; G. W. MacLeod, mining engineer; George S. Cowie, Algoma Steel Corporation, members of the staff of the Spanish River Pulp and Paper Company; and J. Chapman of Batchawana Bay.

Previous Work in the Area

No extensive examination of this area had previously been made by any geologist, although a number of men had studied certain sections of it. Several persons had made brief examinations of the iron formation, most of these being for private interests, and the writer is indebted to George S. Cowie for the opportunity of looking over a number of old reports and maps dealing with the iron range.

A report was made in 1902 by I. M. Stewart to A. B. Wilmott, Superintendent of Exploration for the Lake Superior Corporation. This report dealt with Palmer township, the unsurveyed land to the north of it (now township 28, range XIII), and the townships of Ryan and Kincaid. Other reports dealing with the iron formation have been made by Robert Seldon Rose, of Madison, Wis.; Andria Formis, of Ishpeming, Mich.; D. J. Ranson, of Sault Ste. Marie, Mich.; J. H. Cundy, of Iron Mountain, Mich.; and J. A. Holmes, the first Director of the United States Bureau of Mines. Mr. Holmes made his report to George C. Heck of Raleigh, N.C., in 1899 when he was State Geologist of North Carolina. Mr. Heck's father is said to have purchased the land on the iron range from explorers, without having seen the iron deposits.

Among the geologists engaged in the government service, the first to perform work in the Batchawana area was Sir William Logan, Director of the Canadian Geological Survey. In the "Geology of Canada,"[1] he discusses brifly some of the formations between Pointe aux Mines and Mamainse. Thomas Macfarlane[2] gives a detailed description of the formations along the east shore of Lake Superior and also mentions part of the iron formation north of Batchawana bay. A. P. Coleman mentioned this iron formation in some of his reports,[3] after having made an examination of parts of the formation. He also mentions briefly some of the copper mines.[4]

In the Report of the Royal Commission on the Mineral Resources of Ontario, 1890, there is considerable data on the mines in this area, and special reference will later be made to the information contained therein, as well as to the conclusions of a number of the other writers mentioned.

Topography

The Batchawana area is one of the most rugged in Ontario. Within its boundaries hills rise to an elevation of nearly 2,000 feet. Mamainse hill, one of the highest in the region, and the highest whose elevation has been definitely

[1]Geol. Surv. Can., Report of Progress from Its Commencement to 1863, pp. 82 and 699.
[2]Ibid, Report of Progress from 1863 to 1866, pp. 115-47.
[3]Copper and Iron Regions of Ontario, Ont. Bur. Mines, Vol. IX, 1900, pp. 161-62; Vol. X, 1901, pp. 180-81.
[4]Copper Regions of the Upper Lakes, Ont. Bur. Mines, Vol. VIII, pt. 2, 1899, p. 121.

determined, is 1,958 feet in height. Since Lake Superior stands at 602 feet above sea-level, this hill rises 1,356 feet above the lake, and it furnishes a good lookout station for a large area. During the work of surveying Lake Superior, the United States Hydrographic Survey established a station on its summit, which is situated immediately east of Smith lake near the boundary between Ryan and Palmer townships. Mamainse hill forms part of a prominent ridge of diabase hills which lies about seven miles north of Batchawana bay and in which several points have as great an elevation as, if they are not indeed higher than, Mamainse hill. The diabase which composes these hills, the most striking topographical features of the area, will be known as the Mamainse diabase.



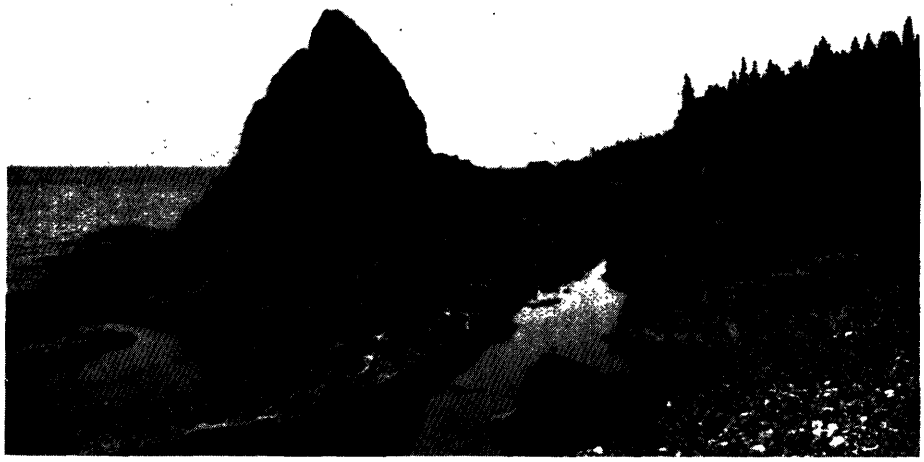
Prominent hill due to Keweenawan diabase dike, looking north across Mitchell lake from the railroad.

In other portions of the area, a diabase younger than the Mamainse formation forms prominent ridges where dikes of this rock, which is believed to be Keeweenawan, cut the older formations (see photograph above).

Next to the diabases the granite is the most prominent ridge-forming rock of the area. In general, this rock forms an undulating upland much less rugged than the areas underlain by diabase, but where it comes out on the shore of Lake Superior, in Mica bay, it forms prominent ridges. From Batchawana river, the railroad climbs steadily upward from an elevation of 1,022 feet to one of 1,395 feet at Rand, near the north side of the map area. At the latter point it has reached the granite area, and it rises slowly from there to the summit, near the Montreal river. Along the deep valley of the Batchawana river, there are very rough granite hills, with almost unscalable cliffs. From either bank of the river, in the region a few miles below the railroad, it is necessary to climb from 500 to 700 feet to attain the granite upland.

Although the hills are relatively low, the shore of Lake Superior in this area is very rugged, due to the Middle Keweenawan lavas and interbedded conglomerates eroding at different rates. This section of the lake shore is very dangerous to navigators (see photograph on page 56). Where the same series consists of sandstone and conglomerate the shore is low and flat, as along Herrick and Fisher townships and on Batchawana island. In these areas

there are large swamps inland; low terraces occur along the shore, and there is a prominent one farther back, at varying distances from the lake and rising on an average to 55 feet above its present level. This indicates a former lake level. At much higher elevations there are remnants of the old post-glacial lake deposits, but they do not constitute very distinct terraces. In the lower lands skirting the shore, there are practically no streams, except the larger ones which cross the low lands in descending from the hills. The water all seeps out through the Keweenawan sandstones and lava flows, except in a few sections where there is a layer of clay underlying the surface.



Rugged shoreline of interbedded Middle Keweenawan lavas and conglomerates, Mica bay, east shore of Lake Superior.

There are two main streams in the area, the Batchawana and Harmony rivers, in addition to a number of smaller ones, which are not navigable by canoes for any appreciable distance. The Batchawana, which is much the largest of these, enters Batchawana bay; and the Harmony flows into Harmony bay, a minor section of Batchawana bay. There has been much confusion concerning the Harmony river, because locally it is known as the Chippewa. According to the ruling of the Geographic Board, the main stream flowing into Harmony bay should be called the Harmony river, while the south branch of this stream, which crosses the Algoma Central and Hudson Bay railway at the old Chippewa station, is the Chippewa river. The Harmony is a stream of fair size and is navigable for canoes, except at times of low water, up as far as its junction with the Chippewa. It is also navigable in sections above this point, even up into the Forest Reserve, but on the whole it does not constitute a good canoe route because there are long sections which are blocked with logs and others of swift, shallow water.

The Batchawana is a very swift and shallow stream throughout the greater portion of its course from the railroad to Lake Superior. It has a fall of 420 feet in this distance, and with the exception of about two miles below the dam at the railroad and about four miles near the mouth, the stream is so swift that it is impossible to paddle against it. When the water is high, it is a fairly good canoe route for one descending the river. There are several falls and bad

rapids. Just below the railroad, the Spanish River Pulp and Paper Company has constructed a dam which impounds a large volume of water in Mitchell lake and the low land above it. At this dam, the falls and rapids furnish a drop of about 30 feet. From this rapids to the next one, two miles below, there is very little current. At the second rapids, there is an old bridge, now impassable, on the tote road from Lake Superior to the railroad. From this bridge down to the foot of the canyon at the southeast corner of Palmer township, the river is practically a series of rapids and shallows with a few falls. The first of the falls occurs about five miles below the mouth of the Little Batchawana river, where a series of rough rapids and small falls occur in a picturesque gorge. The second falls, a drop of 12 feet over diabase, is in Palmer



Falls over diabase on the Batchawana river a mile and a half below the east border of Palmer township.

township, a mile and a half from the point where the river crosses its east border (see photograph above). The falls in the southeast corner of the township is at the head of a canyon, and there is a rough rapids above it. The vertical fall is eight feet in height, but the rapids above and below, together with the falls, cause a drop in the river of about 35 feet. This falls is at the head of the wagon road from the Spanish River Pulp and Paper Company's camp on the lake at the mouth of the river.

The Batchawana river has undoubtedly changed its course since the glacial epoch. There are indications that the channel of this stream at one time lay through Mitchell lake and the low land southwest from this lake. The glacier filled up this old channel and compelled the stream to find a new course over the hillocks of rock which now cause the first falls and rapids in its channel.

Micrometer Surveys

A micrometer survey was made of the Batchawana river from the east border of township 26, range XIV, down to the east border of Palmer township. As Palmer township was subdivided when it was surveyed and the river was

mapped with fair accuracy, it did not seem necessary to continue the survey to the mouth. The survey of the river was carried out under considerable difficulty because of its very swift current and the impossibility of paddling against it in most places. Mitchell lake, Carpenter lake, Moose lake, and Lake Adelaide, the large lake in the southern part of township 26, range XIII, were all surveyed with micrometer and prismatic compass. The other large lakes of the area are inaccessible to canoes, and they were mapped by traverses and sketches. No attempt was made to do detailed topographic work in the main granite areas at any great distance from the contact between the granite and the other formations.

Flora and Fauna

The greater part of the timber on the Batchawana area is hardwood. Maple is abundant, but small, gnarled, and otherwise defective. Many trees reach a foot in diameter and some 14 inches. There is a great deal of black birch.



Wharf at Batchawana village, Batchawana bay.

The trees are large, although the trunks are relatively short and they do not yield many logs to a trunk. A considerable amount of this timber is being cut in the region around Batchawana bay. On Batchawana island and in places on the mainland along the lake shore, hemlock is cut for bark and lumber. In some of the sheltered spots in Palmer township, water elms of fine shape and up to four feet in diameter were seen. The pine has been nearly all removed, and practically all the available spruce within hauling distance of the lake and the streams has been cut for pulp. There is a good deal of cedar available in the swampy areas, although it is not as a rule very sound. A few white oak trees were seen, one two feet in diameter, but they are not commercially important.

The higher levels of the region are mostly covered with hardwood; and some of this land would be suitable for cultivation, although there is very little of it which is sufficiently level to grow anything but grass if it were cleared. One marvels at the fact that Palmer and some of the other townships are said to have been subdivided for agricultural purposes. The proximity of the area to Lake Superior was apparently the main reason for supposing that the region might become an agricultural district. There is a small farming settlement on the shore near Batchawana village, where the boats from the Sault call twice a week, chiefly for fish; and some hay is grown on some of the less rocky land. Vegetables also do well in this section, and it is rather surprising to find

that even apples may be grown. The more hardy varieties are said to do quite well around Batchawana bay, where the ameliorating influence of even so cold a body of water as Lake Superior is so strongly felt.

The provincial highway is now being constructed around Batchawana bay, and the right-of-way has been cut to a point about half way between the Harmony and Batchawana rivers. When this road is completed, it will give ready access to this area from the Sault, about thirty-five miles distant. At present the village of Batchawana in the Indian reserve is supplied with one outgoing and one incoming mail a week. The mail is carried from Goulais Bay.

There is considerable game in the area. A number of bears were seen during the summer and a good many deer. There are not a great many moose; and small game, such as rabbits and partridge, seemed to be relatively scarce. This has been a favourite region for brook trout, but they seemed to be very scarce, compared with their abundance in the region surrounding the head waters of the Batchawana. A successful fishing industry is carried on in Lake Superior from Batchawana village and Mamainse harbour.

GENERAL GEOLOGY

The following is a table of the rock formations which have been recognized in this area, arranged in order of age:—

QUATERNARY		
	RECENT:	Gravel and sand along lake shore and streams.
	PLEISTOCENE:	Drift and stratified gravel, sand, and clay deposited in post-glacial lakes. Clays well varved.
PRE-CAMBRIAN		
	KEWEENAWAN:	Upper Keweenawan—conglomerate, sandstone, concretionary shale, and marl. Middle Keweenawan—conglomerate and sandstone interbedded with amygdaloidal basalt and felsite. Dikes of olivine diabase and quartz porphyry cut these. Lower Keweenawan—diabase, porphyritic and non-porphyritic, quartzose to quartzless, in dikes and bosses.
	ALGOMAN(?):	Granite and granite gneiss.
	MAMAINSEAN:	Diabase grading into gabbro and diorite. A few lava flows.
	BATCHAWANA SERIES:	Banded iron formation, arkose, greywacké, banded slate, acid and basic lavas, and schist equivalents.

Batachawana Series

Batchawana series is the name given by the writer in the report on the Goulais River and Mississagi Reserve Iron Ranges[1] to a complex series of metamorphosed sediments and lava flows, widely distributed in that area. The series, in that area, contained banded iron formation, arkose, greywacké, slate, impure quartzite, and conglomerate interbedded with basic and acid lavas, some of which are strikingly ellipsoidal. Some of these rocks have been sheared to schists and banded gneisses. There are many similarities between this series and the Keewatin in other areas, the most striking being in the ellipsoidal lavas and banded iron formation. On the other hand, there are marked similarities between this and some of the later series, such as the Sudbury, in the conglomerate with granite boulders and the banded greywacké. It is the opinion of the writer that the Batchawana series should be correlated with the Sudbury rather than with the Keewatin, although it is possible that more detailed work may reveal the presence of more than one series in this area.

The Batchawana series occurs over a limited section in this area. It carries iron formation similar to that in the Forest Reserve and on the Goulais river.

[1]Ont. Dept. Mines, Vol. XXXIV, pt. 4, 1925.

It also contains arkose and greywacké, but no distinct conglomerate was found. Further, the basic lavas are in a much smaller proportion. The series is made up chiefly of acid lavas, rhyolite and felsite, interbedded with arkose and greywacké. Pillow lavas were not recognized with certainty, but green schists appear to have been derived from such lavas in some parts of the area, particularly in the southern portion. The acid lavas and arkose have been altered to sericite schists in some sections of the field.

The arkose and rhyolite are distinguished in some parts of the area with great difficulty because they have been squeezed and silicified until they now have in many sections a sort of banded structure. This situation is well illustrated along the railroad track between the Batchawana river and Rand. Even in thin section, the differences are not always marked, owing to recrystallization. Several thin sections of slightly banded arkose consisted of quartz, orthoclase, biotite, and tiny grains of zircon. One contains garnet. In some the biotite shows fairly distinct orientation, in others practically no parallel orientation.

The Batchawana series is almost restricted to the eastern portion of the map area. Its former, much greater distribution is indicated by the occurrence of iron formation associated with other rocks of this series in Palmer township and the township to the north. Large areas of the formation have been destroyed by the intrusion of the granite and Mamainse diabase, leaving only small remnants here and there. The iron formation and certain quartz veins, which occur in this series, will be described later in this report under "Economic Geology." These are the only features of economic interest in the area.

Mamainse Diabase

The term Mamainse diabase has been given to the rock which covers parts of several townships in the central portion of the Batchawana area. The rock forms Mamainse hill and several adjacent hills, the most prominent topographic features in the area. Since the age of this rock cannot be very accurately fixed, it seems best for the present at least to give it a local name. It cuts the rocks of the Batchawana series and it is in turn cut by the granite, which is older than rocks regarded as Lower Keweenawan. It is probable that it is equivalent to the rather extensive basic igneous formation, south of Lake Superior, known as the Hemlock formation and prominent in the Crystal Falls iron district, Michigan.[1] The age of the Hemlock formation has not been definitely fixed beyond the fact that it is Huronian, probably middle Huronian.

The Mamainse is a very monotonous formation to study in the field. For the most part, it forms great hills of normal diabase, grading in places into diorite, epidiorite, and gabbro. It is very uninteresting from the economic standpoint, the only metallic deposits found with it being stringers of pyrite and chalcopyrite. On the west side of Smith lake, in Ryan township, near the middle of section 12, Mr. Ranson had a prospect on narrow stringers containing chalcopyrite. In this formation, near its border where it has been highly altered by the intrusion of the granite, a few carbonate and quartz veins have been found, as, for example, in the lower canyon on the Batchawana river; but they are barren.

It is impossible to separate this diabase from the Lower Keweenawan diabase, where they are about equally metamorphosed, unless the latter is porphyritic. Some of the dikes in the Batchawana series mapped as Lower Keweenawan may belong to this formation, and there may be dikes of the

[1]C. R. Van Hise and C. K. Leith, Geology of the Lake Superior Region, U.S. Geol. Surv., Mon. 52, p. 294.

Keweenawan diabase in the area which were mapped as Mamainse because they could not be distinguished from it. It would seem peculiar that there should not be dikes of the Keweenawan in this formation, unless its toughness prevented it from fracturing as readily as the granite and the rocks of the Batchawana series. It is probable that they exist but that they are not distinguishable. A number of thin sections were made of diabase from dikes in the Mamainse formation in the hope that the presence of quartz or some other feature might identify the rock as Keweenawan, but the study of these sections revealed little of value. Both formations vary greatly in the extent to which they have been altered in different parts of the area.

In thin section, the rocks of the Mamainse formation show much alteration of ilmenite to leucoxene; pyroxene to uralite, hornblende, and in a few places to serpentine; feldspars to kaolin and zoisite. Epidote is developed in a number of specimens. No primary quartz was found, nor sign of olivine.

Algoman (?)

The Batchawana area is almost surrounded with batholiths of granite. This rock is mostly the biotite type, but it grades into types which have more hornblende or pyroxene than biotite. In most places, the formation is comparatively massive in structure, but there are areas in which the granite has been squeezed into gneiss. It is quite gneissic in township 27, range XIV, for example, reminding one of the Laurentian gneiss in other areas, while near Rand a massive red granite resembles a much later granite. This raised the question as to whether there was granite of two ages in this area, just as there is in the region near Northland, about 24 miles north of Sault Ste. Marie, where R. G. McConnell has recognized these formations. There was no definite evidence of two granites, however, and the massive type was found grading into the gneiss, the grey granite into the red, and the highly quartzose phase into the feldspar-rich phase. The only facts which have been established regarding the age of this granite are that it is younger than the Mamainse diabase and the Batchawana series and that it is older than the oldest identified Keweenawan. The Middle Keweenawan lavas and sediments lie unconformably upon it, and it is cut by the diabase dikes, which do not cut the Middle Keweenawan rocks and which are regarded as Lower Keweenawan in age (see photographs on pages 62 and 63, and Fig. 2 on page 66). It may, therefore, be equivalent to the Algoman.

The relations between the granite, the Mamainse diabase, and the Keweenawan formations may be well observed in Mica bay. Here, in a small area, the granite is found cutting the older diabase, cut by the latest dikes of the region, the olivine diabase, and overlain by the Upper and Middle Keweenawan sediments and lavas. The granite has furnished the bulk of the boulders for the Keweenawan conglomerates (see photographs on pages 67 and 70). It is interesting to read Macfarlane's description of the relations between the granite, which he considered Laurentian, and the greenstone, which was regarded as Huronian.[1] The idea that the granite, being Laurentian, was older than the Huronian was so firmly established in the minds of the geologists of that day that it was difficult for some of them to observe with an eye single the exact conditions. Macfarlane drew the opposite conclusion to Foster and Whitney from almost identical observations and indicates that his ideas were influenced by the existing classification of the then-known Laurentian and Huronian rocks. He considered the granite the older of the two formations, whereas it is the younger.

[1]Geol. Surv. Can., Report of Progress from 1863 to 1866, 1866, p. 128.

The granite is considerably altered near its contact with the older formations, and in some cases there is little left but kaolin and sericite from the feldspars and chlorite or serpentine from the ferromagnesian minerals. In one section, considerable titanite is seen from the contact of the granite and a younger diabase dike. What appears to be allanite in zonal arrangement with clinozoisite, which surrounds it, also occurs. Since this mineral was only found in one section, it could not be identified with certainty, but the index of refraction and



Lower Keweenawan porphyritic diabase cutting granite at the first falls on Harmony river. Phenocrysts of feldspar may be seen in the diabase on the right.

the pleochroism in tones of brown indicate allanite. Epidote and augite also occur. The microcline is fresher than the albite or orthoclase. In all these sections of granite there is little evidence of zonal structure in the feldspars, as there is in many dike rocks.

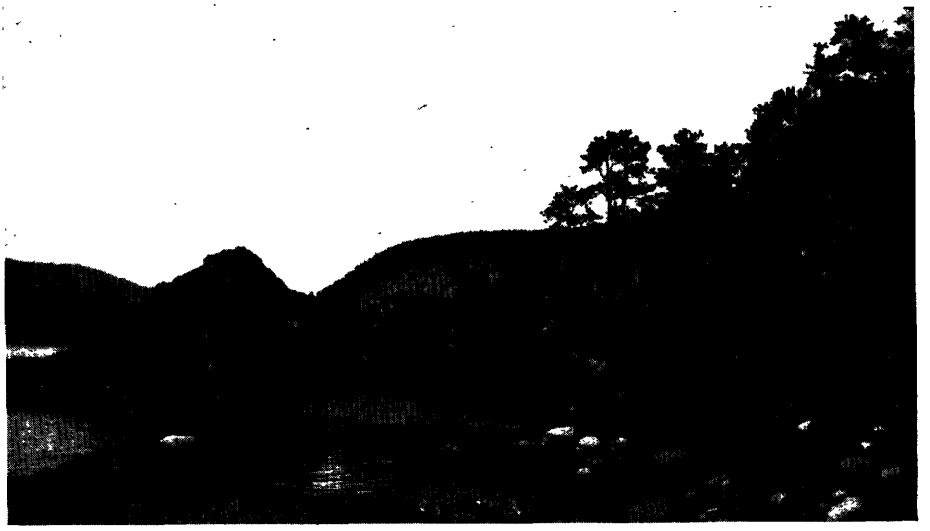
In some places the granite grades into granite porphyry near the contact, and in others into a speckled dioritic rock rich in secondary hornblende. The gneissic structure is more highly developed near the contact than elsewhere, partly owing to movement along the contact and partly to the development of minerals, like hornblende and biotite, which are inequidimensional in form. These minerals are partly due to hydrothermal metamorphism.

Very little detailed work was done on the granite masses, except near their contacts with the older formations. From an economic standpoint, this granite should be of interest near its contact with the older formations, especially the Batchawana series, and a good many quartz veins have been found adjacent

to this contact. Some of these carry pyrite, but so far none carrying an appreciable amount of gold have been found.

Keweenawan System

As in other parts of the Lake Superior basin, there is in the Batchawana area a remarkable development of the Keweenawan system. The occurrence of such a thick series of sediments and lavas in this region, and the fact that they dip towards the Lake Superior basin from various points, considered with all the evidence of igneous activity on an enormous scale, indicates that from a date well back in the pre-Cambrian era a prominent basin existed where Lake Superior



Mica bay, east shore of Lake Superior. Keweenawan amygdaloidal basalt, in foreground, which lies on the flank of the large granite hill in the background. Some beds of this lava show ropy structure.

now lies. This basin has been greatly modified from time to time by filling with lavas and sediments and by excavation through the action of water and ice. This geosyncline has been a very important factor in the settling of the crust, in the intrusion and extrusion of igneous rocks, and in the deposition of ores which accompanied the igneous activity.

The rocks which are now commonly known as Keweenawan were originally called the Upper Copper-bearing series by Logan.[1] They have also been known as the Nipigon series. The term Keweenawan has now come into general use, and the system is commonly divided into three series: Upper, Middle, and Lower Keweenawan. It is believed that all three of these series are represented in the Batchawana area. The Upper series is very thin and has a very restricted distribution, while the Middle series is of great thickness and widely distributed. The Lower series consists, in so far as it has been observed, entirely of igneous rock in dikes and bosses. There are apparently representatives of most of the formations found in other parts of the Lake Superior basin, with the exception of the sediments of the Lower series. As pointed out later, there may be some question regarding the placing of the latest sediments in the Upper Keweenawan

[1]Geol. Surv. Can., Report of Progress from Its Commencement to 1863, 1863, p. 67.

instead of in the Cambrian. The amygdaloids in the Middle Keweenawan of this area resemble those of Keweenaw peninsula, but there is very much less of the acid types of lava. Very little copper has so far been found in this area, and none occurs in the amygdules of the basalts, but it is partly in the native state as it is in Michigan and on Michipicoten island.

Olivine diabase dikes cut the Middle Keweenawan formations in this area, and they may be a late phase of the igneous activity of this epoch; they were not observed cutting the Upper Keweenawan sediments. They are the latest igneous rock in this area as well as in many other pre-Cambrian areas of Ontario. Some geologists regard them as Paleozoic in age, but they have not been



Lower Keweenawan diabase dike forming prominent hill opposite mile 81, Algoma Central and Hudson Bay railway. A fault cuts across the foot of this hill.

found cutting Paleozoic formations. There are also two quartz porphyry dikes in the area cutting the Middle Keweenawan formations, and they present the same problem as the diabase dikes in the matter of age relations.

LOWER KEWEENAWAN

There are in the area a vast number of dikes of diabase and a considerable number of bosses and irregular intrusions of the same rock. The dikes ordinarily run between 10 and 80 feet in width, but 100 feet or more is not uncommon. In the bedded formations they tend to follow the strike of the beds, as may be observed by a glance at that portion of the map covered by the Batchawana series. There are, however, many exceptions to this arrangement. These dikes are so numerous in some sections that they constitute a considerable proportion of the rock formation. Apparently a tremendous amount of the crust must have been in the liquid condition when these intrusions occurred, although they entered the older rocks so quietly that very little disturbance resulted and the contact metamorphic effect was very slight. The dikes are now on edge, giving the impression that they are sills tilted to a high angle, but apparently the rocks which they intrude were folded before they were intruded and the fluid rock was readily injected along the bedding planes and contacts.

It proved impracticable to attempt to outline all of these intrusions on the map, and only a few of them have been traced out in detail. The presence of a large number has been indicated by short sections. They are most numerous in the bedded formations, as these seem to have permitted readier access to them than the massive formations; but there are great numbers in the granite, although comparatively few could be placed on the map. They are separated from the intrusions of the Mamainse diabase with difficulty, because these two formations have in many cases been altered to an equal degree and it has been found impossible to outline intrusions of one in the other unless the younger diabase is porphyritic. Dikes mapped as one formation no doubt belong in some cases to the other diabase. On the whole the dikes of this later diabase are much less porphyritic in the Batchawana area than they are in the Forest Reserve, where phenocrysts of feldspar were seen which were two inches in diameter. Nothing approaching this size was observed in the Batchawana area.

This diabase grades into gabbro and from a normal diabase to a quartz diabase. A number of slides examined showed some quartz in nearly every specimen although it is believed that a portion of the quartz is secondary. The formation seems to correspond to the quartz diabase which is so common as dikes in the Michipicoten region and many other parts of Ontario and which has generally been regarded as Keweenawan in age. No dikes of this rock were found cutting the Middle Keweenawan, and they must be older than that series. They may be of the same age as the Duluth gabbro, the representative of the Lower Keweenawan in Minnesota, at the other end of the Lake Superior basin. The formation contains nothing of economic interest so far as observed in this area.

MIDDLE KEWEENAWAN

Character and Distribution

The Middle Keweenawan is the most remarkable series in the area. The section of interbedded conglomerate, sandstone, and amygdaloidal lavas between Mica and Pancake bays along the shore of Lake Superior is of great thickness. It is estimated at 16,339 feet, of which 2,597 feet consists of sediments, chiefly conglomerate. These sediments and lava flows were laid down alternately, and apparently on a sloping surface. There is a predominance of igneous rock near the base, but beyond this there is no very definite distribution of the sediments and lavas throughout the section. The land to the northeast of the basin in which these rocks were deposited must have been high to permit the transport of such large boulders as those forming the conglomerate.

The structure of the series is comparatively simple, as it possesses a nearly uniform, monoclinal dip towards the southwest (Fig. 6). It lies unconformably on the Algoman granite and is overlain unconformably by the sediments of the Upper Keweenawan series. The conglomerate and lava beds vary greatly in thickness within short distances. The thick bands of lava are made up of a number of flows poured out one upon another and distinguished by their coarser grained bases and highly amygdaloidal tops. So variable are the bands of sediment and lavas that it was found impossible to trace most of them any appreciable distance inland through swampy and drift-covered land. The individual bands have, however, been indicated approximately along the shore on the accompanying map.

Rocks of this series outcrop for a short distance along the south shore of Alona bay, north of Pointe-aux-Mines, and they underlie the large area between the bottom of Mica bay on the north, Pancake bay on the southwest, and the

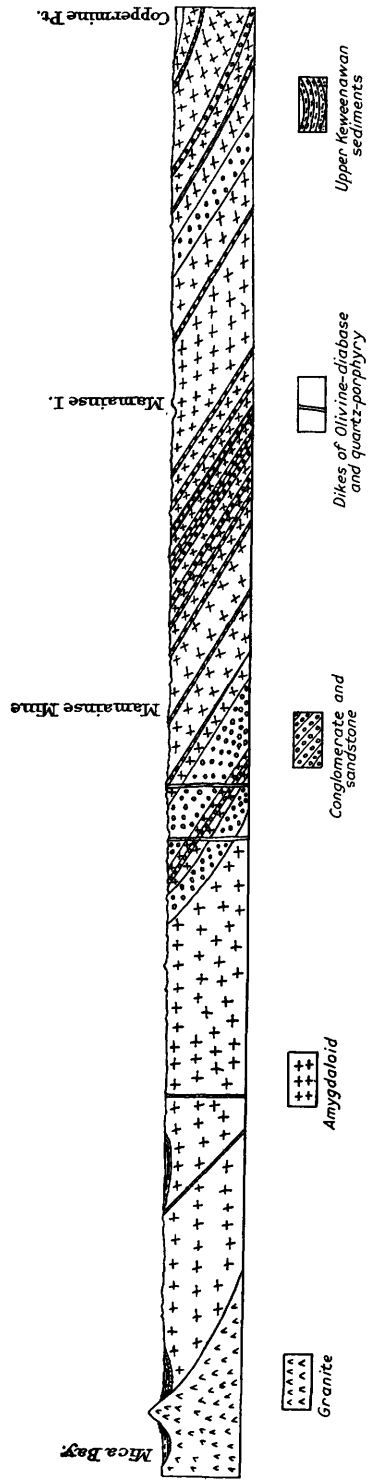
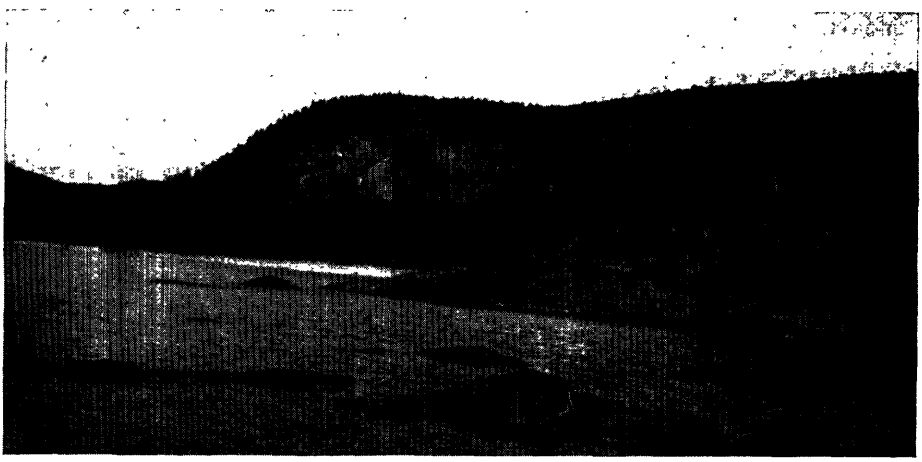


Fig. 6—Generalized section showing the structure of the formations between Mica bay and Coppermine point, east shore of Lake Superior. *See* geological map, No. 35*b*, accompanying this report.

eastern end of Batchawana bay on the east. Apparently the same series is represented by sandstone to the south of Batchawana bay, although the writer has not studied the formations in that region. Over most of Herrick and Fisher townships, it is entirely concealed by drift and stratified sand and gravel, but its appearance just west of the mouth of Harmony river, again on the east shore of Batchawana bay, on Batchawana island, and in a few spots in Herrick township indicates that it undoubtedly occurs beneath these much more recent deposits. No lavas were found in Herrick township or on Batchawana island, the rocks being sandstone and conglomerate with comparatively small pebbles of quartz, but a patch of basic amygdaloid occurs on the east shore of Batchawana bay opposite Batchawana island and another just west of the mouth of the Harmony



Algoman granite ridge, with Upper Keweenawan sediments for a short distance on either side. Middle Keweenawan lavas in the foreground, Mica bay, Lake Superior.

river. There seems to be no doubt, therefore, that all of these exposures belong to Middle Keweenawan formations.

On the geological maps covering the east shore of Lake Superior, which have previously been issued, portions of Batchawana island and parts of Fisher and Herrick townships have been mapped as if underlain by Paleozic formations. This has been due to the fact that Sir William Logan on his map accompanying the "Geology of Canada, 1863,"[1] mapped the sandstone outcropping in these areas as St. Peters of the Chazy, Lower Silurian. No limestone, and scarcely any shale, has been found in these areas.

Section between Mica and Pancake Bays

In the Report of Progress from 1863 to 1866, Macfarlane published a good detailed section of a portion of the Middle Keweenawan series along the shore between Pointe-aux-Mines and the southwest extremity of Mamainse point. The thickness given for this section is 16,208 feet, of which 2,138 feet consists of conglomerate and sandstone and the remainder of igneous rocks. He states that the figures given are approximate, since they were obtained by pacing along a very rough shore line. The section made by the writer during the past summer is similar to Macfarlane's in total thickness, there being a difference of 131 feet, but the relative amounts of sediments and lavas differ considerably

[1]Page 132.

more than the total thickness given in the two sections. Much difficulty was experienced in correlating the two sections and in deciding just where Macfarlane's section begins and ends. Possibly there is also a difference in the interpretation of the position of some sediments which are in this report placed in the Upper Keweenawan. Such a section is made under considerable difficulty because of the ruggedness of the shore line and the numerous indentations in it. The determination of the dip in some of the thick bands of lavas is made with difficulty, and one must depend in most cases upon the bands of sandstone in the conglomerate for accurate dip readings. Even then cross-bedding may be a disturbing factor.

The section given below begins with the lowest exposure of the amygdaloid at the south end of the band of Upper Keweenawan sediments in Mica bay and extends to a point near Coppermine lighthouse. Doubtless the amygdaloid extends northward for approximately 15 chains underneath the Upper Keweenawan sediments, but this distance was not included in the section. The section was made partly by chaining and partly by pacing to a point as far south as Mamainse island. Southwest of this point distances had to be scaled and estimated from the Hydrographic Survey map in some sections, owing to the deep bays and the difficulty of tracing the formations. The distances and the thicknesses of formations in this section are, therefore, in some cases estimations, but they give an idea of the relations of the sediments and lavas and their approximate thicknesses. The section is as follows:—

		Thickness feet
	Granite followed by Upper Keweenawan sediments for 1,120 feet, probably underlain by amygdaloid	
1.	Amygdaloid: Basic lavas grading from highly amygdaloidal basalt in upper part of flow to fine-grained diabase near base. Large amygdules filled with calcite, chlorite, and epidote. Near base of band a network of stringers of calcite and serpentine, the latter approaching asbestos. Many barren calcite veins. A band of peculiar spherulitic lava 60 feet in thickness. Bands of coarse hornblendic lava and soft, iron-rich basalt. Strike N. 20°-30° W.; dip 35°-50° southward	2,496
2.	Conglomerate: Irregular bed with granite boulders 15 inches in diameter	5
3.	Amygdaloid: Basalt highly amygdaloidal to dense and massive. Amygdules with chlorite and cavities up to 5 inches in diameter filled with calcite. Small agates. Structures outlined in hematite resembling ellipsoids. Overlain by Upper Keweenawan sediments and cut by 10-foot olivine diabase dike. Strike of amygdaloid N. 10° W., dip 45° S. 80° W.; and of overlying sediments northeast, and 21° W.	4,503
4.	Conglomerate: Strike N. 10° W.; average dip 25° S. 80° W.	248
5.	Amygdaloid: Heavy-bedded lava, coarsely amygdaloidal near surface with amygdules of chlorite. Strike N. 10° W.; dip 25° S. 80° W.	38
6.	Conglomerate: Mostly sandstone, red and coarse grained. Strike N. 10° W.; dip 20° S. 80° W.	9
7.	Amygdaloid: Dense and grey, a few amygdules of calcite and chlorite	35
8.	Conglomerate: Very coarse and poorly assorted. Boulders of granite and gneiss, 3 to 4 feet in diameter, and great variety of rocks in pebbles. Cut by olivine diabase dike 1½ feet wide. Strike north and south; dip 30° W.	871
9.	Amygdaloid: Dense, heavy bedded, slightly amygdaloidal, grey basalt and highly amygdaloidal red basalt, containing epidote and large amygdules of calcite and chlorite. A quartz porphyry dike 65 feet wide cuts this band	295
10.	Conglomerate: Band of rapidly changing thickness	13
11.	Amygdaloid: Strike north and south; dip 30° W.	587
12.	Conglomerate: Large granite boulders, but not so large as those in No. 8. Strike north and south; dip 30° W. This is conglomerate at Mamainse mine	89
13.	Amygdaloid: Rather coarse-grained, dark-green, soft, friable lava, highly amygdaloidal in upper portion	703
14.	Conglomerate: Large granite boulders. Strike north and south; dip 30° W.	112
15.	Amygdaloid: Ragged basalt with inclusions of brick-red felsite up to 1½ feet in diameter	208
16.	Conglomerate: Strike north and south; dip 30° W.	23
17.	Amygdaloid: Small agates, amygdules of chlorite and calcite, and stringers of calcite	215

		Thickness feet
18.	Conglomerate: Abundant pebbles of great variety of rocks but no large boulders. Strike N. 20° W.; dip 30° S. 70° W.	115
19.	Amygdaloid: Strike N. 20° W.; dip 35° S. 70° W.	245
20.	Conglomerate: Same strike and dip.	110
21.	Amygdaloid: Contains many calcite veins.	87
22.	Conglomerate: Abundant granite pebbles of medium size. Strike north and south; dip 40° W.	97
23.	Amygdaloid: Same strike and dip.	280
24.	Conglomerate: Many granite boulders of medium size. Strike N. 25° W.; dip 40° S. 65° W.	175
25.	Amygdaloid: Partly augite porphyry, weathering in places to epidote with a yellowish-green shimmer and elsewhere to a bronze, spotted surface.	410
26.	Conglomerate: Bands of pink to purple sandstone in conglomerate. Strike N. 20° W.; dip 42° S. 70° W.	41
27.	Amygdaloid: Soft and friable, partly porphyritic and partly amygdaloidal lava. Strike N. 10° W.; dip 40° S. 80° W.	310
28.	Conglomerate: Conglomerate and red sandstone. Strike north and south; dip 35° W.	7
29.	Amygdaloid: Resembles that at Mamainse mine. Friable, green lava at base and coarsely amygdaloidal at top of flow. Much calcite and chlorite in amygdules. Strike north and south; dip 35° W., to western edge of Mamainse island.	770
	For remainder of section, thickness approximate	
30.	Amygdaloid: Continuation of No. 29 in Hibbard bay.	550
31.	Conglomerate: Strike north and south; dip 30° W.	10
32.	Amygdaloid.	660
33.	Conglomerate: Strike north and south; dip 30° W. Full of boulders of granite but not so large as those near the base of section.	495
34.	Amygdaloid.	360
35.	Conglomerate: Strike north and south; dip 30° W.	12
36.	Amygdaloid.	165
37.	Conglomerate.	115
38.	Amygdaloid: Cut by a quartz porphyry dike. Strike varies from north and south to N. 70° W., and dip from 15° to 25° W.	625
39.	Conglomerate: Strike N. 30° W.; dip 15° S. 60° W.	50
40.	Amygdaloid: Contains large vesicles, up to one foot in diameter, filled with calcite, chlorite, and agate. Structures in outline like ellipsoids. Dips under lake. About 200 feet exposed.	200
	Total thickness.	16,044

Since this section was necessarily obtained by measuring each band separately across the strike, it is probable that the sum of the thicknesses of the separate bands will exceed the total average thickness of the section, since the formations must have been deposited on a sloping surface and the conglomerate beds will naturally grow thinner with increasing distance from the shoreline.

Conglomerate and Sandstone

The Middle Keweenawan conglomerate is quite remarkable for the very large boulders which it contains and the recurrence of similar bands throughout a very thick series of rocks. The thick band of this rock in Mica bay contains many large, well-rounded to subangular boulders of granite and gneiss, the largest of which is practically four feet in diameter (see photograph on next page). It has been suspected that this conglomerate might be of glacial origin and Dr. Bell[1] states that the boulders in this locality are nearly all well rounded and smooth and that on some of those of gneiss small grooves like glacial striae may be observed, although they are not well marked. In writing on the "Geological Section of Michigan," Lane and Seaman[2] state that the conglomerate lying at the top of the Lower Keweenawan and below the Lake Shore traps

[1]Robert Bell, Geol. Surv. Can., Report of Progress, 1876-77, p. 214.
[2]A. C. Lane and A. E. Seaman, Jour. Geol., Vol. XV, 1907, p. 688.

contains a wide variety of pebbles and large boulders and that in structure it is at times suggestive of till.

A careful examination of the conglomerates along the east shore of Lake Superior failed to reveal any real evidence of glaciation. No striated, grooved, or soled boulders were found. Several thin sections of the matrix were examined, and no sign of boulder clay was found in them. A. P. Coleman very kindly looked over these sections and agreed that they possessed no evidence of glacial origin. The matrix consists chiefly of volcanic debris, with grains of quartz



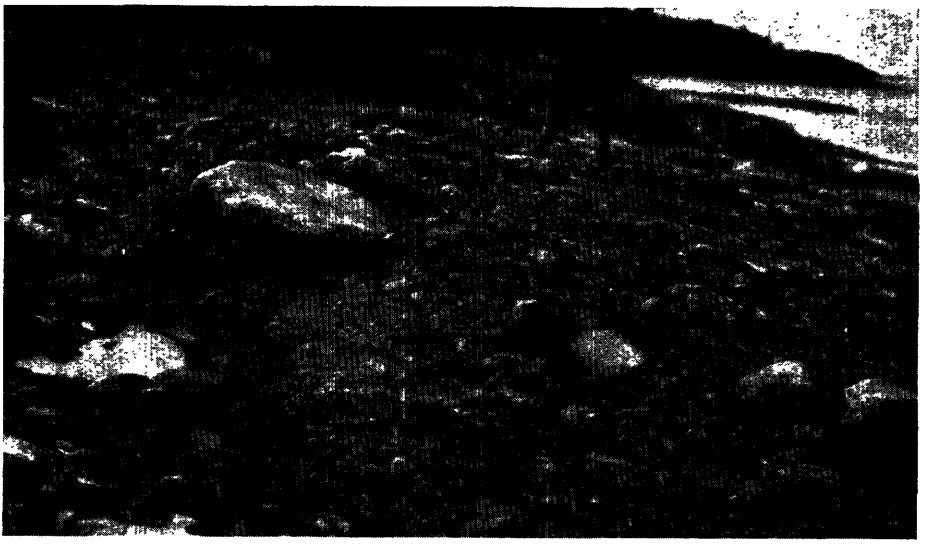
Large granite boulder in Middle Keweenawan conglomerate, Mica bay.

and feldspar. The larger fragments are fairly well rounded in some cases, and the rock is such as one might expect to find where the volcanic rocks were being locally weathered and where a variety of materials was being brought in from outside.

There is a great variety of rocks in the boulders and pebbles in the conglomerate. Granite and granite gneiss constitute the bulk of the fragments in most of the bands. The proportion of these to the other rocks varies considerably in different bands, and the largest boulders are in the lower portion of the series. There is no very definite relation, however, between the size of the boulders and the distance from the base of the section, as there is a recurrence of very coarse conglomerate at various levels up to the top of the highest amygdaloid observed. Beyond this the large boulders are absent, and much of the formation consists of small pebble quartz conglomerate and coarse sandstone. The large boulders in this conglomerate must have come from high granite hills to the northeast and been transported by torrential streams. It is

probable that heavy waves and shore currents distributed them in the basin and did much of the work of rounding them. In addition to the granite pebbles and boulders, fragments, well rounded, of greenstone, diabase, quartz, schist, and amygdaloidal lavas occur in the conglomerate. If the series were subaerial, there should be a larger proportion of the local volcanic rocks in the conglomerate, as there is in some of the conglomerate bands in this series in Michigan. The water in which deposition of these beds took place was doubtless shallow.

The sandstones of this series are mostly argillaceous and arkosic in character. There is much undecomposed material in the matrix, consisting of particles of volcanic rock and feldspar, indicating rather rapid deposition and lack



Middle Keweenawan conglomerate showing large boulders and pebbles arranged in rows, Mica bay.

of complete assortment and chemical decomposition. The rocks are rather soft. The sand grains consist chiefly of quartz, but there are fragments of volcanic rocks, feldspar, and other minerals. The colour of the sandstone varies from light grey to red, and much of it is mottled red and grey. Some of it is streaked, blotched, and otherwise variegated. It varies from thick to very thin bedded, and in places it grades into shaly layers, although there is very little shale in the series. Cross-bedding is a characteristic feature of much of it, and ripple marks occur in some places.

Igneous Rocks

The lavas in this series have commonly been called melaphyre, meaning altered olivine basalt. They are practically all basic rocks, as there is much less of the acid types in this area than in Michigan, for example, where the amygdaloids are so abundant. Most of the flows are highly amygdaloidal near the surface, becoming less so and grading into fairly coarse-grained diabases near the base. Some flows show a distinct amygdaloidal band at the bottom. This varies from two inches to perhaps a foot in thickness and grades upward with smaller amygdules into a denser diabase without amygdules. This denser

band grades gradually upward into the increasingly amygdaloidal portion of the flow as mentioned above. It is possible to pick out several flows in some bands, piled one on top of another, from the coarser, non-amygdaloidal and the highly amygdaloidal bands. Some flows are distinctly porphyritic, and they might be designated augite porphyries.

There is one very peculiar lava, forming a band about 60 feet in thickness, in the lowest amygdaloid in the Mica bay section. It is a porphyritic rock containing reddish to grey feldspar crystals arranged in roughly radiating groups. These crystals are long and narrow running up to three-quarters of an inch in length, and they are embedded in a grey to greenish basic rock. They have sharp outlines, although in some places they show considerable alteration to calcite and kaolin. The groundmass in which the feldspars lie possesses ophitic texture, the feldspars being much smaller than the phenocrysts. In addition to the feldspars, it contains a little pyroxene and a great deal of serpentine. The latter has developed from olivine, and associated with it is a brownish-red, pleochroic mineral which Dr. T. L. Walker has identified as iddingsite. The feldspars and olivine seem to constitute the bulk of the material in the rock. Magnetite is present, and epidote occurs as a secondary mineral. Calcite is abundant as a replacing mineral in feldspar crystals and throughout the groundmass. It seems to have in part, at least, developed from the other minerals by alteration and to have been partly introduced from external sources.

The amygdaloids in this section differ from those in northern Michigan in the scarcity of zeolites in the veins and amygdules. Only one occurrence was observed, and that was a small quantity in a thin section. This may indicate a lesser amount of the alteration of the basalts by warm solutions, and it may also bear on the relatively small amount of copper in this region. In areas where much copper has been deposited there is evidence of more intensive alteration of the conglomerates and amygdules than there is in much of this area, where most of the alteration of the rocks has been produced by weathering. The common amygdule fillings are calcite, chlorite, and chalcedony. In the field one gains the impression that a considerable amount of epidote occurs in the basalts, but in thin sections there appears to be relatively little of this mineral. Macfarlane[1] regarded delessite, the iron-rich chlorite, as a common amygdule-filling. The observations of the writer indicate that the greenish filling which is so abundant in the upper parts of many flows consists of some calcite and chalcedony, but mainly of a mineral more strongly resembling serpentine than chlorite. In thin section it is greenish in colour, slightly pleochroic to non-pleochroic, fibrous to scaly, spherulitic to massive. The radiating structure is very common in some specimens, and it seems to be quite characteristic of most of the occurrences of this green mineral. The bi-refringence of the mineral is more like that of serpentine than chlorite. Chemical tests made on this substance by J. E. Maynard show that it is soluble in sulphuric acid, but soluble with difficulty in hot hydrochloric acid, and the proportion of iron present is too low for an iron-rich chlorite such as delessite. The occurrence of the mineral as a cavity-filling seems to preclude the possibility of its being serpentine and to favour its being some chlorite mineral.

In the lowest band of amygdaloid there is an interesting network of small veins of serpentine. Some of the crystals are almost as fibrous as asbestos. They are arranged as the cross-fibre type of this mineral. Numerous calcite veins and stringers, for the most part barren, cut the amygdaloids; calcite is

[1]Thos. Macfarlane, Geol. Surv. Can., Report of Progress from 1863 to 1866, pp. 115-47.

abundant in most thin sections as amygdule-filling and as replacements along cracks and elsewhere in the sections. Serpentine is a very common product of the weathering of olivine, which is a characteristic mineral of most of the basic lava. Most of the feldspar and pyroxene crystals are fairly fresh, although the feldspars in some sections show kaolin and the pyroxenes, serpentine. Iron oxide as hematite and magnetite is so plentiful in some flows that the rock assumes a deep red colour and crumbles readily on weathering.

Acid lavas are almost lacking in this series. There is a prominent band of a very fine grained, felsitic, reddish lava in a ridge lying back of the buildings of the Nipigon Mining Company's camp on Hibbard (Sand) bay. Under the microscope this may be recognized as a very fine grained rhyolite. A band of similar rock may be seen near the southern group of buildings at Mamainse mine, and fragments of a brick-red felsite occur in the amygdaloid numbered 15 in the structure section. The quartz porphyry dikes mentioned later may belong to the igneous rocks of the Middle Keweenawan.

UPPER KEWEENAWAN

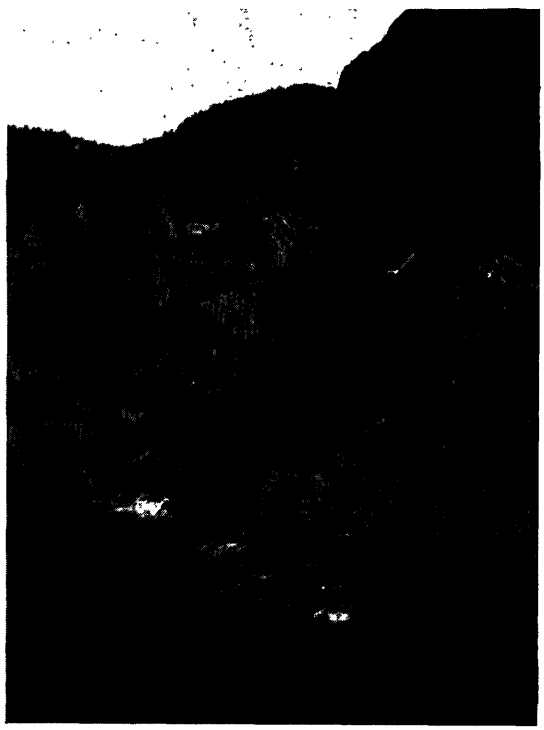
Near the bottom of Mica bay, at one other point in this bay and at a point in Alona bay, north of Pointe-aux-Mines, there outcrops a series of sediments which are either Upper Keweenawan or younger in age. The rocks of this series lie unconformably in strike and dip on the formations of the Middle Keweenawan. The relations between the two series may be seen in the structure section (Fig. 2) and also in the photograph on page 67. Since the unconformity in places is considerable this series may possibly be Cambrian in age, but the writer prefers to regard it as Upper Keweenawan for the present at least. Its unconformability with the rocks of the Middle Keweenawan was recognized by Macfarlane.[1]

The rocks of this series are conglomerate, sandstone, shale, and marl. The conglomerate contains pebbles and boulders similar to those in the Middle Keweenawan conglomerate, although none of those seen approach in size the larger ones in the older series. The sandstone is for the most part soft and argillaceous, and it grades into a concretionary shale. The concretions are flattened and oval. The marl is quite limited in extent. At the contact of the sandstone with the granite, there is an interesting breccia indicating deposition on a weathered surface of the granite. At the base, it consists of large irregular fragments of granite cemented by limestone, shale, and sandstone. These fragments gradually become mixed with smaller fragments of granite, crystalline limestone, quartzite, and other rocks; above this breccia, which is 15 feet in thickness, there lies the concretionary shale mentioned above. The shale contains dark carbonaceous spots and it is also micaceous. To the northwest along the shore of the bay, the sandstone and shale become more or less interbedded. The sandstone is thin bedded, flaggy, and ripple marked. It varies in colour from brownish to reddish. The strike is northeast, and the dip varies from 5° to 20° N.W.

On the southern side of the granite ridge the rocks along the shore for over 1,100 feet are of the same series, and here they lie unconformably on the amygdaloid beneath. They are breccia, sandstone, concretionary shale, and conglomerate. The beds first dip south away from the granite and then northwest. The strike ranges from N. 58° E. to N. 85° E., and the dip from 22 degrees southeastward to 30 degrees northwestward. Farther to the southwest, along the shore, another small area of rocks of this series may be seen, as indicated on the accompanying geological map, lying unconformably on the amygdaloid.

Dikes of Olivine Diabase and Quartz Porphyry

A number of dikes of olivine diabase cut the lavas and conglomerate of the Middle Keweenawan series. They were not found in the area covered by the Upper Keweenawan sediments; it is not known, therefore, whether they are older or younger than these rocks. They are apparently similar to the olivine diabase dikes found in the Michipicoten, Sudbury, and other areas in Northern Ontario, where they are the youngest igneous rocks recognized. In this section several of these dikes were studied and they were found to be fairly fresh,



Olivine diabase dike cutting granite, Mica bay. Note the spheroidal weathering in the dike.

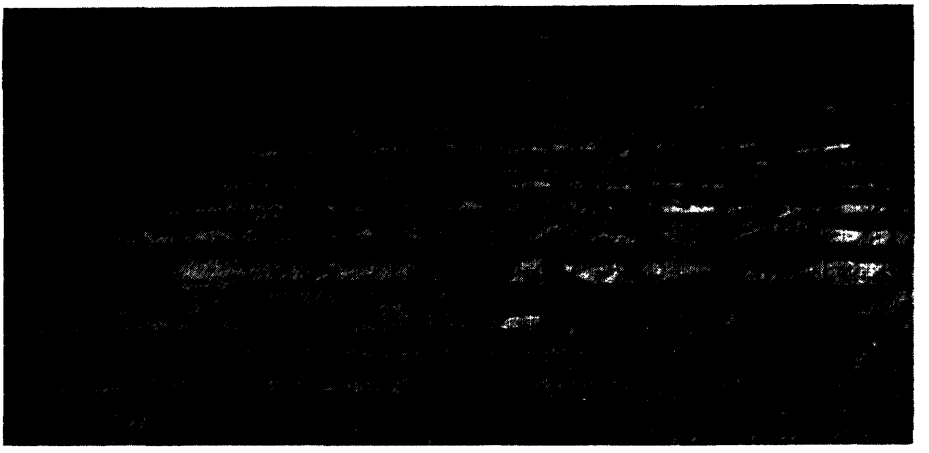
with the exception of the olivine which has nearly all changed to serpentine. Some of this mineral is spherulitic, the fibres being arranged in rosettes. There is considerable ilmenite, which is practically unaltered. The rock is a typical fine-grained diabase.

In addition to the olivine diabase dikes, there are several of quartz porphyry cutting the Middle Keweenawan formations. These dikes are much larger than those of olivine diabase, and in places they have greatly disturbed the adjacent rocks. The rock is unusual in appearance as it varies from red to white and until broken it resembles a sandstone. It may be even mistaken for a tuff at some points. Thin sections show that it is a rhyolite or quartz porphyry which has been crushed so that the feldspar and quartz phenocrysts have been greatly

[1]Op. cit., p. 137.

broken. It is distinguished from a tuff by the fact that the broken fragments are so placed that the original grains may be reconstructed.

There are at least two large intrusions of this rock. A large dike, 65 feet wide, cuts the amygdaloid in a little bay 20 chains northeast of Mamainse mine, and an irregular mass intrudes conglomerate and amygdaloid at a point 125 chains southeast, along the shore, from Coppermine lighthouse. Another dike, believed to be of the same age and character, was seen at several points in the northeastern part of Palmer township. The structure of the formations adjacent to the intrusion southeast of the lighthouse is very complex and puzzling. The formations a short distance from it are in normal position, and the only explanation for this condition seems to be found in assuming that the rock solidified and that it was then disturbed by forces beneath rather than by move-



Varved clay on Harmony river above the first falls and rapids.

ment of the rocks of the surrounding area. The disturbing effects of the intrusions of acidic rocks of Keweenawan age have been noted in several places in Michigan where they have crushed and brecciated the adjacent formations.[1] The intrusions of the felsites of Bare hill seem to have produced results similar to those seen on the east shore of Lake Superior.

The age of both the acid and basic dikes cutting the Middle Keweenawan formations can only be surmised, since they are the youngest igneous rocks so far known in the pre-Cambrian shield. It seems reasonable to regard them as a late phase of the Middle Keweenawan, the last phase of the great period of igneous activity which dominated the geological history of the Lake Superior basin throughout Lower and Middle Keweenawan time.

Pleistocene

The main features of the Pleistocene geology of this area are the deposits of stratified gravel, sand, and clay which were laid down in Lake Algonquin, the great lake which covered the Lake Superior basin after the ice retreated. Well-varved clays, reddish and blue, are exposed about two miles above the first falls and rapids on the Harmony river (see photograph above), at an elevation of

[1]Van Hise and Leith, Geology of the Lake Superior Region, U.S. Geol. Surv., Mon. 52, pp. 382, 385.

approximately 175 feet above Lake Superior. A terrace of post-glacial material runs around the lake and rises to an average elevation of about 55 feet above its present level.

STRUCTURAL GEOLOGY

In the Batchawana, as in many other pre-Cambrian areas, the main structural features resulted from intense folding and extensive igneous intrusion. No definite evidence of faulting on a large scale was found, although it was expected that the Agawa fault, so distinctly shown along the course of the Agawa river to the north of this area, would be located in this area as well. The rather abrupt ending of the Batchawana sediments against the granite just north of Rand was regarded as probable evidence of the presence of this fault, but the contact proved to be an intrusive contact.

A small fault occurs in the rhyolite of the Batchawana series just below mile-post 81 on the railroad. At this point a low scarp with slickensided surface was seen. The throw is not great, because the same type of rock occurs on both sides of the fracture. Diabase from a large dike a little to the west has been intruded along this fault as an offshoot from the main mass.

The great numbers of diabase dikes, only a part of which have been shown on the accompanying map, have greatly complicated the structure of this area. They resemble sills on edge, since they mostly follow the strike of the sediments; but they have been intruded along the nearly vertical bedding-planes in the highly folded formations. In some cases they cut across the strike of the sediments, and in the granite they do not have any fixed direction. The general strike of the bedded formations is east and west, to N. 20° W., and the dip in the older formations runs between 70° N. and vertical.

The structure of the Middle Keweenawan formations is comparatively simple. There is a marked monoclinal dip towards the Lake Superior basin, and the rocks have not been appreciably disturbed by faults, although duplication of beds, owing to strike faults, might be anticipated. As pointed out above, the intrusion of quartz porphyry has greatly disturbed and broken the adjacent rocks at some points. The unconformity between the Upper and Lower Keweenawan series may be taken as an indication of the settling of the Lake Superior basin in Keweenawan time and the tilting of the formations before the period closed.

ECONOMIC GEOLOGY

The metals which up to the present time have attracted much attention to the Batchawana area are iron and copper. Many assays have been run on quartz veins but without giving much encouragement to the prospector. The occurrence of copper at a number of points in the Middle Keweenawan formations, and the great success which has attended copper-mining operations on similar rocks in Michigan, early aroused great interest in these formations on the east shore of Lake Superior and on Michipicoten island. A large number of prospects were staked for copper in the earlier days of mining in Ontario, and several mines were started. The deposits on the east shore so far discovered have been mostly of the vein type, and no amygdaloidal deposits have been found. This type is one of the main producing types of deposits in Michigan. The east end of the Lake Superior basin seems to have been too far removed from the centre of the main copper depositing zone of igneous activity to receive a fair share of the metal. Michipicoten island, which lies nearer Keweenaw peninsula, has fared a little better than the east shore of the lake. The main hope of finding larger deposits of copper in this area will lie in discovering important fractures

which occurred near the close of the Middle Keweenawan epoch and which may have served for the migration of copper-bearing solutions.. Unfortunately no important crustal breaks of that age have been found. Those fractures which do exist are relatively small and appear to have resulted from cooling of lavas and slumping of sediments rather than from larger movements.

No iron ore has been mined in this area, but there are a few prospects which have attracted attention since their discovery in 1865. These are on banded iron formation in the Batchawana series and they are located in Palmer township, and township 28, range XIII, directly north of Palmer. These properties are known as the Batchewanung (Batchawana) mine and the Vulcan and Mammoth locations. A railroad grade was made from Batchawana village to the Batchawana mine, a distance of between six and seven miles, but the steel was never laid.

Iron Formation

The iron formation in this area is believed to be of the same age as that in the Mississagi Forest Reserve and on the Goulais river. It occurs as isolated patches, or island-like bodies, surrounded by Mamainse diabase. Some of these patches contain, in addition to banded iron formation, small amounts of other rocks such as arkose, greywacké, felsite, greenstone, sericite schist, and green schist—rocks similar to those with the iron formation in the Batchawana series elsewhere.

There are two small bands of the iron formation in the area, in addition to the main bands in Palmer township and township 28, range XIII. These are situated in township 26, ranges XIII and XIV. The former is a narrow band in the Batchawana sediments, and the latter a remnant in the diabase. A number of claims have been staked on the latter band, but it cannot be regarded as of economic interest. In places the iron formation has been almost completely displaced by the diabase, but some of the iron has been recrystallized and it forms small streaks in the diabase.

Batchawana (Batchewanung) Mine

This property covers most of sections 27 to 30 and 31 to 35 in Palmer township, and the workings run nearly east and west along a line lying three miles north of the mouth of Carp river on Batchawana bay. As nearly as can be learned, the iron formation was discovered by Hugh Wilson, Provincial Land Surveyor, when surveying Palmer township in 1865. The property was taken over by the Batchewanung Mining Company, and a great deal of work was done. Test pits, a shaft, and tunnels were all opened up. Buildings were constructed, and a grade for a railroad was built from the wharf at Batchawana bay to the mine. One wonders why all these preparations were made for shipping ore before a body of it was found.

Descriptions of this property are found in the reports by Macfarlane[1] and Coleman,[2] who visited the property many years ago. The writer's conclusions agree quite closely with those of these earlier geologists regarding the geologic and economic features of this property. Macfarlane says that the iron formation was opened up at many points, but he could nowhere find ore resembling in solidity and richness that of the Marquette range. The ore is mostly specular hematite, but the jasper is so plentiful that it is difficult to get a piece of ore as much as 8 to 12 inches in diameter without jasper. The bed ranges from 20 to 40 feet in width, but any large quantity of it would not exceed 30 to 40 per

[1]Op. cit., pp. 129-30.
[2]Ont. Bur. Mines, Vol. X, 1901, p. 189.

cent. in iron. He states further that the rocks in the neighbourhood are diabase, diabase schist, greenstone, and greenstone-slate, the latter forming the walls of the iron formation which strikes approximately east and west and dips 80° N. He considered the rocks as Huronian in age as did Dr. Coleman, who examined the property about 35 years later.

There have been various reports regarding the railroad to this property, and Coleman states that the steel was never laid on the grade in spite of some reports to the effect that trains hauled ore from the mine to the wharf.

At the present time all trace of the buildings is gone. Part of the grade is overgrown as well as most of the test pits. The open cut near the west end of the outcrop, the shaft, and the tunnels in the hillside may still be seen. The open cut exposes a band of iron formation, cut above and below by Mamainse diabase, which grows schistose towards the contact with the iron formation. This formation is 25 feet thick and consists of jasper with streaks of specular hematite, associated with a banded gneiss on the footwall side. Under the microscope this gneiss is recognized as metamorphosed arkose and greywacké. In the hanging wall there is greenstone and green schist. The cut is in the face of a hill, and the exposed face is 35 feet in height. The dip is 49° N.

A specimen of the better ore from this cut was submitted to the Provincial Assayer and it gave: iron, 30.46 per cent.; silica, 57.90 per cent.

To the west of this cut the formation pinches out, but to the east along the ridge there is a shaft four and a half chains from the open cut. This is full of water, but it was estimated to be 25 or 30 feet deep. It is sunk on a band of jasper 20 feet wide and standing nearly vertically. The iron content is possibly slightly higher than in the open cut.

Still farther east, at five and a half chains from the shaft, two tunnels have been driven into the side of the hill, which rises about 200 feet above the valley. The iron formation is only 10 feet in width, and there is considerable felsite in the footwall. At 30 chains to the east of the tunnels there are a number of test pits now caved in, but nothing of economic interest was found in this direction. The iron formation apparently runs to within about half a mile of the Batchawana river.

The iron in this band is mostly in the form of hematite; that in the Mammoth location is nearly all magnetite; and in the Vulcan location, between the two, there is considerable of both of these minerals. The only explanation for this condition seems to be in the closer approach of the granite on the north side producing more metamorphism in the iron formation in that section. The diabase intrudes the formation in all three bands, and it cannot be the cause of the greater metamorphism in one than in the other. Probably all three of these bands were connected before they were intruded by the diabase.

Vulcan and Mammoth Locations

These properties were discovered by Hugh Wilson at the time he surveyed Palmer township in 1865. They are often spoken of now as the Heck lands because they came into possession of George C. Heck of Raleigh, N.C. As previously mentioned, they have been examined by several men who have written brief reports on them. The Vulcan location consists of two blocks, A and B. The former block contains 200 acres, and the latter 311 acres. The Mammoth location lying to the north of these contains 400 acres. The Vulcan locations are situated along the north side of the north boundary of Pa'mer township, in township 28, range XIII, eight miles in a straight line from the mouth of the Carp river and about eleven miles from Batchawana village by trail. The trail

is still in fair condition for about half the distance from Lake Superior to the north end of Palmer township. Beyond this the old Agawa trail, which was well beaten 20 years ago, is badly grown up, and it was necessary to recut it to permit packing in to the locations. The trails on the properties are practically all overgrown, most of the trenches are also overgrown, and practically no sign of most of the claim lines can be found, if they were ever all run. The north boundary of Palmer was located, and the line followed. The post between sections 4 and 5 was also found, and the post for the Mammoth tie-line, just east of the former post was picked up; but the tie-line could not be followed all the way to the location. Two traverses were paced from the north boundary of Palmer to the Mammoth location, and it is believed that this location is placed too far to the north on the surveyor's map.

In approaching the claims, the first sign of the iron formation of block B is found near the branch of the Carp river, which comes in from the east along the north boundary of Palmer township. Near the point where this branch joins the one from the north, in section 5, there are several pits on jasper, said to have been sunk by D. J. Ranson. The remains of his shack and some rusty tools may still be seen just across the creek to the west. The formation is 20 feet wide and carries less than 30 per cent. of iron. As it is followed approximately northeast it crosses the boundary of the township into block B. It is greatly cut up by diabase and is covered in some sections with drift. It may be followed from one knob to another with the dip needle, since it contains considerable magnetite. It dips about 30° S.E. Narrow bands of jasper may be seen in the bed of the creek along the boundary of Palmer township, but the main portion of the formation lies several chains to the north of the creek. In the creek bed there is some ellipsoidal greenstone and rhyolite with the jasper, as there is in other portions of the Batchawana series. On the Mammoth tie-line, there is also some felsite or rhyolite with the jasper.

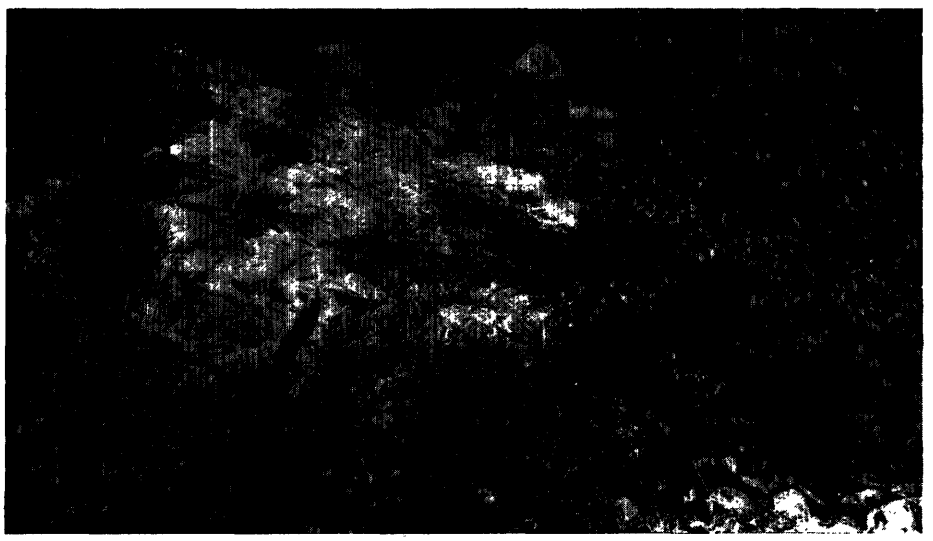
As suggested by others, the formation grows a little higher in iron towards the eastern end of the locations than it is near the western end. An analysis by the Provincial Assayer of a specimen taken from an outcrop on a knob just west of the little lake, shown on the map in block B, near the Mammoth tie-line, gave the following: iron, 42.08 per cent.; silica, 43.30; sulphur, 0.075.

This outcrop represents a shallow capping on top of a diabase knob, and it dips at 17° S. Most of the iron formation lies as resistant remnants on the diabase intrusions and it has no considerable depth. For example, on the Mammoth tie-line, half way between the township line and the little beaver lake in the southwest corner of the Mammoth location, there is a band of lean iron formation 60 feet in thickness. If it is followed to the east a short distance to a deep ravine, it is found that it is only a capping on the diabase. Two traverses were made across block A without observing any disturbance of the dip needle or compass, although there is sufficient magnetite in even narrow stringers of the iron formation to greatly disturb the needle. This is convincing evidence that although there are a number of outcrops of the formation extending across the eastern part of block B and the western part of block A, these have no great depth. Some of those who have previously examined these claims have assumed that the igneous rock adjacent to the iron formation was lava, interbedded with the jasper, instead of an intrusive formation cutting it off at a relatively shallow depth. This assumption completely changes the conclusion which must be drawn regarding its extent and commercial possibilities. Some have even gone so far as to assume that the bands of iron formation at the Batchawana mine, those on the Vulcan location, and those on the Mammoth location are all con-

nected. They have no connection now, although they are doubtless parts of the same formation separated by diabase intrusions.

There is a large exposure of well-banded magnetite on the Mammoth location on the northeast side of the small beaver lake in the southwest corner of the location. A pit has been sunk in this body, and several tons of lean ore has been blasted out of it. The ore is siliceous magnetite interbanded with grey to white silica, some of the bands running up to half an inch in width.

Two specimens were taken from the outcrop which show its uniformity in iron content. The richer one represents the better type of ore, and the other



Test pit in iron formation on the edge of a beaver pond in the southwest corner of the Mammoth location.

was collected as an average sample. They were analysed by W. K. McNeill, the Provincial Assayer, and gave the following results:—

	No. 1.	No. 2.
	per cent.	per cent.
Iron	36.34	32.70
Silica	49.78	54.30
Sulphur	.068	.012
Phosphorus	.....	.098

The sulphur is high in this ore, and pyrite may be seen in many samples. The ore would readily lend itself to magnetic concentration, if there were a sufficient quantity of it to justify operating; but the fact that it is completely surrounded by diabase makes its depth quite conjectural. This deposit ends at five and a half chains to the west of the cut and at eight chains north; at 60 degrees east it is cut off by diabase. The maximum width is five chains. Its dip varies from 30° N., through vertical, to a high angle to the southward. The strike varies also, as the formation is greatly contorted in places, but the general strike for the formation on this location is close to N. 60° E. As the formation is followed eastward from this pit, a number of patches of siliceous magnetite were

found but no continuous band, and there is nothing exposed which appears to be of economic interest. Diabase and granite occupy practically the whole of the location.

Copper Deposits[1]

It has been claimed that David Thompson was the first white man to discover copper on the east shore of Lake Superior. He visited Mamainse in 1798. Attempts to mine copper in the Batchawana area were made about 1842. One of the earliest mines was opened up by Hugh R. Fletcher, for the Quebec and Lake Superior Mining Company, immediately north of Pointe-aux-Mines. Little sign of this old mine can now be seen except the overgrown dumps. Of the operations Macfarlane[2] writes in 1866:—

> Here there are the ruins of several buildings, and of a stamp-work with ten heads of stamps water-wheel, etc. The spalling bank lies above the stamp-work, and at the end of an adit, which, at about 220 feet from its mouth, is connected with a shaft from the surface, having a depth of about 40 feet. The adit continues past the shaft for about 30 feet and penetrates the underlying gneiss. The line of junction is very decided and runs N. 53 degrees W., dipping 37 degrees northeastward. The trap is seen at places in the bottom of the adit to contain fragments of gneiss. At the end of a drift, which goes off to the southeast near the end of the adit, is a shaft which is filled with water. . . . As to the vein which has here been explored, it is also in the trap, but it can scarcely be more than 20 feet from the gneiss. It is very rotten and decomposed, does not seem to have definite walls, and would seem to be filled up to a great extent with pieces of the side-rock. The quantity of ore contained in it does not seem to be considerable. Judging partly from heaps lying on the spalling bank, it contains, besides fragments of the side-rock, calcspar, quartz, heavy-spar, specular iron ore, copper glance, purple copper, and copper pyrites. The quantity of the three last minerals is such as to show that the vein is not remunerative. This is rendered certain by the fact that it has had a fair trial, and has been abandoned.

It is stated that in the days when this property was operated, the Indians caused the miners trouble by attacking the camp. A small cannon at the camp of the Nipigon Mining Company on Hibbard bay is said to have been brought from this old mine at Pointe-aux-Mines and to have constituted half of the artillery kept for the defence of the camp.

In following the shore southward from Pointe-aux-Mines, many evidences of prospecting and of small calcite veins may be seen. At a point in the second amygdaloid of the section between Mica bay and Pancake bay (Fig. 2), 830 feet from its contact with the overlying conglomerate, there is a little vein carrying native copper. This vein consists of calcite with a little quartz, and it can be traced along the strike for 30 feet. It cuts a reddish, fairly dense, feldspathic lava and it carries a little native copper and malachite. No extension of this vein could be found inland, and it is restricted to a low, wave-washed cliff.

Mamainse Mine

Between Mamainse island and Mica bay, there is a very small bay on which the old Mamainse mine is located. There are, or there have been, upwards of 30 buildings at this camp. These are all abandoned, and most of them have been partly dismantled. They were well constructed, and the housing facilities were sufficient for the employees of a very large mine. There was a large mill apparently fully equipped, but now in ruins, and one marvels at the extravagance in expenditure when one looks in vain for the ore to feed the mill. Prodigal expenditure of money seems to have been a characteristic of many of the operations in this region, even when allowance is made for the fact that in the days when these properties were developed diamond-drilling methods had not reached the perfection which they have to-day. It was customary,

[1]For notes on the early history of copper mining on the east shore of Lake Superior, *see* Archibald Blue, Copper at Point Mamainse, Ont. Bur. Mines, Vol. III, 1893, p. 62.

[2]Op. cit., p. 144.

apparently, to sink costly shafts on the slightest evidence of mineralization. There are three shafts at the Mamainse mine. Since these are full of water, it is impossible to state their depth. In the report of the Royal Commission, several statements regarding the Mamainse mine appear, and it is not clear which properties are described. Apparently the report of Edward Norris, in which he states that he represents the Lake Superior Copper Company which has three shafts, 320, 280, and 60 feet, respectively, in depth, refers to this mine.[1] This company secured the property, containing 6,400 acres, from the Lake Superior Native Copper Company about the year 1887. The latter company started work in 1882 and ceased operations in 1884. According to some statements some work was done on this property about the year 1853, and it was taken up again in the eighties.

The outcrop which apparently stimulated interest in the property may be seen on the shore just northwest of the shaft nearest the lake. In this outcrop



Mamainse mine from the lake. Conglomerate overlain by amygdaloid is shown in the foreground. Shafts were sunk near the contact of these formations.

a little native copper and malachite may be seen in stringers of cherty rock. The lode varies from 1½ to 13 feet in width and consists mostly of altered amygdaloid along the contact of two beds of lava of relatively coarse grain. This strikes toward the shaft. All the shafts start in the amygdaloid, but the one farthest from the lake runs into conglomerate. They are inclined about 50 degrees towards the east.

Nipigon Mining Company's Property

The one mining camp in the area which has been maintained intact is that situated on the north side of Hibbard (Sand) bay on the old Sand Bay location. The present owners of the property have kept a watchman on the premises ever since operations ceased in 1894. The watchman now on the property is Oscar Carlson, and he states that the existing company is known as the Nipigon Mining Company, a descendant of the Silver Islet Company. The first company to operate in this region was the Montreal Mining Company, which secured the lands from the crown in 1856, and in 1871 sold them to the Ontario Mineral Lands Company, later part of the Silver Islet Consolidated Mining and Lands

[1]Mineral Resources of Ontario, Rept. Roy. Com., 1890, p. 102.

Company. In 1890 the Sand Bay property passed to a syndicate, the Canada Lands Purchase.

Work by the Montreal Mining Company ceased in 1857, and it was not until 1884 that work was actively taken up by the Silver Islet Company with Captain T. H. Trethewey in charge of the work. Since the old workings are now mostly overgrown and caved and the shafts are full of water, it is best to quote Mr. Blue's descriptions of these operations[1] after he had visited the property when work was in progress in 1892. He says:—

A number of mineral veins were discovered by him [Captain Trethewey] but most of the time was wasted in searching for silver, owing to a small discovery of that metal having been made. Two shafts were sunk on a conglomerate bed at Roussainville to depths of 65 and 87 feet respectively, but the copper ore taken out yielded less than one per cent. An opening upon No. 11 vein on Sand Bay location discovered samples of ore which by analysis yielded many thousands of dollars of silver per ton, yet the aggregate was very small. . . . From this time no further work was attempted until December, 1891, when the new proprietors employed Captain Trethewey to explore Sand Bay location with the diamond-drill. . . . The results were so gratifying that the syndicate decided to undertake development work on a larger and more satisfactory scale. . . . The site of the shaft is on vein No. 10, or the Copper Creek vein, about a mile and a half from the bay. The vein has a north and south course, cutting across the beds of country rock which have a strike of northwest and southeast. Two small streams join near the shaft-house to run southerly along the vein, upon which a channel several feet deep has been cut. The conglomerate forms the hanging wall at the mouth of the shaft, and a crosscutting eastward shows it to have a thickness of 45 feet, with underlying trap beyond it. The footwall is amygdaloid. Near the junction of the streams the exposure appears to show a thrust or fault in the formations of about 50 feet, but the overlying drift hides the actual position. The vein dips to the east at an angle of 45 degrees, and is continuous at that angle to a depth of 295 feet. The width, too, is equally uniform, being at the surface 6½ feet and at the bottom 6 feet 2 inches. At 80 feet, where a level has been driven southward on the vein 49 feet and northward 20 feet, the vein has passed into the underlying bed of trap, but the walls are well defined on both sides. . . . The vein matter consists of traps, amygdaloids, conglomerate, quartz, and calcspar, holding metallic copper and copper sulphides, but the rich ore occurs only in pockets and the extent of it is uncertain. There is, however, a good-sized pile of rich ore on the surface and much of the vein matter thrown out on the dump contains ore of greater or less richness. . . . The Copper Creek or No. 10 vein has been traced north from the shaft-house 1¼ miles and south 1,700 feet by pits and trenches, and at various points it shows fine ore. About three-quarters of a mile north of the shaft another vein has been discovered upon which openings have been made which show good ore for 1,000 feet. The vein runs so close to No. 10 that the two are supposed to unite at a point beyond which the explorations have been made, or possibly they are only parts of the same vein separated by a horse of country rock.

On a ridge back of the camp on Hibbard (Sand) bay, there is a large outcrop of a red felsite, and to the northeast of it a higher ridge of amygdaloid, rising about 250 feet above the lake, on which two shafts have been sunk. In the dumps from these shafts specimens of chalcopyrite and bornite were found, and it is said that native silver was also found there in sufficient quantities to keep the prospectors interested. A great number of trenches have been dug; in fact, the hill is literally covered with them, but nothing of much interest was found on this ridge. Silver Creek shaft lies about half a mile northeast of the shafts mentioned above. The depth of this shaft is not known, but it must be considerable, judging from the size of the dump. The rock on the dump is amygdaloidal basalt with specks and stringers of chalcopyrite. A little bornite has developed from the chalcopyrite by sulphide enrichment. According to Mr. Carlson, the shaft received its name from the discovery of a little native silver in the ore. Little could be learned of the conditions at the shaft, since it is in a depression and exposures are poor.

At the Copper Creek shaft, the account of which by Mr. Blue is quoted above, there is a pile of conglomerate, carrying native copper, lying beside the shaft-house (see photograph on page 84). This rock is quite similar to that mined in Michigan; and if it occurs in sufficient quantity, it should make good ore.

[1]Op. cit.

Apparently it must have come from a pocket in the mine, since there is practically no sign of such rock on the dump, which consists of amygdaloidal basalt. No granite pebbles were found in the conglomerate, although granite pebbles are abundant in the conglomerate at the surface and in all the conglomerate bands throughout the area. One wonders whether the absence of granite pebbles can be due to the copper being deposited in portions of the conglomerate in which granite pebbles are scarce, the nature of the rock influencing the deposition of the copper and the ease of replacement. Mixed with the native copper ore are fragments of chalcocite. This mineral may also be seen on the edge of the creek about 50 feet north of the shaft, where a small vein of good ore is exposed for a few feet. It was analysed by L. Telfer, who pronounced it chalcocite.



Conglomerate with native copper at the shaft on Copper Creek vein.

On the point at the northern corner of Hibbard bay, a vein of calcite, known as vein No. 4, outcrops at the water's edge, where it is four feet in width. It gradually pinches out landward in about a chain, and under the water it may be followed for about another chain. It contains hematite and traces of copper in the form of malachite. It has been prospected inland, and a shaft was sunk on it to a depth of 40 feet, but the operation was abandoned. On Mamainse island, a pit has been sunk on the chloritic amygdaloid carrying stringers of calcite, but no copper could be seen on the dump. Numerous other prospects have been tested all along the Mamainse headland, but none have proved as interesting as the Copper Creek vein.

Begley Location

Near the east end of Batchawana bay, three miles southeast of the mouth of the Harmony river, there is an old location which has attracted some attention in the past. It is known as the Begley location and it is adequately described by Macfarlane[1] who says of it:—

[1]Op. cit., p. 121.

It is distant a mile and a quarter from the water and the principal working is situated on the summit of a rocky bluff, 900 feet long and 300 feet high, which exhibits to the southward perpendicular cliffs at least 200 feet high, the face of which runs N. 70° W. This bluff consists of granitic gneiss, composed principally of orthoclase, with quartz, and a small quantity of dark-green soft mica or chlorite. . . . Copper ore, in important quantity, was first observed at a point distant about 150 feet from the west end of the cliff. Here the face of the rock has been cut into, and a quartz vein exposed, about three feet thick, more or less richly impregnated with copper glance, purple copper, and specular iron ore. . . . It runs along the face of the cliff, parallel with the jointing of the rock, which is N. 75° W., and the face is in many places stained green from the decomposition of the cupriferous minerals. At the foot of the bluff an enormous talus of debris has accumulated, consisting mainly of large blocks of rock from the overhanging cliffs. The quartz veins, and the parallel joints of the rock, together with their northern dip, must have greatly assisted the atmospheric agencies in loosening the blocks. Among the debris a considerable quantity of copper ore is found, three hand-specimens of the poorest workable sorts of which yielded respectively 1.4, 1.8, and 2.3 per cent. of copper. Some pieces would, of course, contain more than this, and one, exceptionally rich, which I selected, yielded 11.1 per cent. There are other veins or rather layers of quartz observable at other parts of the face of the bluff, but their strike is always the same. Sections of these veins are exposed at both ends and in a cleft about the middle of the cliff. At these places, the granitoid gneiss is seen to contain numerous quartz veins or layers, most of them vertical and appearing to run parallel with the cleavage of the rock. Others of them run across the jointing, connecting the vertical veins, and the whole presents the appearance of a network of quartz veins intersecting the rock, which at places is indistinguishable from the granite. A good many of these veins contain disseminated copper ore. The best ore was found on the top of the bluff, and about 60 feet from the edge of the cliff, in a mass of quartz of considerable thickness. Rich pieces of purple copper and copper pyrites were here excavated. The whole occurrence reminds one forcibly of the *stockwerke* at Altenburg, and this, with the presence of tourmaline in some of the veins, induced me to search for tin ore in them, but without result.

This property has apparently lain dormant most of the time since Macfarlane's description was written. The reason which has been given for failure to develop it is that the ore averaged too low in copper for a deposit of its size to be worked successfully.

Quartz Veins

Several small quartz veins occur in the vicinity of the dam on Batchawana river, just below the railroad. Test pits have been sunk and several claims have been staked on these veins at one time. Nothing of economic interest seems to have been uncovered. A number of claims were also taken up at one time in the vicinity of Carpenter lake, but they have not been held or developed. In several other parts of the region quartz veins occur; they are most common in the sediments and schists in the vicinity of the granite intrusions. They seem to be lacking in metal content. One of the most promising of these veins occurs on an island in Moose lake. A little work has been done on it, and it contains a little sulphide of iron and copper, but an assay for gold by the Provincial Assayer gave negative results.

A vein which has attracted considerable attention occurs at the falls, at the head of the canyon on the Batchawana river, in the southeast corner of Palmer township. At this point the Mamainse diabase has been schisted along its contact with the granite and considerably carbonated. There are a number of brownish veins in the schist and greenstone, carrying silica, carbonate, and pyrite, the latter weathering rusty and staining the adjacent rocks. An assay of this vein material showed that it is barren of precious metals.

SAHKATAWICH (RUSH) LAKE SECTION, WOMAN RIVER IRON RANGE, DISTRICT OF SUDBURY

By E. S. Moore

INTRODUCTION

In the year 1909, the iron formation in the Woman River area was described by R. C. Allen in the Eighteenth Annual Report of the Ontario Bureau of Mines. In this report, the Woman River iron range was mapped in considerable detail as far east as the Sahkatawich (Rush) river. East of this stream, the geological formations were outlined in a general way and some of the iron formation was indicated. The main body of the iron formation apparently had not been recognized in the eastern section of the range at the time the field work was done for this report. In 1908, a number of claims were staked by W. E. Smith, of Sudbury, on the range between Sahkatawich river and Sahkatawich (Rush) lake. Mr. Smith discovered several large bodies of high sulphur iron ore, and there are at present 23 claims on the range held by the Jefferson Mining Corporation, and commonly known as the Jefferson claims. Mr. Smith, now of Smith and Rietz, barristers, of Minneapolis, is the representative of this corporation.

In 1910, about 4,000 feet of diamond-drilling was done on these claims in search for iron, and at that time a little sphalerite, galena, and chalcopyrite was found in one of the holes in the iron formation. Two years later, a shaft eight feet deep was put down on the best lead-zinc showing.

During the latter part of the field season of 1925, after completing the work on the Batchawana area, the writer and his party made an examination of the Jefferson claims. Fortunately Mr. Smith was on the property during part of the time the work was being carried on, and the writer is greatly indebted to him for his hospitality and the assistance which he rendered in furnishing information regarding the property, and for maps showing canoe routes and development work on the claims. The mapping of the canoe route from Stackpool to Sahkatawich lake has been largely done by Mr. Smith.

The writer is indebted to Dr. T. L. Tanton, of the Geological Survey, Ottawa, for the loan of several specimens of rocks and ores from this area, collected during a visit to the property several years ago. The party had the very acceptable company, during part of their study of this area, of Professor Ellis Thomson of the University of Toronto, who visited the lead-zinc deposit for the purpose of collecting data on it for the Geological Survey at Ottawa.

Location and Accessibility of the Property

The Jefferson claims lie partly in Genoa and partly in Marion township, district of Sudbury, between the northern end of Sahkatawich lake and Sahkatawich river. This is the Indian name for the lake and river and means rush or rushy, but it is also widely known by the English term (Rush). The nearest accessible railroad station is Stackpool, on the main line of the Canadian National, 124 miles from Sudbury. A good canoe route starts from Stackpool and extends to the iron range at the northeast end of Sahkatawich lake, a distance of about 14 miles. On this route there are nine portages ranging from 100 to 1,750 paces in length. The eastern end of the iron range may be seen on a small island in the little lake just north of Sahkatawich lake, but there is nothing of interest,

from the economic viewpoint, for some distance to the west of this exposure of the iron formation. From the bay at the northwest corner of Sahkatawich lake, a good trail leads to the workings and follows the iron formation southwestward to Sahkatawich river. There is also a good canoe route from the east end of the range via Sahkatawich lake and river to the west end. There is one portage above the claims on Sahkatawich river, but it is only 16 chains long.

There is another route to the iron range, via the Groundhog river, Woman river, and Sahkatawich river, but it is much longer than the Stackpool route. It is, however, a very good route for the return journey to the railroad, as the trip may be made in a little over a day from the west end of the Jefferson claims.

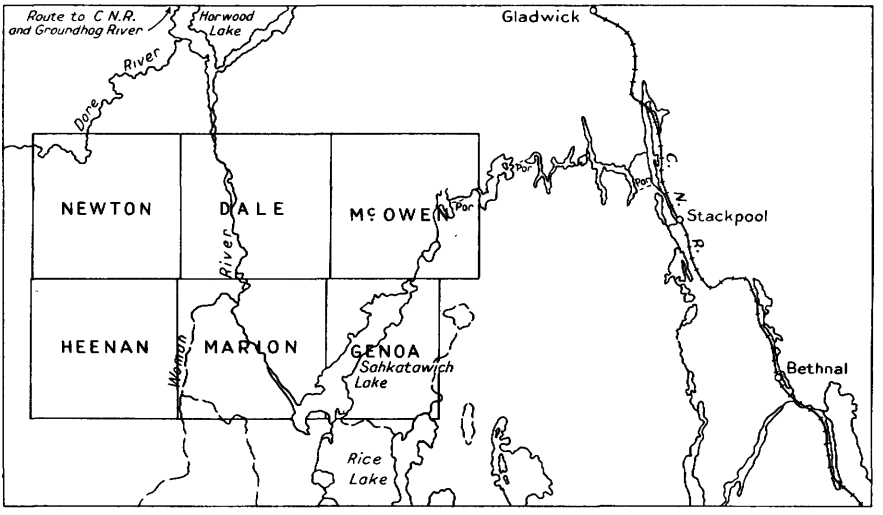


Fig. 7—Index map showing location of and routes to the Sahkatawich Lake section of the Woman River iron range. Scale, 8 miles to the inch.

There are a number of portages, but they are short and well travelled, since this is part of one of the old Hudson Bay routes from James bay to the south. It is also possible to reach the iron range from the south along this route from Biscotasing. It leads down to the Canadian National railroad at Groundhog River station (Fig. 7).

If a railroad were constructed to this range, it could be built without much difficulty from a point slightly south of Stackpool. The distance would be 14 or 15 miles.

Surface Features of the Region

The area lies well up on the peneplain, and the surface is relatively flat. The elevation of Stackpool is 1,255 feet, and the region around the iron range has a similar elevation. It is covered with lakes and swamps in some sections, but in other sections there are plenty of rock exposures. The iron range forms a ridge running approximately northeast and southwest and rising in places to a height of 60 feet above the surrounding swamps.

GENERAL GEOLOGY

The rock around Stackpool and in the area between this point and Sahkatawich lake is practically all granite, but a short distance north of this lake a band

of Keewatin formations is met on the canoe route. This band widens to the westward, spreading a long way to the north and south. In this band the Woman River iron range is located. It runs from the north end of Sahkatawich lake to a point west of Woman river.

In Allen's report on the Woman River area,[1] he recognized the following formations: basal greenstones, iron formation, acid igneous rocks, mica porphyry, and basic igneous rocks, in order of age, the first-mentioned being the oldest. A similar classification could be made for the rocks on the Jefferson claims, with the addition of small amounts of conglomerate and quartzite. The formations might, therefore, be arranged as in the following table:—

PLEISTOCENE:	Glacial drift.
PRE-CAMBRIAN	
KEWEENAWAN:	Olivine diabase dikes.
ALGOMAN (?):	Granite and quartz-feldspar porphyry.
HURONIAN (or Keewatin?):	Coarse-grained greenstone, mostly diabase.
KEEWATIN:	Rhyolites, quartz porphyry, felsite breccia, conglomerate, and quartzite. Iron formation. Greenstone, green schist, and rhyolite.

The greenstones are similar to those in the Keewatin in other areas. No typical ellipsoidal or pillow structure was seen, but the rocks are apparently basic to intermediate lavas. Interbedded with these basic rocks and their schist equivalents are acid rocks. These are rhyolites and quartz porphyries, some bands being lava flows and others dike-like intrusions. Some of the greenstones are interbedded with the acid rocks, and both with iron formation. Cutting these rocks are coarser greenstones, which are diabases, for the most part and may be later than the Keewatin, possibly Huronian in age. There are large intrusions of the rock on the north side of the iron formation near the west boundary of Genoa township, and in one place it may be seen cutting the iron formation.

The iron formation dips steeply southward, and almost throughout the range there is a band of clastic rock on the hanging-wall side. This is described as a volcanic breccia by Allen,[2] and in the eastern portion of the range this description would be applicable for most of it. In places it grades into distinct conglomerate with pebbles of rhyolite or felsite, up to six inches in diameter and well rounded. There are also a few pebbles of quartz, much smaller in size than those of felsite. There are no pebbles of iron formation, or of the other rocks of the area, so far as could be seen. This band of conglomerate is well exposed on the southeast border of the iron formation in claims W.D. 1,733 and 1,734. Its strike is not quite parallel to that of the bands in the iron formation, and the question might be raised as to whether it is unconformable on the iron formation. It is possible, as indicated in other parts of the area, that the schistosity of the adjacent rocks does not coincide everywhere with the strike of the banded formation.

In the central and eastern portion of the area, the breccia is garnetiferous, and near diamond-drill holes Nos. 2 and 3, in claim W.D. 717, the rock is garnet-chlorite-actinolite-quartz schist. Apparently the original rock was an impure quartzite. In this rock there is a little pyrite and considerable magnetite, the latter being distinctly later than the garnet, since it fills cracks in it. This may have some bearing on the age of the magnetite in the iron formation.

[1] R. C. Allen, Iron Formation of Woman River Area, Ont. Bur. Mines, Vol. XVIII, pt. 1, 1909, p. 255.
[2] Ibid.

The granite occupies the area around Stackpool, and on the second lake on the canoe route from Stackpool it may be seen cutting the Keewatin greenstone. Near the north end of Sahkatawich lake, it cuts off the iron formation and other Keewatin rocks, and occupies part of the west shore of Sahkatawich lake. It is probable that it has been responsible for metamorphosing the iron in the eastern portion of the iron range to magnetite. Further, it is probable that some of the quartz porphyry and feldspar porphyry dikes which cut the iron formation and associated rocks are offshoots of the granite mass. This has not been definitely proved, but some of these porphyry dikes are distinctly later than the Keewatin rocks and it seems reasonable to regard them as derivatives of the granite magma.

There are a number of large olivine diabase dikes cutting the iron formation, which are regarded as Keweenawan in age. A section from one of these dikes in claim W.D. 719 shows the rock to be a typical diabase with beautifully developed ophitic texture. The minerals are unusually fresh, even the olivine showing very little serpentine in some crystals. Most of these dikes strike nearly north and they cut the iron formation transversely. One of them, in claim W.D. 719, has faulted the iron formation a distance of 35 feet. Near diamond-drill holes Nos. 7 and 8, in claim W.D. 1,727, two of these dikes, running parallel to each other, have greatly complicated the structure in the ore body for mining operations.

Iron Formation

The iron formation in this range is very interesting because of the variety of ore types it contains. In a general way it is a typical banded type, containing interbanded silica, jasper, siliceous magnetite, and cherty iron carbonate, as well as a variety of sulphides of iron, lead, zinc, and copper. The iron formation extends, with a few breaks, from the northern end of Sahkatawich lake, a little south of west, to a point beyond the Woman river, a distance of about 11½ miles. In the western portion of this range, the formation consists chiefly of ferruginous cherts with some cherty iron carbonate and iron ore. Allen seems to consider that the other iron minerals came almost entirely from the iron carbonate by alteration. Sulphide is apparently a subordinate mineral in the formation. On the east side of the Sahkatawich river, the character of the iron formation changes considerably and sulphides of iron form a very important part of the formation. On the western claims of the Jefferson group, iron carbonate, magnetite, and silica constitute the greater part of the formation. These are in varying proportions in different sections of the range, but the association is quite constant. There is very little pyrrhotite in the formation on these western claims but it comes in gradually, and on some of the eastern claims it may form from one-third to over one-half of some samples. The iron carbonate decreases in proportion and the ores become siliceous, magnetite, and sulphide ores as contrasted with the carbonate, siliceous, sulphide ores of the western claims. On claim W. D. 717, the other sulphides are largely replaced for a short distance by galena and sphalerite, forming a lead-zinc deposit carrying over 70 per cent. of lead. Of the sulphides, pyrite is the oldest, pyrrhotite is next in age, then chalcopyrite, followed by galena and sphalerite. The relative age of the two latter sulphides is in doubt.

That the lead, zinc, and copper sulphides and the pyrrhotite are of igneous origin and that they have been injected into the iron formation, there seems to be no doubt. The source of the pyrite is not so easily determined. The fact that it is associated with these other sulphides in the eastern portion of the range and that it is almost absent in the western portion gives strong support

to the assumption that it has also come into the banded iron formation from some igneous source and that it has replaced the carbonate and silica in the original banded formation. The magnetite has doubtless formed by alteration of the original iron carbonate, but the iron of the sulphides has, in some measure at least, been introduced into the iron formation. This is indicated by the relatively higher iron content of the formation where pyrrhotite is present than where it is absent. In many sections of the formation, the increased iron content of the formation would correspond fairly closely to the iron content of the pyrrhotite in the rock.

There are a number of narrow bands of banded iron formation in the range in addition to the main band, and these have been indicated on the map. They are not of any economic interest.

The iron formation is very high in sulphur throughout this section of the range, and there is nothing in the formation which could be used for ore without roasting and sintering. The possibility of treating the ore so that it would be available for the market will be discussed later in this report.

ECONOMIC GEOLOGY

Iron Deposits

Claims W. D. 1,736 to 1,731

For the purpose of discussing in detail the iron deposits on the Jefferson property, it will be convenient to group certain of the claims together. This is because the iron formation is continuous across several claims and is cut out by intrusions on others.

The following description applies to the main band of iron formation on claims W.D. 1,736 to 1,731, considering them in order from west to east.

The ore bodies in this section of the range consist chiefly of pyrite, iron carbonate, and silica. Pyrrhotite is practically absent, and magnetite is so scarce in some portions of the iron formation that the compass is scarcely disturbed. The range is much more disturbed and broken than it is farther east. There are masses of the formation in the schists which seem to have little or no connection with the other bodies of the same formation. Whether these are lenses of the iron formation which have become separated from one another by shearing of the range along a line which would vary in direction from nearly southeast to east, or whether these bodies are masses of iron formation originally deposited as separate units in the Keewatin rocks, is not quite clear. The enclosing rocks are greatly squeezed and deformed, and it is probable that deformation has played an important part in producing the present condition. The accompanying map shows the arrangement, somewhat *en échelon*, of the different ore bodies. In claim W.D. 1,736, the first body of sulphide-carbonate ore is met on the trail one-sixth of a mile from Sahkatawich river. It is 75 feet wide, and of this 40 feet is average ore of this type. The body, which is only a lens and lacks connection with the other bodies in the area, is in sericite schists and greenstones. There is a large break in the range followed by another lens on the east boundary of this claim. Here the formation is 100 feet wide, but not over one-quarter of it is average ore. The associated rocks are felsite, banded silica, sericite schist, and greenstone. This lens is followed by a large swamp and then by another lens lying near the centre of claim W.D. 1,735, which is stripped for 130 feet along the strike and 50 feet across it. About 25 feet is of average ore. Highly siliceous, banded iron formation lies on the north side of the pyrite-rich ore.

In claim W.D. 1,734 there are two large lenses of the sulphide-carbonate ore in the banded iron formation. On the south side, the hanging wall consists of felsite breccia, the rock so common along the south side of the range, almost throughout its length. This rock has been considerably carbonated near the contact with the iron formation. One of these lenses is 330 feet long and capable of being mined for a width of 50 feet. The total width is 90 feet. The second lens is 87 feet wide, and of this only 40 feet would approach average ore. Conglomerate with pebbles of rhyolite, or felsite, and quartz lies to the south of the lens and strikes N. 70° W. The strike of the iron formation is N. 70° E. At the east end of the lens, greenstone and conglomerate take the place of the iron formation and there is another large break in the iron range. Two more small lenses occur in claim W.D. 1,734, and these are followed by a still larger break. The iron formation is almost completely eliminated in claim W.D. 1,733 by large intrusions of greenstone and coarse quartz porphyry. There is very little ore in claim W.D. 1,732, where a shaft has been sunk on the formation near the middle of the south boundary. A sample of the formation at this shaft was analysed by the Provincial Assayer and the following figures obtained: iron, 40.44 per cent.; silica, 11.25; and sulphur, 31.44. A diamond-drill hole (No. 10) was also put down near the same point without reaching the iron formation. Although there is a band of iron formation 60 feet wide here, the large mass of quartz porphyry which outcrops on all sides has apparently cut the formation off beneath the shaft, so that the iron formation rests as a shallow body on top of the quartz porphyry.

Northeast from the point where the range crosses the boundary between claims W.D. 1,731 and 1,732, the iron formation gradually widens out until it reaches 85 feet in width and carries the average content of iron. A little east of the east border of claim W.D. 1,731, at the creek which here crosses the range, the formation is completely eliminated by intrusions of quartz porphyry.

As indicated by the description given above, the western part of the range is much broken and if it were ever mined it would have to be treated very largely as separate lenses. On these claims, it is estimated that there is 1,500,000 tons of ore, carrying 40 per cent. iron on the average, to a depth of 100 feet. Some of the lenses will probably extend to several hundred feet in depth, but others will likely prove quite shallow.

Claims W.D. 1,730, 1,729; and 728 to 722

The iron formation, which is completely destroyed by the quartz porphyry intrusion in the western portion of claim W.D. 1,730, gradually comes in again and keeps a fairly uniform width of about 35 feet across claim W.D. 1,729. The sulphide along the contact with the quartz porphyry was analysed for gold, but the result was a negative one.

Diamond-drill hole No. 9 was drilled near the east border of claim W.D. 728, where 17 feet of carbonate-sulphide ore is exposed in a stripping. The strike is N. 50° E., and the dip is vertical. The hole is ledged in felsite, and the distance from the southeast side of the iron formation to the hole is 103 feet. The hole is drilled at an angle of 70 degrees northwest. At a point 280 feet down, a five-foot sample was taken by the drillers and analysed by Lerch Brothers, Hibbing, Minn. It gave the following results, for which the writer is indebted to Mr. Smith: iron, 41.28 per cent.; silica, 4.21; sulphur, 15.16; and phosphorus, 0.015. A specimen collected at the surface and analysed by the Provincial Assayer gave: iron, 42.10 per cent.; sulphur, 20.20; lime, 0.46; magnesia, trace. It was expected that this ore would carry more magnesia and lime than it does. It contains considerable iron carbonate; and magnetite, pyrite, and a small

quantity of pyrrhotite are present. It would appear that the pyrite had replaced the carbonate.

To the east of hole No. 9, the ore body widens out, and at diamond-drill holes Nos. 7 and 8, between the west border of claim W.D. 727 and the creek, it is 61 feet wide. Of this, 40 feet consist of average ore and 21 feet of lean material. North of the sulphide body, there is 30 feet of banded iron formation, followed by 40 feet of greenstone. On the south side, the holes are ledged in felsite on the edge of a swamp at the bottom of the hill. The iron formation is vertical. The strike is N. 50° E. Cutting the iron formation transversely are two porphyritic diabase dikes. The larger one is 27 feet wide, and 35 feet east of it the narrower one occurs with a width of eight feet. These probably join near the drill-holes at the foot of the hill.

An analysis taken from the core at the time of drilling, from a depth of 145 to 150 feet in hole No. 7, gave the following figures: iron, 39.98 per cent.; silica, 6.32; sulphur, 16.61; phosphorus, 0.012. Another analysis, from hole No. 8, at a depth of 220 to 285 feet, this being a composite sample, gave the following: iron, 41.77 per cent.; silica, 3.12; sulphur, 16.69; phosphorus, 0.013. These two analyses were made by Lerch Brothers, and they are published through the courtesy of Mr. Smith.

Hole No. 8 dips 75 degrees and is 437 feet deep; No. 7 is 298 feet deep and dips 45 degrees. The ore, where they cut it, is about 75 feet thick. Eastward from these two holes the iron formation grows narrower, but it continues with a fairly uniform width across claims W.D. 726, 725, and 724, although covered in places with drift and swamp. Within a short distance of the boundary of claims W.D. 724 and 725, on either side, two large diabase dikes, 40 and 43 feet, respectively, cut the formation transversely. Practically all of these Keweenawan diabase dikes cut the range at a high angle.

At diamond-drill holes Nos. 5 and 6, which have been driven on the range near the centre of the south boundary of claim W.D. 723, the sulphide ore is about 25 feet wide at the surface. The holes are put down at an angle of 65 degrees toward the iron formation. No. 5 starts 75 feet from the iron formation in the garnetiferous, quartzitic breccia and cuts 20 feet of ore at 160 feet. No. 6 starts 150 feet back from the formation and cuts the same width of the formation at 250 feet vertically below the surface.

Analyses from the ore here run 36.81 to 45.85 per cent. iron, the average being over 40 per cent. The sulphur runs from 18 to 25 per cent. Phosphorus is practically the same as in previous analyses except in one sample, high in silica and low in iron, which carries 0.024 per cent. The silica is mostly below 9 per cent.

Continuing eastward from these holes the formation narrows, until by the time the east border of claim W.D. 723 is reached, it has almost pinched out. There is no ore worth mentioning, so far as could be observed, on claim W.D. 721. There is much drift and some banded iron formation on this claim and on claim W.D. 722, but there is little ore.

It is estimated that on claims W.D. 1,730 to 721 there may be 1,300,000 long tons of ore running, on the average, 40 per cent. or more of iron to a depth of 100 feet. There is no doubt that in places the ore will extend to a depth of 1,000 feet or more.

Claims W.D. 720 to 715

The best portion of the iron formation lies within the above claims. The formation keeps its width better than it does farther west, being more uniformly

wide. It has a higher content of iron and silica, but the sulphur is on the whole a little lower. There is a larger proportion of pyrrhotite than pyrite, and magnetite than siderite, compared to the range farther west. It is also remarkable in containing within its boundaries a lead-zinc deposit.

In addition to the main part of the range, there are two outlying patches of iron formation, one in claim W.D: 716 and another in claim S. 3,693. The former consists of lean banded iron formation, with a little sulphide, and the latter is composed of mixtures of lean banded jasper, siliceous magnetite and silica, with small patches of ore relatively low in sulphur and in some places carrying upwards of 60 per cent. iron. The formation has been thoroughly trenched and stripped without exhibiting any commercial ore bodies.

At diamond-drill holes Nos. 1 and 4, one trench exposes nearly 80 feet of sulphide ore. The iron formation is made up of bands of sulphide-magnetite ore and leaner bands high in silica. Hole No. 1 is ledged in the siliceous, garnetiferous, felsite breccia 70 feet south of the iron formation. It dips at 65° N., has a depth of 363½ feet, and cuts 50 feet of ore. Hole No. 4 is 90 feet south of No. 1 and it is 351 feet deep, at an angle of 62 degrees. It cuts practically the same width of ore as No. 1, but the ore is flattening out with depth. At the surface the dip is practically vertical, but according to the drill-holes it dips about 50° S. at a depth of 250 feet. A quartz porphyry dike cuts the iron formation near its centre. It is between four and five feet in width where the drill-holes cut it. The dike, which varies from a quartz to a feldspar porphyry, can be followed most of the way across this group of claims. It appears first on the north side of the iron formation, cutting the coarse greenstone, then in the centre of the formation, and finally on its south margin, at the east end of the main band in claim W.D. 715. It is the latest rock in the area, outside of the Keweenawan diabase. The quartz phenocrysts in this porphyry are smaller than those in the porphyry in claims W.D. 1,733 and 1,730, where they stand out like large fish eyes, up to a quarter of an inch in diameter.

A number of analyses made of the cores from holes Nos. 1 and 4 by Lerch Brothers of Hibbing, Minn., and furnished by the courtesy of Mr. Smith, show the following as the range in the composition of the ore in these holes: iron, 42.56 to 50.20 per cent.; silica, 5.27 to 20.31; sulphur, 10.62 to 25.97; phosphorus, 0.013 to 0.29. The iron content will average 45 per cent. or more, the sulphur 15 per cent., or less.

At diamond-drill holes Nos. 2 and 3, the iron formation is made up of a band of sulphide ore along the hanging-wall side, followed by lean, banded, siliceous iron formation. The ore body is 30 to 34 feet wide, strikes N. 70° E., and dips 80° S. 20° E. It consists of silica, magnetite, pyrite, and pyrrhotite. An analysis of a typical sample collected by the writer and analysed by the Provincial Assayer gave: iron, 48.04 per cent.; silica, 15.60; sulphur, 19.44. The analyses made of the core from hole No. 2 by Lerch Brothers at the time of the drilling show the following variations in the composition of the ore between the depths of 148 and 263 feet: iron, 32.19 (only 5 feet) to 50.22 per cent., average over 45 per cent.; silica, 8.11 to 29.16 (only 5 feet), average less than 15 per cent.; sulphur, 7.63 to 29.30, average over 15 per cent.; phosphorus, 0.012 to 0.045. In these drill-holes streaks of sphalerite and galena were found, which led to the discovery of the deposits described below.

Between these holes and the east end of the ore outcrop, in claim W.D. 715, the deposit varies from 30 to 80 feet in width. In the wider portions, about one half of the deposit is capable of being mined. It is estimated that in this eastern group of claims there could be mined, to a depth of 100 feet, approxi-

mately 1,800,000 long tons of ore, running as high as 43 per cent. iron on the average. It is high in sulphur and cannot be used in its present form. There is much evidence that the ore could be mined to 1,000 feet or more in depth and that these claims could furnish between 15,000,000 and 20,000,000 tons.

Utilization of the Iron Ore

From the account given above, it is evident that there is in this iron range many millions of tons of iron ore, running between 40 and 45 per cent. iron, which could be mined, but which is useless without some special treatment to eliminate the sulphur. The ore is lower in silica than much of the low-grade iron ore with equal iron content in the pre-Cambrian formations in Ontario. There is a growing desire on the part of blast furnace operators to seek low silica ores even if the sulphur is higher than in the old standards. However, the sulphur is so high in this ore that it cannot be considered as available for any treatment, on a commercial basis, which is at present known.

In the year 1922 some of this ore was taken out and shipped by H. C. Dudley, of Duluth, Minn., to Dwight & Lloyd Sintering Company, New York, for testing. Mr. Smith has kindly furnished the writer with a copy of the original report to Mr. Dudley on the tests which were made. The copy is signed by R. L. Lloyd, vice-president of the company, and in part it reads as follows:—

> The whole shipment thus lumped together contained about 18 per cent. of sulphur, and this we crushed through a 4-mesh screen and made the usual sintering tests on them.
>
> The first sintering test was made without any preparation of the ore at all, except crushing, and the sinter produced from that test was very good indeed, but the sulphur in the resultant sinter remained at 3.8 per cent. We then took some of the original ore and mixed varying proportions of already sintered ore with it until we reduced the sulphur in the mixture to about 7 per cent. At this point we were able to produce a very good sinter which contained only 0.44 per cent. sulphur, which is marketable material.
>
> We then made a double sintering test, that is, we sintered the ore without preparation, other than crushing, producing a sinter containing about 3.8 per cent. sulphur. This sinter was then crushed and resintered with the addition of a small percentage of coke, and at 6 per cent. coke a very good sinter is produced, containing about 0.6 per cent. sulphur.
>
> So far as the experiments go, it is shown that a marketable sinter can be produced, using only the sulphur in the ore as a fuel, but the return of 75 per cent. of the product for resintering strikes us as being more than necessary in that the ore can be brought down to a sulphuric content just sufficient for sintering by roasting methods probably a little cheaper than by sintering methods.

From the above report it is evident that this ore can be treated for the market but at an expense which makes competition with high-grade ores impossible at the prices now obtaining on the iron ranges. Nothing is said regarding the phosphorus in the ore. It is low, as shown by all the analyses, and the small increase which would likely result from the sintering process would not make it particularly objectionable. It is highest in the siliceous ores, and the more siliceous portion of the iron formation is eliminated in mining this sulphide ore.

Lead-Zinc Deposit

It is quite unusual to find a lead and zinc deposit in banded iron formation in the Keewatin system. While drilling holes Nos. 2 and 3 on claim W.D. 717, streaks of sphalerite and galena were found in the core of one of the holes. This led to the discovery of an outcrop in a trench 360 feet east of the drill-holes. A shaft was sunk to a depth of eight feet on this outcrop, and at that depth a vein of almost solid galena, assaying 73.44 per cent. lead and 6.01 per cent. zinc, was found. The ore was assayed by the Provincial Assayer, who also assayed for silver, with negative results. A description of this deposit has previously been given by the writer.[1]

[1] E. S. Moore, A Lead and Zinc Deposit in Keewatin Iron Formation, Trans. Can. Inst. Min. and Met., Montreal meeting, March, 1926.

In addition to the 34 inches of galena and sphalerite, there is four inches of leaner ore in the bottom of the shaft. Ar the surface, the vein at the west side of the pit is only six inches wide, with a high proportion of sphalerite; on the east side it is 18 inches wide. In the bottom of the shaft, the vein is three feet wide on the east side, but it is not solid as it is on the west side. At 50 feet east of the shaft, there is an irregular band of sphalerite, galena, and chalcopyrite in the iron formation and another irregular band of stringers 25 feet north of this point in the same formation. On a claim about a quarter of a mile north and



Vein of galena and sphalerite in the shaft on claim W.D. 717.

one mile east of the shaft described, A. Burton has sunk a shaft 40 feet deep on a narrow zone of graphitic schist and gouge. In this zone there is a dark quartz stringer which, in places, carries a little galena, sphalerite, and chalcopyrite. Traces of galena and sphalerite have been found in other parts of the area.

The presence of pyrrhotite, chalcopyrite, galena, and sphalerite in the iron formation is regarded by the writer as good evidence of injection of these substances by igneous action. It is believed that they had their source in the granite quartz porphyry magma. It is further considered that the bulk of the pyrite in the iron formation is not indigenous in the iron formation but is an igneous product. The pyrite, as previously pointed out, is the earliest of the sulphides, pyrrhotite is the next in age, then chalcopyrite and either galena or sphalerite. These sulphides are replacements along fissures and bedding planes and along the contact between the iron formation and its hanging wall.

It is believed that there is nothing to prevent these sulphides from extending to great depths, but a little more blasting will be necessary to determine whether the lead-zinc ore widens out into a large deposit or pinches out within a short distance. A vast amount of trenching and stripping, as well as 4,000 feet of diamond-drilling, has been done on the iron range, but a little more work is needed to determine the extent of this ore deposit at the shaft.

INDEX, PART II

PAGE

A

A.C. 1737 lead-zinc claim, Tp. 23, Alg.
See Vacheresse, Fred.
Agawa r., fault 76
Algoma dist.:
Reports, Batchawana area 53-85
Sault Ste. Marie area 1-52
Algoma Central r'y.
See also Searchmont.
Batchawana series 56
Diabase, photo (mile 81) 64
Huronian 14
Pleistocene 42
Algoma Steel Corporation 50
Algoman system.
Batchawana area, description and distribution 5, 61, 62
Genoa and Marion tps 88
Mica bay, photo 67
Algonquin lake (glacial).
Batchawana area 75
Soo area 43, 44
Allen, R. C 86, 88
Alluvial deposits. *See* Pleistocene.
Alona bay, rocks 65
Analysis.
Iron ore, Marion tp 91-93
Palmer tp 80
Anderson tp.
Algoman rocks 11
Basement series 5
Iron ore 47
Ann l 13
Artesian water 50
Ash, Sault Ste. Marie area 4
Aweres formation.
See also Soo series.
Description, distribution, lithology, structure and photo 12, 16-20
Aweres l 17
Aweres tp.
See also Aweres formation.
Island l.
Trout l.
Olivine diabase 38

B

Balsam fir 4
Bare hill 75
Basalt.
See also Lava.
Mica bay, photo 63
Basement series.
Soo area, notes and photo 5-10
Midge l., photo 34
Batchawana, photo 58
Batchawana bay.
Apples 59
Basement series 5
Cambrian 40
Copper. *See* Begley c. claim.
Report on area by E. S. Moore 53-85

PAGE

Batchawana iron mine 77, 78
Batchawana isld.
Rocks 55, 67
Trees 58
Batchawana river.
Carbonate and quartz veins, barren 60, 85
Description and photo 56, 57
Granite 55
Batchawana series
Soo area, description and distribution 59, 60
Iron formation in 77
Batchewanung iron mine. *See* Batchawana iron m.
Bears 59
Beaverbrook valley 28
Begley copper claim 84, 85
Bellevue.
Algoman series E. of 11
Basement series 10
Huronian 12, 14, 17, 18
photo 19
Bellevue ridge.
Cambrian 40
Cobalt series 26, 28
photo 29
Folding 20
Iron ore, boring for 48
See also Breitung iron m.
Keweenawan 37, 38
Mineral prospecting 46
Quartzite 2
Silica, economic 49, 50
Birch 4
Birch, black 58
Blue, Archibald 83
Bone l 27
Boss l 46
Boston, U.S., boulder clays 32
Boulder clay. *See also* Clay.
Boston, U.S 32
Description of normal 32
Distribution 42
Boulder (s).
Mica bay, photo 70, 71
Striated, in Cobalt series 3 4
Boulder conglomerate.
Origin, character, lithology and photo 30-34
Breitung iron mine, Deroche tp 47
Brick and tile 49
Bruce limestone.
Distribution and description 22, 23
Quarried 48
Brunton, Sir Stopford 1, 47
Bruce series.
See also Bruce limestone.
Mississagi quartzite.
Description 20
Divisions; composition 5
Named by Collins 12, 20
Building stones 48, 49
Burrows, A. G 1
Burton, A 95
Bussineau, Angus 52

PAGE

C

Cambrian system.
Sault Ste. Marie area, distribution, lithology, and structure.....40-42
Carlson, Oscar..... 82
Carp r.
Character of E. branch..... 3
Iron formation near..... 79
Pleistocene deposits.....43, 44, 49
Cascade mine..... 45
Cedar.....4, 58
Chalcocite.
Ryan tp..... 60
Sand Bay copper m..... 84
Chalcopyrite.....44-47
Chapman, J..... 54
Chippewa r..... 56
Chlorite schist. *See also* Basement series.
Sault Ste. Marie area, description and distribution..... 9
Clay.
Harmony r., varved, photo..... 75
Soo area, economic.....2, 49
Cobalt series.
Composition; divisions..... 5
Distribution; lithology; sections.... 23-35
Iron ore in..... 48
Named by Miller..... 12
Photos.....29, 34
Silica in..... 49
Coleman, A. P.....30, 70
Collins, W. H.
Acknowledgments to..... 1, 2
Bruce series named by.....12, 20
Views on boulder conglomerates, Ramsay L. area..... 31
Cooke, H. C.
Views on Cobalt boulder conglomerates Timiskaming dist., Que..... 31
Conglomerate.
See also Aweres formation.
Batchawana area, notes and photos..69-71
Batchawana series. *See* Keweenawan.
Genoa and Marion tps. *See* Keewatin.
Sault Ste. Marie area, distribution, description and photos.....7, 8, 17
Mica bay, photo..... 56
Copper. *See also* Chalcopyrite.
Batchawana area.....76, 81-85
Michipicoten isld.....53, 64, 76
Copper Creek vein, Sand Bay copper m.
Notes and photo.....83, 84
Coppermine pt.
Section from, to Mica bay.....66-69
Cowie, Geo. S..... 54
Crystal Falls iron dist., Mich..... 60
Crystalline limestone. *See* Bruce limestone.
Cundy, J. H..... 54

D

Deer..... 59
Deer l..... 8, 9
Delessite..... 72
Dennis tp., rocks..... 40
Deroche tp.
See also Maple l.
Midge l.
Pothole l.
Basement series..... 9

PAGE

Deroche tp.—*Continued*
Calcite vein..... 46
Cambrian..... 41
Huronian..... 26
Iron ore..... 47, 48
Younger granite..... 38, 39
Diabase.
Batchawana area:
description.....10, 36
Duncan tp., description..... 37
Harmony r., photo..... 62
photos.....57, 64
Vankoughnet tp.....2, 36
Dick, J..... 53
Dickson, A. D..... 53
Diorite.
Batchawana area. *See* Mamainse series.
Driving ck., Sault Ste. Marie area.
Lead..... 15
Pre-glacial depression..... 3
Quartzites W. of..... 22
Younger granite.....13, 38, 40
Driving l., Sault Ste. Marie area.....6, 21
Driving Creek formation.
See also Soo series.
Cut by granite..... 39
Description..... 12
Distribution and structure.....13, 14
Dudley, H. C..... 94
Duncan greenstone.
See also Soo series.
Description, lithology and structure..12-16
Duncan tp.
Algoman rocks..... 11
Basement series.....5, 21
diabase..... 3
Copper..... 46
Granite for building..... 49
Huronian rocks.....13-15, 21
Iron ore..... 47
Keweenawan rocks.....37-39
Lead-silver mg..... 45

E

Edwards l.
Iron ore. *See* W. D. 722 iron loc.
Elizabeth l., rocks.....13, 15
Elliott, James..... 49
Elm.....4, 58
Espanola greywacké and limestone, Sault Ste. Marie area, absent..... 20
Everett, artesian water..... 50

F

Farm land, Soo area..... 58
Fenwick tp.
Algoman rocks..... 11
Basement series..... 5, 9
Pleistocene..... 42
Ridge, altitude..... 2
See also Lucinda min. claim.
Fir, balsam..... 4
Fisher tp.
Pleistocene..... 67
Rocks..... 55
Fishing industry..... 59
Fletcher, Hugh R..... 81
Fluvio-glacial deposits.....42, 43

PAGE

Forest. *See* Trees.
Forest fires..... 3
Formis, Andria..... 54

G

Galena.
Mississagi forest reserve..... 52
Searchmont..... 51
Soo area.....44-46
Game..... 59
Garden r.
Algoman rocks..... 10
Basement series..... 5, 6
Cobalt series.....24, 25, 29
Huronian rocks..... 21
Pleistocene.....2, 43, 44
Garden River.
Marble quarry N. of.....23, 48
Pleistocene deposit N. of..... 42
Garden River Indian reserve.
Huronian, Cobalt series.....24, 26, 29
Bruce series..... 21
Soo series.....12, 15
Keweenawan rocks.....37, 39
Mineral prospecting..... 46
See also Surette l.
Garnet schist, Genoa tp..... 88
Genoa tp.
Iron. *See* Sahkatawich l.
Lead-zinc ores, notes and photo.....91-96
Map.....*facing* 88
Geology, economic.
Batchawana area.....76-85
Genoa and Marion tps.....89-91
Soo area.....44-96
Geology, general.
Batchawana area.....59-76
Genoa and Marion tps.....87-89
Soo area..... 4-44
Gimby, J. E..... 51
Gledhill, T. L.
Notes by, on Vacheresse lead-zinc claim.....51-52
Gneiss, Sault Ste. Marie area.
Areas of, character..... 2
Goulais bay.
Cambrian N. of.....40, 50
Cobalt series N. of..... 28
Pleistocene..... 2
Goulais river.
Basement series.....5, 7, 9
Cambrian rocks..... 40
Lead-zinc. *See* Vacheresse, Fred.
Pleistocene.....2, 43
Pre-glacial valley..... 3
Granite.
See also Algoman system.
Younger granite.
Batchawana area.
Algoman system cut by olivine diabase, photo..... 74
Genoa and Marion tps..... 88
Harmony r., cut by diabase, photo... 62
Sault Ste. Marie area.
as building stone..... 49
areas of, character..... 2
Vankoughnet tp..... 3
Granite gneiss. *See* Algoman series.
Granite siding.
Lacustrine deposits..... 43
Green mt..... 3

PAGE

Greenstone. *See* Duncan greenstone.
Greywacké. *See* Cobalt series.
Griffin, D. K..... 53
Gros Cap.
Altitude of area..... 10
Granite.....10, 11, 35, 49
underlying Aweres formation..... 18
Lavas..... 35
contact with granite..... 36

H

Harmony (Chippewa) r.
Clay, varved, photo..... 75
Diabase cutting granite, photo..... 62
Keweenawan W. of..... 67
Name; notes; navigation..... 56
Sandstone near..... 40
Havilland bay..... 3
Havilland tp.
Basement series..... 5
schists.....3, 9, 10
Cambrian rocks..... 41
Huronian rocks..... 26
Cobalt series..... 33
Keweenawan rocks..... 39
Hawkshaw-Derrer iron claims..... 48
Heck, Geo. C.....54, 78
Hematite.
See Batchawana iron ore.
Iron ore.
Hemlock..... 4
Hemlcok formation..... 60
Herrick tp.
Pleistocene deposit..... 67
Rocks..... 55
Hibbard (Sand) bay.
Copper. *See* Nipigon Mg. Co.
Lavas..... 73
Holmes, J. A..... 54
Hornblende schist.
Sault Ste. Marie area.....9, 10
Horseshoe bay.
Cambrian rocks.....41, 42
Cobalt series.....23, 29
Keweenawan, lava E. of.....30, 36
granite..... 38
Huronian.
Genoa and Marion tps..(?)..... 88
Composition and divisions..... 4, 5
Distribution and lithology.....12-35

I

Iron.
See also Woman R. iron range.
Batchawana area..... 76
Soo area, mining.....47, 48
Iron formation.
Batchawana area.....77-80
Genoa and Marion tps.....88-94
Island l., Huronian rocks.....14-19
Summer resort..... 3

J

Jackson isld., lavas..... 35
Jarvis tp.
See also Cascade m.
Reserve l.
Mineral prospecting..... 46
Younger granite..... 38

PAGE

Jasper.
Batchawana area....77, 79
Jefferson iron claims.
Description; sketch map....86, 87, 90, 91

K

Kars ck.... 28
Kars tp.
Cambrian....40, 41
Pleistocene.... 43
Shore-lines.... 44
Keewatin formation.
Genoa and Marion tps....88-90
Keweenawan formation.
Batchawana area.... 59
description; distribution; photos; section....63-75
Sault Ste. Marie area.
composition; divisions.... 4
distribution; lithology; structure...35-42
Mitchell I, photo.... 55
King mt., altitude.... 2, 3
Cobalt series....3, 26, 28
quartzites.... 50
section S.W. of.... 27
Knight, Cyril W.... 1
Korah tp., artesian water.... 50

L

Lacustrine deposits....2, 43
Lake Algonquin. *See* Algonquin l.
Lake Superior.
See also Batchawana bay.
Gros Cap.
L. Superior sandstone.
Mica bay.
Sault Ste. Marie.
Copper, first discovery.... 81
Lakes in Soo area.... 3
Lake Superior sandstone.
Soo area, artesian wells in.... 50
Distribution; lithology; structure; age....40-43
Quarried.... 48
Lake Superior Native Copper Co.... 82
Lava.
Batchawana area.... 68
See also Batchawana series.
Mamainse series.
Mica bay, photos....56, 67
Sault Ste. Marie area.
See also Basement series.
Batchawana series.
Duncan greenstone.
Keweenawan.
position in Keweenawan.... 4
Woman River iron range.
distribution; description.... 89
Lead.
Genoa tp.... 89
Notes and photo....94-96
Searchmont (near), report by Gledhill 51, 52
Legge, Charles.... 47
Legge l.... 14
Lerch Bros....91, 93
Ley tp.
See also Horseshoe bay.
Pleistocene....43, 44
drift.... 2
underlain by Cambrian.... 40

PAGE

Limestone. *See* Bruce limestone.
Lloyd, R. L.... 94
Logan, Sir William.... 54
Loon l., Deroche tp.... 27
Lower Island lake. *See* Island lakes.
Lucinda mineral claim.... 46
Lumbering, Soo area.... 3

M

McConnell, R. G.
In photo.... 19
Report by, Sault Ste. Marie area....1-51
McCormick, R. S.... 54
Macfarlane, Thomas.
Notes on Begley copper claim.... 84
copper m. N. of Pointe-aux-Mines.... 72
delessite.... 72
rocks, Batchawana area.
Work by, Batchawana area.... 67
MacLeod, G. W.
Notes on Vacheresse lead-zinc deposit, 51
Acknowledgments to.... 54
McNeill, W. K....52, 80
Magnetite. *See also* Iron ore.
Batchawana iron m.
See also Iron ore.
Malachite.... 82
Mamainse copper m....81, 82
Conglomerate.... 68
Diabase near.... 75
Lavas.... 73
Section E. and W. of.... 66
Mamainse diabase....55, 60, 61
Mamainse hill....54, 55, 60
Mamainse isld.
Copper prospecting.... 84
Rocks....68, 69
Mamainse pt.... 67
Mammoth iron mine, Palmer tp.
Description; analysis; photo....78-81
Maps.
Genoa and Marion tps., sketch..*facing* 88
Batchawana area....*In pocket*
Sault Ste. Marie area....*In pocket*
description.... 1
Maple....3, 4 58
Maple isld.... 40
Maple l.
Conglomerate S. of, photo.... 7
Iron ore.... 47
Marble quarry....23, 48
Marion tp., iron. *See* Jefferson i. claims.
Map....*facing* 88
Maud ck....13, 14
Maynard, J. E.... 72
Melaphyre. *See also* Olivine basalt.
Meaning of name.... 71
Meniss l.... 22
Mica bay.
Photo.... 56
Rocks.... 55
basalt, photo.... 63
conglomerate, notes and photos..69-73
diabase, cutting granite.... 6
photo.... 74
Section from, to Pancake bay....65-69
Michigan.
Copper deposits, character.... 76
Michipicoten isld., copper.... 76

PAGE

Midge l.
Basement series..... 5, 6
underlying Cobalt series..... 10
Huronian rocks.....23, 26, 27
contact with Pre-Cambrian..... 33
Iron, boring for..... 48
Miller, W. G.
Acknowledgments to..... 1
Cobalt series named by..... 12
Views on boulder conglomerates, Cobalt area..... 30
Mississagi forest reserve.
Galena..... 52
Mississagi quartzite. *See also* Bruce series.
Character and distribution.....19-22
Mitchell l.....57, 55
Montreal Mining Co..... 82
Moore, E. S.
Reports by: Batchawana area.....53-85
Sahkatawich L. area...86-96
Moose..... 59
Moose l..... 85
Murray, Alexander..... 1

N

Nipigon Mining Co.....81-84
Nipissing glacial stage..... 44
Norris, Edward..... 82
Northland, rocks..... 5-7

O

Oak.....4, 58
Olivine diabase.
Batchawana area, notes and photo..74, 75
Genoa and Marion tps. *See* Algoman.
Sault Ste. Marie area.
distribution and description.....37, 38
position in Keweenawan..... 4
See also Keweenawan.
Ontario Mineral Lands Co..... 82
Outwash deposits, Sault Ste. Marie area 43

P

Paleozoic. *See* Cambrian.
Palmer tp.
Diabase..... 75
Iron mg.....77-81
Quartz veins prospected for copper 85
Trees..... 58
Pancake bay.
Section from, to Mica bay.....65-69
Parisian island, sandstone.....40, 41
Partridge..... 59
Pennefather tp.
Lacustrine deposits..... 43
Sandstone..... 40
Pikes peak..... 3
Pine..... 3, 4
Pleistocene deposits.
Batchawana area.....75, 76
Sault Ste. Marie area.....2, 42-44
Pointe-aux-Mines.
Copper mg. N. of..... 81
Rocks.....65, 67
Poplar..... 4

PAGE

Pothole l..... 8
Pre-Cambrian.
Batchawana area.....59-75
Genoa and Marion tps.....88-90
Sault Ste. Marie area..... 4, 5
Pre-Huronian, subdivisions..... 4
Prince tp.
Copper..... 46
Granite batholith.....11, 49
Keweenawan..... 35
Shore lines..... 44

Q

Quarry ridge..... 44
Quartz diabase.
Sault Ste. Marie area, position in Keweenawan..... 4
Quartz-feldspar porphyry.
Genoa and Marion tps. *See* Huronian.
Quartz porphyry.
Genoa and Marion tps. *See* Keewatin.
Quartzite.
Sault Ste. Marie area.
See also Bruce series.
Cobalt series.
Soo series.
description..... 8
distribution, structure and photo..18-20
King mt..... 3
Quaternary. *See* Pleistocene.

R

Rabbits..... 59
Ramsay l..... 30
Rankin concession.
Cobalt series..... 23
section..... 25
Copper..... 46
Rankin copper m..... 46
Ranson, D. J.....54, 79
Robertson, J. W..... 46
Robertson l..... 3
Root r.
E. branch, character..... 3
Lower Cobalt series, near..... 23
Pleistocene deposits.....2, 3, 44, 49
Sandstone..... 40
quarried..... 49
Rose, Robt. Seldon..... 54
Ranson ck., copper..... 46
Recent deposits. *See* Pleistocene.
Reserve ck., rocks..... 13
Reserve l.
Huronian rocks.....13-15
Section from, to Trout l..... 12
Rhyolite.
Marion and Genoa tps. *See* Keewatin.
Rounthwaite, C. H. E..... 54
Roussainville..... 83
Rudder Head pt..... 40
Rush l. *See* Sahkatawich l.
Ryan tp. *See* Smith l.

S

S. 3,693, iron loc..... 93
Sahkatawich (Rush) l.
Iron in area, report by E. S. Moore..86-96
Sahkatawich r..... 89
St. Joe l., rocks..... 18

PAGE
St. Mary r., Pleistocene....43, 44
rocks....40, 42
Sand bay. *See* Hibbard bay.
Sand Bay copper m.
Sandstone.
Batchawana area. *See* Keweenawan.
Sault Ste. Marie area. *See* L. Superior sandstone.
Sault Ste. Marie.
Boulder clay, N. of.... 42
Brickyard near.... 43
Building stone for.... 48
Lacustrine deposits.... 43
L. Nipissing (glacial) stage.... 44
Report on area, by R. G. McConnell. 1-51
Water supply.... 50
Schists. *See* Chlorite scists.
Hornblende schists.
Searchmont.
Lead-zinc N. of. *See* Vacheresse, F.
Shepherd ck.... 3
Shore lines.... 44
Silica, economic.... 49
Sill l....5, 46
Silt, Sault Ste. Marie area.... 2
Silver.
Discoveries reported.... 44
Duncan tp.... 45
Silver Creek shaft.... 83
Silver Islet Consolidated Mg. and Lands Co....82, 83
Smith, W. E.
Acknowledgments to....91-94
Iron ore prospecting, Woman R. range 86
Smith l....55, 60
Soo. *See* Sault Ste. Marie.
Soo Falls Brewing Co.... 50
Soo series.
Sault Ste. Marie area, divisions; composition.... 4, 5
section; distribution; description..12, 13
Spanish River Pulp and Paper Co.... 57
Sphalerite. *See* Zinc.
Spruce....3, 4
Stackpool....87, 89
Steelton. *See* Sault Ste. Marie.
Stewart, I. M.... 54
Stokely ck.... 3, 26
Sudbury dist. *See* Sahkatawich L. area.
Sugar maple.... 3
Surette l., rocks....10, 16

T

Tamarac.... 4
Tanton, T. L.... 86
Tarentorus tp.... 50
Terraces.... 2
Thompson, David.... 81
Thomson, Ellis.... 86
Tile.... 49
Timber. *See* Trees.
Topography.
Batchawana area....54, 55
Sault Ste. Marie area.... 2, 3
Trees.
Batchawana area.... 58
Sault Ste. Marie area.... 3, 4
Trethewey, Capt. T. H.... 83
Tribble, G. B....53, 54
Trout l., Aweres tp. PAGE
Huronian E. of....18, 19
Keweenawan.... 39
Prospecting S. of.... 46
Section from, to Reserve l.... 12
Summer resort.... 3
Tupper tp.
Artesian wells.... 50
Basement series....5, 10
Huronian.... 28
Keweenawan.... 38
Metalliferous prospects.... 46

V

Vacheresse, Fred.... 51
Vankoughnet tp.
See also King mt.
Robertson l.
Sill l.
Cobalt series....26, 28, 33
Diabase sill.... 2
Geology comparable with Cobalt area 44
Iron ore....47, 48
Keweenawan series.... 36
Schists....9, 10
Victoria silver-lead m.... 45
Vulcan iron m....78, 79

W

Walker, Dr. T. L.
Iddingsite identified by, Mica bay... 72
Water, artesian.... 50
W. D. 715 iron loc., porphyry.... 93
W. D. 716 iron loc., Genoa tp.... 93
W. D. 717 iron loc., Genoa tp.
Garnet schist.... 88
Lead-zinc deposit.... 89
notes and photos....94-96
W. D. 719 iron loc., Genoa tp.... 89
W. D. 721-726 iron locs.... 92
W. D. 728 iron loc.... 91
W. D. 1,727 iron loc.... 89
W. D. 1,729 iron loc.... 91
W. D. 1,730 iron loc.... 93
W. D. 1,731-6 iron locs. *See* Jefferson claims.
W. D. 1,733-4 iron locs....88, 93
Weaskog ck.... 45
West pt., rocks.... 26
West Korah.... 50
Whitefish bay. *See* Parisian isld.
Whitehead, W. H.... 31
Williams iron m....47, 48
Wilmott, A. B.... 54
Wilson, Hugh....77, 78
Wilson, Morley.
Views on Cobalt conglomerates, western Que....31, 34
Woman River iron range.
Report on part of, by Moore....86-96
Wynne-Roberts, R. O.... 50

Y

Yates, artesian water.... 50
Younger granite formation.
Sault Ste. Marie area, character; agreement; distribution....4, 38-40

Z

Zinc.
See also Vacheresse, Fred.
Genoa tp....89, 94

To accompany Report by E. S. Moore in Vol. XXXV, Part 2, Ont. Dept. of Mines.

Insert to face page 88.

D A L E

M c O W E N

M A R I O N

G E N O A

Harris Lake

Olscamp Lake

Edwards L.

Sahkatawich (Rush) Lake

Sahkatawich River

Falls 24'

Rapids

Falls 2'

Port 17 cts.

SHAFT

WD 722 WD 723 WD 721 WD 719 WD 718 WD 715 WD 716 WD 720 WD 724 WD 725 WD 726 WD 727 WD 728 WD 1729 WD 1730 WD 1731 WD 1732 WD 1733 WD 1734 WD 1735 WD 1736

D.D. 5 D.D. 6 D.D. 7 D.D. 8 D.D. 9 D.D. 10 D.D. 11 D.D. 12 D.D. 13 D.D. 14 D.D. 15 D.D. 16 D.D. 17

S 3694 S 3693

Swamp Alder Swamp Quartz porphyry Diabase Rhyolite Gabbro

L E G E N D

Symbols

- D.D. 5 — Diamond Drill Hole
- Geological boundary
- Camp buildings
- Trail
- Road
- Shaft

KEEWATIN

- Greenstones, rhyolites, Quartz porphyries & felsites.
- Iron formation
- Conglomerate, felsite, Felsite breccia, and quartzite.

ALGOMAN

- Granite

KEWEENAWAN

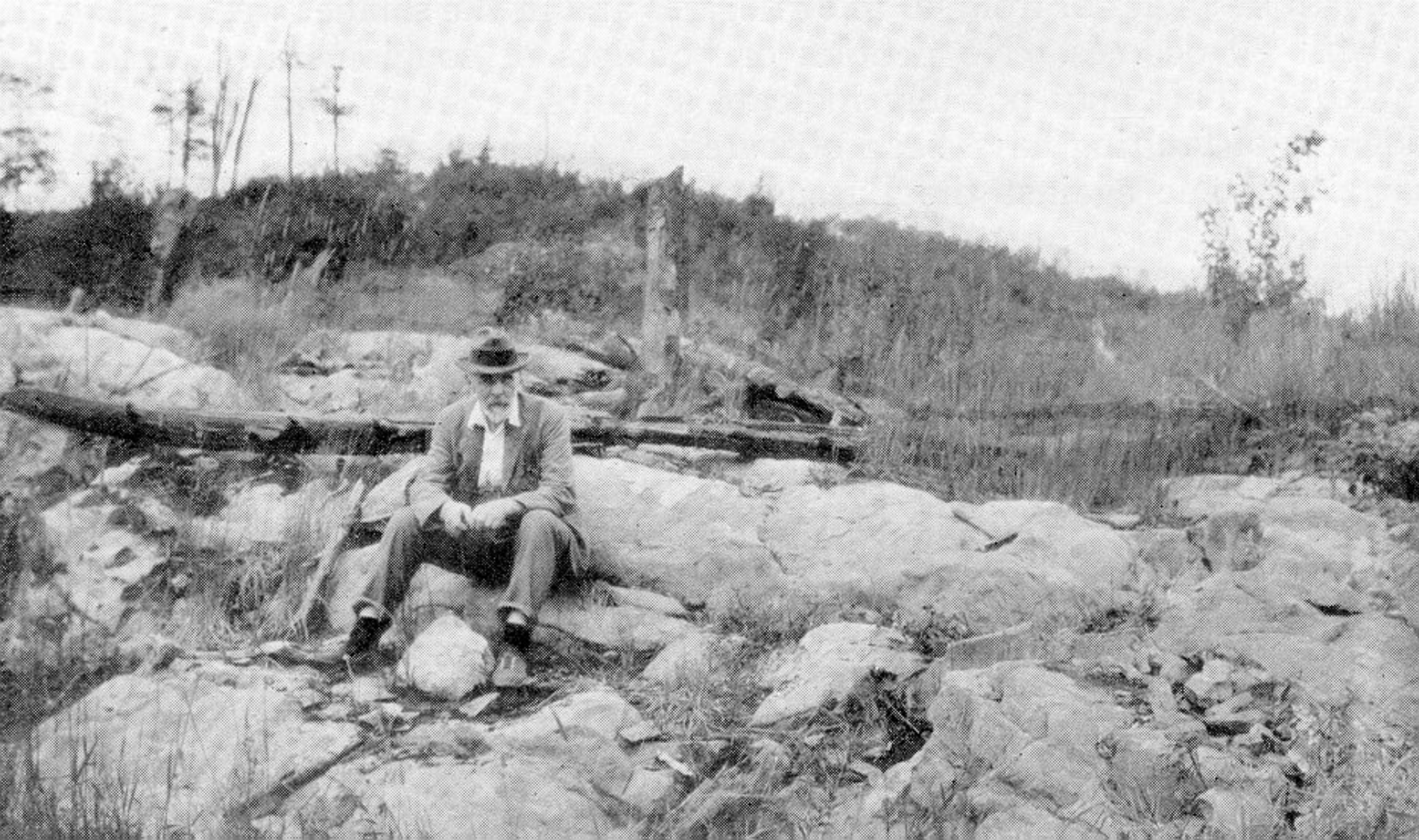
- Olivine-diabase dikes.

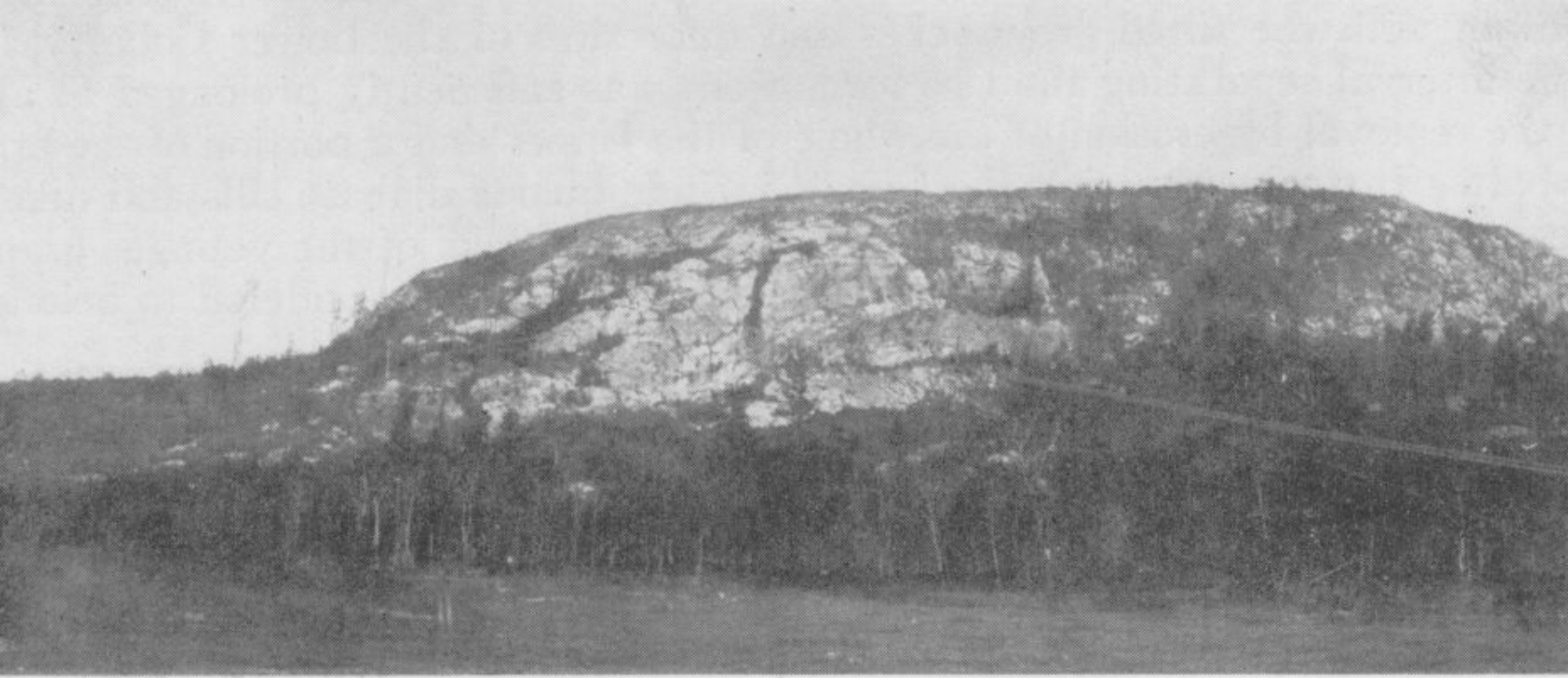
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GEOLOGICAL MAP OF THE SAHKATAWICH LAKE SECTION OF THE WOMAN RIVER IRON RANGE.







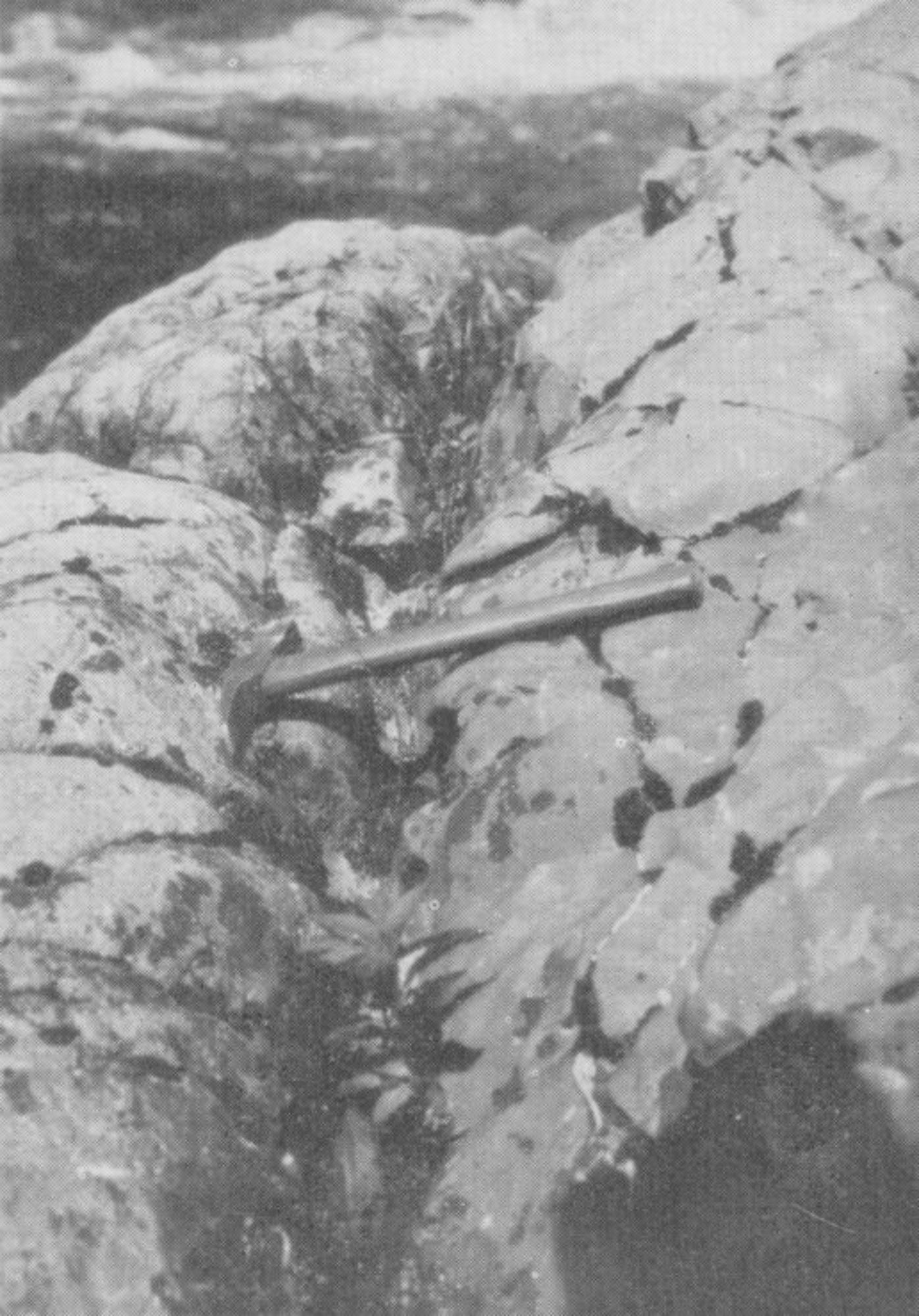




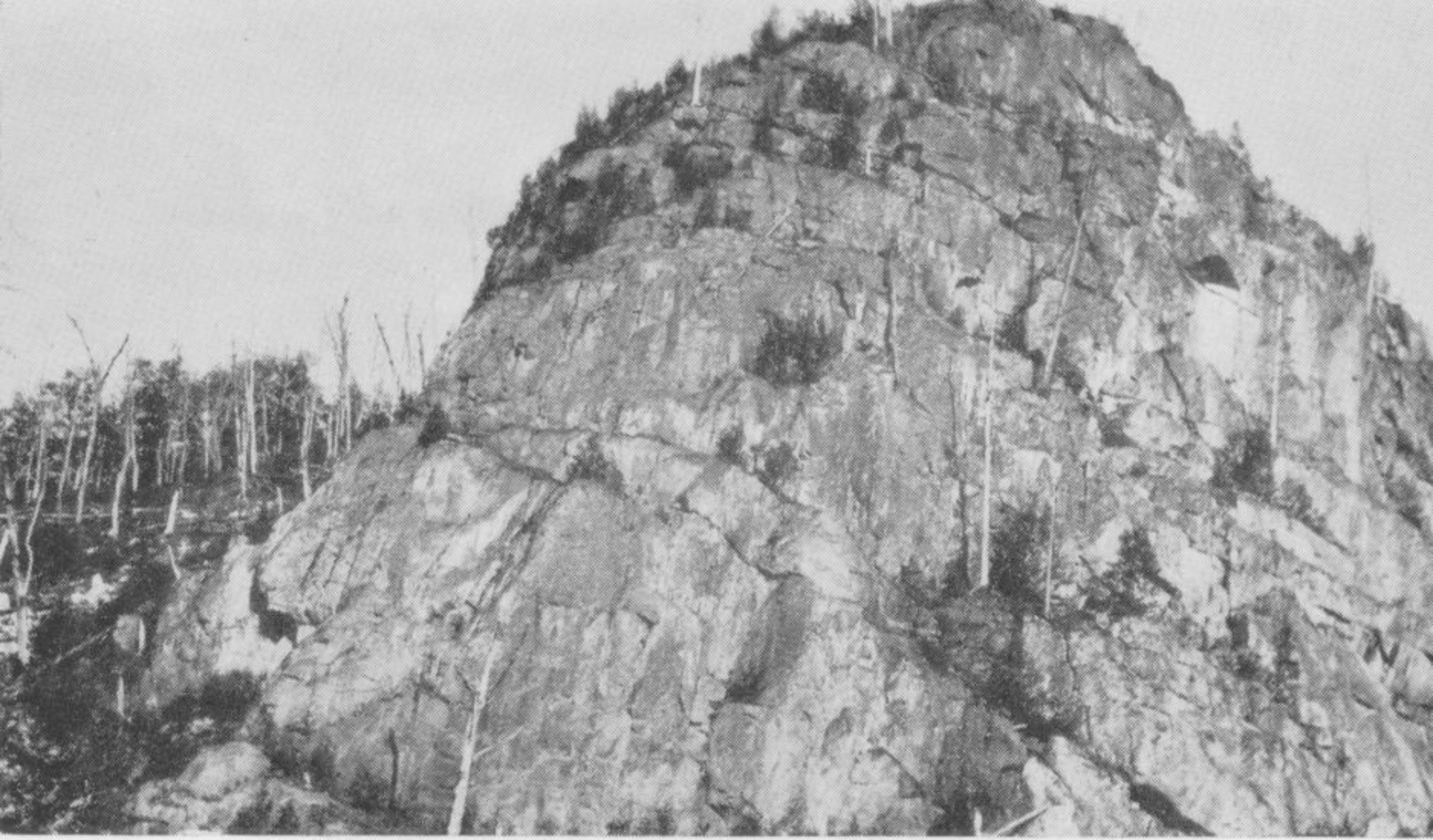












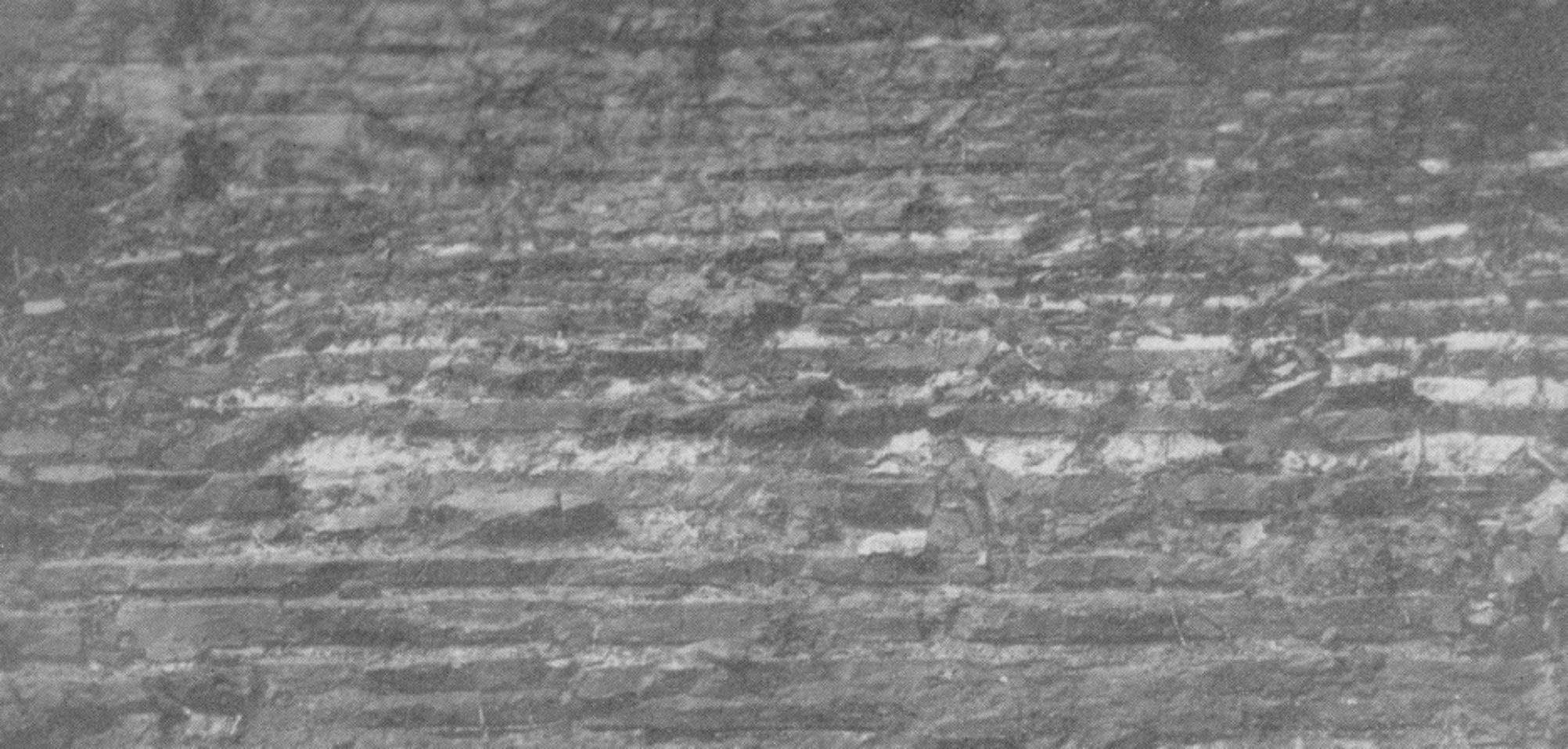






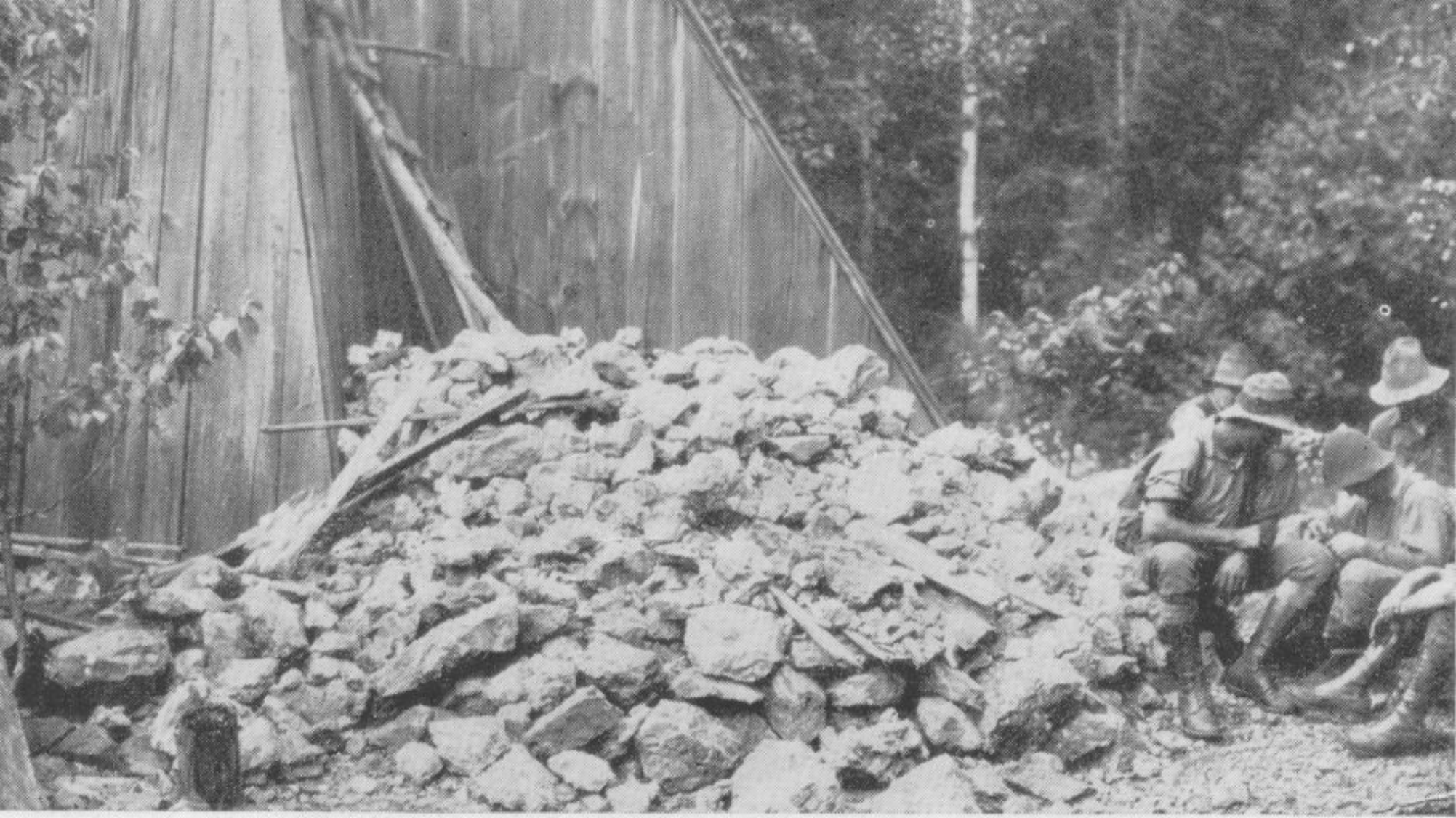














PROVINCE OF ONTARIO
DEPARTMENT OF MINES

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

THIRTY-FIFTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXV, PART III, 1926

Gowganda Silver Area (Fourth Report, Revised), by A. G. Burrows..1–61
Gowganda Vein Minerals, by E. W. Todd.....62–78
Anima-Nipissing Lake Area, by E. W. Todd.....79–104

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CONTENTS

Vol. XXXV, Part III

Gowganda Silver Area

	PAGE
Introduction	1
Location	2
Topography	2
Superficial Deposits	2
Glaciation	3
Production	3
Literature	6
Power	6
General Geology	6
Keewatin	7
Types of Keewatin	8
Iron Formation	8
Dikes in Keewatin	8
Quartz Porphyry	9
Algoman	9
Matachewan Series	10
Cobalt Series	10
Unconformities at Base of Cobalt Series	12
Unconformity in Cobalt Series	13
Adinole	13
Nipissing Diabase	13
Red Rock	15
Structure of Diabase	15
Miller Lake Area	15
Area West of Gowganda Lake	17
Relations of Nipissing Diabase Areas	18
Jointing in Diabase	19
Thickness of Sill	20
Dikes Later than Nipissing Diabase	20
Olivine Diabase	20
Quartz Diabase Dikes	20
Occurrence of Silver Ore	20
Origin of Silver Ore	23
Veins	23
Ore Shoots	25
Description of Mines and Prospects	25
Haultain and Nicol Townships	25
Bonsall	25
Miller Lake O'Brien	27
Capitol	32
Haultain Township	33
Castle-Trethewey	33
Miller Lake and Everett	38
Barbara	38
Ottawa Gowganda	38
Haultain	38
Wigwam	39
Millcrest	39
Cobalt Nugget	40
Nicol Township	40
Big Four	40
Castle, R.S.C. 106 and R.S.C. 92	40
Chapelle Claim	41
Tonopah (Walsh)	41
Morrison	44
Huronian Belt	44
Hylands-Johnston-Gardner	44
Coleroy	44
Hart Claims	46
Silver Bullion	46
Lawson Township	48
Bishop	48
Gowganda Keora	48
Powerful	48
Milner Township	49
Bishop	49
Crews-McFarlan	49
Hewitt	50
Mann	51
Northcliff	53
Reeve-Dobie	53
South Bay	55
Van Hise Township	55
Alpine	55
Hedlund	56
Charters Township	56
Garvey	56
Haines	57
Leith Township	57
Hudson Bay	57
Silverado	57
Donovan Township	58
Duggan	58
Wilder	58
Morel Township	58
Bishop	58
Corkill Township	58
Geology	59
Exploration of Kell Claims	59
Kell (G. G. 4,124 and 4,125)	60
South Bay Power Company	61

Gowganda Vein Minerals

Introduction	62
Method of Examination	62
Character of Veins	63
Crushed Vein Material	64
Normal Type of Vein Material	66
Dendritic Types	71
Green Gangue Material in Castle-Trethewey Veins	75
Temiskamite from Coleroy Mine	76
Antimony and Mercury in Silver	77
Summary	77

Anima-Nipissing Lake Area

Introduction	79
Location and Extent	79
Access	79
Topography	80
Lakes and Streams	80
Montreal River Waters	81
Sturgeon River Waters	81
Matabitchuan River Waters	82
Summary of Natural Resources	82
Previous Geological Work	83
Accompanying Map	83

	PAGE
General Geology	84
Legend	84
Keewatin	84
Basic Lavas	85
Acid Lavas, Agglomerate	87
Tuff	88
Haileyburian (?)	89
Algoman	89
Granite	89
Quartz Porphyry	90
Algoman-Keewatin Complex	91
Matachewan	91
Animikean (Cobalt Series)	91
Lower Cobalt Series	92
Upper Cobalt Series	93
Keweenawan	93
Nipissing Diabase	93
Olivine Diabase and Quartz Diabase Dikes	94
Quaternary	94
Glacial and Recent	94
Economic Geology	95
Contact Relationships of Nipissing Diabase	95
Brigstocke and Cole Townships	95
Banting and Chambers Townships	97
Strathy and Best Townships	98
Veins in the Nipissing Diabase	100
Crescent Silver Cobalt Mining Company, Limited	101
Ores in the Keewatin and Haileyburian (?)	103
Northland Pyrite Mine	104

ILLUSTRATIONS

PAGE

General view looking southwest ... 1
Basal conglomerate containing boulders of porphyritic diabase, quartz porphyry, etc., claim R. S. C. 123 ... 11
"Tower" hill, showing unconformity between conglomerate of the Cobalt series and Keewatin ... 12
Top of diabase sill with overlying banded slate-like greywacké, north of Lake Irene ... 14
Diabase sill overlying Keewatin, claim L. M. 105, near Everett lake ... 16
Diabase sill underlying Keewatin along road south of Leroy lake ... 16
Diabase underlying Keewatin, southeast of Leroy lake on claim P. B. 140 ... 18
Specimen of polished ore from Miller Lake O'Brien mine ... 24
Miller Lake O'Brien mine ... 29
Specimen of polished ore from the Crews-McFarlan mine ... 49
Interesting vein structure, Tonopah mine ... 63
Stringy type of vein filling in Miller Lake section, suggesting colloidal origin ... 63
Polished surface of dendritic ore from Miller Lake O'Brien mine ... 64
Crushed vein material ... 65
Contemporary intergrowths of arsenides, silver, and calcite ... 67
Minute growths of arsenides completely enclosed in calcite ... 69
Hudson Bay mine specimen etched with dilute nitric acid ... 70
Specimen from Mann mine, showing silver dendrite surrounded by arsenides ... 72
Part of same specimen etched with dilute nitric acid ... 72
Detail of dendritic growths in specimen from Miller Lake O'Brien mine ... 73
Polished section of dendritic ore, etched with dilute hydrochloric acid, from the Castle-Trethewey mine ... 74
Ellipsoidal Keewatin rock with large phenocrysts of basic plagioclase, northwest of Cedar lake ... 87
Footwall of Nipissing diabase resting on granite southwest of Mountain lake ... 98
Cliff of diabase with columnar jointing, south of Mountain lake ... 99
Large quartz vein in Nipissing diabase, Thieving Bear lake ... 100
Entrance to adit and engine-house, Crescent Silver Cobalt Mining Company, Limited ... 101
Vein showing a mixture of arsenides and calcite, Crescent Silver Cobalt mine ... 103

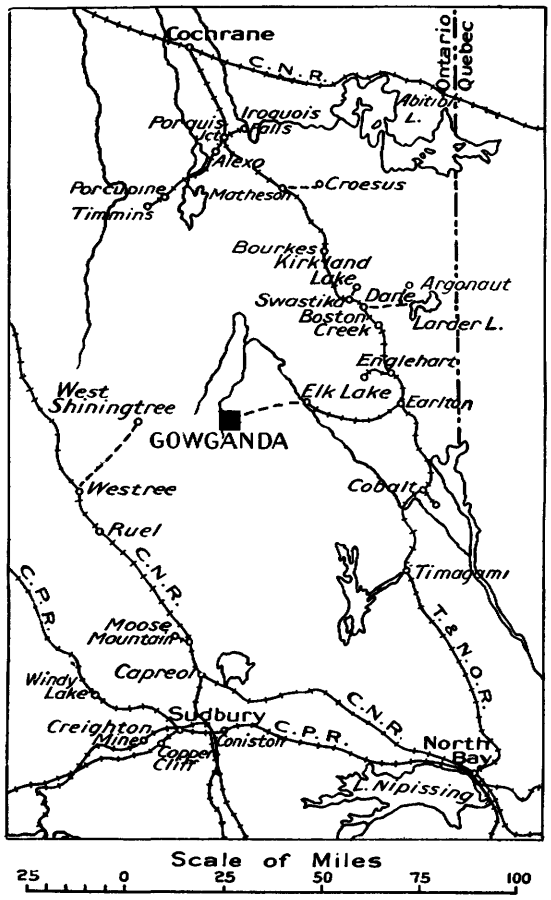
SKETCH MAPS AND DIAGRAMS

Sketch map showing location of Gowganda ... *facing* 1
Section showing relationship of Nipissing diabase sill to older formations at Gowganda ... 19
Geological plan of part of Nicol township ... 21
Key plan of Gowganda silver area, showing the location of the principal mines and prospects ... 26
Surface plan of part of Miller Lake O'Brien mine ... 28
Flow-sheet, Miller Lake O'Brien mill, January, 1926 ... 30
Plan of part of workings, Miller Lake O'Brien mine ... 31
Projected section, Miller Lake O'Brien mine ... 32
Surface plan of Castle-Trethewey mine ... 33
Composite plan of workings, Castle-Trethewey mine, from No. 3 shaft eastward ... 34
Section through shafts Nos. 2 and 3, Castle-Trethewey mine ... 35
Flow-sheet of concentrating mill, Castle-Trethewey Mines, Ltd ... 36
Vertical section, showing Wigwam silver mine ... 39
Plan of workings of Walsh mine, Tonopah Canadian Mines Company ... 42
Section of Walsh mine, Tonopah Canadian Mines Company ... 43
Coleroy Gowganda mine workings ... 45
Plan showing shaft, buildings, and workings, Silver Bullion mine ... 46
Vertical section of Silver Bullion mine, December, 1925 ... 47
Section of No. 3 vein, Mann mine ... 51
Plan showing vein system at the Mann mine ... 52
Vein system at Reeve-Dobie mine ... 54
Cross-section at the Kell property, Corkill township ... 60
Plan of adit, Crescent Silver Cobalt Mining Company, Limited ... 102

COLOURED GEOLOGICAL MAPS
(In pocket at back of report)

Map No. 35*c*—Anima-Nipissing Lake Area, Districts of Timiskaming and Nipissing, Ontario. Scale, 1 mile to the inch.

Map No. 35*d*—Part of the Gowganda Silver Area, District of Timiskaming, Ontario. Scale, half a mile to the inch.



Sketch map showing location of Gowganda.

GOWGANDA SILVER AREA

(*Fourth Report, Revised*)

By A. G. Burrows

INTRODUCTION

The greater part of the field season of 1920 was spent by the writer in revising the geology of the Gowganda silver area, special attention being given to the occurrence and structure of the Nipissing diabase sill with which the silver deposits are associated.

H. T. Leslie and H. C. Rickaby of Toronto acted as assistants and performed their work in a satisfactory manner. A number of cross-sections illustrating the attitude of the diabase sill in its relation to the other formations were prepared from their field work.

Since the Fourth Report on Gowganda has been out of print for some time,[1] it was thought advisable to republish it with some additional information. A coloured geological map (No. 35*d*) of the Miller Lake section is also included.



General view looking southwest. Castle-Trethewey mine on the right, Miller Lake O'Brien mill on the left in the background.

During parts of the months of September and October, 1925, the writer made an examination of the properties which were being worked at that time. These are located in that portion of the field which extends from Gowganda lake to Wigwam lake. In the area lying west of Gowganda lake, which at different times has been quite active, none of the properties were in operation.

The writer was assisted by E. W. Todd, Geologist, Department of Mines, Toronto, during part of the examination. Mr. Todd has prepared a separate paper on Vein Minerals, giving special attention to the identification of a number of arsenides and sulpharsenides which accompany the silver in Gowganda veins.

[1]Vol. XXX, pt. 3, 1921. Copies of the general geological map of Gowganda, No. 30*b*, scale one mile to the inch, accompanying this report, are available on application to the Deputy Minister of Mines, Toronto. The area embraced is shown on the key map on page 26.

Thanks are extended to the managers of the mines for the hospitable treatment received, and also for the use of mine plans and sections, and for facilitation of underground examination. Additional information regarding development work early in 1926 was also received from them.

Location

The Gowganda silver area is situated in the southwestern part of the district of Timiskaming and forms part of the Timagami Forest Reserve. Gowganda[1] lake, from which the area derives its name, lies about 56 miles northwestward from Cobalt. The nearest railway station is Elk Lake, the terminus of a branch line running westward from Earlton, which is on the main line of the Temiskaming and Northern Ontario Railway.

The road from Elk Lake to Gowganda lake, about 27 miles in length, has been much improved since 1920 and is now suitable for motor-vehicle traffic. Due to the hilly character of the country the road is very crooked, and there are some dangerous curves, requiring considerable caution by the motorists. The trip into the camp from Elk Lake can now be made easily in two hours, where formerly a whole day was required by team. A stage operates daily, except Sunday, between Elk Lake and Gowganda.

Side roads leave the main road to several of the mines and prospects.

Topography

The general character of the surface of the country is quite similar to that of other parts of the pre-Cambrian of Northern Ontario. Viewed from hill-tops, the surrounding horizon presents a series of gentle undulations with here and there a break, caused by a prominent hill or ridge. In detail, however, the surface is very rough and broken, and different geological formations present differences in surface contour. Rocky ridges alternate with swampy depressions abounding in small lakes over much of the area. The large lakes usually have considerable rocky shoreline, and the water in them is clear. Generally, the longer axes of the lakes are north and south, this being the prevailing direction of the ridges.

The area is situated near the headwaters of the Montreal river, and most of it is drained by the waters of the East Branch of that river, which, together with other streams, flows northward. There is a marked parallelism in the large lakes, which are quite numerous: Spawning, Elkhorn, Gowganda, Obushkong, Bloom, Wigwam, Lost, and Calcite. The depressed valleys in which these lakes are found probably originated in extensive north-south fault movements.

The most prominent features are the diabase, conglomerate, and greywacké ridges; whereas the granite and syenite of the Algoman and the schists of the Keewatin generally occur in low rounded ridges and depressed parts of the area. The highest elevation is attained southwest of Spawning lake, in a greywacké ridge, which is 400 feet above the surrounding level, or about 1,550 feet above the sea. The conglomerate hill to the northeast of Obushkong lake is 200 feet above the lake. The diabase ridge at the Alpine property in the west part of Van Hise is 200 feet above the plain. Usually the ridges range from 50 to 150 feet in elevation.

Superficial Deposits

The superficial or unconsolidated material is chiefly sand and gravel and sandy and gravelly loam of glacial origin. The area lies some miles south of

[1]Gowganda is an Indian name meaning "porcupine's home."

the south limit of the great clay belt of Northern Ontario. There is no large tract of agricultural land, although in small patches near Gowganda village and at some of the mines, fine vegetables are grown.

Jackpine plains and rolling sand ridges are characteristic of most of the southern and eastern parts of the area. Large parts of Charters, Lawson, and Corkill townships are covered with sand deposits which conceal most of the rocks. Some of the low, swampy areas are extensive, as in the northeast part of Leith township.

The timber is chiefly white and black spruce, birch, balsam, jackpine, and popular. Red and white pine are found in small groves in isolated parts. Around Gowganda lake the timber is mostly small, but to the south, in Leith and Charters townships, it is of good commercial size.

Forest fires have destroyed large tracts of timber, particularly in the townships of Haultain, Nicol, and Van Hise.

The numerous forest fires over a period of years burned off cleanly some sections of the area. Gradually, however, a growth of young poplar and jackpine is covering the burnt areas, and the country is less readily travelled than it was six years ago.

Glaciation

The marks of glaciation, varying from fine striae to broad grooves or rounded hummocks, are evident at many points. The ice mass moved about due south in this area. Immediately west of Myrtle lake, the glacial striae are S. 10° E., magnetic, and about three miles south on the Crawford claim, H.S. 359, they are S. 20° W., magnetic.

Production

It is now nearly twenty years since silver was discovered in the Gowganda area, and during that time some production has been maintained from various parts of the camp. Production began in the year 1909 when two tons of ore were shipped from the Bartlett property, lying west of Gowganda lake. Shipments of some quantity began in 1910, during which year nine properties produced ore.

The great preponderance of ore shipped has come from properties lying northwest of Miller lake. Several shipments of high-grade ore have been made from the Mann ridge, west of Gowganda lake. Most of this came from the Reeve-Dobie, Mann, and Crews-McFarlan properties.

From 1910 to 1912, the Millerett mine was the main producer, the ore coming chiefly from an ore shoot in the conglomerate which produced 500,000 ounces of silver. The Miller Lake O'Brien mine has operated steadily from 1909 to the present time. The latest properties to enter the ranks of shippers are the Castle-Trethewey and Tonopah, the former starting to ship in 1920 and the latter in 1925. The production from the Castle-Trethewey has grown steadily from 1920 to 1925, the 1925 shipments containing 961,950 ounces of silver. The shipments from the Tonopah have come through development of high-grade veins, no stoping being done in 1925.

A table is appended giving the shipments from Gowganda from the beginning (1910) to the end of 1925, the total number of fine ounces of silver being 8,420,509, and of pounds of cobalt "paid for" 219,392. These amounts are exclusive of some small shipments of silver ore, the data of which have not been obtained by the Department.

The table of shipments was prepared by W. R. Rogers, Director of Publications and Statistics Branch, Department of Mines, Ontario.

SHIPMENTS FROM GOWGANDA MINES, 1910-1925

Year	Bartlett[1] (Crews-McFarlan)	Bonsall	Boyd-Gordon	Burk-Remey	Castle-Trethewey	Miller Lake and Everett	Kell	Mann	Millerett
1910		3.79	27	1.8		(1)			347
1911									128
1912								13.74	192
1913								15.87	
1914								18	
1915									
1916									
1917									
1918	30.2								
1919	42								
1920		13.06			45.31		0.79		
1921					29.88				
1922					10.87				
1923					43.9				
1924					163.21	1.5			
1925					346.19				
Total shipments, tons[2]	72.2	16.85	27	1.8	639.36	1.5	0.79	47.61	667
Silver, ozs.	20,219	10,046	4,678	(3)	1,775,929	3,461	1,621	97,792	611,822
Cobalt, lbs.		101			55,527		254		5,000

SHIPMENTS FROM GOWGANDA MINES, 1910-1925—*Continued*

Year	Miller Lake O'Brien	Reeve-Dobie	Tonopah (Walsh & Morrison)	Welch	Wigwam	Total	Silver	Cobalt paid for
						tons	ounces	lbs.
1910	31	54		1		465.59	471,688	8,432
1911	141.5					269.5	468,687	
1912	112.6					318.34	549,976	
1913	166.9					182.79	502,370	
1914	113.9					131.9	399,300	
1915	109.66					109.66	242,229	
1916	170.57	11				181.57	383,393	
1917	350	5.75				355.75	1,064,635	56,884
1918	160.4					190.6	638,198	26,994
1919	189.79	1.94				233.73	723,764	27,404
1920	115.09	10.44				184.69	433,352	15,236
1921	103.07					132.95	258,292	9,187
1922	75.8					86.67	170,651	8,478
1923	24.43				0.6	68.93	160,761	7,494
1924	26.1					190.81	598,057	18,148
1925	150.15		13.33			509.67	1,355,156	41,135
Total shipments, tons[2]	2,040.96	83.13	13.33	1	0.6	3,613.13		
Silver, ozs	5,759,164	88,584	45,297	1,000			8,420,509	
Cobalt, lbs	157,309		1,201					219,392

NOTE: Shipments of about 6½ tons (between 1910 and 1913) have been reported in addition from the Hudson Bay properties in Leith township.

[1]In addition to the shipments reported to the Department of Mines and shown in the above table of shipments, A. A. Cole's reports for the Temiskaming and Northern Ontario Railway Commission show the following additional shipments:—

1909, Bartlett, 2 tons.
1910, Everett, 8.35 tons; Powerful, 1 ton.
1911, Calcite Lake, 8.5 tons; Canadian Gowganda, 8 tons.

[2]Ore and concentrates.

[3]The silver contents of the Burk-Remey shipment were never reported to the Department.

Literature

References to the Gowganda silver area are to be found in the following reports:—

1876—R. Bell, Geol. Surv. Can., Report of Progress, 1875-76.
1900—J. R. L. Parsons, Report of the Survey and Exploration of Northern Ontario, Ont. Bur. Mines.
1907—W. R. Rogers, Ont. Bur. Mines, Vol. XVI, pt. 2.
1909—A. G. Burrows, Ont. Bur. Mines, Vol. XVIII, pt. 2.
1909—W. H. Collins, Preliminary Report on Gowganda Mining Division, Geol. Surv. Can., No. 1075.
1910—W. H. Collins, Econ. Geol., Vol. V.
N. L. Bowen, Jour. Geol., Vol. XVIII.
1912—G. M. Colvocoresses, Gowganda in 1911, Can. Min. Jour., April 15, 1912.
1913—W. H. Collins, The Geology of Gowganda Mining Division, Geol. Surv. Can., Mem. No. 33.
A. G. Burrows, Gowganda Silver Area, Ont. Bur. Mines, Vol. XIX, pt. 2, 1913, p. 165.
1920—A. G. Burrows, Gowganda Silver Area, Ont. Dept. Mines, Vol. XXIX, pt. 3.
1921—A. G. Burrows, Gowganda and Other Silver Areas, Ont. Dept. Mines, Vol. XXX, pt. 3.

Power

Heretofore the Gowganda area has been handicapped by a lack of power. The Miller Lake O'Brien mine constructed a hydro-electric plant of maximum 500 horse-power at Burke lake; and the South Bay Power Company built a 250-horsepower plant at Hanging-stone lake, which was used by the Castle-Trethewey.

Most of the properties used wood for fuel, and as this is becoming scarce and was always expensive, the power problem was unsatisfactory until 1926.

The Northern Canada Power Company's transmission line from the Quinze river has been extended from Elk lake, where the Porcupine-Quinze lines passes, to Gowganda. This power (25 cycle) is now being used by the Castle-Trethewey, Miller Lake O'Brien, Tonopah, and W. J. 9, and will probably be used by other properties.

GENERAL GEOLOGY

The compact rocks of the area are of pre-Cambrian age. The chief geological subdivisions are as follows:—

POST-NIPISSING:	Olivine diabase, quartz diabase, aplite.
KEWEENAWAN: (NIPISSING)	Quartz diabase (sill).
	Intrusive contact
ANIMIKEAN: (COBALT SERIES)	UPPER: Conglomerate, quartzite, arkose. LOWER: Conglomerate, greywacké, quartzite.
	Unconformity
MATACHEWAN:	Diabase.
	Intrusive contact
ALGOMAN:	Granite, syenite, gneiss.
	Intrusive contact
KEEWATIN:	Basic and acidic volcanic and intrusive rocks, iron formation, chlorite and hornblende schist, etc.

NOTE: Dikes of lamprophyre and dikes and masses of serpentine intrude the Keewatin. They may be of the same age as similar rocks at Cobalt to which W. G. Miller and C. W. Knight have given the name Haileyburian.

The rocks at Gowganda are in general similar to those at Cobalt and other parts of Northern Ontario where the pre-Cambrian predominates. The oldest are of Keewatin age, consisting of altered volcanic rocks, greenstones, volcanic fragmental, etc., and iron formation, with dikes of light-coloured porphyritic rocks. The whole series has been greatly altered to schist, of which hornblende and chlorite schist form a large part. They are in marked contrast, with their ancient metamorphosed appearance and frequent vertical attitude where banded, to the later rocks.

The Keewatin was intruded by batholiths and smaller masses of granite and syenite, that are probably of Algoman age. Some small masses of serpentine occur in the Keewatin; and many basic dikes, older than the Cobalt series, intrude the Keewatin schists and the granite. These dikes were intruded long after the granite and syenite and are little disturbed.

This complex of older rocks was subjected to erosion, and on the irregular weathered surface the sediments of the Cobalt series were deposited. This series lies in gentle folds, with average dip of 10 to 15 degrees, and has been little disturbed except by the sill-diabase intrusion, when the dip is often higher on the hanging-wall side.

Later than all these rocks is a diabase sill, which occurs for the most part in the sedimentary rocks. Occasionally the diabase has been intruded below the contact of the Cobalt series with the Keewatin, since areas of the oldest rocks lie on the sill in the vicinity of Miller lake. A few basic dikes of olivine diabase and quartz diabase have intruded not only the older rocks but also the diabase sill. These are the youngest rocks recognized in the area.

Quartz diabase dikes are found, in part of the area, intruding the Cobalt series, and are more common in Leith township than elsewhere. They may be younger than the sill diabase, but as they are not found in contact with the sill, their age cannot be definitely determined, except that they are later than the Cobalt series.

Keewatin

The rocks of Keewatin age occur in less volume than the Algoman, Animikean, and Nipissing diabase. They are distributed in isolated areas in several townships, the largest volume of these ancient rocks being in Van Hise, Haultain, and Nicol.

The rocks are essentially of volcanic origin, and vesicular and ellipsoidal structures are occasionally seen. They are dominantly of basic composition and are much altered to hornblendic and chloritic schists. Some of the rocks are massive, but most of them are altered to schist. Intermingled with the basic lavas are some fragmental rocks that resemble old conglomerate, together with some tufaceous or volcanic fragmental material. There are a few belts of banded iron formation or jaspilite, now much crumpled. There are also numerous narrow bands of light-coloured rock, like old felsitic or porphyritic dikes, which are folded with the darker volcanic rocks and which appear to have been intruded at an early time into the volcanic flows. When banded, the Keewatin rocks are in nearly vertical attitude, with a general strike about east and west. Very fissile rocks are common, as are schists that break into flat plate-like structures an inch or more in thickness.

Small masses of serpentine, together with narrow dikes of felsite, porphyry, lamprophyre, and diabase, occur frequently in the Keewatin areas.

Types of Keewatin

Hornblende schist and amphibolite occur south of the southwest end of Everett lake. Part of the rock is banded, breaking into plates. A microscopic section shows green fibrous hornblende, the predominating mineral, with grains of zoisite, epidote, secondary feldspar, and chlorite.

A greenish-weathering massive rock occurs north of Miller lake. A specimen from the south line of claim R.S.C. 87 is scaly, fibrous, green hornblende, and may be called amphibolite. To the east of Miller lake the rock is more schistose and is largely hornblende and chlorite schist.

West of Leroy lake, the greenstone is much altered and has a dull green mottled appearance. The rock is rather massive, but passes westward into schist, striking N. 65° E. and dipping 70° N.

Near Leroy lake there are striking bands of light-greenish rock which resemble tuffs with the pillow lava.

Spherulitic lava occurs on a claim just north of the Morrison shaft and near the contact with the sill diabase. The spherulitic rock is accompanied by some flow breccia, which may indicate a flow top apparently facing south. The structure is obscured by the contact with the sill diabase.

To the west of Obushkong lake, there is considerable hornblende schist and associated serpentine, which is much weathered to a rusty brown colour. The serpentine rock also contains some fibrous hornblende and magnetite.

A light-coloured rock is interbanded with greenstone to the west of Obushkong lake. It is fine-grained, consisting of crushed quartz and feldspar with glistening scales of white mica. A dark mineral in thin scales is chlorite, giving the rock a gneissic texture.

Pillow lava occurs half a mile north of Serpentine lake. It is interbanded with a dark-coloured volcanic fragmental rock, half a mile northeast of Leroy lake. It occurs again on claim W.J. 7, southwest of this lake.

Some serpentine in the Keewatin from the 460-foot level of the Miller Lake O'Brien mine contains numerous round inclusions of secondary minerals in a radiating arrangement.

Amygdaloidal lava is associated with iron formation west of Elkhorn lake along the boundary line of Milner and Leith townships. The vesicles of the old lava are filled with quartz, calcite, and epidote. Under the microscope, the flow structure of the rock is beautifully shown in the parallel arrangement of the minute rods of plagioclase feldspar.

Iron Formation

Banded iron formation occurs in a small area of Keewatin southwest of Elkhorn lake and also half a mile northeast of Gowganda lake. The formation is quite limited, consisting of interbanded silica and magnetite in thin layers, less than 30 feet in width. No iron ore of importance occurs in these localities. The formation is quite crumpled in several separated small bands on claims W.D. 961-64. One siliceous band on claim W.D. 963 contains a small deposit of massive iron pyrites.

Dikes in Keewatin

North of Brett lake are several narrow dikes of a reddish-brown lamprophyre. The phenocrysts are augite set in a groundmass of feldspar and scales of fibrous hornblende. Calcite in grains and veinlets is also seen.

In the same area there are several dikes of rather fresh-looking diabase. A microscopic examination of one proves it to be a hornblende diabase. The

age of many of the diabase dikes cannot be stated definitely, since several that are fresh-looking have proven to be of vastly different age in other parts of the area.

Quartz Porphyry

There is a large mass of greenish-grey quartz porphyry directly northeast of Gowganda lake. It forms the main rock of a number of mining claims, many of which show simply the porphyry and narrow north-south dikes of diabase. The porphyry intrudes green schist and iron formation on claim W.D. 961 and is, therefore, younger than certain of the Keewatin rocks. On the previous geological map of Gowganda, it was classed with the Keewatin. It occurs rather as a stock than a dike, since its outcrop is nearly round in shape.

No gold has been found in this rock, as in certain quartz porphyries in some parts of Northern Ontario. The formation may possibly be of Algoman age.

Phenocrysts of quartz are frequently recognized in the porphyry, although there are portions of the mass that are simply a light greenish-grey felsite. A section of a sample from the south line of claim R.S.C. 123 shows abundant quartz phenocrysts and a few ragged outlines of feldspar. The groundmass is granular quartz and feldspar with a little chlorite.

Algoman

The rocks at Gowganda classed as Algoman are granite and syenite, which are in large volume in the townships of Haultain and Van Hise. They are pink and grey, and at times the granite grades into a syenite.

There is a tendency in some parts for the acid rocks to show indications of a gneissic structure, but banding and intense metamorphism, such as occur in other localities, are not found.

In previous reports, the granite and syenite have been classified as Laurentian. However, as no Timiskaming sediments are known in the Gowganda area, it is uncertain to what division the granites belong. Since granite and associated rocks in adjacent areas have been classed with the Algoman intrusives, it seems preferable, for the time being at least, to refer to the Gowganda granite as Algoman.

The most common variety is a hornblende granite, generally pink or flesh-coloured. A microscopic examination of a granite from a locality west of Bloom lake shows a hypidiomorphic mixture of quartz, feldspar (orthoclase and acid plagioclase), and green hornblende, with a little titanite, apatite, and magnetite as accessory minerals. North of Everett lake and extending westward to Davidson lake, the rock is more syenitic. Dikelets of the syenite intrude the Keewatin west of Everett lake.

Another common type is a grey biotite granite, which is intermingled with the hornblende syenite.

There is a small area of porphyritic syenite in Nicol township, just northeast of Wilson lake. Where it approaches the basic Keewatin rocks it becomes darker in colour, with blotches of basic material which have been absorbed from the Keewatin. The porphyritic texture is well marked on the weathered surface where the phenocrysts have been bleached out. Zonal structure is pronounced in the crystals of feldspar and is due to the regular arrangement of included minerals. The ferromagnesian minerals are green hornblende and a little biotite, altering to chlorite; quartz is present in small grains.

Matachewan Series

There are numerous dikes of diabase that are at least older than the Cobalt series. They occur in profusion throughout the Keewatin area northeast of Gowganda townsite, east of Miller lake, and elsewhere. These dikes have an approximate north and south strike. They are fresh-looking rocks, and except by their association are difficult to distinguish from similar-appearing dikes that occur in the Cobalt series and that occasionally intrude the Nipissing diabase. They generally contain some quartz grains, but on the whole are darker looking than the quartz diabase of the sill. They show a somewhat rusty surface, whereas the sill diabase usually has a lighter coloured oxidized appearance. Porphyritic texture is not uncommon in the dikes, with phenocrysts of feldspar varying from half an inch to three inches in length. Such porphyritic texture is not recognized in the diabase sill, and this criterion will serve to distinguish the dikes from the sill where only scattered exposures occur through the drift and relationships cannot be seen. The dikes occurring rarely in the Cobalt series and those that cut the diabase sill strike more nearly east and west than north and south. A number of north and south dikes intruding the syenite-porphyry, which is considered of Algoman age, were observed in the Matachewan area. The north and south trend and the nearness of the localities, together with the similarity of appearance, suggest that the Gowganda dikes are probably also of post-Algoman age and younger than the basic intrusives called Haileyburian in the vicinity of Cobalt. The name "Matachewan" has been given to this widespread series of diabase dikes.

The dikes have no special characteristics, being of ordinary diabase consisting essentially of plagioclase and pyroxene, with or without interstitial quartz. No olivine was observed in the sections examined. Two porphyritic dikes are very striking in appearance, one on the transmission line, claim H.F. 209, and the other crossing the main road on claim T.C. 458, west of Leroy lake. The former of these is older than an adjacent diabase dike with similar north-south strike.

The dikes are not of economic importance as a source of silver, since they are much older than the diabase sill. Considerable prospecting was done on them before their age relations were known. Unless in proximity to the sill, the possibility of silver-bearing veins being found in them is remote. Some native silver in calcite veins has been found in such dikes above the diabase sill. One of the most interesting localities where the dikes occur is on claims W.D. 961 and W.D. 964. Here they intrude a quartz porphyry, or felsite, and iron formation, but are overlain unconformably by conglomerate of the Cobalt series. All these formations are intruded by a younger quartz diabase dike that strikes a few degrees north of east.

Cobalt Series

The Cobalt series covers a great part of the Gowganda area, resting unconformably on the Keewatin-Algoman complex and being in marked contrast with it. The series has been little disturbed, except where it is in proximity to the intrusive sill of diabase. The strata usually dip at low angles, averaging 15 degrees, for the most part eastward. Near the diabase, they are frequently tilted to higher angles, as shown in the outcrop of slate-like greywacké on the east side of the high ridge of diabase east of Lost lake. A similar high dip in reddish slaty rock is seen northeast of Lake Irene. In these cases, the sediments

overlie the sill diabase. No secondary cleavage has been developed, the parting in the slaty varieties following the stratification.

The series includes conglomerate, breccia, greywacké, slate, quartzite, and arkose. The lowest formation is usually a basal conglomerate that rests on an eroded and rolling plain-like surface of the older rocks. Many of the fragments of the conglomerate can be duplicated in rocks that occur in place in the vicinity. The pebbles and boulders include granite, syenite, greenstone, iron formation, and diabase.

Greywacké, which in places carries pebbles very sparsely and is occasionally quartzitic, occurs over most of the western parts of Leith, Milner, and Van Hise townships. Conglomerate is seen at intervals along the west shore of Gowganda lake, on the south end of the long point on the lake, and frequently also east of the lake.



Basal conglomerate (Cobalt series) containing boulders of porphyritic diabase, quartz porphyry, etc., claim R.S.C. 123, northeast of Gowganda lake.

Well banded, slate-like greywacké occurs southeast of Myrtle lake on the east side line of claim T.C. 156, and at several other points. It is often brecciated. This is well seen in the locality just mentioned where the slate is in a bluff dipping eastward. The top of the cliff is much brecciated and overhangs the normal slate below it, which has crumpled away. Similar breccia is seen west of Frying-pan lake and on the government road a mile east of Lost lake. These occurrences are near the late diabase, and the brecciation may be due to the diabase intrusion. However, the occurrence near Myrtle lake lies above the contact with the diabase, with layers of undisturbed slate between.

Typical arkose and quartzite occur in great volume in parts of the area, particularly in the southeast portion, including parts of Nicol, Charters, and Corkill. The large island on Gowganda lake is composed of quartzite. The arkose and quartzite are generally coarse grained and thick-bedded, so that the dip is not always readily recognized.

About half a mile north of Wilson lake in Nicol township, the rocks of the Cobalt series dip gently to the west from the Keewatin. The succession is greywacké conglomerate, slate, quartzite, and an upper coarse conglomerate,

which resembles the conglomerate on the west shore of Gowganda lake. This succession of strata is seen in other parts of the area. Sometimes the greywacké conglomerate, usually called slate conglomerate, is underlain by a coarse basal conglomerate which resembles the upper conglomerate.

The latest of the sediments are quartzite and arkose, which are sometimes underlain by a reddish slaty greywacké.

The upper series has a widespread distribution southeast of Gowganda and consists of quartzite arkose, and thin beds of quartz conglomerate, which, according to Barlow, have a thickness of 1,100 feet at Maple mountain. Collins states that the thickness of the lower and upper formations of the series in its present greatly eroded state probably does not exceed 1,000 feet.



"Tower" hill, showing unconformity between conglomerate of the Cobalt series and Keewatin The light-coloured rock is quartz porphyry intruded by diabase dikes.

The upper series of quartzite and arkose appears to be barren of economic minerals, but at certain localities it is intruded by sill diabase that carries silver-bearing veins.

Unconformities at Base of Cobalt Series

Numerous unconformities between the Cobalt series and the older rocks occur in parts of the area, a few of which are described below. There is a thin patch of conglomerate, with the underlying granite exposed in places through it, on the northwest shore of Obushkong lake. The conglomerate has rounded and angular fragments of the granite, and also a rusty-weathering diabase which cuts the granite immediately at the contact.

An even more striking conglomerate occurs on claims W.D. 961 and 964 northeast of Gowganda lake. The high conglomerate ridge, on which is located the fire-ranging observation-tower, rests on a basement consisting of greyish-green quartz porphyry, iron formation, and diabase dikes of pre-Cobalt series

age. Fragments of all these rocks are found in the conglomerate, near its base. This unconformity is well illustrated in the accompanying photograph.

North of Wilson lake in Nicol township, there are patches of conglomerate on the syenite, which has a characteristic porphyritic texture, and of which fragments are quite numerous in the conglomerate. The presence of so varied a group of inclusions from rocks occurring in place near the conglomerate indicates that many of the constituents of the conglomerate were local, and not transported any great distance. There are, however, numerous fragments of rocks not recognized in place in the area. The old surface, on which the Cobalt series was deposited, seems to have resembled greatly in topography that of the present time.

Unconformity in Cobalt Series

In 1909, N. L. Bowen found an unconformity on the north line of H.R. 311, west of Obushkong lake, where greywacké and fine-grained arkose show on a bluff about twelve feet high. At the base of the arkose, there are about two feet of a coarse reddish conglomerate containing some small pieces of greywacké, which, under the microscope, prove to be the same as the underlying greenish rock, indicating a break in the normal deposition. A similar break was seen southeast of Flanagan lake, near the south line of claim H.S. 712. West of Gowganda lake and on the long point extending into the lake, an upper conglomerate with a coarse reddish matrix occurs in considerable thickness. Similar conglomerate is seen in other parts of the area. The writer is not certain that the few feet of conglomerate below the arkose series on Obushkong lake is equivalent to all this coarse upper conglomerate. Where a great thickness of conglomerate occurs, a search failed to show any fragments of the underlying greywacké in it or many signs of an uneven and eroded surface.

It would appear that there is a local discontinuity in deposition at some points, but the general stratification and dip remain the same in the lower and upper parts of the Cobalt series. Owing to the widespread occurrence of the quartzite and arkose, it is possible to distinguish them from the conglomerate and slaty greywacké by different colours on the map; but the conglomerate, which appears to be part of the upper series, is difficult to separate, consequently it has been grouped with the other sediments apart from the quartzite and arkose. In the earlier reports on the Cobalt area, the upper quartzite and arkose were called the Lorrain series. These rocks are similar to those at Gowganda.

Adinole

Where the sill diabase has been intruded into slate-like greywacké, the overlying rock has been sometimes altered by diabase to adinole. The rock occurs abundantly around Lost lake, being reddish in colour and consisting principally of quartz and crystallized feldspar. Round blackish spots are often developed in the sediments near the contact. A rock of this description is seen along the road a mile west of Lost lake and on claim M.R. 2,239 (O'Gorman) in Leith township.

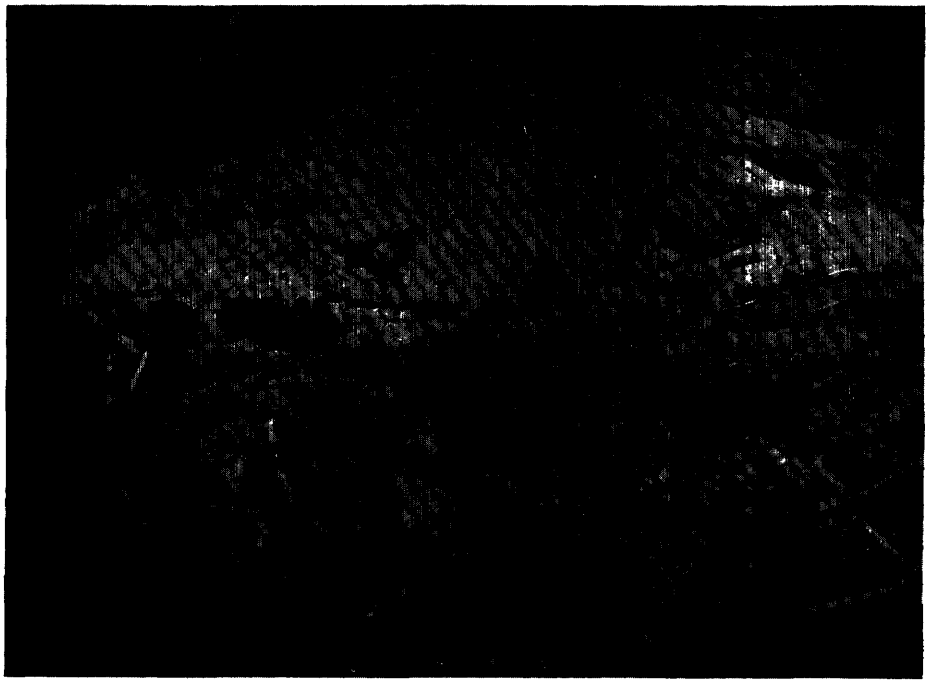
Nipissing Diabase

The most important rock from an economic point of view is the fresh quartz diabase that occurs in the form of laccolithic sills, or more likely one sill, over a great part of the Gowganda area. The resemblance of the outlying areas of diabase to the silver-bearing diabase sill at Cobalt led to the finding and prospecting of all such outcrops over a very wide area stretching from Cobalt to Shiningtree. The Gowganda area is only one part of this wider area in which

isolated masses of quartz diabase have been discovered. Consequently, the diabase at Gowganda is similar to that at Cobalt, with the exception that at Gowganda there is a considerable development of the red facies of the diabase, known as granophyre or red rock, in addition to the normal dark grey diabase. Numerous microscopic descriptions of the Nipissing diabase have been published, including those by C. W. Knight,[1] N. L. Bowen,[2] and W. H. Collins.[3]

The rock is generally intermediate to coarse grained, except at or near contacts where it may be fine grained and trap-like in texture.

The principal minerals of the normal diabase are plagioclase, usually labradorite or a feldspar near it in composition, together with augite, affording



Top of diabase sill with overlying banded slate-like greywacké, exposed on claim G.G. 4,108, north of Lake Irene.

an ophitic texture. Generally primary quartz, either alone or in microscopic intergrowth with feldspar, is present in the interstices. From the almost constant presence of quartz in micrographic intergrowth with feldspar, C. W. Knight has referred to the rock as a quartz diabase. Small quantities of biotite and magnetite, and occasionally apatite and pyrite, are present. N. L. Bowen has found a subordinate pyroxene, which he believes to be enstatite, in sections from the Gowganda diabase. Ordinarily the diabase is of a dark grey colour, weathering to a lighter shade, with brownish spots of weathered pyroxene showing on the surface.

This normal type of diabase is observed all across from the footwall to the hanging-wall in the sill just west of Miller lake, with no red rock produced as differentiated material. The hanging-wall here is basic Keewatin.

[1]Ont. Bur. Mines, Vol. XIX, 1913, pt. 2, p. 98.
[2]Jour. Geol., Oct.-Nov., 1910.
[3]Geol. Surv. Can., Mem. No. 33.

In some places, in addition to the grey feldspar, there is red feldspar imparting a mottled character to the diabase. The red is a more acid plagioclase and occurs with quartz in the interstices. This facies can be observed in places along the ridge west of Gowganda lake, e.g. at the Crews-McFarlan and Reeve-Dobie properties, along with the normal dark grey diabase.

Red Rock

A bright red to brown igneous rock occurs frequently with the normal diabase in several parts of the area. It is well exposed to the east and west of Lost lake. It resembles granite, but owing to its prominent micropegmatitic texture, is called granophyre. Microscopically, it shows crystals of albite surrounded by a radiating intergrowth of quartz and acid plagioclase, together with small quantities of chlorite. The granophyre is so coarse grained in some localities that the micrographic intergrowth can be recognized in hand specimens. This abundant granophyric rock occurs at the top of the diabase sill in the vicinity of Lost lake, at any rate where remnants of sedimentary rock can still be observed.

The origin of the red rock has been discussed fully by M. L. Bowen and W. H. Collins in the reports previously mentioned. In brief, Bowen believes the red rock, or granophyre, together with adinole, to have been formed by hydrothermal action at the contact on superincumbent slaty rocks. Collins states that most of the red rock has resulted from a differentiation of the diabase magma, with a small portion at the top of the sill being formed by assimilation of overlying greywacké and slate.

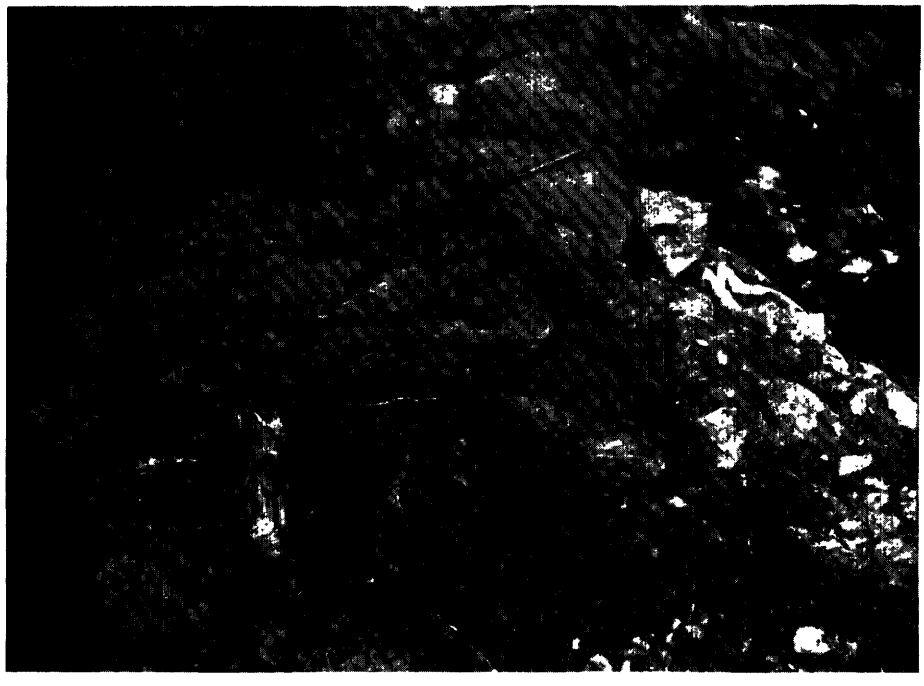
Certainly in the vicinity of Lost lake, there is strong evidence of red rock being formed by contact assimilation, and at points it is difficult if not impossible to define the boundaries of the intrusive and the quartzitic sediments.

Structure of Diabase

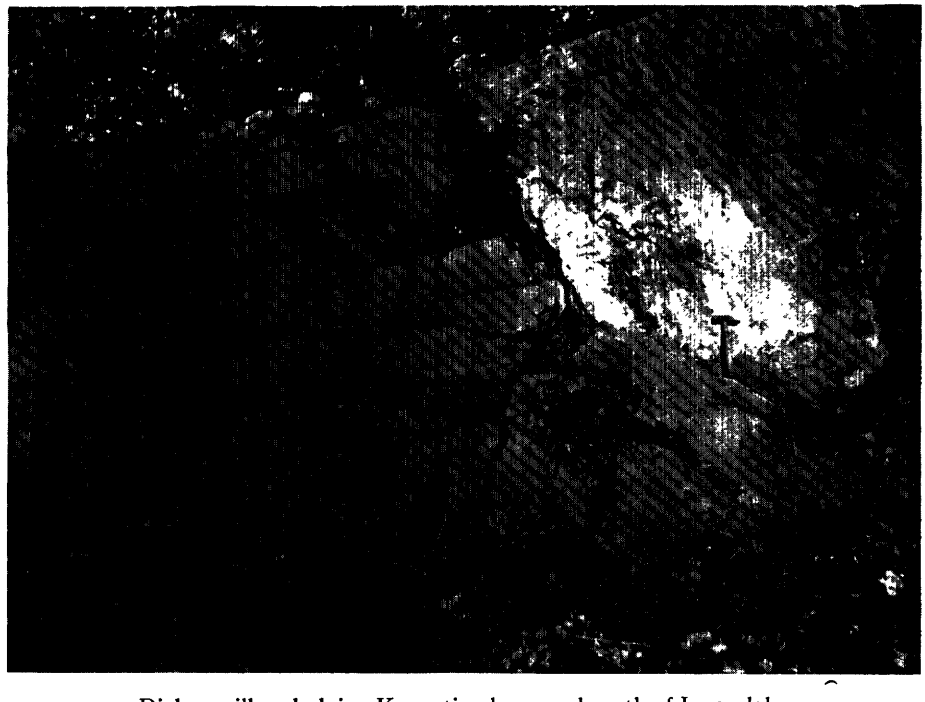
Miller Lake Area

Since the first examination was made by the author over seventeen years ago, repeated forest fires have devasted much of the Gowganda area so that parts have been burned off cleanly, affording many opportunities to note the relationship of the various rocks. Numerous contacts of the diabase with older rocks are well exposed in Haultain and Nicol townships. The sill character of the diabase can be determined from exposures showing both the bottom and the top of the intrusion.

Footwall Contacts.—The footwall of the sill outcrops at various points from the wagon road on claim H.J.B. 46, northward to claim R.S.C. 102, near Everett lake, where it swings eastward and northeastward to Shanty lake and beyond. The contact varies from nearly horizontal to 60 degrees. Near Shanty lake, the diabase overlies the slate-like greywacké almost horizontally, and on claim L.M. 108 it overlies Keewatin banded rocks, dipping 60° N. One of the best footwall contacts occurs on claim H.J.B. 46 to the south of the road, one and a half miles east of Gowganda lake. The diabase in thin isolated patches overlies the sedimentary rock nearly horizontally in places, with a general undulating dip to the northeast. Judging from the contacts along the footwall edge of the diabase, the sill was intruded very irregularly, only conforming to the dip of the sedimentary strata where they are highly stratified, e.g. the greywacké slate near Shanty lake. The attitude of the sill on claim L.M. 108 has been influenced by the highly banded, nearly vertical character of the Keewatin rocks.



Diabase sill overlying Keewatin, claim L.M. 105, near Everett lake.



Diabase sill underlying Keewatin along road south of Leroy lake.

Hanging-Wall Contacts.—The observed contacts at the upper side of the diabase sill are even more numerous than the bottom. The upper contact is well exposed 100 feet west of No. 3 shaft, Castle mine, R.S.C. 101; on claims R.S.C. 95, 91, and 94 of the Miller Lake O'Brien mine; on R.S.C. 136 (Hart) claim; on claims W.J. 13 and W.J. 6, southwest and south of Leroy lake, respectively; and on claim P.B. 140, southeast of Leroy lake.

The circular area of Keewatin rocks, overlain in part by the Cobalt series, occurring in the vicinity of Miller lake, rests on the diabase sill; and it is around this area that most of the contacts just referred to are located. The area of Keewatin and Cobalt series to the east of Leroy lake also lies on the sill, as do the greywacké and conglomerate around Lake Irene. To the east of Lost lake and extending northward to Bloom lake, the diabase sill dips under the sediments of the Cobalt series. For this area the diabase sill has an undulating character, being exposed in places by partial erosion, and at other places concealed by the overlying Keewatin and later sediments. Westward toward Gowganda lake, the sill has been entirely removed by erosion.

A great number of silver discoveries have been made in the diabase where it is in proximity to the contact with the overlying rocks, that is in the upper part of the sill around the margin of the Keewatin-Cobalt series area in the vicinity of Miller lake. A few discoveries of silver have also been made in the overlying rocks.

Columnar jointing in the diabase, representing structure at right angles to the cooling surface, is well developed at various places. It is particularly well shown in the cliffs on the Bonsall property, R.S.C. 83, also on claim H.R. 716, southeast of Leroy lake.

The relationship of the sill diabase to the other rocks is illustrated in a number of cross-sections accompanying this report.

Area West of Gowganda Lake

A sufficient number of contacts have been observed to show that the various outcrops to the west of Gowganda are parts of one sill that has been exposed here and there by erosion of some of the overlying sedimentary rocks. Several ridges of diabase, with a north and south strike and with intervening bands of sediment, occur from the long point on Gowganda lake westward to Elkhorn and Spawning lakes. The intrusion of the diabase sill was not regular but undulating, principally eastward and westward.

The mass of diabase lying between the north and northwest arms of Gowganda lake dips under the sediment to the east and west. At the north end of this ridge, as shown on claim H.F. 250, the diabase sill rises and the footwall is exposed, showing a thin sheet of diabase on the greywacké. Remnants of the diabase sill occur to the west and north of Diabase lake. The west edge of the diabase sill is the hanging-wall side, and the conglomerate along the northwest arm lies on the sill, which is again exposed on the Mann ridge, where good contacts of the sediments with the sill can be seen on the La Brick and Hewitt properties. To the west of the south end of Gowganda lake, the Mann diabase ridge divides into two parts. The eastern part dips under the conglomerate to the east, but overlies the quartzite to the west. The west ridge also overlies the quartzite, but dips westward under the greywacké that occurs around Long lake. The areas of sediment from Long lake northward to Stuart lake all overlie the sill, which outcrops again near Elkhorn northward to Spawning lake.

No contact was observed along the west edge of the diabase with the greywacké near Margueratt lake, but it is believed that this edge is the footwall

side of the sill, the conclusion being derived from the attitude of the diabase bluffs facing westward which show columnar structure inclined to the east.

From Elkhorn lake eastward to Frying-pan and Hanging-stone lakes, only one contact was observed, on claim T.C. 129, and this indicated that the diabase dips under the greywacké at an angle of 60° S.E.

The most convenient locality to observe contacts of the sill diabase with the sediments is Gowganda lake. Numerous contacts occur along the east shore of the long point in Gowganda lake showing the sill below the greywacké. The best of these are on claims H.R. 292 and H.S. 377. On the latter claim, there is a wide exposure of diabase from which the overlying greywacké has been removed by erosion, exposing the trap-like character of the diabase where the contact was at the top of the sill.



Diabase underlying Keewatin, southeast of Leroy lake on claim P.B. 140.

Good contacts occur also on claim H.S. 451 at the southwest end of the lake, where there is a thin sheet of sediment, a few feet thick, lying on the sill. Some adinole has been developed by contact metamorphism.

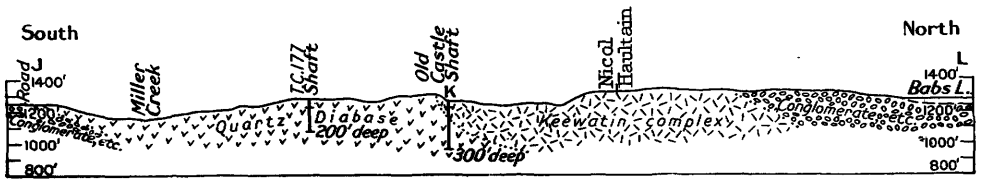
Relations of Nipissing Diabase Areas

The Gowganda lake fault along the east shore of this lake follows the depression northward to Dinny and Davidson lakes, and the west branch of the Montreal river to the south. On claim T.C. 162, near Gowganda village, some of the footwall of the diabase sill occurs as remnants overlying quartz porphyry; while to the west of the ravine is a prominent ridge of the sill faulted downward. In addition, the rocks on the west side of the fault have been thrown about one mile to the north, indicated by a prominent olivine diabase dike, which has been displaced by the fault. A parallel north-south fault is

indicated by the north arm of Gowganda lake, extending to Diabase and Obushkong lakes.

One contact was observed along the east side of the long, narrow diabase ridge lying west of Davidson lake, the diabase quartzite contact being nearly vertical and the inclination, if any, being to the east. Along the west side, near Obushkong lake, several contacts were observed showing the diabase overlying the quartzite at an angle of 45 degrees. The sill in this long, narrow exposure appears to rise toward the north. Around Burke lake, the contacts indicate the diabase going under quartzite and connecting with the diabase west of Gowganda lake.

While geological work has not been carried sufficiently far to show the relationship of all the areas of sill diabase in Gowganda to each other, where this work has been done, it has been possible to connect certain exposures as being parts of one sill. In some portions of the area, the diabase has been completely eroded; in others, the footwall and hanging-wall contacts are revealed, and a cross-section of the diabase is seen at the surface. The diabase exposures from Lost lake to Elkhorn lake can be shown to belong to one sill. The strong north-south fault along the east side of Gowganda lake has the downthrow on



Section JKL, showing relationship of Nipissing diabase sill to older formations at Gowganda. Horizontal scale, one-half mile to the inch, the same as map No. 35*d*.

its west side, consequently much of the diabase lying west of Gowganda lake has been preserved from erosion.

It is very probable that regional study of the diabase areas, including the Cobalt, South Lorrain, Timagami, Elk Lake, Gowganda, and other areas lying west of Lake Timiskaming would show all of these to be parts of one diabase sill of immense lateral proportions.

Jointing in Diabase

The diabase in many exposures shows a columnar structure, which has been formed at right angles to the upper or lower surfaces of the sill. The jointing planes are often conspicuous on the faces of cliffs and also in underground workings. These planes usually stand at high angles, indicating a low dip of the contact with the older rocks. Parting planes roughly parallel to the contact occur in the diabase.

In some localities, the hexagonal columns give place to rough, cylindrical-like columns, the cross-section being circular. These structures are often 10 to 15 feet across, and within the structure there may be parting planes six inches to a foot apart, also curved. The structure may be observed in the diabase on the surface at the Castle-Trethewey and Miller Lake O'Brien properties, and elsewhere. The occurrence of this peculiar jointing seems to afford a favourable location for the occurrence of silver-bearing veins, for fractures are found following the curved structures in parts of their course, making for a network of veins. Such structures are observed underground at the producing mines.

The occurrence of silver ore in the Miller Lake section of Gowganda, near the upper contact of the diabase sill, may be due to some peculiar contact conditions of the diabase with the older rocks, such as bay-like (convex) protrusions of the sill, or the reverse, which could account for the curved joint fractures that are so noticeable at various properties. The contacts are so seldom encountered in the underground workings, being cut at only a few points, that it would be difficult to construct in detail the curving plane contact of the diabase and the older rocks.

The ore shoots occur in more or less connected veins in separate groups in the diabase sill.

Thickness of Sill

While there are localities where the diabase sill is exposed at the surface diagonally across its thickness, only at the Miller Lake O'Brien mine has an estimate of the thickness been made in mine work and diamond-drilling done from the top to the bottom. J. G. Dickenson reports a diamond-drill hole from the 350-foot level, approximately 350 feet from the upper contact, to have penetrated the underlying Keewatin at 940 feet, which would give a rough estimate of 1,290 feet for the sill. This is probably somewhat greater than the actual thickness in the locality. To the north of the Castle-Trethewey, on claim L.M. 108, the width of surface exposure is about 1,250 feet, and the actual thickness of the sill would be less than this.

Dikes Later than Nipissing Diabase

Olivine Diabase

Only one olivine diabase dike was observed in the Miller Lake section. This dike is about 100 feet in width and has been traced about five miles in a northwest direction. It intrudes all the other formations, intersecting the diabase sill that occurs around Miller lake. The dike is well exposed along the road on the ridge just west of the Canadian Gowganda property. The rock has a porphyritic texture, showing phenocrysts of light-greenish plagioclase up to an inch in length in an ophitic groundmass of plagioclase, augite, and olivine.

An olivine diabase dike with similar strike occurs to the northwest of Obushkong lake and is described by N. L. Bowen[1] in an earlier report on the Gowganda silver area. This dike is evidently a faulted portion of that previously described.

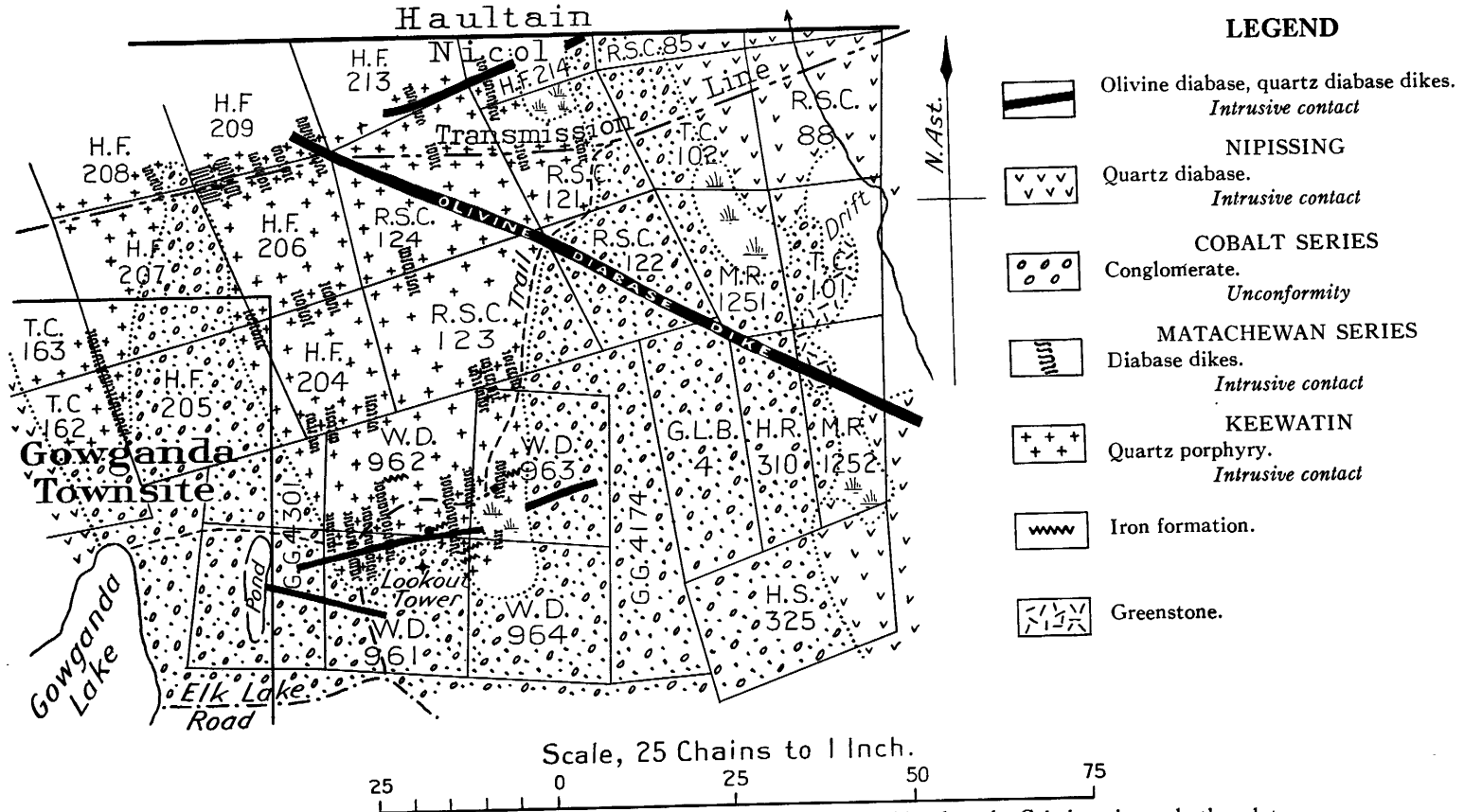
Quartz Diabase Dikes

There are also several quartz diabase dikes, that intrude the Cobalt series, whose relation to the diabase sill is unknown, and several that intrude the diabase sill. These are non-porphyritic, and have a more rusty weathered surface than the sill diabase. Two of these dikes, striking northeast, cross the Bonsall property, claims R.S.C. 83 and R.S.C. 84. Their relation to the silver-smaltite-bearing veins is not known. A calcite vein about three inches wide carrying masses of galena lies along the contact of one of these dikes with the sill diabase on claim R.S.C. 84. The pure galena carries 11.6 ounces of silver per ton.

Occurrence of Silver Ore

Silver-bearing veins have been found in widely separated areas from Cobalt westward to Shiningtree. Of the outlying areas, Gowganda is important in

[1]The Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming, Ont. Bur. Mines, Vol. XIX, pt. 2, 1913, p. 179.



Geological plan of part of Nicol township, illustrating certain diabase dikes older than the Cobalt series and others later than the Nipissing diabase.

the discovery of veins and shipment of silver ore. Nearly all the silver deposits are in the Nipissing diabase, which occurs in a number of townships around Gowganda lake. The most important townships are Haultain, Nicol, and Milner, from which a number of shipments of high-grade ore have been made. Silver has also been discovered in several other townships, including Leith, Van Hise, Charters, Lawson, Corkill, and Morel. Small quantities of ore have been shipped from Leith, Lawson, and Corkill townships.

In addition to those found in the diabase, a few silver-bearing veins have been discovered in the Keewatin greenstone, and the conglomerate of the Cobalt series. Where the discoveries have been made, these formations overlie the diabase sill and the veins are near the hanging-wall contact. In Gowganda no silver-bearing veins have as yet been found in rocks that lie below the diabase sill. At Cobalt most of the ore has been obtained from deposits, chiefly in conglomerate and greywacké, below the sill, which has been removed by erosion.

While a few places in Gowganda reveal the footwall rocks on which the diabase sill rested, most of the sediments and some of the Keewatin rocks are above the sill. The erosion has extended chiefly into the upper part of the sill, exposing it in more or less irregular and connected areas. An example of this is the sill of diabase in the Miller Lake section, which rises toward the west, but eastward to Lost and Wigwam lakes it has several patches of older rocks overlying it. Discoveries of silver ore have indicated the desirability of prospecting the diabase and older rocks in the vicinity of the upper or hanging-wall contact, at least in the Miller Lake section.

The workings at the Miller Lake O'Brien mine are all in the upper part of the diabase sill. The rich ore shoot at the Millerett mine, which was mined out several years ago, was in conglomerate that lay above the diabase sill. On the Castle property, R.S.C. 101, a high-grade vein discovered in 1920, was in Keewatin overlying the diabase sill, while operations later proved the vein to continue below the contact into the underlying diabase. Some rich ore was also encountered in Keewatin overlying the sill on the Silver Bullion property northeast of Leroy lake.

The silver-bearing veins at No. 2 shaft of the Castle property, R.S.C. 101, are in the diabase, which has been eroded well down from the original top of the sill, and are apparently not far from the centre of the sill.

The veins at No. 1 shaft, Bonsall mine, are in the lower part of the sill, while those at No. 3 shaft are in the upper part of the sill near the upper contact with the Keewatin.

The most recently discovered silver ore in Gowganda, that at the Tonopah mine, was first located in the diabase about 250 feet from the overlying Keewatin greenstone.

The principal ore shoots in the Miller Lake section have occurrred in the upper part of the diabase sill within about 400 feet from the contact.

Silver ore has been found at several horizons in the diabase to the west of Gowganda. At the Boyd-Gordon and Mann properties, the veins that produced the ore are in the upper part of the sill; the hanging-wall contact with the greywacké was encountered a few hundred feet west of the Boyd-Gordon shaft.

At Nos. 1 and 3 shafts of the Crews-McFarlan (formerly Bartlett) property near the south end of Gowganda lake, work was done on several veins that are in the lower part of the diabase sill. The footwall here is quartzite, but the workings have not been carried at either shaft to the contact which can be seen on the surface to the east. The diabase from the bottom workings of No. 1 shaft is fairly fine grained.

Origin of Silver Ore

Regarding the origin of the silver-cobalt veins at Cobalt, W. G. Miller remarks as follows:—

> The material in these veins has, in all likelihood, been deposited from highly heated and impure waters which circulated through the cracks and fissures of the crust and were probably associated with—followed—the Nipissing diabase eruption. It is rather difficult to predicate the original source of the metals—silver, cobalt, nickel, arsenic, and others—now found in these veins. They may have come up from a considerable depth with the waters, or they may have been leached out of what are now the folded and disturbed greenstones and other rocks of the Keewatin. Analyses of various rocks of the area have not given a clue as to the origin of the ores. However, the widespread occurence of cobalt veins in the diabase, or in close association with it, shown by discoveries during the last seven or eight years, throughout a region three thousand square miles or more in extent, appears to be pretty conclusive proof that the diabase and the ores came from one and the same magma. . . .
>
> The waters are said to be associated or connected with the diabase eruption in the sense that they probably represented the end product of the eruption. In many volcanic regions hot springs are present long after the rocks have been solidified. In the Cobalt area the fissures and joints now occupied by the ores were probably produced by the gradual shrinkage in cooling of the diabase, the ores being deposited by the waters which represented the last stage of vulcanicity.[1]

Veins

Certain characteristics of some veins in Gowganda, Elk Lake, and elsewhere seem to point to a genetic relationship with the diabase. A number of the veins are aplitic in composition. The aplite is considered a differentiation from the diabase magma. Frequently the aplite grades into diabase along the walls; at other times it is sharply defined against the diabase walls. Some veins show aplite next to the diabase, followed by a layer of crystallized quartz, the crystals of which extend into the calcite, which may occupy the centre of the vein. This type of vein frequently carries some native silver, smaltite, and niccolite. The silver in the aplite and diabase is usually in thin scales or sheets. The occurrence of the diabase, aplite, and quartz, successively, points to differentiation, while the calcite and the ores have come in later, probably from the same source. The aplite type of vein, however, varies greatly in the arrangement of the constituent parts, the calcite and ores often being irregularly distributed in the aplite.

Most of the veins are not aplite, but the chief gangue is calcite, frequently accompanied by some quartz; in fact, some silver-bearing veins carry considerable quartz. Some of the veins are quite narrow and interrupted, following the columnar jointing planes, and evidently represent the filling of cooling cracks after solidification and shrinkage of the sill.

Many veins are quite strong and can be traced in a fairly straight course for several hundred feet. They sometimes occur in a series more or less parallel. Several parallel veins, with strike N. 15° E., were found on the Mann property west of Gowganda lake. Some of the parallel veins are sufficiently close to mine together. Veins of this character have been worked at the Miller Lake O'Brien and Castle mines.

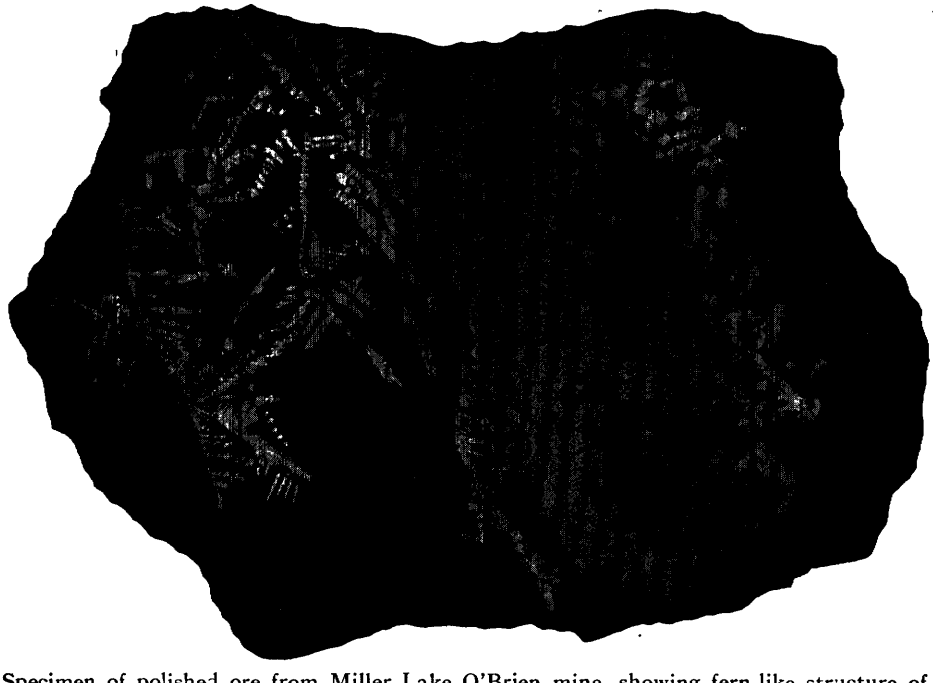
The veins vary greatly in width, and it would be difficult to state an average. The productive veins are usually from a fraction of an inch to 12 inches in width. However, veins occur that are as wide as two or three feet; but these are exceptional, and generally the wide calcite veins have not shown much value. One very strong vein, as wide as three feet in places, was found southeast of Miller lake. This vein, known as the Morrison, was traced for 2,000 feet across

[1]The Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming, Ont. Bur. Mines, Vol. XIX, pt. 2, 1913, p. 8.

several claims. On claim T.C. 315, some high-grade ore consisting of silver, smaltite, niccolite, and native bismuth occurred over a length of about eight feet along the surface.

A wide calcite vein, striking east, occurs on the Miller Lake O'Brien property. This vein cuts a north and south silver-bearing vein. Vein No. 7 at this property for a portion of its length showed a width of two feet of high-grade ore. The high-grade ore of No. 3 vein, Mann mine, varied from one to 5½ inches in width.

Several narrow veins with approximately the same strike sometimes unite to form one vein for some distance. Deposits of this character occur on the Miller Lake O'Brien and Castle properties. Where veins are parallel, one vein may carry ore and an adjacent one may have little or no ore; while farther along in the workings these conditions may be reversed. Where several silver-bearing veins occur over a stoping width, the intervening wall rock usually carries native silver in the form of thin scales or sheets in minute cracks, which



Specimen of polished ore from Miller Lake O'Brien mine, showing fern-like structure of crystallized native silver and cobalt-iron arsenides (white) and crystallized arsenides (light grey) in calcite gangue (dark grey). Some of the silver occurs in minute veinlets in the calcite and arsenides.

are generally roughly parallel with the veins. Even along a single narrow vein, there is generally a little leaf silver in the rock adjacent to the vein.

A narrow calcite vein an inch or so in width may show segregations, over a few feet in length, of silver and smaltite[1] entirely filling the vein, while the rest of the vein is calcite with dissemination of copper pyrites. Crystals of reddish-brown apatite with specularite and copper pyrite occur in calcite veins half a mile north of Leroy lake. Apatite has not been recognized elsewhere at Gowganda.

[1]The term "smaltite" is used in the report to cover the grey arsenical minerals which accompany the silver. Detailed examination of certain ores by E. W. Todd has shown the grey mineral to be a mixture of several arsenides and sulpharsenides of iron, cobalt, and nickel. Without such examination it is impossible to name the individual minerals.

Ore Shoots

As at Cobalt, it has been found at Gowganda that the high-grade silver ore occurs in shoots in the veins. A vein may be several hundred feet in length and show over 100 feet of an ore shoot, or one only a few feet in length. A number of veins have shown a little native silver in places, but with no determinable ore shoots. The ore shoots vary greatly in size. The largest of these so far discovered were in the area northwest of Miller lake. An ore shoot in the conglomerate at the old Millerett property (now Miller Lake O'Brien) was about 150 feet long, averaging about two inches in width of high-grade ore, together with mill rock for about two feet on either side of the high-grade. Ore shoots on the Miller Lake O'Brien and Castle properties are up to 300 feet in length. In No. 3 vein, Mann mine, several ore shoots were discovered and developed, varying from 35 to 65 feet in length. Extremely rich but short ore shoots were mined at the Reeve-Dobie.

These measurements refer to the length of shoots on the surface or in drifts. The pitch length of a shoot may be greater or less than the drift length. Near Miller lake, the shoots are generally found to be longer on the pitch than along the drift.

DESCRIPTION OF MINES AND PROSPECTS

When the camp was revisited in 1925, the activity was confined to the area stretching from Gowganda lake to Lost lake. However, as much work has been done in other parts of the area over a period of several years, and since some of the properties are likely to be reopened, the descriptions given in the report of 1921 are reprinted in this report.

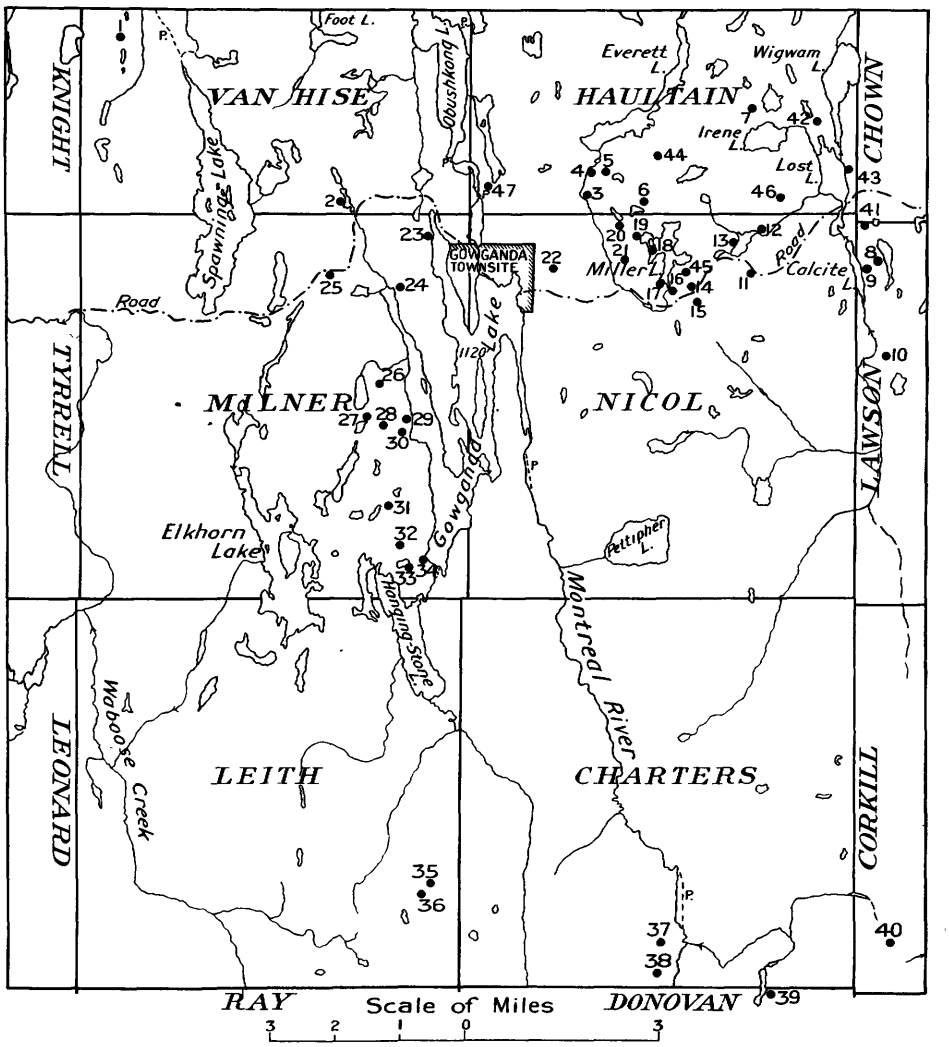
Haultain and Nicol Townships

Bonsall

The Bonsall property was among the earliest operated at Gowganda. It includes eight claims: R.S.C. 82 to 89, inclusive, situated northwest of Miller lake. The first work was done on claims 82 and 83, on veins carrying native silver discovered by Percy Bonsall in 1908. Most of the silver and smaltite showed in a narrow vein, averaging about one inch, with strike N. 34° E., which was traced for 100 feet by trenching. The surface of the vein was much oxidized, showing crystallized silver in black, cobalt and nickel, decomposition products. A shaft was sunk on the vein to a depth of 25 feet and a drift run northward.

A main shaft was later sunk on a cross-vein that strikes nearly east and varies from one to four inches in width. This vein intersects the previously described vein 30 feet east of the shaft. A drift at the 25-foot level was made along the vein for 60 feet and on the narrower vein for 40 feet. High-grade ore of the character shown near the surface was not encountered. The rich ore was found to occur near the junction of the two veins. About 30 sacks of ore were taken out in 1909. The main shaft was continued to a depth of 125 feet with a north-south drift of 60 feet in a faulted zone on the 75-foot level and 186 feet of drifting and crosscutting on the 120-foot level.

The property was reopened several years later by the Miller Lake O'Brien interests, who did considerable work at the lower level. A strong north-south fault, dipping 45° E. and showing about 12 feet in width of fractured diabase, was encountered 45 feet east of the shaft. This fault was also crossed at 60 feet in the shaft and would reach the surface in the bed of Miller creek. To the



KEY PLAN OF GOWGANDA SILVER AREA, SHOWING THE LOCATION OF THE PRINCIPAL MINES AND PROSPECTS.

VAN HISE
1. Alpine
2. Hedlund

HAULTAIN
3. Bonsall (O'Brien)
4. Everett
5. Castle-Trethewey
6. Capitol
7. Barbara
42. Haultain
43. Wigwam
44. Millcrest
46. Ottawa Gowganda
47. Cobalt Nugget

LAWSON
8. Keora
9. Bishop
10. Powerful
41. Sanderson

NICOL
11. Lafayette
12. Silver Bullion
13. Coleroy
14. Morrison
15. Canadian Gowganda
16. Hylands-Johnston
17. Hart
18. Tonopah
19. Castle-Trethewey
20. Miller Lake O'Brien
21. T. C. 177
22. Big Four
45. W. J. 9

MILNER
23. Gowganda Lake
24. Northcliff
25. Bishop
26. Hewitt
27. Boyd-Gordon
28. Mann
29. Milne
30. Silvers Ltd.
31. Reeve-Dobie
32. Crews-McFarlan
33. O'Brien
34. South Bay

LEITH
35. Silverado
36. Hudson Bay

CHARTERS
37. Garvey
38. Haines

DONOVAN
39. Willans

CORKILL
40. Kell

east of the fault, the east and west vein was drifted on for 130 feet. The vein carries calcite with some quartz containing copper pyrites, galena, and a little native silver. A second vein, 175 feet southeast of this vein, was drifted on for 26 feet. It showed low assay values in silver.

From March to July, 1920, the property was worked under the management of George Glendinning. The workings at the various shafts were dewatered, and the veins sampled at the several levels. At the main shaft, No. 1, the work at the 120-foot level consisted in extending the drift on the main vein for 71 feet and on the south vein for 108 feet, with 23 feet of crosscutting. At the 75-foot level a crosscut was made eastward 33 feet to the vein, and 83 feet of drifting was done in a northeast direction. A raise was made at the intersection of the vein to the 25-foot level. This level was also connected with the open-cut. From these operations a quantity of silver ore was hand-sorted, bagged, and shipped to Cobalt.

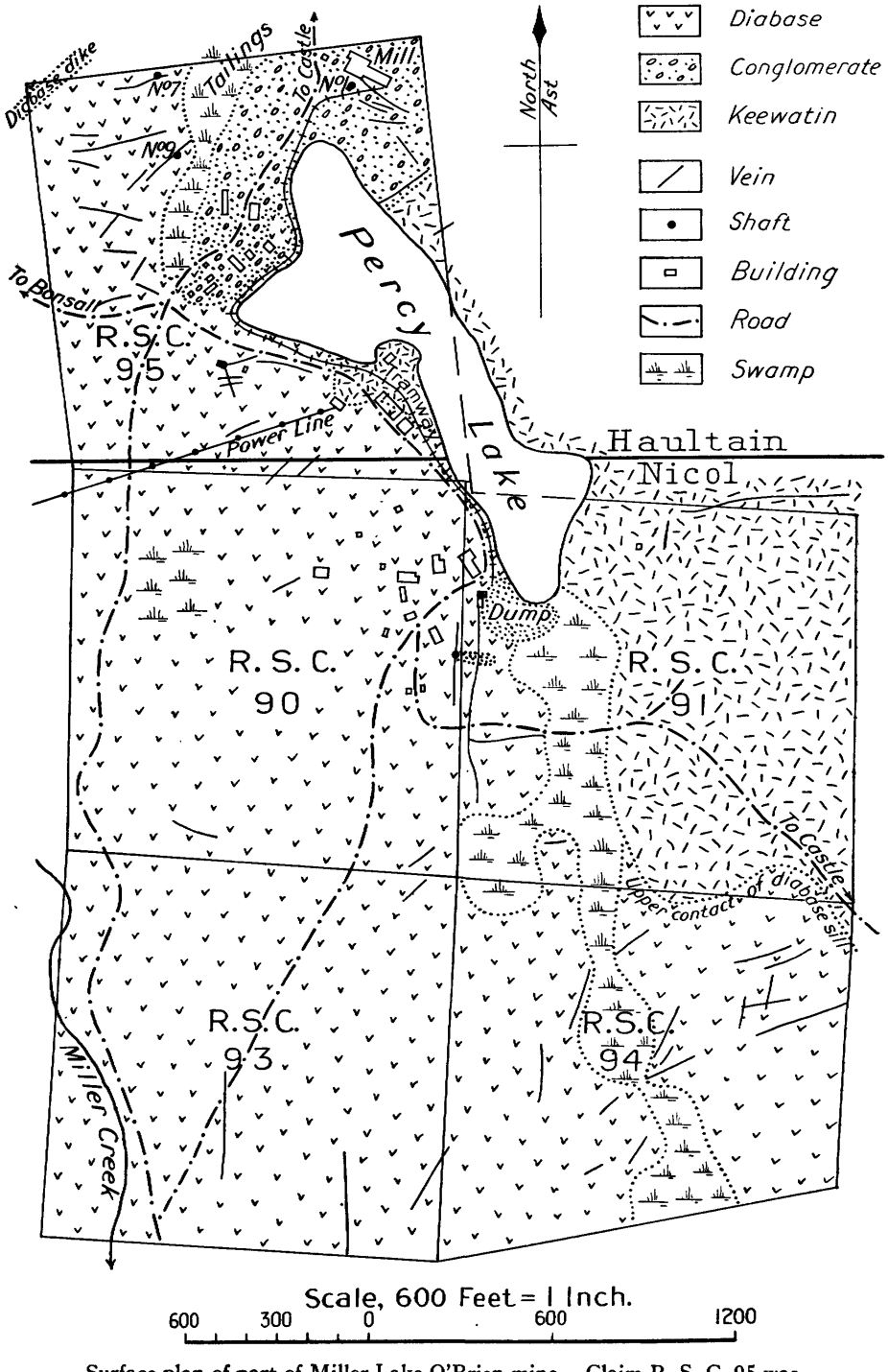
In addition to the operations at the main shaft, some work has been done on the east side of the property, on claim R.S.C. 84. Two shafts were sunk by the early operators on silver-bearing calcite veins. The east shaft, 60 feet deep with some lateral workings, was too wet for operating, and a second shaft was sunk to the 100-foot level on a narrow calcite vein, an inch or two in width, which showed a few segregations of silver and smaltite. The drift at the 100-foot level, 74 feet in length, showed the vein to carry a little silver and smaltite, similar to that on the surface. Several veins occur on the surface, but little work has been done. Owing to the favourable location of the veins in the diabase near the upper contact with the Keewatin, it would seem that this locality would warrant more extensive exploration.

The property is equipped with a plant at the western workings, consisting of two 50 h.p. boilers, a straight-line compressor, and a hoist. A plant at the eastern workings was destroyed by a forest fire. The property has been purchased by the owners of the Miller Lake O'Brien mine and now forms part of that group. Very little additional work, beyond trenching on the northeast claim, has been done. A north-south vein in the Keewatin on the Castle property was traced southward on to the Bonsall claim.

Miller Lake O'Brien

The following is reproduced from the Twenty-ninth Annual Report of the Ontario Department of Mines, 1920, part III, pages 81 to 84.

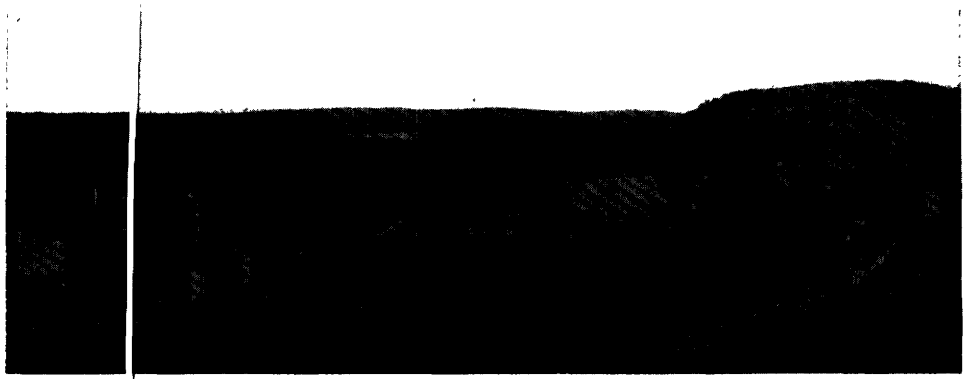
The Miller Lake O'Brien mine comprises a group of claims to the northwest of Miller lake. They were formerly the Gates claims, on which discoveries of native silver and smaltite were made in 1908. Later the Millerett mine was purchased by the Miller Lake O'Brien Company. The first development was done on veins with a general north and south strike, lying near the line between claims R.S.C. 90 (654) and R.S.C. 91 (653). Of these the most important were known as No. 2 vein system, which produced most of the ore in the early years of the mine. Development showed the veins of this system to dip steeply to the west, with the pitch of the ore shoots to the south. Of this system, the footwall veins have been the most productive. The ore shoot in the hanging-wall veins did not extend to the 140-foot level, whereas the footwall ore body continued nearly to the 350-foot level. Each of these series carried two or more veins, which were sufficiently close together, where the ore shoots occurred, to allow mining in one stope. The veins were generally from two to five inches wide, and in the ore shoots individual veins were not always productive, but where one was barren, a parallel vein would carry the high-grade ore. Very little ore was taken from this system above the 60-foot level. The greater proportion of the silver values was confined to the veins themselves, there being only a small impregnation of the wall rock. Strong east and west faults, dipping 30° N., were encountered in the workings on No. 2 system. In developing this vein system a series of cross-veins was encountered south [and east] of the shaft, on the 250-foot level, having an east and west strike. This series of veins is known as the cross-system and dips to the south at a high angle. An ore



Surface plan of part of Miller Lake O'Brien mine. Claim R. S. C. 95 was formerly the Millerett mine.

shoot was found on the 250-foot level and was stoped a short distance above the 140-foot level. It was followed down below the 400-foot level with decreasing length along the drifts.

The latest discovered ore system is known as the "Flynn." The first ore was encountered on the 350-foot level. A long east and west drift had crossed a very pronounced north and south fault, dipping 50° E., and a northerly crosscut had intersected No. 6 vein, which was followed to a second fault, striking east and west and dipping 30° to 40° N. Ore was found in No. 6 vein above this fault. From this discovery the development was extended to a number of veins, the principal of which are No. 6, No. 7 N., No. 7 N.W. On stoping No. 6 above the 350-foot level it was found to join No. 7 N., producing the greatest width of high-grade found in the mine, where one portion of the vein was three feet wide, of high-grade silver, smaltite, and calcite. Later, in drifting on No. 7 vein on the 350-foot level, portions of it were of high-grade ore two feet wide. In this rich section of the "Flynn" system, the stope was 14 feet in width, in places, of high-grade veins and mill rock. Development in this part of the mine threw light on the ore relationships. The workings show that the high-grade values did not extend into the Keewatin, while [in that formation] the veins themselves became more indefinite, branching into stringers carrying galena, copper pyrites, and other common minerals. The contact as determined at a few points in different parts of the mine dips from 30 to 20 degrees (with the sill diabase below the Keewatin greenstone), gradually flattening.



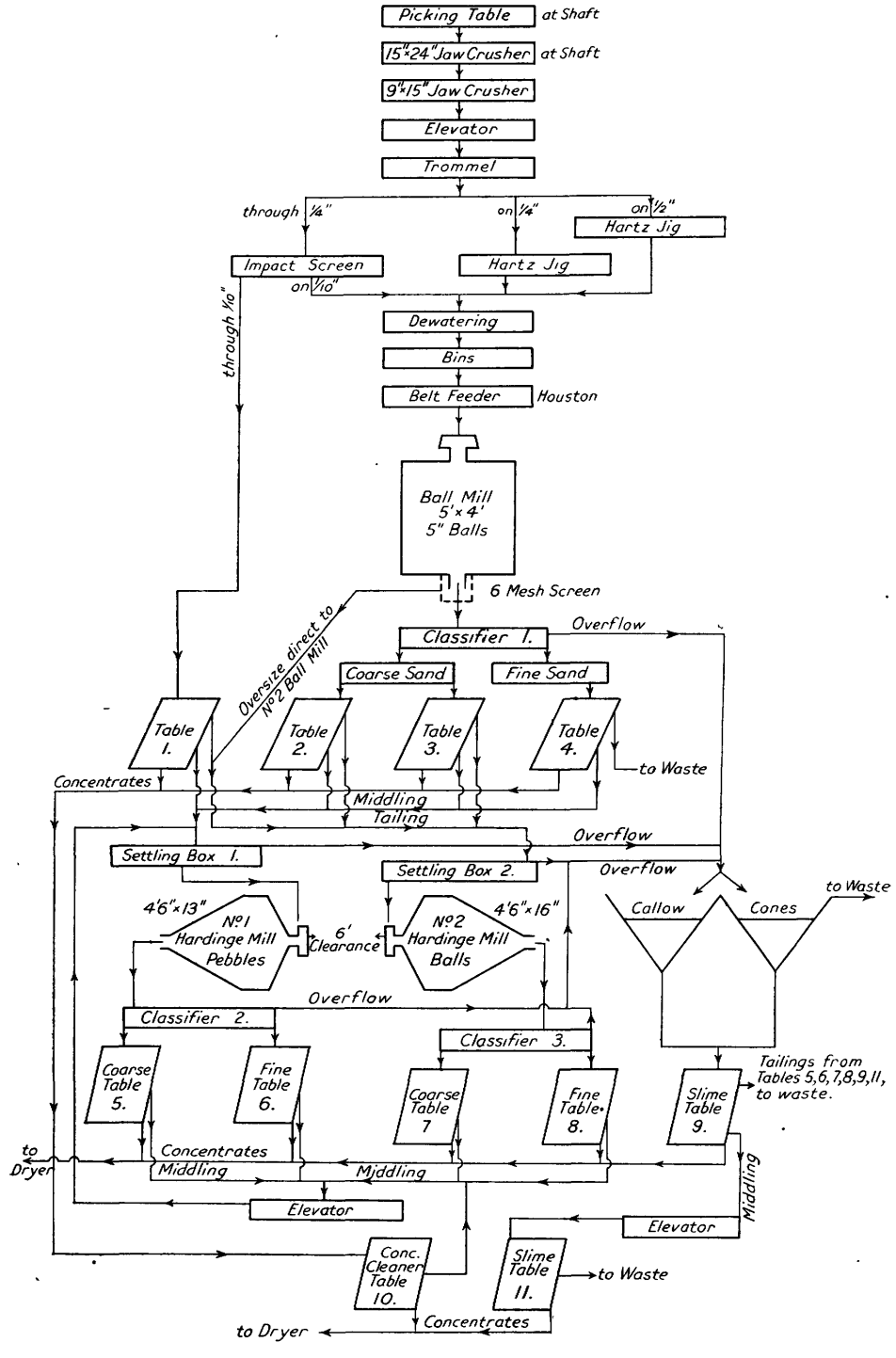
Miller Lake O'Brien mine.

Development has shown the aforementioned east and west fault to be generally the lower boundary of the ore. The veins carrying the ore are said to have been only slightly displaced by the fault. One vein, No. 7 N.W., was observed to have been faulted about three feet. In this vein the east and west fault is not the lower boundary of the ore, since ore was being stoped from it on the 400-foot level below the fault. The ore occurs in the diabase below the Keewatin greenstone, while the main ore shoots pitch to the north, being controlled by the Keewatin-diabase contact and the east and west fault, the ore not necessarily coming close to the contact. In developing vein No. 7 N., which carries the principal ore body, an inclined winze (87° W.) has been carried from the 350-foot level to the 525-foot level, and the ore from this and other veins is developed from the several levels.

Development at this mine on R.S.C. 90 and 91 has shown all the ore so far to be in the diabase. The early workings at No. 2 vein system were in the diabase, which outcropped at the surface, where only a small portion of the sill had been eroded. Later work being in the diabase below the Keewatin, it has been determined that silver ore occurs at greater depth from the present surface, depending roughly on the Keewatin-diabase contact. The silver ore occurs in the upper portion of the diabase sill in proximity to the contact. . . .

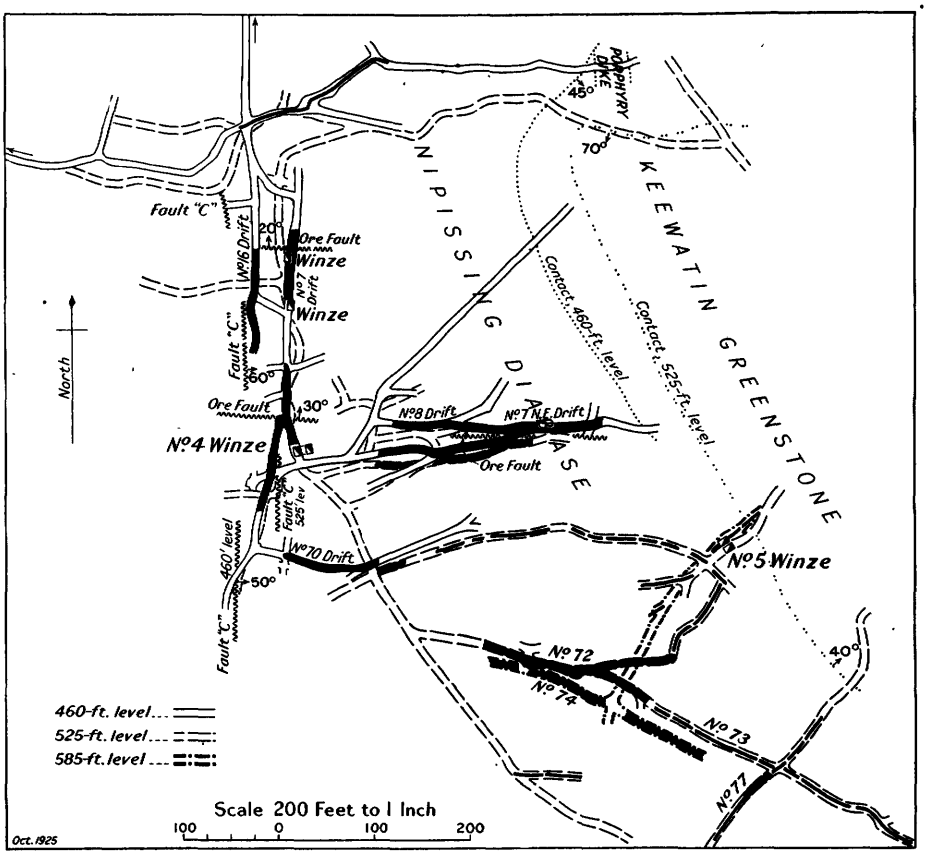
Power for the mine is supplied by a hydro-electric development at the foot of Gowganda lake. The natural fall is 27 feet, but by a dam it is raised to 30 feet and the installation is capable of developing 500 horse-power. The transmission line is 2¼ miles in length and the voltage 4,000.

During 1920, operations were continued on the series of veins in the Flynn system. A new vein, No. 16, carrying native silver, which lies 25 feet west of the north part of the main vein, No. 7 N., was discovered and drifted on for 140 feet on the 460-foot level. This vein lies above the strong north-south fault, which dips 50° E.; and the ore shoot in this vein, as well as N. 7 N.W., was not located below the fault. Further work was done on vein No. 7 N.E., in which ore was found on the 525-foot level below the prominent east-west fault, called the ore fault, which in several veins terminated the downward extensions of ore shoots.



Flow-sheet, Miller Lake O'Brien mill, January, 1926.

Further exploratory work was done in 1924 on a series of veins lying to the south of the Flynn system, resulting in the finding of further ore shoots on which more recent development work has been done. The veins occur in a connecting system of fractures which, in part, follow the curved columnar jointing of the diabase. The most important ore shoot on the 525-foot level is No. 73, where for a length of 210 feet the ore is high grade. It consists of from one to three veins up to six inches in width. In one part of the stope, three veins occur, showing considerable leaf silver in the wall rock, in a width of 18 feet. The



Plan of part of workings, Miller Lake O'Brien mine. The ore is indicated by the solid black patches.

high-grade veins consist of calcite and a little quartz, with native silver and iron-cobalt-nickel arsenides. Some of the calcite has a roughly banded structure and is very fine grained, suggesting colloidal origin. Most of the calcite is, however, coarsely crystallized, from grey to pink in colour. The veins in places show a band of calcite, parallel to which are the silver and cobalt minerals together with calcite. Strips of diabase at times occur in the veins, and these have been much altered by vein solutions, as has also the wall rock along the veins. The ore, as described elsewhere by Mr. Todd, has been greatly brecciated.

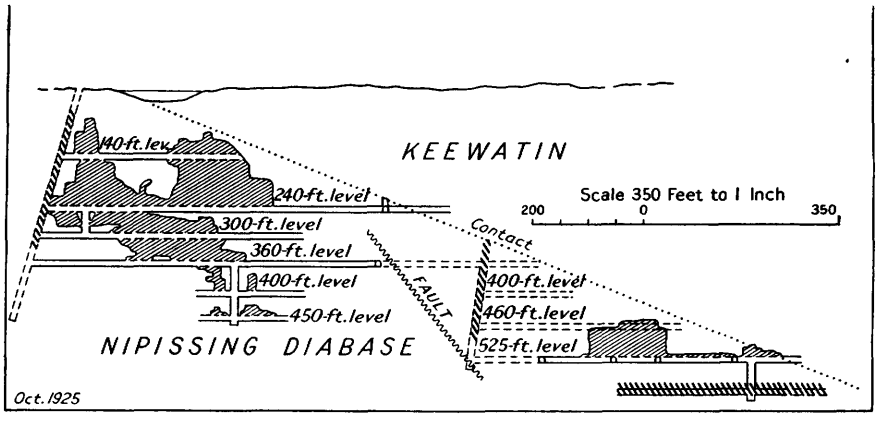
Exploratory work along veins has been continued at the 525-foot level from the diabase into the Keewatin, but so far no ore shoots have been indicated in the greenstone.

Development was continued by means of a winze on vein No. 71 to the 585-foot level, and ore of similar character to that on the 525-foot level was drifted on for 300 feet on the downward extension of No. 73. The winze has been continued to the 650-foot level with rich ore showing for 206 feet on vein No. 71, while vein No. 72 has not yet been cut on this level. In the latest work on the 650-foot level, a cross-vein, No. 79, containing high-grade ore, and a third high-grade vein, No. 80, branching from it, were encountered; the latter parallels No. 71. In addition to veins carrying silver, several containing cobalt-bearing minerals have been encountered on different levels.

Such minerals as copper pyrites, iron pyrites, galena, sphalerite, native bismuth, niccolite, and argentite occur in the veins.

Transformers sufficient to take care of the entire power requirements on a 25-cycle basis have been installed. For the time being 200 horse-power from the Northern Canada Power Company will be used in the mill, the balance of power to be supplied by the 60-cycle installation at Burke lake.

J. G. Dickenson is manager and H. G. Kennedy is superintendent.



Projected section, Miller Lake O'Brien mine.

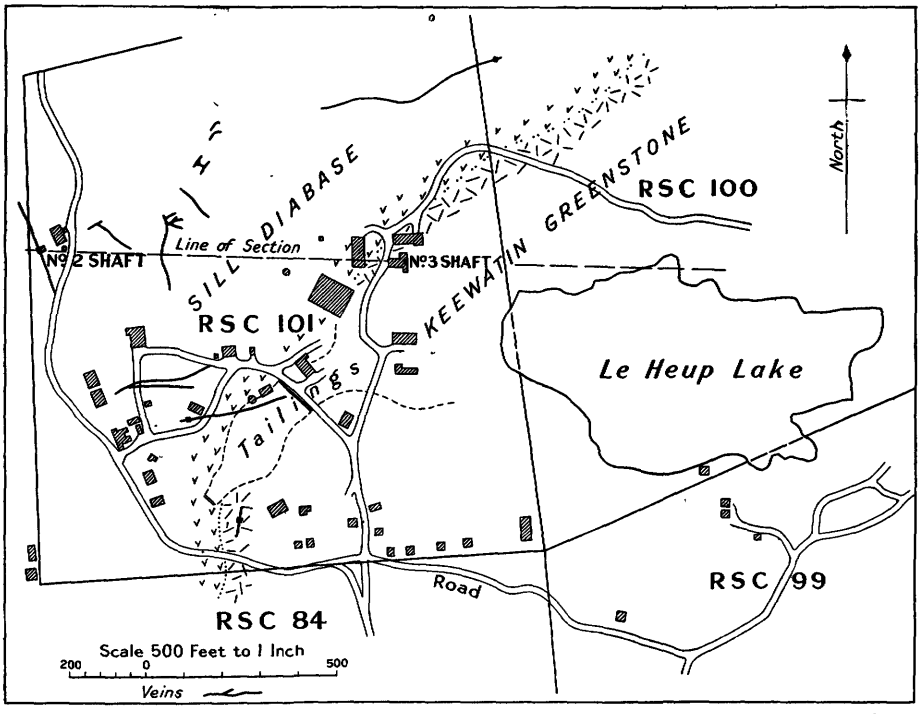
Capitol

The Capitol Silver Mines consists of a large group of claims located in the Everett-Miller Lake section of Gowganda. Most of the claims are on formations which lie above the diabase sill, but the holdings include some of the footwall rocks and also the Nipissing diabase, so that the various geological horizons, which in the several silver areas have proved important for the finding of silver-bearing veins, are covered. So far, however, the important finds in the Miller Lake area have been in the upper part of the diabase sill and in formations lying on the sill.

Work was done on claim H.S. 351, formerly called the Symmes-Young. A strong, attractive north-south vein, carrying iron-cobalt-nickel arsenides, was discovered in 1908 and exposed by trenching for 700 feet on this and the adjoining claim to the north. In places there are several parallel veins, from an inch to three inches in width, exposed in trenches. A shaft was sunk 44 feet on the vein at a point where the width was 12 inches. At a depth of 30 feet, there were several veins exposed in a width of 15 inches. A sample of the grey cobalt-nickel-bearing minerals examined by J. A. Reid contained 12.44 per cent. cobalt and 13.31 per cent. nickel. The ore carried less than an ounce of silver per ton.

To explore the property, the Capitol management proposed to sink a shaft into the underlying diabase sill. The shaft, located 60 feet west of the vein, passed through 110 feet of sediments of the Cobalt series which overlay Keewatin greenstone; at a depth of 819 feet, where sinking was discontinued, the formation was Keewatin greenstone. At the 800-foot level, crosscuts 273 feet east and 182 feet west were made. Further work, by diamond-drilling from this horizon, located the contact with the sill diabase at 1,039 feet from the surface.

During the autumn of 1925, work was transferred to claim H.S. 363, which lies along the main Gowganda road near Leroy lake. The Nipissing diabase outcrops in the southeast corner of the claim and is overlain to the north by Keewatin greenstone intruded by north-south Matachewan diabase dikes.



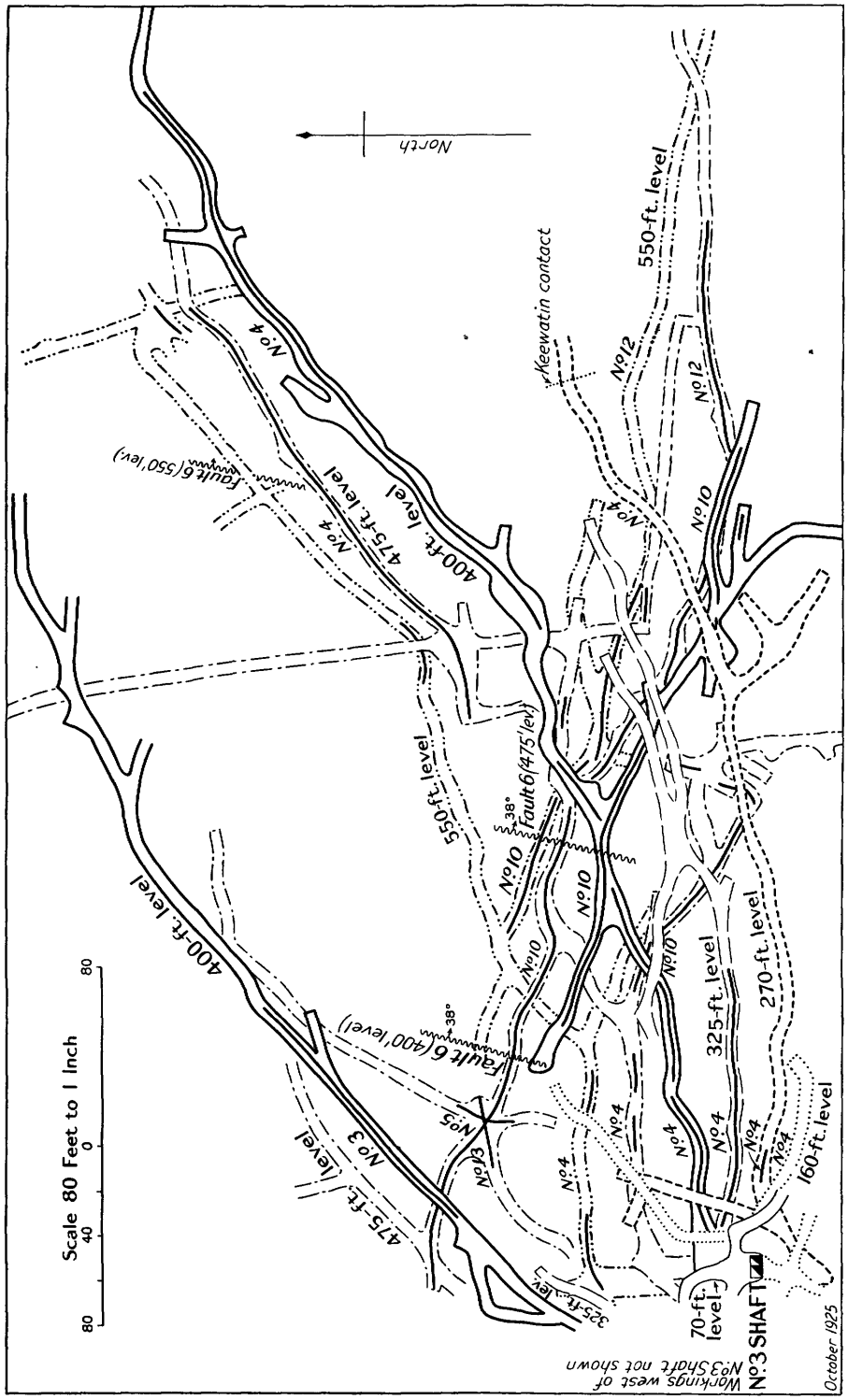
Surface plan of Castle-Trethewey mine.

A number of fractures were exposed by trenching. A north-south quartz-calcite vein, along a diabase dike carrying some decomposed cobalt minerals, on assay by the management showed silver values up to 350 ounces per ton. Work was discontinued during the winter months. While in operation, the property was in charge of W. S. Dobbins.

Haultain Township

Castle-Trethewey (R.S.C. 101, etc.)

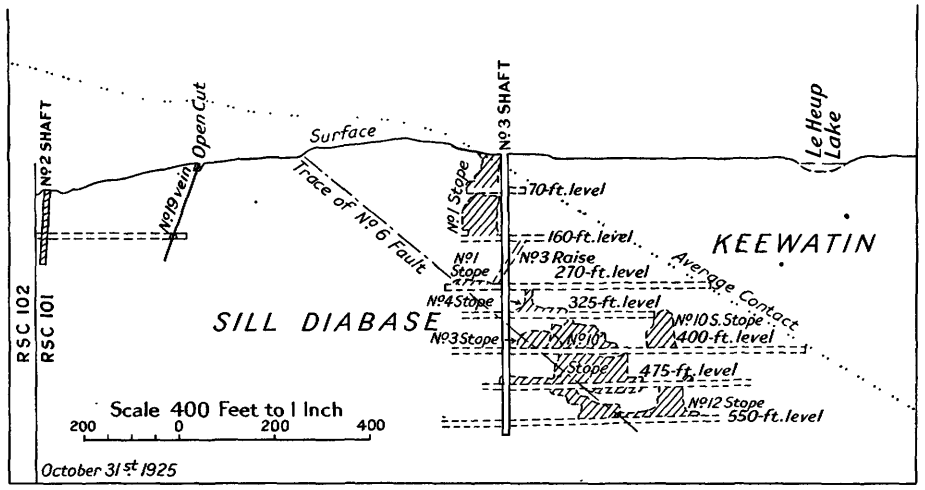
Operations were begun on this portion of the company's holdings in the fall of 1919. A series of veins were located by trenching near the west line of the claim. The veins are continuations of fractures that were worked several years previously on claim R.S.C. 102 by the Miller Lake and Everett mines. They strike approximately N. 30° W. and dip S. 85° S.W. At the surface, the



Composite plan of workings, Castle-Trethewey mine, from No. 3 shaft eastward.

silver deposit consisted of a series of closely spaced calcite and quartz veins over a width of 18 inches. In sinking No. 2 shaft, the veins were found at times to unite into fewer and wider veins, a width of five inches of high-grade ore being occasionally encountered. Native silver, iron-cobalt-nickel arsenides, copper pyrites, and specularite occurred in portions of the veins. Where several narrow veins occurred closely spaced, one would carry ore and an adjacent one be practically barren, with the values shifting from one vein to another at different horizons. The shoot as developed had a length of 80 feet, extending to about the 150-foot level. The broken ore was passed over picking tables, and the high-grade ore together with silver-bearing wall rock gave a grade of shipping ore of approximately 1,000 ounces per ton. Exploratory work in the vicinity of this ore shoot did not reveal ore, although a number of strong calcite veins were located.

In the spring of 1920, a prospector discovered a high-grade vein in the Keewatin near the contact with the underlying diabase on which an open-cut



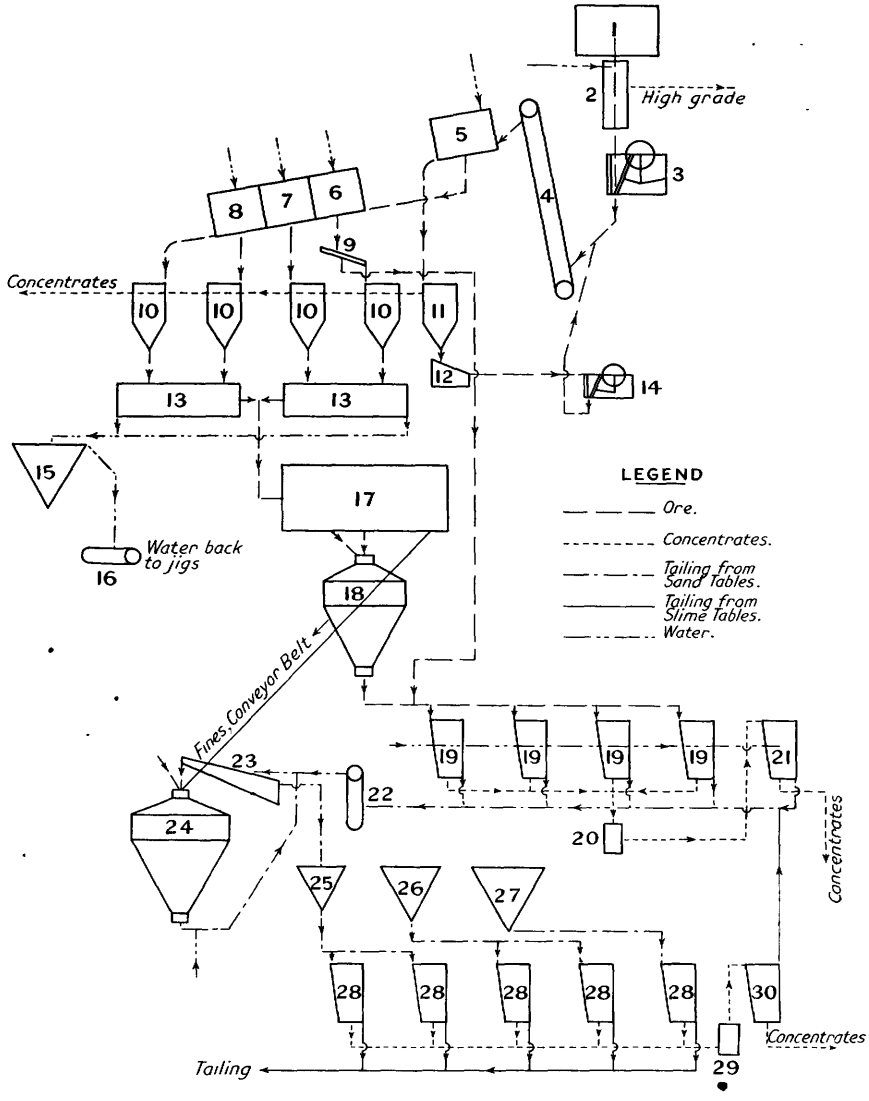
Section through shafts Nos. 2 and 3, Castle-Trethewey mine.

was first made showing a shoot 30 feet in length. Oxidation extended down several feet, and a number of bags of loose fragments of silver, up to 15 inches in length, were sacked. Solid ore when first encountered showed a width of three inches of silver, arsenides, and calcite.

To develop the ore, a vertical shaft (No. 3) was started in the fall of 1920. The contact was reached at a depth of 30 feet and was confused, since the Keewatin rock here is a fine-grained hornblende diabase. The high-grade vein was found to continue from the Keewatin into the Nipissing diabase, to be followed by an overlapping vein on the north side in which the ore continued downward.

During the early development of this area, the ore shoots were encountered to the northwest of the shaft, the principal veins, Nos. 1, 2, and 3, dipping to the north.

Following the early operations previously described, No. 3 shaft (vertical) was gradually deepened, and by 1925 a number of veins were developed to the 550-foot level. New veins were encountered lying to the east and northeast of the shaft, the workings being in the Nipissing diabase. The connecting veins



FLOW-SHEET OF CONCENTRATING MILL, CASTLE-TRETHEWEY MINES, LTD.

1. 65-ton ore pocket.
2. Picking table.
3. Jaw crusher, 20 by 10 inches.
4. Bucket elevator.
5. Trommel (1½-inch opening), 42 inches by 4 feet.
6. Trommel (¼-inch opening), 42 inches by 3 feet.
7. Trommel (⅝-inch opening), 42 inches by 3 feet.
8. Trommel (1-inch opening), 42 inches by 3 feet.
9. Impact screen, 10-mesh.
10. 4 single-compartment Hartz jigs.
11. 1 Hartz jig (ball jig).
12. Dewatering screen.
13. 2 drag-belt dewaterers.
14. Jaw crusher, 14 by 8 inches.
15. 8-foot settling cone.
16. 3-inch centrifugal pump.
17. 200-ton ore bin.
18. Hardinge ball mill, 6 feet by 16 inches
19. 4 Plat-O sand tables.
20. Bucket elevator.
21. Plat-O recleaning table.
22. 2-inch Wilfley sand pump.
23. Dorr duplex classifier.
24. Hardinge ball mill, 6 feet by 22 inch.
25. 5-foot Callow cone.
26. 6-foot Callow cone.
27. 8-foot Callow cone.
28. 5 Plat-O slime tables.
29. Bucket elevator.
30. Plat-O recleaning table.

are filling- and replacement-deposits along intersecting fractures. The veins have a dip which is dependent on the attitude of the overlying contact. Above the workings at No. 3 shaft, the diabase-greenstone contact rises to the west and north, the contact at the surface being represented by a broad curve. The columnar jointing planes in several directions are at right angles to the contact, and since the fracturing follows in part the columnar jointing planes, the dip of veins is dependent on the contact. The principal directions of veins are, roughly, northeast and northwest, the strike and dip varying over the length. The dips vary from northeast to northwest. Important veins like No. 4 and No. 10 intersect at several levels. In one place three veins, Nos. 5, 10, and 13, intersect at a point where the curving joint planes are prominent. The general relationship of the veins is shown on the accompanying plan of the underground workings.

Several strong faults are encountered in the workings. One fault, No. 6, roughly parallels the contact, and most of the ore already found lies above the fault. The veins themselves show only minor faulting, up to a few feet. The ore occurs as shoots along the veins, and these vary in length up to 300 feet. They consist of high-grade vein and wall rock impregnated with leaf silver. The veins are commonly from two to five inches in width. The shoots at No. 3 shaft occur within 400 feet of the contact, which dips on an average of 30° E. In addition to calcite and quartz as gangue minerals a light greenish-coloured secondary hornblende occurs prominently in certain veins, e.g. No. 5 vein.

In the accompanying section from No. 2 to No. 3 shafts, Castle mine, were the contact shown continued to the west at the same dip, the ore at No. 2 shaft would lie about 660 feet from the contact, but it is probable that the contact, which has been eroded to the present surface, may have flattened to the west, in which case the ore would be in the upper part of the diabase sill, as at No. 3 shaft.

Since the property was visited in October, 1925, No. 3 shaft has been deepened to the 700-foot level and lateral work started on the 625-foot level.

During 1925, much trenching was done on the surface and a number of veins carrying native silver and arsenides were located. One of these occurs in the Keewatin on the southern part of claim R.S.C. 101. The most important is the vein series lying north of No. 3 shaft, to which a crosscut is being run on the 475-foot level.

The following information is taken from the annual report of Castle-Trethewey Mines, Limited, for the year ending June 30, 1926. The mill capacity was increased from 60 to 100 tons per day. Owing to the broken-up condition of the ground, the minimum stoping width was increased to 60 inches. The waste rock is now discarded before crushing, and the high-grade is recovered by the jigs with little loss due to sliming.

PRODUCTION RECORD, CASTLE-TRETHEWEY MINE, SINCE COMMENCEMENT OF OPERATION

Period	Milled, tons	Recovery per ton, ounces	Gross production, ounces	Silver and cobalt, gross value
Feb. 1, '22 to June 30, '22	sorting	.....	40,000	$28,000.00
July 1, '22 to June 30, '23	sorting	.....	62,811	41,146.80
July 1, '23 to June 30, '24	7,607	46.03	350,147	229,656.95
July 1, '24 to June 30, '25	30,273	30.62	927,088	637,712.10
July 1, '25 to June 30, '26	34,425	29.03	999,234	683,610.48
Total	72,305	31.48	2,379,280	$1,620,117.33

The estimated ore reserves as at June 30, 1926, were 86,615 tons, at 31.2 ounces to the ton, making 2,701,655 ounces of silver. The operating cost per ton milled was $11.51, or 39.8 cents per ounce.

Power, which had been furnished by two 90 h.p. Deisel engines and a small hydro-electric plant at South Bay, Gowganda, has been supplied by the Northern Canada Power Company from its hydro-electric plant on the Quinze river since March, 1926, permitting an increase in development work from 400 to 1,000 feet per month.

Murray Kennedy was in charge of the property for a number of years, being succeeded by Horace G. Young at the beginning of 1926.

Miller Lake and Everett (R.S.C. 102)

This property, lying to the west of R.S.C. 101, was operated some years ago by the Miller Lake and Everett Mines, Limited, and 8.35 tons of silver ore were shipped in 1910. The ore was taken from a long open-cut on a series of silver-bearing veins striking N. 35° W. The ore was hand-sorted, and there are a few tons of mill rock on the dump at present, where fragments of diabase frequently show scales of native silver. Fissuring is pronounced on claims R.S.C. 101 and 102 in the vicinity of the north and south centre line.

The property was operated again in 1924, and further shipment of 1.5 tons of silver ore was made.

Barbara

During parts of 1915 and 1916, some exploratory work was done on the Barbara property, situated to the north of Lake Irene. Several veins of quartz and calcite show on the surface. A strong vein on claim S.W. 8, striking N. 15° E., has been trenched for several hundred feet and consists of calcite and quartz, from an inch to two inches in width, carrying copper pyrites and bornite. A little native silver shows in seams in the very coarse, gabbro-like diabase. A shaft was sunk to the 100-foot level, and some crosscutting was done on the level to intersect veins. The veins are located well within the diabase sill. The sedimentary rocks, a quarter of a mile south around Lake Irene, lie on the sill.

Some smaltite and silver occur in veins on claim S.W. 18, south of Lake Irene.

Ottawa Gowganda

The property, consisting of claims L.O. 74, 75, and 76, is situated half a mile west of Lost lake. The rock exposures are dominantly Nipissing diabase and a little conglomerate of the Cobalt series overlying the diabase. In addition, there is a narrow diabase dike intruding the sill diabase on claim L.O. 76.

In the early days of Gowganda, a shaft was sunk to a depth of 207 feet and a little lateral work done on the 100- and 200-foot levels. During 1925, much trenching, with some blasting, was done on the surface. This work exposed a number of veins, showing calcite, quartz, copper pyrites, bornite, specular iron, and cobalt bloom, and a little silver was occasionally seen in the veins and wall rock. The company is known as the Ottawa Gowganda Mining Company, Limited.

Erosion appears to have cut only into the upper part of the diabase sill, which in the Miller Lake section is a favourable horizon for silver deposits.

Haultain

The property, consisting of five claims, is located to the southwest of Wigwam lake, and is operated by the Haultain Mining Company, Limited.

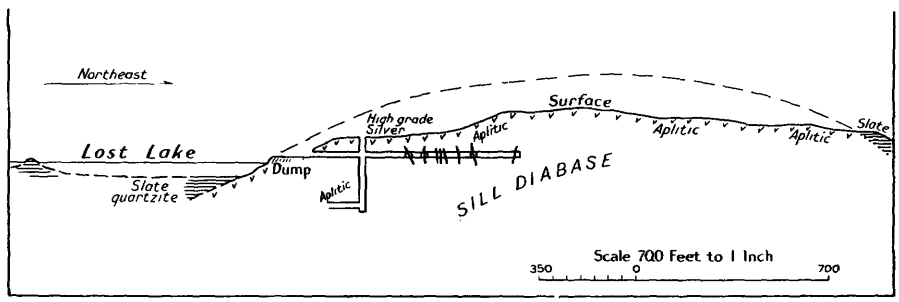
Erosion has cut into the upper portion of the diabase sill with hanging-wall contacts of the Cobalt series on the east and west. On claims G.G. 4,628 and

4,838, a number of roughly parallel veins, approximately N. 20° E., are exposed at the surface, indicating considerable fracturing in the crest of the diabase sill. Calcite, quartz, cobalt-nickel-iron-bearing arsenides, bornite, copper pyrites, with some native silver occur in the veins. The silver, arsenides, and sulphides are sparsely distributed in the veins.

A shaft has been sunk to the 150-foot level on No. 5 vein, and drifting at this level had just begun at the time of the visit. Some native silver was observed in the grey calcite vein material. The property is equipped with a small plant consisting of hoist, compressor, and boiler. A 15-foot arrastre was being constructed at the ti ne of the writer's visit.

Wigwam

Wigwam Silver Mines, Limited, has seven claims, but the work has been confined to H.R. 499 and L.O. 316, on the east shore of Lost lake. The diabase rises as a high ridge from the lake; and to prospect the ridge, on which occur a number of veins in some of which native silver has been found, a tunnel was driven from 20 feet above the lake in a northeast direction for 800 feet. The



Vertical section, showing Wigwam silver mine, prepared by Horace Strong.

property was idle at the time of the writer's visit, but J. W. Sanderson, manager, furnished the following information:—

At 610 feet in the tunnel, a vein two feet wide was drifted on for 230 feet. At 350 feet, silver and arsenides were discovered in a strong vein, which was drifted on for 400 feet. At 384 feet in the tunnel, a calcite vein carrying silver was also intersected. A winze was sunk at a distance of 200 feet from the tunnel entrance, where two intersecting veins carrying some silver were located; and some work was done on the 100- and 190-foot levels below the tunnel. A raise of 114 feet was also put to the surface at the winze. Some faults, showing heavy gouge, were encountered in the workings.

The mass of diabase has an arched structure, dipping under cobalt sediments on the east and west sides. Most of the veins have a northeast strike. Aplite occurs in some of the veins.

Mr. Horace Strong, engineer in charge of the operations, suggests that there is a north-south major fault at the shore of Lost lake; and it is the intention, when the property is reopened, to drift westward to the contact at the lowest level.

Millcrest

The property consists of groups of claims located south of Everett lake and on the east side of Miller lake. Work was started on the north group late in the autumn of 1925, calcite veins with cobalt bloom being found in the diabase

near the hanging-wall side. By March, 1926, a shaft had been sunk 65 feet, the vein being about 12 inches wide. Some native silver is reported from the vein. W. H. Fairburn is manager for the Millcrest Mining Company, Limited.

Cobalt Nugget (H.F. 243-45)

Some exploratory work was done during 1925 on the property, which lies northeast of Burke lake. Heavy fracturing occurs near the east side of the diabase ridge near Dinny lake. The most prominent vein strikes N. 25° E., and on this a shaft was sunk 40 feet. Faulting has followed along the calcite vein, and secondary chalcedonic quartz has cemented the earlier calcite. Open spaces or vugs occur in the vein structure, which dips from the shaft on the east side near the bottom. No silver or cobalt minerals were recognized in the vein at the bottom of the shaft, but some cobalt bloom occurs in pieces on the dump. Some rich specimens of silver ore are reported from near the surface.

The veins occur in a downfaulted mass of diabase, but the horizon of the exposed veins, with relation to the top and bottom of the sill, is not known.

Nicol Township

Big Four

The Big Four consists of four mining claims, W.D. 961-64, situated half a mile northeast of Gowganda lake. There is a great assemblage of rocks, consisting of Keewatin iron formation and green schist, quartz porphyry, older diabase dikes, Cobalt series conglomerate, and later diabase dikes. The diabase sill is not exposed on the property.

A vein, carrying calcite, arsenopyrite, cobaltite, iron pyrites, and galena, was found on claim W.D. 962. It strikes N. 14° E. and dips 30° E. An open-cut about 20 feet in length was made along the vein, disclosing a width of 5 to 6 inches of material carrying much bloom and arsenides. This showing is cut off by a diabase dike to the south. To the south of the dike, which is 50 feet wide, there are also some small showings of bloom. The vein or lens carrying the cobaltite occurs in iron formation, here represented by a siliceous rock resembling chert, which for four feet above the vein is much stained with iron rust. A sample from the vein carries no gold and 8 ounces of silver per ton. A shaft sunk at a point 50 feet east of the outcrop of the vein intersected the low-dipping vein, which showed the same mineralization.

Some prospecting was also done on rusty siliceous iron formation three chains northeast of the shaft. This work indicated a mass of solid iron pyrites in the iron formation lying between two north-south diabase dikes 9 feet apart and having a footwall of quartz porphyry dipping 60° N. Toward the north, the iron pyrites, about 6 feet wide, becomes leaner, grading into siliceous iron formation. The area immediately beyond the two dikes of diabase is drift covered and may conceal the extension of the sulphide band. A sample of the iron pyrites carries 41.35 per cent. of sulphur. The siliceous iron formation, carrying disseminated iron pyrites, contains no gold.

Castle, R.S.C. 106 and R.S.C. 92 (652)

Considerable exploratory work was done on these claims in 1919 by the Trethewey Silver Cobalt Mines, Limited, with a view to prospecting the diabase formation which occurs beneath the Keewatin. These claims are situated just northwest of Miller lake.

A shaft was started in Keewatin on claim R.S.C. 106 and sunk to the 300-foot level. The diabase was first encountered at 90 feet, and from this depth to 130 feet the shaft was in both formations, showing a nearly vertical contact for this distance. Below this, the shaft was entirely in the diabase, and a crosscut 400 feet in length to the north of east was run to the contact, indicating a general dip of contact of 20 degrees from 130 feet in the shaft. The contact was further ascertained, in a long drift extending 500 feet to the north of the crosscut, to be 15° N.E. Consequently, at this horizon, the diabase dips gently under the Keewatin. A calcite vein, striking north and south and dipping steeply to the west, was discovered 130 feet from the shaft; and drifting on the vein for about 230 feet has been done on the 300-foot level and also on the 360-foot level, which is connected with the upper level by a steeply inclined winze on the vein. This vein carries in places some native silver, together with smaltite, niccolite, native bismuth, copper pyrites and pyrite, and some quartz. Several strong faults dipping 30° N.E. were encountered in the workings. One of these displaced the vein 20 feet on the 300-foot level. Several other calcite veins were also discovered. One of these showed a width of six inches in a crosscut west from the main vein, while another was encountered 400 feet from the shaft in the long crosscut, near the Keewatin contact. This vein of calcite up to four inches wide carries some smaltite.

Claim R.S.C. 92 reverted to its original owners and was purchased by the Miller Lake O'Brien mine.

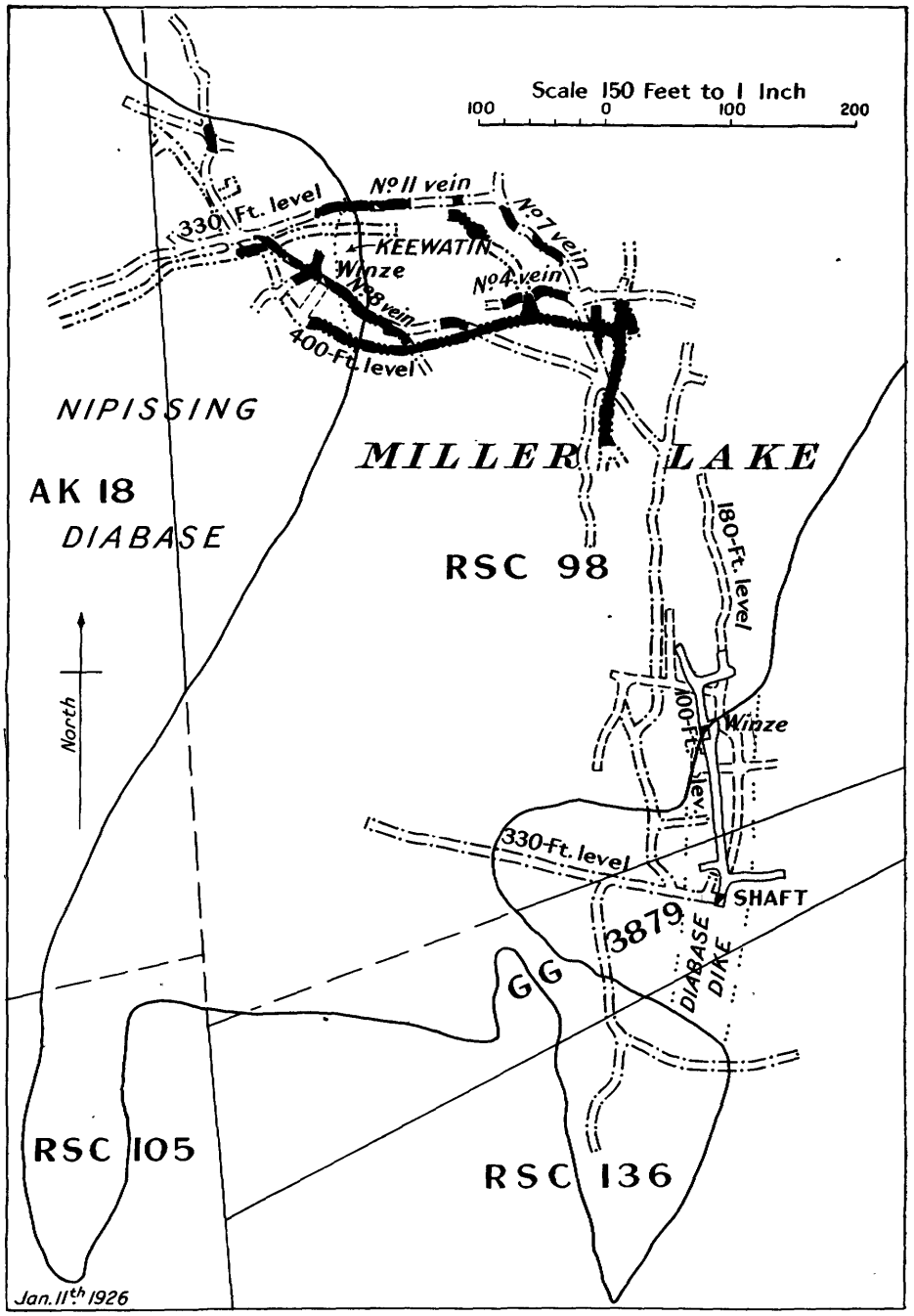
Chapelle Claim, H.R. 715 (195)

This property lies to the east of Leroy lake, including part of the lake. The rock exposed on the surface is nearly all sill diabase, with a small amount of Keewatin near the northeast corner-post. In October, 1919, C. L. Campbell and W. H. Fairburn, who had optioned the property, began work by continuing the sinking of a shaft that had been begun some years before. This shaft is on a strong aplite dike and calcite vein. Some high-grade silver ore was encountered by the former operators at 48 feet and again in the drift at the 85-foot level. Small amounts of silver had been found frequently while sinking the shaft and running the drift. Exploration showed that the vein, which strikes S. 20° W. when drifted on to the south, was faulted 55 feet to the southeast. This fault, which dips 60° N.E., contains drag vein material and also that of an aplite dike. In the face of the drift beyond the fault, there is a 4-inch vein of calcite and two mineralized aplite dikes of 1½ and 4 inches, respectively. Specimens on the dump show calcite and aplite, with copper pyrites, bornite, iron pyrites, and some smaltite and niccolite.

A number of veins were located on the surface by means of trenching in previous years, but most of these are now concealed by sand filling in the trenches. These veins occur in the diabase, which rises as a sill from the northwest, having the same relation to the Keewatin area northwest of Leroy lake as the diabase to the northwest of Miller lake, that is, it dips under the Keewatin. Work was discontinued on this claim in November, 1919.

Tonopah (Walsh)

In 1924 the Tonopah Canadian Mines Company secured options on a number of properties in the vicinity of Miller lake, including Walsh, Hart, Morrison. Most of the exploratory work has been confined to the Walsh and Morrison.

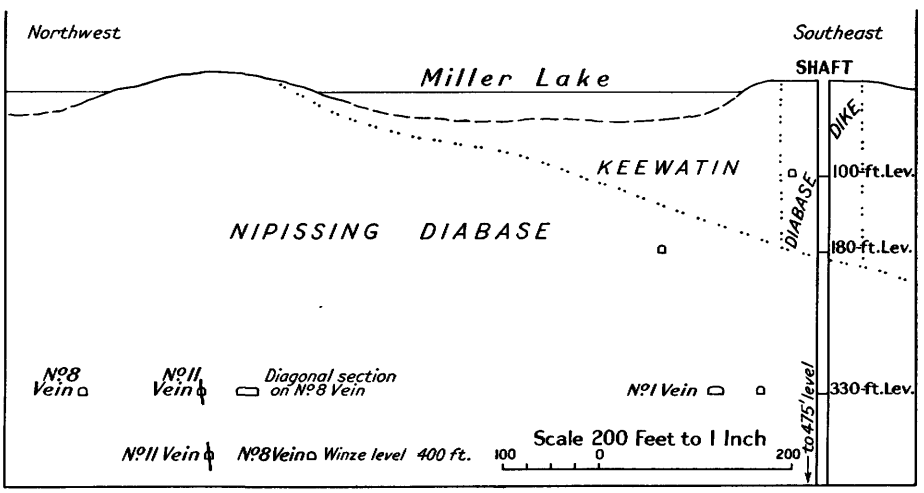


Plan of workings of Walsh mine, Tonopah Canadian Mines Company.

The Walsh property was under option to the Crown Reserve Mining Company during parts of 1917 and 1918. A shaft, previously sunk 60 feet, was continued to 200 feet, and exploratory work was done on the 100- and 180-foot levels, this work for the most part being on veins in a diabase dike, which intrudes the Keewatin greenstone and which lay above the diabase sill. Silver was discovered over a short length in a calcite vein on the 100-foot level, but the results on the 180-foot level were less promising.

During the early part of 1920, the Walsh Mines, Limited, reopened the property and continued prospecting on the 180-foot level. The diabase sill was encountered in the northern part of the workings and some exploratory work was done on it, after which the property was closed down.

The Victoria Syndicate pumped out and sampled the property early in 1924, and later on the Tonopah Canadian Mines Company took the property over. The shaft was sunk to the 330-foot level, passing from the diabase dike into the diabase sill at about 210 feet. The two diabases being somewhat alike, the contact was difficult to locate in the shaft within a few feet. However, the dike



Section of Walsh mine, Tonopah Canadian Mines Company.

which contains prominent phenocrysts of plagioclase gave place to the non-porphyritic diabase sill, and this rock is encountered in all the workings on the 330- and 400-foot levels.

Following exploratory work on several veins at the 330-foot level, at about 500 feet north-northwest of the shaft an ore zone was encountered, in which there are a number of intersecting veins, Nos. 7, 8, 9, 10, and 11.

It was observed that the diabase in the area of veins showed a stronger development of jointing than elsewhere, the surfaces of the joints assuming the cylindrical character, with numerous parallel parting planes, which is a feature of the favourable location of ore in the Miller Lake area.

The principal vein, No. 8, contains one high-grade ore shoot, 130 feet in length, while several ore shoots of shorter length were located in the different veins.

An inclined winze was sunk on No. 8 vein to the 400-foot level, and development work was done on the veins at this level. About 1,000 feet of work, of which 460 feet was in ore, was accomplished from the winze. One vein from

4 to 9 inches in width showed a shoot of high-grade 120 feet long. Some of the ore is mill rock averaging 30 ounces of silver over a stoping width.

The shaft has been deepened to 480 feet, and the vein system is to be developed at this depth.

The new hoist and compressor, which were first driven by steam, have been electrified, and the electric power was in use on March 20. Plans have been prepared and excavations are under way for a 75-ton concentrating plant. Ernest Craig is manager.

Morrison

The property, claims T.C. 315 and T.C. 204, is situated southeast of Miller lake. It is under option to the Tonopah Canadian Mines Company. Considerable surface work, together with a shaft and open-cuts, was accomplished in the early days of the camp, and silver and accompanying arsenides were found in a number of calcite veins, which occur in the Nipissing diabase. The diabase dips beneath the Keewatin lava on the north part of the claims. In 1925, the Tonopah Canadian Mines Company sank a shaft to the 300-foot level, from which lateral exploratory work was done, a number of veins being encountered. E. Craig reports some low-grade ore, together with a little high-grade ore indicated by the work done to the 300-foot level. High-grade ore, with a width of four inches is reported in a winze started from the level.

A gasoline-driven motor and compressor furnish air for the drills.

Huronian Belt

Claim W.J. 9, lying north of the Morrison, is under option to the Huronian Belt Company. The rocks exposed at the surface are Keewatin schists and greenstones. To determine the depth of the diabase sill, diamond-drilling was done, and this indicated the diabase at 263 feet below the surface at the location of the shaft. The dip of the sill is roughly 20° N.

Early trenching and two prospect shafts were made on a strong calcite vein, carrying cobalt-bearing minerals, which lies to the west of the new shaft. This shaft is being sunk into the diabase sill where lateral work will be done. Leonard Smith is superintendent of the property.

Hylands-Johnston-Gardner

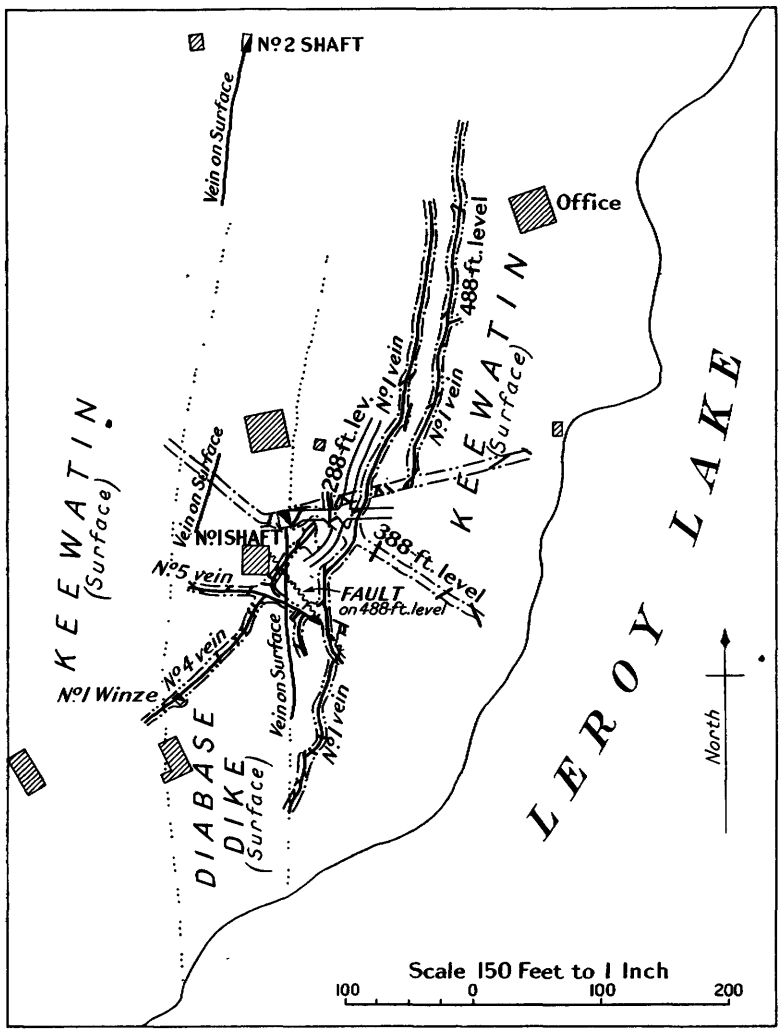
Some work was done on this group of claims (R.S.C. 131-34 and 140-42) in the latter part of 1925. A shaft was sunk 100 feet by hand steel.

A company known as Plata Mines, Limited, was incorporated June 5, 1926, and Noranda Mines, Limited, has purchased or taken options on a controlling interest in the new company which owns the property. The shaft is now down 200 feet and is being continued to the 350-foot level where a programme of lateral exploration will be carried out.

Coleroy

The property is located on the southwest shore of Leroy lake and was operated as the Collins claim for a number of years by F. H. Collins. The rocks exposed at the surface are Keewatin greenstones and tuffs, striking N. 60° E. These are intruded by a dike of Matachewan diabase with a northerly trend. Surface work exposed a vein, along the east contact of the dike, consisting of calcite, quartz, copper pyrites, iron pyrites, with sparse cobalt and nickel minerals and native silver. A second vein of similar character was found on the west side of the dike, 375 feet north of the main shaft, on which a shaft was

sunk 20 feet. A vertical shaft was started on the east vein, which dipped from the shaft at 50 feet, the shaft below this being in the dike to the 288-foot level. A second vein crossed the shaft from 165 feet to 180 feet. The contact with the underlying diabase was encountered at 288 feet. The contact has an average dip of 30° N.W.



Coleroy Gowganda mine workings. The diabase sill was encountered at the 288-foot level. The workings on the two lower levels are entirely in the diabase sill.

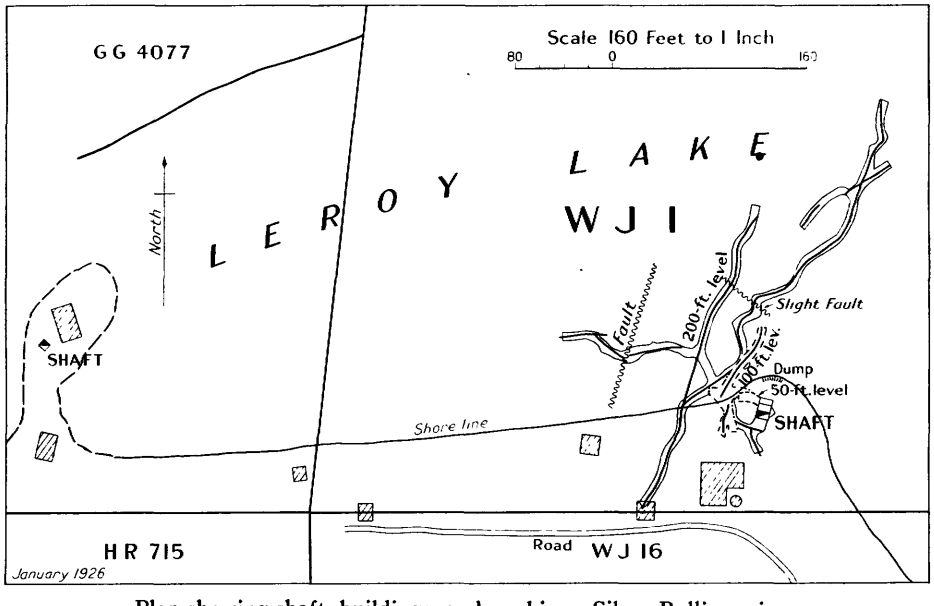
The shaft was first deepened by the new company, Coleroy Gowganda, to the 388-foot level, where lateral work was done on a series of calcite veins in the diabase. No. 1 vein, with a width up to 12 inches and strike N. 18° E., was drifted on for 360 feet. Some indications of silver were obtained, but no high-grade was found. The shaft was deepened another 100 feet, where lateral work is in progress on veins located approximately 200 feet below the contact. Several faults, displacing the veins a few inches to a few feet, were found.

Some native silver, argentite, and cobalt-nickel arsenides in small amounts were encountered in the drift on the 488-foot level along No. 1 vein. The most promising showings were found in No. 4 vein, which lies southwest of the shaft. For 40 feet, the calcite contains native silver and argentite, with grey and copper-coloured arsenides. A winze has been started on the showing.

The property has the same geological structure as the Castle, the diabase coming up under the Keewatin in a reversed direction. John Shaw is manager.

Hart Claims

The Hart claims, R.S.C. 135 and 136, were under option for a part of the year 1920. This property is favourably located along the hanging-wall contact of the sill diabase with the Keewatin, the sill outcropping on the southern claim and the southwestern part of the northern claim. A shaft was sunk to the 100-foot level on a strong calcite vein. The vein strikes N. 23° E., is nearly vertical,



Plan showing shaft, buildings, and workings, Silver Bullion mine.

and averages about four to six inches in width. Masses of vein material from the drift show abundant copper pyrites, bornite, and pyrite. A little silver is reported from the vein. When visited in September, 1920, the drifts had reached 80 feet and 25 feet, north and south of the shaft, respectively. A number of calcite veins are exposed on the surface.

The property has been taken over by the Tonopah Canadian Mines Company.

Silver Bullion

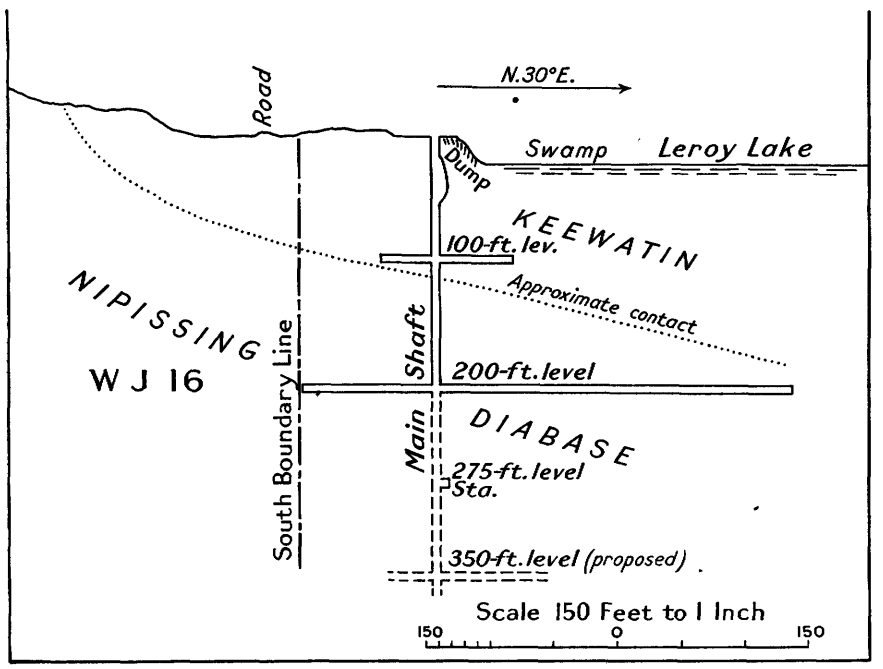
The following information is reprinted from the 1921 report:—

The Silver Bullion property is situated at the northeast end of Leroy lake. It includes two claims, on each of which a shaft has been sunk. The eastern claim, W.J. 1, formerly called the Dodds, contains outcropping of schistose Keewatin greenstone. Near the south line of the claim a vein, carrying native silver, smaltite, and native bismuth, with strike nearly east and west, was discovered. An open-cut was made on the vein by former operators, the cut being carried to a flat slip beyond which no work was done. A few bags of silver ore were taken from the open-cut. Further work by the Silver Bullion company showed the lower extension of the vein to be faulted

four feet to the north. A shaft was put down on the vein to a depth of approximately 50 feet by means of hand steel. The work showed a succession of faults and slips, the vein being displaced a few feet north or south, with the greater movement to the north. The greatest throw is at the bottom of the shaft where the lower part of the vein is displaced six feet to the north. At 30 feet in the shaft, the vein is six inches in width. Segregations of silver, smaltite, niccolite, and bismuth were encountered in the calcite vein. A plant, consisting of a 100 h.p. boiler, a 6-drill compressor, and a 6- by 8-inch hoist, was installed in the fall of 1920. The property was closed down shortly after, but it is expected operations will be resumed early in 1921.

The shaft on the western claim is located on a small island where there is an outcropping of Keewatin. It was sunk 100 feet, and the area under the lake was prospected by a crosscut to the south. A two-inch vein of calcite was encountered 90 feet to the south of the shaft. This vein showed a little smaltite. The shaft was abandoned for the new shaft on the Dodds vein.

Later the shaft was deepened and exploratory work was done on the 100- and 200-foot levels under the direction of Horace F. Strong. The contact



Vertical section of Silver Bullion mine, December, 1925.

between the Keewatin greenstone and Nipissing diabase was encountered 15 feet below the 100-foot level, indicating a dip of contact of about 20° N.E.

Most of the work was done on the 200-foot level, where several strong intersecting veins were drifted on. The principal gangue is calcite, but there is also much quartz. One vein striking N. 30° E., up to 18 inches in width, carries considerable bornite and copper pyrites. These minerals are associated with quartz, which occurs near the walls of the vein, the calcite generally occupying the centre of the vein as a later filling. A few showings of native silver were found in the vein to the northeast of the shaft, and also in a vein to the west.

It was proposed to deepen the shaft to the 350-foot level and to explore the diabase at this horizon, the workings still being in the upper part of the diabase, a favourable prospecting horizon for this section of Gowganda.

The accompanying plan and section of the property were prepared by Mr. Strong.

Lawson Township

Considerable exploratory work has been carried on at various times on properties in the vicinity of Calcite lake. During 1920, none of these properties was in operation.

Bishop

The Bishop Mining Company operated mining claim L.O. 313, adjacent to the east shore of Calcite lake. As the shore of the lake is precipitous, it was possible to carry on exploration by means of an adit level eastward into the ridge. The adit is 515 feet long, and at 216 feet from the portal, north and south drifts, 464 feet and 177 feet respectively, were made on a calcite vein, which showed a little silver ore here and there but no continuous ore shoot.

No. 1 winze, 300 feet from the portal, is 18 feet deep, and No. 2 winze at the end of the main drift is 100 feet deep with 100 feet of work at the lower level.

The plant consists of two 60 h.p. boilers, a 6-drill compressor and hoist.

Gowganda Keora

The property, consisting of claims L.O. 357 and L.O. 358, is located to the east of Calcite lake. It was first worked by the Calcite Lake Mining Company and later by the Caleta Mining Company. Most of the underground work was done several years ago. When visited by Mr. Todd in October, 1925, the workings had been dewatered to the 200-foot level by the Porcupine Keora Company. The deepest workings are at the 285-foot level.

The mine workings are in Nipissing diabase, which in this locality forms a ridge, the diabase dipping under the older formations on the east and west. Near Leta lake, a small patch of sediment lies on the diabase, so that the present surface represents a section still near the top of the sill.

At the 100-foot level, there is 160 feet of drifting on a calcite vein, two to six inches wide, striking N. 35° E. On the 150-foot level, the vein was drifted on for 150 feet and a parallel vein 30 feet south of the shaft was followed for 65 feet. On the 200-foot level, the main vein was drifted on for 160 feet, of which 50 feet was new work. Several short crosscuts were made on this level, the most important one being 200 feet in length northwest from the shaft encountering several narrow veins.

Native silver occurs as flakes in somewhat sugary white calcite on the main vein at the different levels examined. A small shipment was made in former years by the Calcite Lake Mining Company.

A 30-ton mill operated from September 1 to 15 in 1925 and started again October 26, treating 500 tons of ore up to the end of January, 1926.

Powerful

The Powerful prospect is situated about one mile southeastward from Calcite lake. The property has been worked intermittently for several years. Exploration has been carried on by means of a long adit level that has been run eastward into a prominent diabase ridge on claim H.R. 397. The contact with the quartzite is drift covered a short distance west of the portal of the adit, consequently the attitude of the contact is not known. The following description of underground work is taken from the mining inspector's report for 1916:—

A tunnel runs northeast into a hill and 700 feet of crosscutting and drifting has been done at this level. From the east end of the tunnel a raise 158 feet long at an angle of 45 degrees has been driven to the surface. A winze has also been sunk near the face of the tunnel. It is 145 feet deep and is vertical for 90 feet and inclined at 70 degrees for the remainder of the distance. From this

winze three levels have been opened up and the following work done: at 50 feet below the tunnel level, about 75 feet of drifting and crosscutting; at 90 feet below tunnel level, 400 feet of drifting and crosscutting and 30 feet of raising; at 145 feet below tunnel level, 85 feet of drifting.

The machinery on the claim consists of a Leonard boiler, 80 h.p.; a Laidlaw-Dunn-Gordon compressor, 14 by 14 by 12 inches; a Jenckes hoist 6 by 8 inches.

Milner Township

Bishop

The Bishop Mining Company operated a group of claims lying northwest of the northwest arm of Gowganda lake. A shaft on claim T.C. 136 was sunk 130 feet with drifting of 20 feet. The surface of the diabase exposed here is near the top of the sill. A small remnant of the overlying sediment, partly altered to adinole, occurs along the road north of the shaft. The diabase is well fractured and some silver occurs in veins at the surface, but underground operations were discontinued before sufficient lateral work was done to determine the possibilities of the veins underground. The veins have an approximate northeast strike and are nearly vertical. Some of the vein material on the dump shows bloom and flakes of native silver.



Specimen of polished ore from the Crews-McFarlan (Bartlett) mine showing calcite vein, one inch in width, with adhering diabase wall. Native silver is shown in the light parts in the form of veinlets and patches in the calcite and along the contact. A little argentite and copper pyrites occur with the silver.

Crews-McFarlan

The Crews-McFarlan mine has not been operated since 1919. It includes four claims, H.F. 221-24, situated near the south end of the southwest bay of Gowganda lake. The property has been worked intermittently since the fall of 1908, following the spectacular discoveries of native silver by two prospectors, F. McIntosh and S. McLaughlin. Under the name of the Bartlett mine, it was first operated by the Bartlett Mines Company, later by the Scottish Nigeria Mining Company, and finally by the Crews-McFarlan Mining Company. The property is equipped with a plant consisting of two 80 h.p. return tubular boilers, a 12-drill compressor, two hoists, and a machine shop.

Shafts Nos. 1 and 2 were sunk by the original company, and later operators have increased the underground workings.

No. 1 shaft, at which the most extensive work has been done, is on claim H.F. 222. It is in the lower part of the diabase sill about 500 feet west of the

outcrop of the underlying quartzite, which dips about 45° W. The shaft is 300 feet deep with workings on three levels, totalling over 1,000 feet. It was started on a high-grade ore shoot that extended downward only 25 feet. The ore was massive smaltite and native silver in calcite from two to three inches in width. A series of open-cuts were made southwestward from the shaft on a number of lenses of ore over a distance of 350 feet. The chief gangue material with the ore is calcite, but lenses of the mineral occur with an aplite dike along which the open-cut was made. The aplite and diabase wall rock are much fractured in places and contain sheets and scales of native silver. Some of the vein material carries considerable copper pyrites. The high-grade ore consisted of smaltite with native silver and argentite. Some of the diabase and aplite carrying abundant leaf silver is of good milling grade. Most of the ore shipped from the property came from the open-cut.

No. 2 shaft, located in the southwestern part of the property, was sunk 100 feet and drifting and crosscutting amounting to 360 feet done. The work did not indicate commercial ore. A narrow vein, about a quarter of an inch in width, carrying massive smaltite and silver, was encountered in the workings. Directly west of the shaft, there is an aplite dike which showed a lens of calcite with smaltite and silver over a few feet. A shallow open-cut was made along the lens of ore by the early operators, and a few bags of high-grade material were obtained.

The most recent work was done on claim H.F. 224 in the southeastern part of the property where several veins were located by trenching. One of these, having a width of one inch, contained a shoot of high-grade ore along which an open-cut was made and a quantity of high-grade ore obtained. A shaft, No. 3, situated 40 feet to the north of the open-cut and near a second vein, was sunk to a depth of 75 feet, and at 50 feet a crosscut made southwestward to the silver-bearing vein on which some exploratory work was done and also on the vein located near the shaft. Some silver ore was encountered on this level, but the outlook was not sufficiently encouraging to continue operations under the high cost of operation.

The ore obtained from the open-cut was of peculiar appearance as most of the calcite vein matter is very dark, almost black in colour. This dark colour is evidently due to very fine particles of magnetite disseminated in the calcite. Some of the high-grade vein shows massive native silver with argentite in calcite, the silver occurring in veinlets and masses generally near the contact with the diabase. Other samples show massive smaltite with the silver minerals. Four chains southeast of the shaft there is a two-inch aplite dike, showing calcite with niccolite and smaltite, on which a shallow pit was sunk.

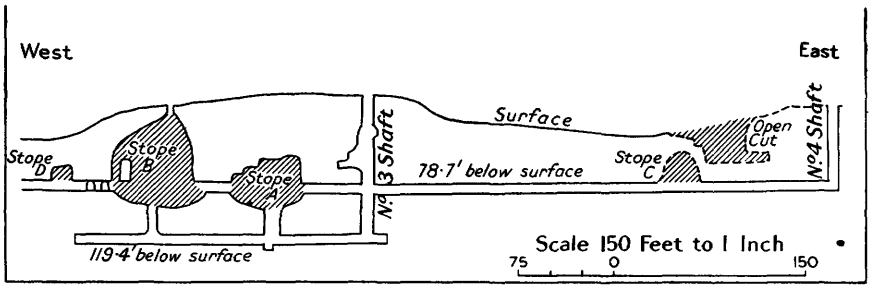
Hewitt

For some years previous to 1920, the Hewitt Lake Mining Company operated a group of claims lying west of Gowganda lake and half a mile north of the Mann mines. When these were visited in 1920, no work was being done and the workings were filled with water. One shaft is reported to have been sunk to a depth of 300 feet with some lateral work, but no information is obtainable as to the silver-bearing character of the veins. The Nipissing diabase is exposed at the surface, erosion having removed the overlying sediments from a part of it. Some small patches of sediment still show on the diabase sill, consequently the workings are in the upper part of the diabase where fractures would be looked for.

Mann

The Mann mine is situated on a diabase ridge half a mile west of the northwest arm of Gowganda lake. It includes a group of claims, H.R. 249-52, staked by the Mann-Ryan interests in 1908, following a discovery of native silver by Robt. Mann. This discovery of silver was made on a bluff of diabase, where a decomposed calcite smaltite vein, about three inches wide, showed a rib of native silver protruding from the vein. The vein, known as the discovery or No. 1 vein, was traced several hundred feet by trenching to the west, with several showings of native silver along the surface.

The principal vein is No. 3, which has produced almost all the ore shipped from the mine. The vein has been traced 1,300 feet by trenching, while open-cuts and underground operations indicated several ore shoots. No. 3 shaft has been sunk to a depth of 200 feet with levels at 80 feet, 120 feet, and 200 feet, while No. 4 shaft, located 350 feet to the east, was sunk to the 80-foot level and connected on this level with No. 3 shaft. Most of the underground work was done on the 80-foot level, where three stopes were opened up to the west of No. 3 shaft and one stope 100 feet west of No. 4 shaft. The east stope connects with an open-cut which was made just west of No. 4 shaft. This cut is 30 feet long, and about 14 tons of high-grade ore were taken from it. The ore shoot

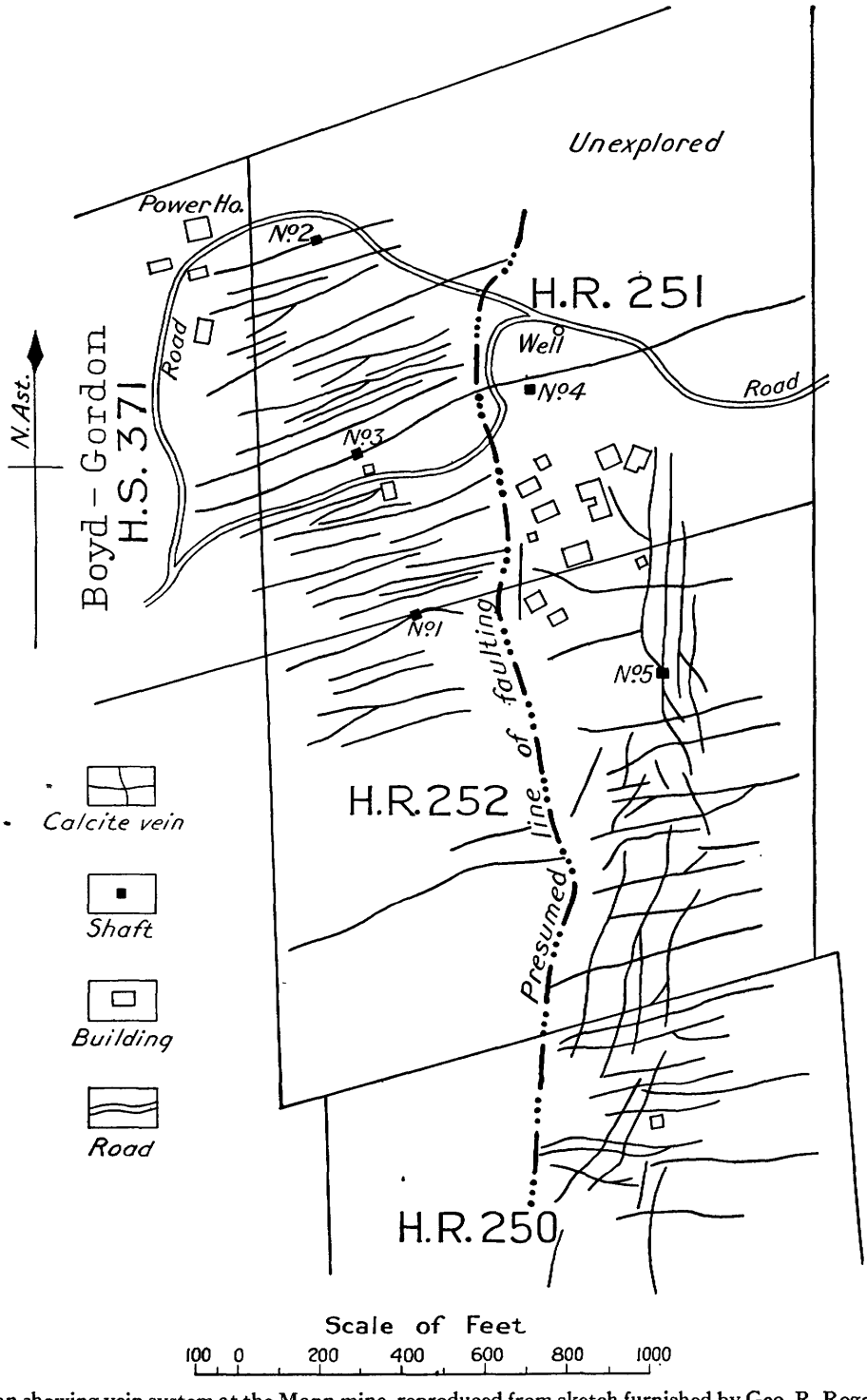


Section of No. 3 vein, Mann mine.

pitches west at 45 degrees and does not extend below the level. An ore shoot near No. 3 shaft also shows a pitch to the west and was 50 feet in length on the 80-foot level. The ore shoot was stoped from about 15 feet below the level to near the surface. A third stope was made on the vein 130 feet west of No. 3 shaft and was also carried from 15 feet below the level to near the surface. The shoot was about 60 feet long on the level. A fourth small shoot about 15 feet in length was found near the end of the west drift on the 80-foot level. High-grade ore was also encountered on the 120-foot level, 200 feet west of No. 3 shaft; 450 feet of drifting along the vein was also done on the 200-foot level of No. 3 shaft.

The vein is about one to 5½ inches in width. The ore was hand-sorted at the surface and bagged for shipment. Twenty tons of low-grade ore were treated at the Millerett mill in 1912, and from this 715 ounces of fine silver were produced. The high-grade ore is chiefly native silver with smaltite in calcite. Forty-eight tons of high-grade silver ore, from which were recovered 99,076 ounces of silver, were shipped from the property. One shipment averaging 2,000 ounces of silver per ton contained $2 per ton in gold.

On the Mann property, there are two pronounced north and south ridges. On the west ridge, all of the veins have a strike of a few degrees north of east, whereas on the east ridge there are a number of veins which strike nearly north,



Plan showing vein system at the Mann mine, reproduced from sketch furnished by Geo. R. Rogers. The vein in which most work has been done, and from which most of the ore was produced, is No. 3.

in addition to a number which strike east. This has suggested the possibility of faulting. The underground work proved a strong north-south fault dipping 45° W., with a crushed zone about four feet in width. The western part of No. 3 vein was displaced 15 feet to the south by this fault. The Boyd-Gordon mine, H.S. 371, was taken over by the Mann mine in 1912.

George Rogers was in charge of the Mann property during most of the development of No. 3 vein from which the shipments were made. The property was closed down in 1914.

Northcliff

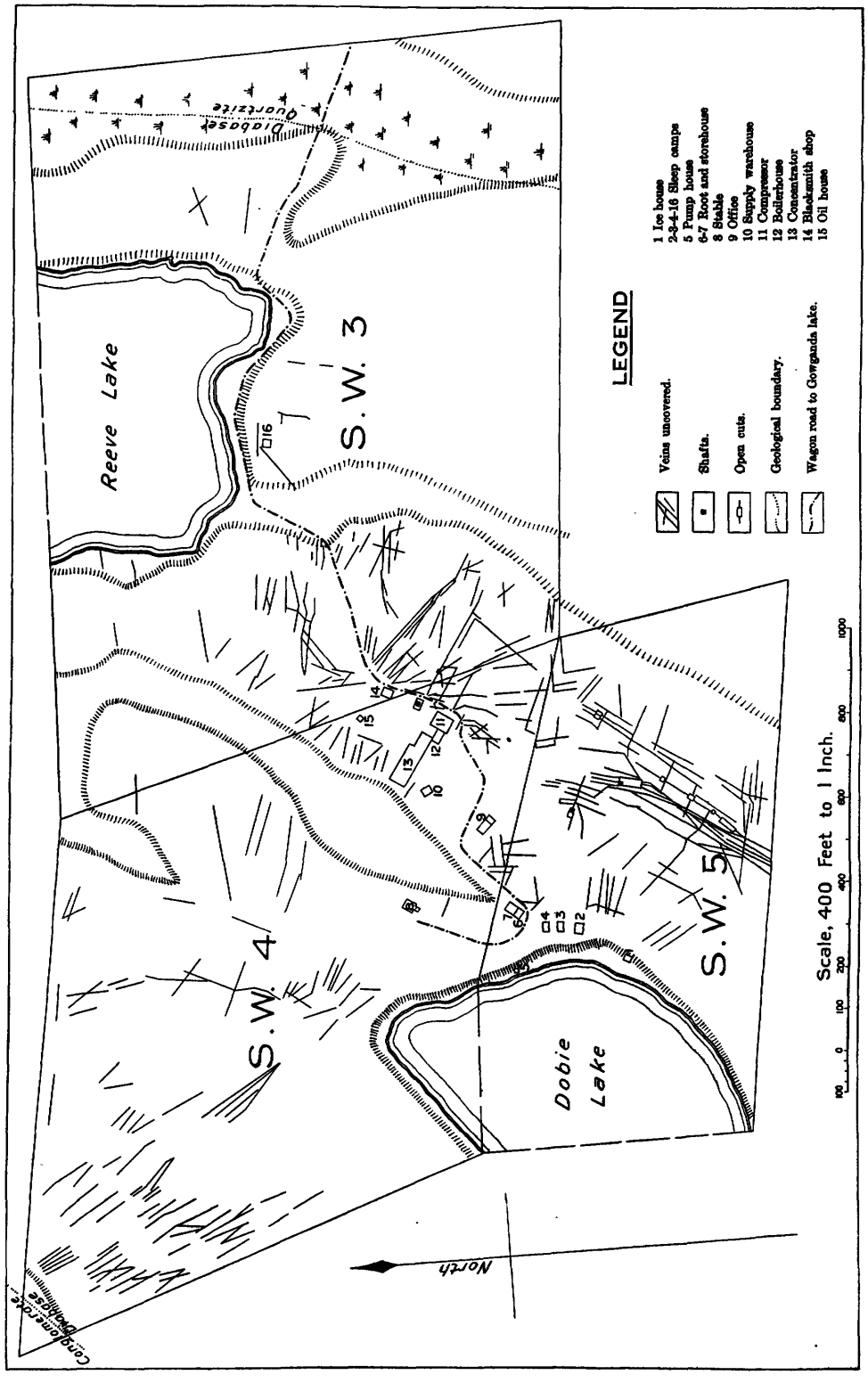
The Northcliff prospect is situated at the north end of the northwest arm of Gowganda lake. The property consists of about 160 acres, the principal claim of which is J.S. 282. The veins are in the Nipissing diabase, which occurs as a high ridge along the northeast shore of the lake. The ridge rises abruptly from the water's edge to an elevation of 125 feet. The relationship to the conglomerate is seen along the north line of J.S. 282, where the diabase underlies the conglomerate at 60° W.

The property was operated from the fall of 1919 for about one year. Some surface work was done on a series of veins on the top of the ridge. An open-cut 25 feet long was made on a calcite vein with strike N. 20° E., which averages from about one to three inches in width. Some specimens showing crystallized smaltite and silver were taken from the open-cut. The vein is faulted ten feet west of the south end of the cut. Shallow cuts and trenches were also made on some other fractures near the open-cut. Most attention was, however, given to driving a tunnel eastward into the hill from near the water's edge. This work was stopped before it was certain that the underground extension of the surface vein carrying silver had been intersected. Several calcite veins, from one to three inches in width, and a stringer of quartz showing some silver were cut in the tunnel, but no drifting was done on them.

The tunnel is about 285 feet in length. The work was accomplished by using steam-drills, but this was not found satisfactory, and it is expected when conditions improve that a compressor plant will be installed.

Reeve-Dobie

The Reeve-Dobie mine, which had been operated intermittently since 1908, was closed down in the fall of 1920. It has been worked by various interests. The original discoveries were among the most spectacular in the camp, and from open-cuts along short ore shoots some very rich silver ore was shipped. The early work consisted in prospecting for high-grade ore which was found to occur in a number of short shoots along a mineralized zone about 700 feet in length. Most of the high-grade ore was taken from a number of open-cuts. Later a mill was erected which ran for a short time treating diabase carrying minute veinlets containing native silver. The mill was reopened in 1919, a flotation plant was added, and ore from an open-cut or glory hole to the south of the shaft was treated. The ore was dropped to the 50-foot level and trammed to the shaft. The mill rock was said to carry from 30 to 35 ounces of silver per ton. Underground operations were carried to the 200-foot level, and considerable drifting and crosscutting was done. A number of strong faults were encountered in the workings. Very little work has been done on the west side of the property where there is much fracturing.



Vein system at Reeve-Dobie mine, reproduced from a mine plan. The principal workings are on the northeast-southwest veins in the southwest part of the property.

South Bay

The South Bay Mining Company did exploratory work several years ago on claims H.S. 723 and 724. They also sank a shaft to a depth of 100 feet on the O'Brien claim, H.S. 602, lying to the west. There is a series of five calcite-quartz veins near the shaft, with a general northwest strike, running from H.S. 602 to H.S. 723. In addition to the shaft, several large open-cuts were made on veins. A description of the property is given in a report on the Gowganda Silver Area:[1]—

> Active development was in progress on that part of the property which adjoins the southeast claim of the Bartlett mine when visited in October, 1912. A great amount of surface trenching had been accomplished, and open-cuts had been made on some of the veins. Smaltite, niccolite, and silver were found at different points. At one place, 90 feet south of the shaft, some high-grade ore had been taken from a cut about 20 feet in length. The shaft was down 100 feet, and a crosscut was being run to the south to intersect three northwest-southeast veins which showed on the surface. A north crosscut was also being run towards a vein with strike N. 60° W. which crosses from the Bartlett property. A 50-foot shaft had also been sunk just south of the north boundary line, on a vein parallel to the one just mentioned. The material on the dump consists of diabase, with aplite and calcite. Native silver and argentite occur in some of the vein material. Part of the vein about one inch in width consists of crystallized epidote and quartz carrying silver and argentite.
>
> Columnar structure is quite pronounced in the diabase, and along the joints veins have been formed, suggesting the filling of cooling cracks. Some of the country rock is quite reddish and coarse grained, and traceable into the dark grey diabase. Much of the reddish rock adjoining the veins is greatly stained with cobalt and nickel bloom.

Van Hise Township

Alpine (Gamey-Thompson)

The property of the Alpine Silver Mines is situated in the western part of Van Hise township to the northwest of Spawning lake. Here there is a north-south ridge of diabase about two and a half miles in length, reaching an elevation of 200 feet above the surrounding plain, which consists of sediments of the Cobalt series overlain in part by sand and gravel.

A series of aplitic veins was discovered on the diabase ridge, along which a great amount of trenching, accompanied by the sinking of shallow pits and two shafts to moderate depths, has been done. Associated with the aplite dikes are lenses and veinlets of calcite, which occur in different parts of the dikes, as shown along the surface. Most of the work has been done on claim H.R. 458. The aplite dikes vary from about six to twelve inches in width. A northerly trench is along an aplite dike for 140 feet, showing veinlets of calcite, and aplite impregnated with calcite, with frequent occurrences of native silver. Along one streak the calcite is two inches in width on the north wall of the dike, which strikes N. 83° W.

A second aplite dike has been followed for 450 feet by means of trenches. It has a strike of N. 20° E. for 120 feet at the north end, and a strike of N. 60° E. for the southern portion, while the dip is 80° W. The best surface showings occur north of the 30-foot shaft. Some rich nuggety silver ore was taken from an open-cut just north of this shaft. The matrix is also aplite, with lenticular calcite structures. A third dike occurs at the southwest end of the second dike and has been followed for 300 feet. Just south of the intersection of the dikes, there is some high-grade ore.

A tunnel 575 feet in length has been driven from the base of the hill westward to intersect the first dike at a depth of about 170 feet. The aplite dike was

[1]The Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming, Ont. Bur. Mines, Vol. XIX, pt. 2, 1913, p. 186.

drifted on underground for 80 feet before work was discontinued. A shaft was sunk on another aplite dike with a northwest strike to a depth of 29 feet.

The diabase sill has been fractured with the formation of intersecting aplite dikes, along which segregations of calcite carrying native silver have been formed at several points on the dikes. The columnar jointing planes exposed in the long tunnel would suggest that the diabase is in the form of a sill rising from the east.

A power plant, consisting of a 60 h.p. boiler and 3-drill compressor, was installed recently and exploration will be carried on in 1921. E. J. Thompson is superintendent.

Hedlund

During 1920, L. O. Hedlund was prospecting T.C. 141 and an adjacent claim to the east, situated a mile and a half north of the northwest arm of Gowganda lake. These claims were staked around McLoughlin lake, which has since been drained by the blasting of a rock ledge at its lower end in aid of the waterpower supply of Gowganda lake and which is now represented by a marsh. Considerable work was done on the west side of the marsh in the sill diabase, and also on the east side, in a dike of diabase which intrudes the conglomerate. The best results were obtained west of the marsh, where there are quartz veins showing some native silver. A shaft has been sunk to a depth of ten feet at the junction of a quartz vein two to three inches in width, with a northeast strike and narrow transverse stringers of aplite. The quartz vein with offsets has been traced southwestwards several hundred feet. It has a banded structure showing scales of native silver in the white quartz, together with copper pyrites, galena, and a little niccolite at the shaft. A little cobalt bloom was also seen in the narrow veins near the shaft. The transverse veins at the shaft also show a little native silver in the aplite.

The sill diabase outcrops at a few places in the marsh but was not observed in contact with the older rocks that occur to the east of the marsh. On the west side of claim T.C. 141, the diabase underlies the conglomerate at a high angle.

Charters Township

Garvey

The Garvey claim, E.D. 123½, situated west of the Montreal river, in the south part of Charters township, was being prospected during the summer of 1920 by the Garvey brothers. A number of veins were discovered on a knoll of diabase near the west line of the property.

The veins vary greatly in strike and are more or less connected, as revealed by the trenching. The vein in which most silver was noted is about one to two inches in width, strikes N. 60° E., and was traced for 125 feet. In part of the distance there is an open fissure, but toward the east end of the trench, for a distance of 30 feet, there are showings of high-grade ore, consisting of silver and smaltite, some of the silver being in the black decomposition products of cobalt and nickel minerals. A second vein, 13 feet northwest, strikes N. 48° E. and contains aplite six inches wide together with calcite. Fragments of the aplite show scales of native silver. Cobalt bloom can be seen along the walls of several other veins, represented by open fissures for six inches or more. The discoveries having been so recently made, practically no work has been done beyond trenching, so that more time will be required to prove their economic value. The greatly fractured diabase knoll affords a promising location for considerable exploratory work.

Haines

The Haines claim, H.R. 439, is half a mile south of the Garvey claim and near the south boundary of the township. Some work was being done in a shaft on a vein which strikes N. 45° E. The shaft was down 11 feet, and for six feet from the surface showed a lens of calcite carrying some silver and smaltite, while at the bottom of the shaft there is a thin seam of calcite.

Work was also done by the same interests on claim G.G. 2,606 in Donovan township, where a shallow shaft has been sunk on a calcite vein from an inch to two and a half inches in width, with a strike N. 62° E. The vein carries disseminated smaltite, niccolite, chloanthite, and some native silver. The rock is a coarse-grained diabase showing some reddish granophyric interstices of quartz and feldspar.

Leith Township

Hudson Bay

This property is in the southeast part of Leith township and includes mining claims H.S. 695, 696, and 716. It was operated from 1910 to 1913, but has since been idle. Two shafts were sunk on silver-bearing veins on claim H.S. 716 and one shaft on claim H.S. 696. When visited in 1920, some of the veins could be seen at the shafts near the surface, while some heavy smaltite silver-bearing ore was picked up on the dump. It is reported that about six tons of silver ore were taken from the workings, chiefly from shaft No. 2.

At No. 1 shaft, which was sunk 94 feet with a drift of 128 feet, there is a strong calcite vein seven inches in width in addition to some narrow stringers. Some massive smaltite, 20 inches in width, is reported from the open-cut. No. 2 shaft was sunk 110 feet with drifting of 274 feet. The vein showed, near the collar of the shaft, a width of two inches with a dip of N. 80° W. No. 3 shaft was sunk 214 feet with drifting amounting to 362 feet on the 76-foot level, and 359 feet of drifting and crosscutting on the second level. The vein in shaft No. 3 is reported to be from one to four inches wide, and in places to carry high values in silver. Four veins were encountered in drifting, two of them showing native silver. It is expected that this property will be reopened when conditions of mining and transportation are improved.

Silverado

The Silverado Mining Company operated a group of 14 claims located in the southeast part of Leith township and the southwest part of Charters township, most of the claims being in Leith. The property is adjacent to the Hudson Bay mine. Most of the exploratory work has been done on claim H.S. 693, where several veins have been located. Nos. 1, 2, and 3 veins have a general north-south strike. Some trenching has been done and shallow pits have been made on these veins, indicating the occurrence of smaltite, niccolite, copper pyrites, aplite, and calcite. Native silver was found in No. 1 vein and also in No. 4 vein, which strikes more nearly east. Some very high-grade silver ore an inch in width was obtained from a pit on No. 4 vein. A shaft has been sunk on No. 3 vein to a depth of 100 feet, and a drift to the north and a crosscut to the southwest were begun to intersect veins that outcrop at the surface.

The veins are in the Nipissing diabase, with which conglomerate and quartzite of the Cobalt series form the contact. On claim G.G. 4,149 the sedimentary rock adjacent to the diabase has been altered to adinole, showing rounded spots. The top of the sill is exposed in the locality.

The plant consists of a 125 h.p. return tubular boiler, a 7-drill compressor, hoist, and pumps. A saw-mill has also been erected to prepare lumber for the mine buildings.

Donovan Township

Duggan

Some work was done on claims H.R. 720 and T.C. 418 during part of 1920 by Howard Duggan. These claims are along the east branch of the Montreal river in Donovan township. Veins were discovered by earlier stakers in 1909, and in succeeding years considerable prospecting was carried on by means of trenches and open-cuts. On claim H.R. 720, there is a calcite vein three inches in width, with strike N. 71° W., that has been traced for about 400 feet on this claim and on an adjacent claim to the northwest for 200 feet. A little native silver, smaltite, and niccolite were found in places in the calcite. A pit 10 feet deep was sunk on the vein 150 feet east of No. 4 post. Just west of the pit is another vein, three inches in width, showing calcite with a little smaltite, crossing the longer vein.

Two veins of calcite carrying bloom and copper pyrites occur in the northwestern part of claim T.C. 418.

Wilder

Claims G.G. 3,541 and 3,542, located in Donovan township, a quarter of a mile east of Collins lake, were explored by Frank Wilder during part of 1920. An open-cut 28 feet long and nearly five feet deep was made along a calcite vein varying in width from half an inch to two inches, and in strike from N. 65° E. to N. 45° E. A few segregations of native silver and smaltite, together with some niccolite in one place, occur in the calcite vein. Two branch veins, one two inches wide and the other from one and a half to four inches wide, are shown near the southwest end of the open-cut. Two of the showings of silver are near the intersections with the main vein. Seven feet north of the east end of the cut on the main vein, a second vein, varying in width up to two inches, has been followed northeastward for 175 feet. The wall rock of the veins is Nipissing diabase.

Morel Township

Bishop

During part of 1920, Wm. Shields carried on exploratory work on claim L.O. 305 lying to the northwest of Bloom lake. A vein striking east and varying in width up to six inches was trenched for several hundred feet. The vein filling is calcite, which carries in places smaltite, together with some massive bornite and native silver. The wall rock is Nipissing diabase. The shaft was sunk to a depth of 50 feet.

Corkill Township

The township of Corkill came into prominence after the discovery of native silver on the Kell claims, G.G. 3,786 and 3,449, about 12 miles southeastward from Gowganda. The locality is reached by a wagon road, which leaves the main Elk Lake-Gowganda road about half a mile west of Long Point lake. From Gowganda, a canoe route up the East Branch of the Montreal river to the lower end of the third portage can be used. From this point there is a trail eastward by way of Steele lake and partly following the south boundary of Charters township to Corkill township.

Corkill is largely covered with sand and gravel deposits of glacial origin, occurring in plains and gently rolling ridges. The township contains a number of spring lakes, the largest of which is Lady Isabel, locally called Beauty lake. This lake has beautifully clear water, has no surface outlet, and abounds in lake trout. Brook trout are found in several spring creeks in the area south of Long Point lake.

Geology

Several ridges of Nipissing diabase and Animikie quartzite outcrop through the drift. Of these, the ridges of diabase form the chief topographical features, reaching in places 250 feet above the plain.

Diabase.—The diabase ridge in the southwest corner of the township was examined closely. Its structure is that of a highly inclined sill rather than a dike. The normal quartz diabase is dark grey, but in a few places was found to contain dark red spots, which are chiefly acid plagioclase (albite) showing some differentiation not recognized in dikes. Microscopically, the rock has an ophitic texture, the laths of feldspar being partly altered to saussurite, and the augite partly to chlorite. Micrographic intergrowths of quartz and red plagioclase occur abundantly in the interstices of the specimen examined. The diabase resembles that of Gowganda, Elk lake, and elsewhere, and is clearly in the form of a sill. An excellent contact of the overlying diabase and the quartzite occurs on the line between claims G.G. 4,247 and 4,326. The contact is well up the east side of a steep ridge that overlooks Shack lake and dips 55° W.

Quartzite.—Quartzite of varied grain and colour is the only sedimentary rock found in the area near the silver discoveries. In this respect this area resembles Cane and Auld townships and the silver area near Maple mountain.

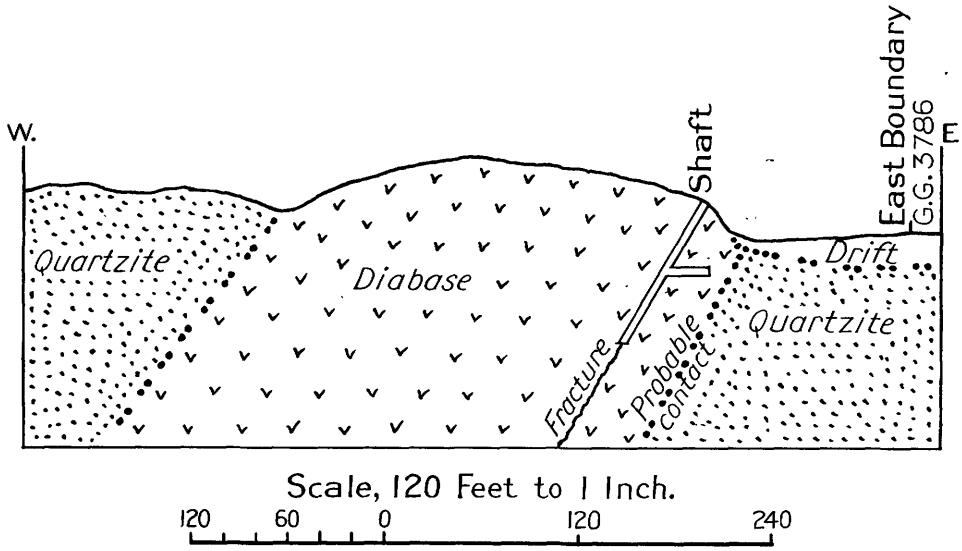
Discovery of Silver.—Claims were staked as early as 1909, but little work was done until several years later. The discovery made by Hugh Kell and associates was of native silver in veins on a narrow diabase ridge on G.G. 3,786 in the southwestern part of the township. The first find was made in a number of loose fragments of diabase carrying sections of a calcite vein. Further exploration resulted in the finding of native silver in place at points along the east side of the ridge. Here, there is a main fracture that roughly parallels the contact with the quartzite, dipping 55° to 60° W. What appears to be the same fracture zone has been located by means of trenches and pits at intervals over several claims. The main fracture varies up to 18 inches in width. The principal constituents are calcite and quartz, carrying angular fragments of diabase and showing cobalt bloom in places along the surface. There are also roughly parallel veinlets of quartz and calcite, mostly on the footwall side of the main fracture, as well as subsidiary veins that run diagonally from the main fracture. In some of these latter, high-grade silver ore was discovered.

Exploration of Kell Claims

The property was optioned during 1919-20 to J. G. Smith, ex-Governor of Vermont. Well-constructed camp buildings and a steam power-plant were built on claims lying to the east of those carrying the silver-bearing veins. The steam plant consists of an 80 h.p. boiler, a 4-drill Ingersoll-Rand compressor, and a 6 by 8-inch Jenckes hoisting engine. A shaft inclined 58 degrees was sunk on the main fracture to a depth of 104 feet, and 275 feet of drifting on the 54-foot level and about 50 feet on the 100-foot level were accomplished. A

raise was also made from the 54-foot level to an outcrop of high-grade ore 25 feet south of the shaft. The diabase along the footwall in the shaft showed some native silver to the 100-foot level, and a little silver was encountered in the drift on the 54-foot level to the south of the shaft.

A small shipment of ore, 1,584 pounds, containing 1,620.9 ounces of silver, was made from an open-cut south of the shaft, together with a few bags from an open-cut 700 feet north of the shaft. A number of prospecting pits have been sunk along the main fracture. From one of these, 200 feet south of the shaft, good specimens of the rare nickel sulphide, millerite, were obtained. An assemblage of minerals, including argentite, smaltite, niccolite, and millerite, together with small quantities of magnetite, specularite, and pyrrhotite, have been obtained from the calcite-quartz veins. The presence of the last three minerals indicates a high temperature of formation of the veins. Most of the ore shipped consisted of white calcite with native silver in scales, together with some argentite.



Cross-section at the Kell property, Corkill township, showing highly inclined attitude of the diabase sill and shaft on the fracture near the footwall.

Some heavy smaltite with native silver was obtained from an open-cut north of the shaft. Work had been discontinued for two months when the property was visited in July, 1920, so that only the surface conditions could be studied. From information obtained and an examination of the surface, it was judged that the narrow subsidiary calcite veins on the footwall side of the main fracture afford the most promise for high-grade silver ore.

Kell (G.G. 4,124 and 4,125)

Mining claims G.G. 4,124 and 4,125, along the west shore of Lady Isabel lake, belong to Hugh Kell. The rock here is diabase, occurring as a northwest and southeast ridge outcropping through the drift. Unlike the fracture on the Kell claims previously described, the veins are transverse to the long axis of the diabase outcrop. They are largely of quartz with a ribboned structure. Calcite lenses occur with the quartz veins. Small particles of galena and copper pyrites are frequently seen. A little native silver occurs in the quartz and as scales in the diabase. A series of veins averaging one to three inches in width occur

along the east base of the diabase ridge running back over the hill. At one place there are three in a width of 15 inches. A few shallow pits have been sunk on several veins, but many of the veins are unprospected.

South Bay Power Company

A hydro-electric power plant has been installed by the South Bay Power Company at the outlet of Hanging-stone lake, where it discharges into Gowganda lake. The natural head is 58 feet, but by means of a dam this has been raised to 69 feet 4 inches. The flume is 450 feet in length, most of the fall being near Gowganda lake. The drainage area of Hanging-stone lake is approximately 39 square miles, and the present plant is a 250-horsepower installation.

GOWGANDA VEIN MINERALS

By E. W. Todd

Introduction

To supplement his new report on the Gowganda Silver Area, A. G. Burrows suggested the advisability of making a detailed microscopic examination of the minerals commonly found occurring with silver in the veins. Accordingly samples were collected in the autumn of 1925 by Mr. Burrows and the writer from representative veins in the producing mines; also specimens were obtained from certain other properties not at present in operation. In all, some twenty specimens were examined with the microscope, and carefully checked analyses were made on twelve of these by T. E. Rothwell. Time was not available to make an exhaustive study of the veins with a view to providing a complete list of the minerals found in the ores of the camp, and it is quite probable that further study would add to the number of minerals identified in this examination.

Method of Examination

Polished sections of the specimens of ore were examined by means of a Bausch and Lomb microscope, using vertical illumination. Microchemical tests were made with nitric acid, which was found to be the only etching reagent of any practical value in testing the arsenides of cobalt, nickel, and iron, the principal metallic minerals associated with the silver. In this connection the data published by E. Thomson[1] on the identification of these minerals were of great assistance.

The presence of much calcite intimately intergrown with the metallic minerals offered considerable difficulty, as the acid applied to the polished surface was immediately neutralized by the carbonate, and satisfactory etching effects on the arsenides were not obtainable. To overcome this trouble, a prepared flat surface of the ore was immersed in dilute acetic acid until the calcite was dissolved for a depth of about one-eighth of an inch. The resulting holes were filled with hot sealing wax, and after cooling, the surface was polished. This gave a section, free from carbonates, in which the original relationships of the minerals were preserved, a condition not obtained in the practice of imbedding in the wax the powdered minerals after removing the calcite.

It is almost impossible to identify with certainty the various arsenides of cobalt, nickel, and iron in the hand specimens; even with the microscope the polished surfaces of these minerals, before etching, appear practically identical. However, in mixtures of these minerals certain ones are attacked more readily by nitric acid than others, and structures indicating the system of crystallization are developed by the acid. Some of the elements present can be identified by testing the dissolved mineral with a suitable reagent. For example, iron is recognized by the blue colour produced with potassium ferro-cyanide, and nickel by means of the red precipitate formed by the addition under proper conditions of di-methyl-glyoxime. By use of data obtained in this manner, in conjunction with the chemical analysis, it is possible in many cases to identify all of the minerals present in a complex mixture of these closely related minerals.

[1]University of Toronto Studies, No. 20.

Character of Veins

The veins as a rule occur in fissures which were developed in the diabase along joint-planes on the hanging wall of the diabase. There is also evidence of some replacement of wall rock in most cases. Frequently there is a row of

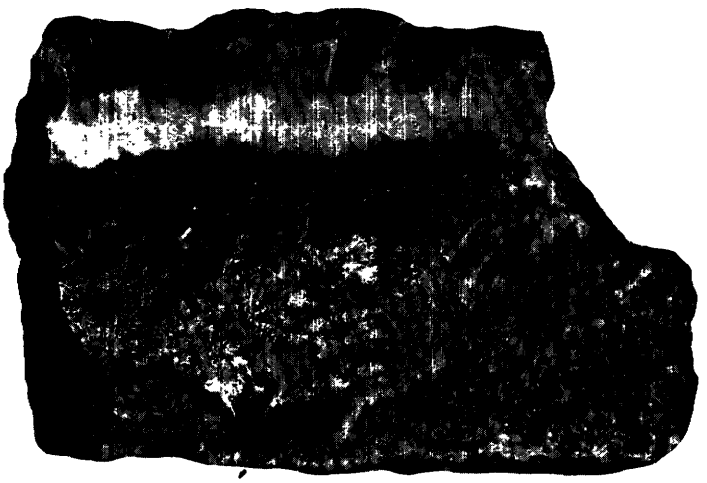


Fig. 1. Natural size.
Interesting vein structure, Tonopah mine.

quartz crystals in the vein near the margin and parallel to the walls, which represents the wall of the original fissure. Bordering the quartz crystals is a replacement zone consisting of calcite with thin streaks of chloritic material representing remnants of wall rock. In this outer zone, chalcopyrite and bornite

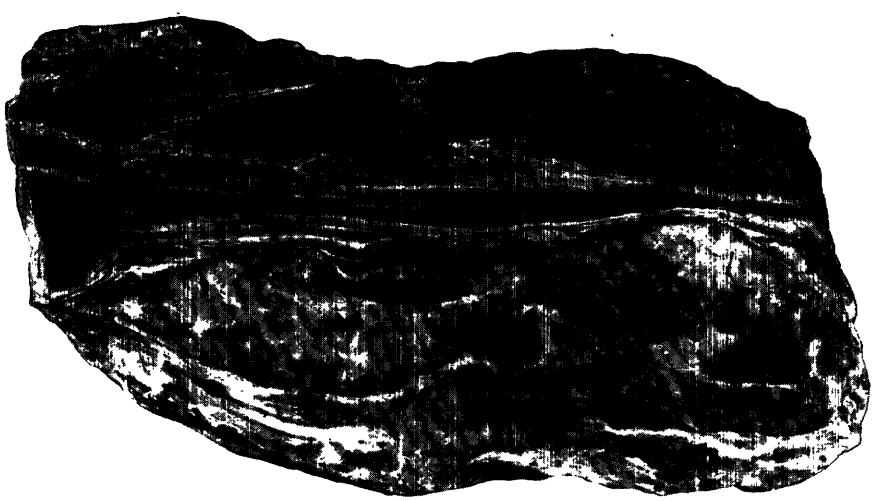


Fig. 2. Natural size.
Stringy type of vein filling in Miller Lake section, suggesting colloidal origin. This material is 98 per cent. calcite.

are sometimes present, and in one vein observed in the Tonapah mine considerable hematite occurs along the margins. Most of the silver is contained within the original fissure walls intimately associated with arsenide minerals and

grey calcite (Fig. 1). Some silver is also found in fractures traversing the original veins and in sheets in the diabase wall rock. This type of silver deposit is not usually accompanied by any minerals other than calcite. The principal gangue mineral is calcite in which are imbedded a few grains of quartz. Analyses made by W. K. McNeill, Provincial Assayer, on a number of samples of gangue showed the magnesia content to be low—less than one per cent. in most cases.

In addition to the grey calcite veins which contain the ore shoots, there are others of white calcite, often sugary in character and usually barren of valuable minerals. This type has been observed cutting the ore-bearing veins. An unusual occurrence of the barren, white-calcite type, known as the Bonsall vein, may be observed on several levels in the Miller Lake O'Brien mine. This vein reaches a width of over four feet and in places contains many angular fragments of the diabase wall rock showing few signs of alteration.

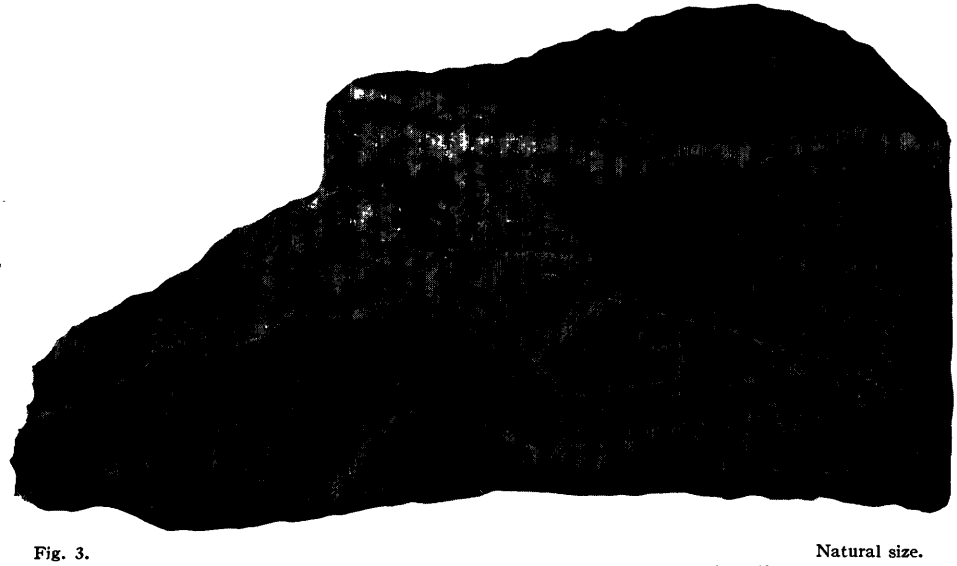


Fig. 3. Natural size.
Polished surface of dendritic ore from Miller Lake O'Brien mine. The silver surrounded by rims of arsenides forms the dendrites (white) which, along with grey calcite, occupy fractures in salmon-coloured carbonate.

A vein on the 525-foot level of the Miller Lake O'Brien mine contains a section of high-grade ore in which the gangue consists in part of pink calcite apparently deposited prior to the ore. The polished surface shows the silver and arsenides in dendritic growths to have come in with grey calcite in fractures in the pink carbonate (Fig. 3).

The arsenides most commonly occur as radiating intergrowths in a groundmass of calcite. Beautiful examples of dendritic growths, in which the arsenides form an envelope surrounding skeletal crystals of silver, have been observed in the Miller Lake O'Brien, the Tonopah, and the Castle-Trethewey mines.

Crushed Vein Material

A peculiar type of crushed vein material occurs in the mines of the Miller Lake section. In the hand specimens it has a lustreless grey colour and an exceedingly fine-grained texture, being almost entirely lacking in crystalline

structure. In general appearance, the groundmass is not unlike the material composing the chilled margins of some diabase dikes.

Specimen No. 1.—In the specimen examined microscopically, minute points of silver project from the surface. This sample, taken from the No. 72 vein on the 585-foot level of the Miller Lake O'Brien mine, in polished section is seen to consist of about equal parts of calcite and white metallic fragments of arsenides possessing high relief and hardness. Many of the fragments are angular in outline and have none of the delicate marginal structures typical of growths of arsenide minerals (Fig. 4). In the section examined, these fragments range in size from 0.5 millimetres in diameter down almost to the limit of visibility with the high-power microscope.



Fig. 4. × 150.
Crushed vein material. Arsenides and silver (light); calcite (black).

On etching with nitric acid, some of the fragments are seen to be composite in character. Three minerals are shown on the etched surface, one of which remains bright even after treatment with concentrated nitric acid for half a minute. This mineral is cobaltite and accounts for the sulphur shown in the analysis. The greater part of the metallic fragments, however, are darkened with the dilute nitric acid, the structure developed showing a complex intergrowth of two minerals, one etching more deeply than the other. A test made for iron proves the presence of large amounts of this element and indicates the presence of the iron diarsenide löllingite, which typically etches slowly. From the analysis the other mineral present is found to have the composition $CoAs_2$, and as it occurs intimately intergrown with a rhombic mineral, it is itself more probably rhombic than cubic; consequently, the mineral is assumed to be safflorite rather than smaltite.

In thin section, the groundmass is composed of crushed calcite, the small fragments of which are bound together with carbonate cementing material. Some of the larger fragments show greatly distorted twinning *lamellae* and cracks filled with finer crushed material. A few small isolated grains of quartz are mixed with the calcite.

The silver occurs in irregular patches and shreds scattered indiscriminately throughout the specimen and without doubt was present when the movement causing the brecciation took place. Other specimens of this type mentioned below show some silver penetrating the crushed material in definite veinlets.

The history of this brecciated vein filling seems to be that following the formation of the normal silver-arsenide veins, movement took place along parts of these, as a result of which the vein contents were crushed into small fragments and then cemented together to form the brecciated material. Further movement of silver-bearing solutions resulted in the deposition of additional amounts of this metal in parts of the veins.

The analysis follows, together with the recalculated percentage composition[1] based on the chemical and microscopic results:—

Analysis		Composition		Ratios of metallic minerals	
	per cent.		per cent.		per cent.
Fe	7.19	Löllingite	26.2	Löllingite	54.9
Co	5.04	Safflorite	15.5	Safflorite	32.5
Ni	.74	Cobaltite	3.4	Cobaltite	7.1
S	.66	Silver	2.68	Silver	5.6
As	31.86	Calcite	49.1		
CaO	27.48	Quartz	1.5		
SiO_2	1.50				
MgO	trace				
Cu, Sb	none				
Ag	2.68				

No mineral corresponding to the 0.74 per cent. of nickel shown in the analysis was observed in the section. It was therefore added to the cobalt. However, a small amount of nickel diarsenide may be present masked by the other minerals.

Specimen No. 2.—A specimen of crushed material from another part of the same vein contains bright metallic streaks, which under the microscope prove to be simply areas of high metallic content. The minerals are the same. Part of the silver cuts the brecciated material in minute veinlets, but most of it occurs as isolated fragments and was present before crushing took place.

Specimen No. 3.—In a high-grade sample of similar material from the 300-foot level of the Tonopah mine, most of the silver is confined to a part of the specimen which lay against a wall of the vein. In this case the silver quite evidently came in along a fracture developed at the margin of the original vein and must be later in point of time.

Normal Type of Vein Material

Specimen No. 4.—A specimen from the No. 4 crosscut east on the 550-foot level of the Castle-Trethewey appears to the unaided eye to be composed of fine-grained segregations of arsenides and silver in calcite. Under the microscope,

[1]The method in common use with rock analyses was employed for the recalculations.

the arsenides are seen to consist of radiating and sheaf-like growths imbedded in and intergrown with calcite, while the silver is distributed throughout the arsenide masses in small isolated fragments (Fig. 5). A relatively small amount of silver occurs in minute veinlets. The greater part of the arsenides consists of löllingite and safflorite. A considerable portion, however, which is not appreciably etched by dilute nitric acid consists of the cobalt triarsenide skutterudite, which forms rims around some of the radiating intergrowths of löllingite and safflorite and also shows in cubic sections scattered through the interiors of the growths.



Fig. 5. × 100.

Contemporary intergrowths of arsenides (white), silver (grey), and calcite (black). Note the small particles of silver imbedded in the arsenides.

The following tables give the composition and proportions of minerals present:—

Analysis		Composition		Ratios of metallic minerals	
	per cent.		per cent.		per cent.
Fe	10.40	Löllingite	38.3	Löllingite	56.6
Co	6.25	Safflorite	16.5	Safflorite	24.4
Ni	.47	Skutterudite	9.9	Skutterudite	14.7
S	trace	Silver	2.81	Silver	4.31
As	47.65	Calcite	32.7		
CaO	18.30	Quartz	.13		
SiO_2	.13				
MgO	trace				
Cu, Sb	none				
Ag	2.81				

Specimen No. 5.—A massive arsenide type of low-grade silver vein from the 585-foot level north of the winze in the Miller Lake O'Brien mine consists of small spherical masses of tin-white arsenides rather closely grown together, with uniformly distributed calcite filling intervening spaces. The metallic minerals are: safflorite, löllingite, cobaltite, and a small amount of chalcopyrite. The cobaltite shows up plainly on the etched surface as small nests of minute cubic crystals scattered through the löllingite and safflorite, which form intimate intergrowths of radiating blades. The close association of the rhombic mineral löllingite with the cobalt mineral in the intergrowths points to the probability of the latter being safflorite rather than smaltite, the cubic representative of the same composition.

The analysis and the percentage composition are as follows:—

Analysis		Ratios of metallic minerals	
	per cent.		per cent.
Fe	6.69	Safflorite	58.5
Co	13.97	Löllingite	30.9
Ni	.53	Cobaltite	8.6
S	1.71	Chalcopyrite	1.8
As	50.70	Silver	.22
Sb	1.05		
Cu	.40		
Ag	.17		

In this and following analyses, which do not approximate a total of 100 per cent., the balance in most cases consists of calcite and a little quartz. Impurities, likely to interfere with the calculation of the proportions of arsenides, in most instances are negligible, as proved by chemical tests on the gangue minerals and by microscopic examination. The recalculations serve to check the accuracy of the microscopic determinations and show approximately the relative amounts of metallic minerals.

In determining the proportions of the minerals in the table above, the antimony and nickel are placed with the arsenic and cobalt, respectively, as no minerals containing these elements were observed in the section.

Specimen No. 6.—This specimen of so-called smaltite ore from the No. 8 vein on the 330-foot level of the Tonopah mine is similar in structure to No. 5. The minerals are essentially the same, the chief difference being in the greater proportion of löllingite present, which in addition to forming intergrowths with safflorite shows in relatively large areas in section.

Analysis		Ratios of metallic minerals	
	per cent.		per cent.
Fe	12.42	Löllingite	60.4
Co	9.27	Safflorite	30.9
Ni	trace	Cobaltite	8.7
S	1.32		
As	52.93		
Sb, Cu	none		
Ag	.03		

The gangue minerals in Nos. 5 and 6 are calcite and a little quartz. Magnesia is found by analysis to be less than one per cent. The spherical arsenide growths are, in the leaner parts of the vein material, completely surrounded by calcite

(Fig. 6), which also occurs imbedded in the metallic masses, often forming a central core. These facts indicate that all of the mineral constituents were present in the vein solution at the time precipitation began and that the deposition of the various minerals was contemporary. The evidence suggests that precipitation of the arsenides starting from many centres in the vein solution was accompanied by crystallization of calcite and that crystals of the latter were imbedded within the growing masses of the arsenides. After most of the arsenides were deposited through slow migration in a slowly cooling solution of very high solid content, calcite still remaining in the mother liquor filled in the spaces between masses of the metallic minerals. The slightest movement in the veins at this stage would produce ruptures in the loosely bonded masses

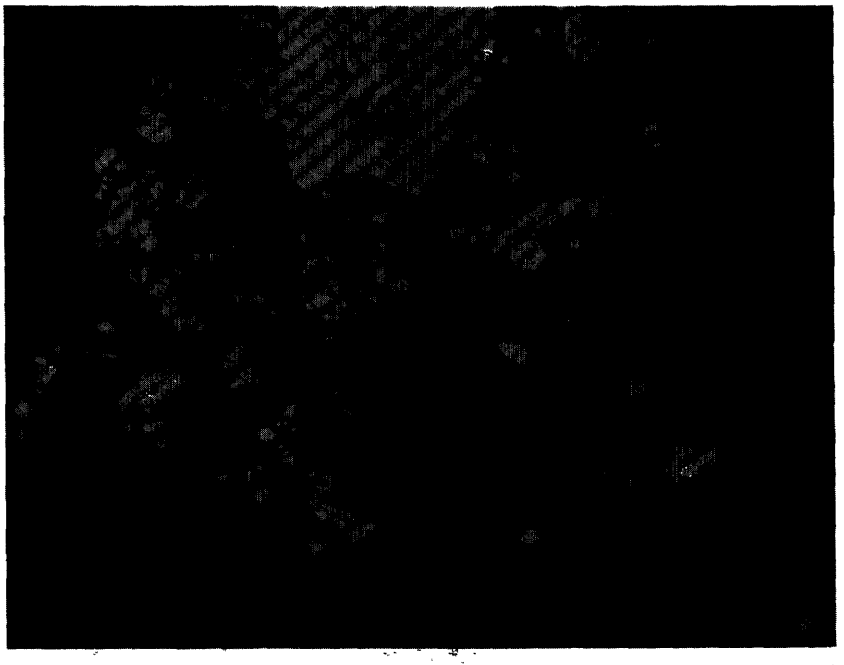


Fig. 6. × 150.
Minute growths of arsenides (white) completely enclosed in calcite (black). Note calcite intergrown with arsenides.

of crystals which would be filled with minerals formed from materials still in solution in the mother liquor. Veinlets so formed would be simply a part of the process of the original deposition.

Specimen No. 7.—An interesting specimen of ore containing 1,339 ounces of silver per ton was obtained from the South Bay mine on H.S. 723. Etching the polished surface showed relatively large amounts of skutterudite and cobaltite along with smaller proportions of löllingite and a cobalt diarsenide mineral, probably safflorite. The skutterudite forms spherical growths surrounding radiating masses of the diarsenides. Some löllingite and safflorite (?) along with calcite also fill in spaces surrounding the skutterudite, and cobaltite occurs as irregular masses, showing cubic crystal outlines, scattered throughout the section. Most of the silver is enclosed in the skutterudite in skeletal crystals and minute isolated fragments, suggesting contemporary deposition with the arsenides. A small amount of argentite is associated with the silver.

The following analysis was made on a sample freed from oxidation products:—

Analysis		Ratios of metallic minerals	
	per cent.		per cent.
Fe	4.28	Skutterudite	41.6
Co	21.10	Cobaltite	26.1
Ni	trace	Löllingite	16.9
S	4.77	Safflorite(?)	15.4
As	64.45		
Cu	.19		
Sb	trace		

Although cobaltite is present in most of the specimens examined, a proportion as high as that occurring in No. 7 is unusual in high-grade veins.



Fig. 7. × 100.

Hudson Bay mine specimen etched with dilute nitric acid. The white circular masses are skutterudite. The radiating mass is an intergrowth of löllingite and safflorite. Part of the grey mass to the right of the photograph is smaltite. Black is calcite.

On account of the presence of a small amount of argentite, the ratios given for the arsenides are probably not exact However, in the prepared sample some of the argentite was removed along with the greater part of the silver, before analysis, so that the figures are substantially correct.

Specimen No. 8.—This sample from Hudson Bay mine also contains a high proportion of skutterudite. The structures brought out by etching the polished surface with dilute nitric acid are shown in Fig. 7. Skutterudite shows as thick circular growths enclosing niccolite in some cases, in others calcite. Spaces between the skutterudite masses are occupied in part by radiating blades of

löllingite and safflorite and, rarely, by masses of cobalt mineral showing good cubic cleavage when suitably etched. The mineral is smaltite, and this is the only specimen in which it has been definitely recognized. A few cobaltite crystals occur in the section in nests often enclosed within the circular masses of skutterudite. These two minerals are readily distinguished, when in close contact, the cobaltite showing a whiter colour when etched with concentrated nitric acid. Calcite occurs intergrown with the arsenides.

Analysis		Ratios of metallic minerals	
	per cent.		per cent.
Fe	7.43	Skutterudite	47.0
Co	12.10	Löllingite	32.2
Ni	2.24	$CoAs_2$	10.6
S	.67	Niccolite	6.0
As	62.56	Cobaltite	4.1
Sb	trace	Silver	.4
Cu	trace		
Ag	.12		

Specimen No. 9.—A highly oxidized surface sample from the Big Four mine shows on the polished surface cobaltite, arsenopyrite, and smaltite (?). No reasonable calculations of the proportions of minerals present can be made because of the impurity of the sample used in the analysis which follows:—

	Per cent.
Fe	7.08
Co	20.27
Ni	trace
S	11.43
As	35.00
Sb, Cu	none
Ag	.06

Dendritic Types

Specimen No. 10.—This specimen of high-grade, somewhat oxidized ore was obtained from the Mann mine. On the polished surface the metallic minerals show in stout dendritic forms with most of the silver occurring as skeletal crystals, which form the nuclei for radiating growths of arsenide minerals (Figs. 8 and 9). Fragments of calcite and quartz are sometimes enclosed in the central silver masses, and frequently the centres are composed entirely of calcite.

A minor amount of silver occurs in vein-like channels through the calcite surrounding the dendrites. In this specimen these veinlets are, in many cases at least, hair-like growths off the main masses of silver. This is brought out when a polished section is resurfaced. Lines of silver which showed on the old surface have disappeared on the new, while others appear in different positions in the section.

The unusual thickness of the rim of arsenides surrounding the silver nuclei in this specimen makes feasible a detailed examination of these minerals. Bordering the silver there is a band of skutterudite, which shows up strikingly when the section is etched with dilute nitric and which is present even on the small veinlets referred to before. Radiating outward from the skutterudite bands is an intergrowth of löllingite and safflorite in which cubic crystals of cobaltite are imbedded in parts of the section. The radiating blades of diarsenides



Fig. 8. × 100.
Specimen from Mann mine, showing silver dendrite surrounded by arsenides. The black mass is calcite enclosing fragments of silver.



Fig. 9. × 150.
Part of same specimen as Fig. 8, etched with dilute nitric acid. Silver (dark grey), skutterudite (white), löllingite and safflorite (grey). The central dark mass is calcite.

occupy positions approximately at right angles to the edges of the silver masses. These structures are shown in Fig. 9.

The constant presence of a layer of skutterudite surrounding the silver offers strong evidence that the arsenide was precipitated upon the silver. It is hard to conceive how this definite arrangement could have been arrived at in any other way.

The specimen examined with the microscope contained 43.3 per cent. silver. In the prepared sample used for analysis considerable silver was eliminated along with the oxidized materials.



Fig. 10. × 150.
Detail of dendritic growths in specimen from Miller Lake O'Brien mine. The dark grey masses are silver; the radiating light grey material is arsenides. Note small masses of silver imbedded in the arsenides. Etched with dilute nitric acid.

Analysis		Ratios of arsenides	
	per cent.		per cent.
Fe	4.81	Skutterudite	42.8
Co	16.02	Löllingite	20.1
Ni	1.10	Safflorite	19.2
S	1.26	Cobaltite	7.4
As	64.79	$NiAs_2$	4.5
Sb, Cu	trace		
Ag	9.48		

The nickel mineral indicated in the analysis, although observed in the section, was not identified. It may be either chloanthite or rammelsbergite.

Specimen No. 11.—A natural-size photograph of No. 11 is shown on page 24. This fine specimen of the dendritic type of ore from the 460-foot level of the Miller Lake O'Brien mine shows essentially the same structure as No. 10.

There is, however, no skutterudite present. The rhombic minerals löllingite and safflorite radiate outwards at right angles from the edges of the silver dendrites (Fig. 10), which enclose a little niccolite in some cases. The microscope shows that a considerable part of the silver occurs in minute particles imbedded in the rims of arsenides surrounding the central silver masses. There are also

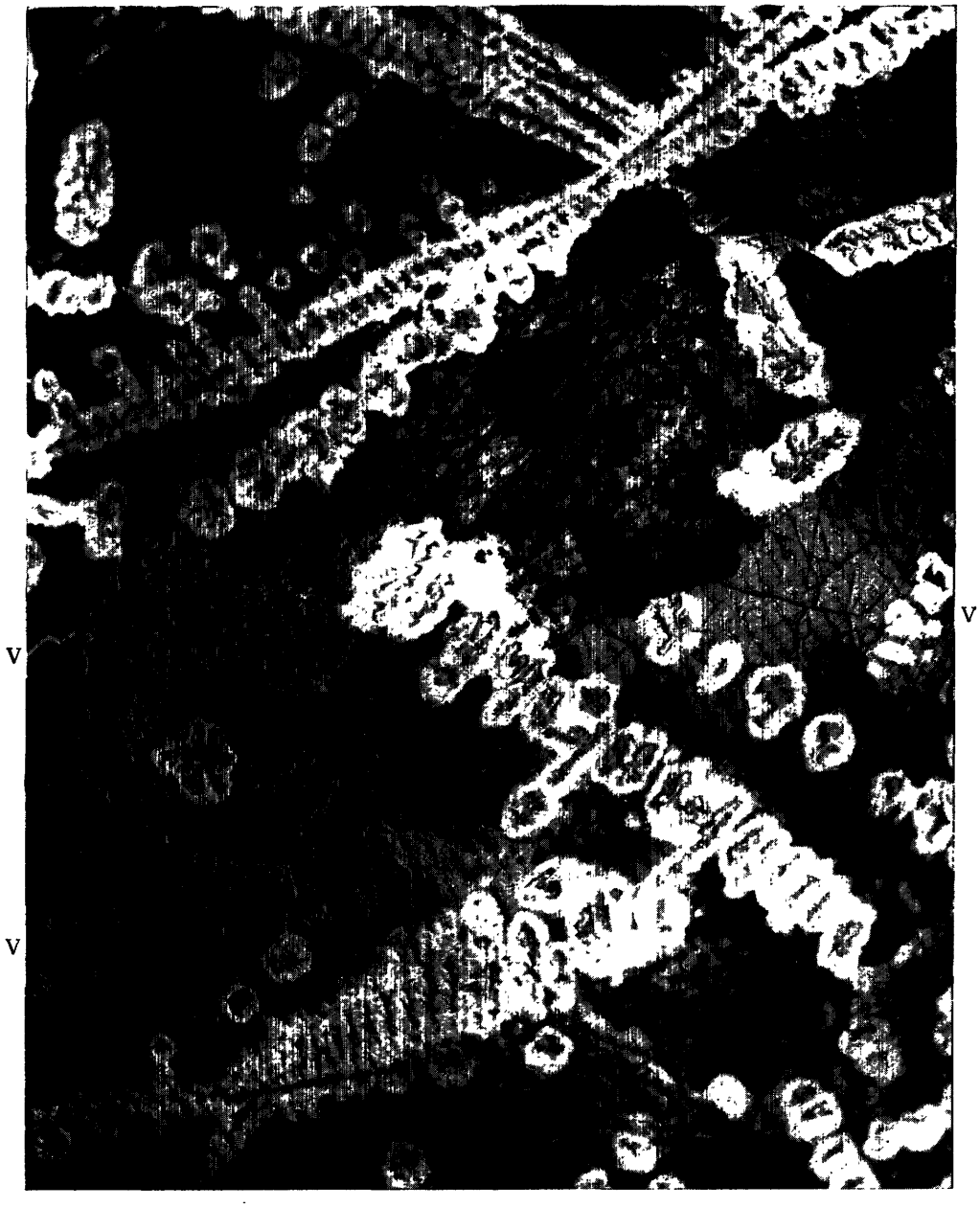


Fig. 11. × 7.

Polished section of dendritic ore, etched with dilute hydrochloric acid, from the Castle-Trethewey mine. The white masses are metallic arsenides which enclose native silver (grey). The green silicate gangue material is shown in high relief; calcite appears in low relief with rough surface. Silver veinlets (V) penetrate the former but not the latter.

small irregular veinlets traversing the calcite, and these are sometimes seen to be continuous with silver composing a dendrite. Such veinlets may have formed during the time of final precipitation of the vein minerals.

Analysis	per cent.	Ratios of arsenides	per cent.
Fe	6.05	Safflorite	53.6
Co	9.56	Löllingite	37.8
Ni	.78	Cobaltite	4.4
S	.72	Niccolite	3.0
As	38.90	Chalcopyrite	1.3
Sb	.27		
Cu	.26		
Ag	.39		

Green Gangue Material in Castle-Trethewey Veins

Specimen No. 12.—In several high-grade veins of the dendritic type occurring in the Castle-Trethewey mine, the gangue consists of a mixture of calcite and a hard porcelanic substance which varies in colour through several shades of light green. In thin section with the microscope, the green material is seen to be composed of a very fine aggregate made up principally of calcite, a whitish translucent compact substance, and fibrous secondary hornblende, which imparts to the gangue its green colour. Fractures in the green material are occupied by veinlets and masses of later calcite.

By use of the heavy liquid, methylene iodide, which has a specific gravity of 3.3, a quantity of the green mineral was obtained sufficiently pure for chemical analysis. To accomplish the separation, the mixture was ground to pass an 80-mesh screen and caught on a 300-mesh. Slimes were washed out, because they form a suspension in the heavy liquid and thus prevent the accomplishment of a good separation. Dry hand-screening does not remove all of the undersize on a fine screen. The powder was then immersed in a long separating funnel in methylene iodide. Materials, including the green one, with a density less than 3.3 floated on this liquid, while the silver, the arsenides, and other metallic minerals sank and were drawn off at the bottom. The density of the liquid was reduced by adding benzol, drop by drop, until the green substance, the next heaviest, sank, while free calcite and any quartz present remained floating at the top of the liquid. The green material drawn from the bottom of the funnel, after washing with benzol and drying, was treated with dilute acetic acid to remove any calcite not liberated in grinding. The sample contained a very small amount of arsenides, which were held up in the heavy liquid by surface tension.

The analysis of the green substance follows:—

	Per cent.
Silica	53.88
Alumina	5.80
Ferric oxide	none
Ferrous oxide	9.90
Lime	11.94
Magnesia	13.81
Potash	.08
Soda	.65
Water	1.96
Carbon dioxide	none

This composition corresponds to a mixture of amphibole and other decomposition products, such as would form through dynamic metamorphism of diabase,

which are represented in thin section by the compact translucent substance, probably saussurite, which is so fine that it cannot be resolved with the microscope.

A general value for the refractive index of the fibrous mineral, kindly determined by Dr. T. L. Walker by the immersion method, is 1.630, which is in close agreement with that of actinolite.

The greater part of the silver occurs in dendritic growths surrounded by an envelope of arsenides imbedded in the green gangue material. A relatively small fraction of the silver forms in the green groundmass veinlets, which, however, do not penetrate the masses of later calcite. The polished surface shows many instances of veinlets of silver in the green gangue, cut off sharply by the edge of calcite masses (Fig. 11).

Some of the dendrites with their envelope of arsenides are as much as three-eighths of an inch in diameter. In addition to the central cores of skeletal crystals, the silver forms minute inclusions in the arsenides, the number decreasing towards the outside of the envelope. At times the silver occupies a network of small irregular ruptures, which do not penetrate the surrounding gangue minerals. The most prominent arsenide is löllingite, which occurs in masses of stout prisms radiating outward from the edges of the silver cores and in fan-like intergrowths with safflorite. In places skutterudite forms relatively large masses and has a tendency to occur as inner rims surrounding the silver, although not so consistently as in the case of specimen No. 10.

From a block of this ore, the silicate and carbonate gangue minerals were removed by use of strong hydrofluoric, sulphuric, and hydrochloric acids, a process which affected the arsenides in an astonishingly small degree. The metallic growths remained firmly bound together in their original positions. This work, done with the object of observing the angles of intersection of the planes of growth in the dendrites, shows that the common angle is 90 degrees, which suggests free growth of a cubic mineral (silver) as the controlling factor in the development of the dendrites.

Temiskamite from Coleroy Mine

Specimen No. 10.—This specimen from the Coleroy mine consists of a bronze-coloured material resembling niccolite and occurring in veins of somewhat sugary white calcite.

The metallic substance occurs in masses which show a faint radiating structure in the hand specimen. The polished surface indicates the presence of several constituents, the one occurring in greatest quantity being a pink mineral, which is quickly blackened with strong effervescence by dilute nitric acid. This mineral, shown by analysis to have the composition Ni_4As_3, is temiskamite. Some niccolite showing a slightly lighter colour occurs along irregular fractures in the temiskamite. Although readily attacked by nitric acid, the niccolite appears to resist its action slightly better than the temiskamite.

A considerable proportion of the specimen consists of two isometric minerals which show up strikingly on the etched surface as cross-sections of the cube and octahedron. One of these minerals not affected by concentrated nitric acid is cobaltite; the other, which is slowly attacked by the acid, is smaltite. These minerals occur as isolated well-formed crystals in the niccolite and temiskamite.

The chemical data follow:—

Analysis		Molecular proportions	CoAsS	$CoAs_2$	NiSb	NiAs	Ni_4As_3
	per cent.						
Fe.....	0.62	0.011	.....	.....	....	....	.....
Ni.....	40.33	.686	.....	.....	0.006	0.080	0.600
Co.....	5.77	.098	0.052	0.046	....	....	.....
As.....	50.53	.674	.052	.092	....	.080	.450
Sb.....	.72	.006	.....	.....	.006	....	.....
S.....	1.66	.052	.052	.....	....	....	.....
	99.63	.....	8.62%	9.60%	1.07%	10.70%	69.03%

The iron shown in the analysis occurs as an oxide in small fractures. Microchemical tests made on the other minerals were negative and consequently the iron is not used in the recalculations.

The above data indicate that the specimen contained 69 per cent. of temiskamite, and the balance consists of niccolite, smaltite, cobaltite, and breithauptite.

Antimony and Mercury in Silver

Certain specimens of sheet silver that resist tarnishing better than others are found to contain a small amount of antimony, possibly representing a little dyscrasite. Two samples examined for mercury contain traces of this element.

Summary

1. The metallic minerals observed in this examination associated with the silver are:—

Löllingite ($FeAs_2$)
Safflorite ($CoAs_2$)
Skutterudite ($CoAs_3$)
Cobaltite (CoAsS)
Arsenopyrite (FeAsS)
Smaltite ($CoAs_2$)
Niccolite (NiAs)
Breithauptite (NiSb)
Chalcopyrite ($CuFeS_2$)
Argentite (Ag_2S)
Hematite (Fe_2O_3)
Bornite (Cu_5FeS_4)
Sphalerite (ZnS)
Bismuth (Bi)
Dyscrasite(?) (Ag_3Sb)
Amalgam
Erythrite ($3CoO.As_2O_5 8H_2O$)
Temiskamite (Ni_4As_3)

2. Löllingite is the most common arsenide in the list; smaltite is possibly one of the rarest of the arsenides; cobaltite is commonly present in the veins, but usually in subordinate amounts.

3. Nickel diarsenides are not prominent in the parts of the camp examined.

4. The principal gangue mineral is calcite; dolomitic veins were not observed. Tests made on various types of gangue material showed the magnesia content to be low in every case. There is usually a little quartz present, lining the walls of the vein and in grains scattered through the interior.

5. The hard compact grey ore found in some veins in the Miller Lake section is a breccia consisting of very fine fragments of arsenides and calcite along with silver.

6. The green gangue material, a prominent constituent in some veins in the Castle-Trethewey mine, is composed of a mixture of secondary hornblende, calcite, and a felt-like substance, probably "saussurite."

7. Contemporaneous precipitation of silver, arsenides, and gangue minerals took place, which gives rise in the microscopic study to apparent contradictions in the order of deposition. Silver appears to have been one of the first minerals to be deposited, and its deposition continued until a late stage in the process of vein formation, as shown by its presence in fractures traversing the veins. The greater part of the silver, however, is enclosed within arsenide growths and calcite in such a way as to indicate contemporaneous precipitation with these minerals.

8. The silver-bearing veins of Gowganda as a rule occur in fissures developed along joint planes in the hanging-wall side of the Nipissing diabase sill. Filling of the fissures was accompanied by replacement of wall rock.

ANIMA-NIPISSING LAKE AREA

By E. W. Todd

INTRODUCTION

This report deals with the continuation of work started in 1924 with the object of mapping the rocks in proximity to the producing silver areas at Cobalt and South Lorrain. A description and map of the territory examined in 1924 is contained in a publication, entitled "The Matabitchuan Area,"[1] which covers a region lying south of Gillies limit between the Montreal river and the Temiskaming and Northern Ontario railway. During the field season of 1925 the work was continued to the northwest as far as Lady Evelyn lake.

Since the days of the early development at Cobalt, the existence of extensive masses of Nipissing diabase in the country surrounding Anima-Nipissing lake has been known. This is the rock responsible for the deposition of the silver and cobalt veins of Northern Ontario, and the accompanying map outlining these areas of diabase and other rocks is intended for use in further prospecting of the region. Older maps show the positions of the diabase bodies only in a general way; extensive areas of this rock are not shown, while, on the other hand, basic rocks belonging to older formations are sometimes shown as Nipissing diabase.

Able and loyal assistance was rendered in the field by G. Gilbert, W. H. Hansen, and S. Lundy. Dr. Gilbert had charge of the party for about three weeks when the writer was engaged in other work. During this time the township of Best and part of Strathy were mapped.

Analyses of several samples of rocks and vein material were made by W. K. McNeill and T. E. Rothwell of the Provincial Assay Office.

The accompanying geological map on the scale of one mile to the inch was drawn for photolithography by J. Ledingham.

Location and Extent

The Anima-Nipissing area lies about ten miles southwest of Cobalt. It borders Gillies limit and Coleman township to the west; and the southeastern section, which includes part of the Cedar and Net lakes area,[2] adjoins the Matabitchuan area.

The accompanying map shows the outlines of the various rock formations found in the townships of Dane, Kittson, Brigstocke, Banting, Best, and parts of Strathy, Chambers, La Roche, Aston, Cole, Leo, and Coleman. These townships are in the districts of Nipissing and Timiskaming and form part of the Timagami Forest Reserve.

Access

Easy access to the area is provided by the Temiskaming and Northern Ontario railway from Timagami, Goward, Rib Lake, and Latchford stations. Anima-Nipissing lake may be entered through Latchford by means of a portage

[1]E. W. Todd, Ont. Dept. Mines, Vol. XXXIV, pt. 3, 1925.
[2]C. W. Knight, Map No. 29*c*, Ont. Dept. Mines, Vol. XXIX, pt. 1, 1920.

from Bay lake of a little over one and a half miles in length. Another route, lying entirely within the area mapped, leads from Goward station through Net, Thieving Bear, and Mountain lakes to Anima-Nipissing. Although there are a number of short portages on this route, it is easily navigated, especially in high-water season. From Lake Timagami there are well-travelled routes giving access to the country surrounding Chambers, Jackpine, Anima-Nipissing, Turner, and Lady Evelyn lakes. However, the last-mentioned lake is more easily approached from Latchford through the Montreal and Mattawapika rivers.

Topography

While the maximum relief probably does not exceed 400 feet, the detail of the surface is exceedingly rugged over most of the area. As is generally the case, the flattest topography is found in the parts underlain by Keewatin and granitic rocks, while, on the other hand, masses of diabase stand up in bold relief. A ridge of this rock, extending north and south across Banting township, rises on an average 200 feet above the surrounding country on both margins. It is broken by many steep-walled valleys that make travelling strenuous work. The same is true of the other exposures of Nipissing diabase shown on the map, particularly the large body in Brigstocke township, north of Anima-Nipissing ake. The southern edge of this mass is flanked by a continuous cliff visible for a considerable distance to the south, while the top is rendered extremely rugged by an intersecting series of northeast and northwest ravines. On the southwest shore of Eagle lake, the diabase forms a perpendicular cliff, which rises about 350 feet above the lake and forms the most prominent landmark observed in the area.

The bodies of conglomerate, which are shown in dark brown on the map and represent erosion remnants, are also characterized by their high relief. The surface of these masses consists of rounded ridges and domes with a much more subdued profile than in the case of the diabase exposures, a difference which is noticeable even from a considerable distance.

The southern part of the large area of quartzite is unusually flat for this type of terrain and is considerably overlain by superficial deposits of boulders and swamp. In Dane and Kittson townships, however, the surface of the quartzite is broken by a number of deep valleys in which erosion has penetrated underlying slate-like greywacké. The walls of these depressions are generally steep and show a transition from flat-lying, bedded greywacké at the bottom to massive quartzite at the top. The bottoms are usually covered with swampy soil and, as a rule, form the course of a stream or chain of lakes.

Rock exposures, on the whole, are plentiful. This is true especially of the Nipissing diabase; the masses outlined on the map are practically continuous outcrops. The areas with fewest rock outcrops are those underlain by the easily weathered greywacké of the Lower Cobalt series.

Lakes and Streams

The numerous lakes in the area fall into three systems, approximately equal in extent, which are drained by the Montreal, Sturgeon, and Matabitchuan rivers. The long axes of most of the lakes lie in two principal directions, northeast and northwest, probably representing two great fault systems. This is a prominent feature, although not as strikingly developed as in the case of the Matabitchuan area[1] to the southeast.

[1]E. W. Todd, op. cit., pp. 27-30.

Montreal River Waters

The largest and now probably the least attractive lake in the area is Lady Evelyn, which empties through the Mattawapika river into the Montreal. Much of the natural beauty of this body of water has been destroyed through the raising of the water-level for power purposes at Mattawapika falls, situated about four miles north of the northeast corner of Dane township. On the lower stretches of the lake, rock outcrops are not plentiful, the shore consisting of low swampy ground or sand ridges, which compose many of the islands in Dane township. On the south shore, a few outcrops of quartzite and greywacké are visible.

A large creek, known locally as the Muskego river, flows into the southeast corner of Lady Evelyn lake through a wide marshy valley, which is drowned back for a distance of about two miles. This creek rises in Brigstocke township, where it forms part of a good canoe route extending from the northwest arm of Anima-Nipissing lake to the Montreal river through Harris, Young Loon, Kittson, and Trout lakes. There are abundant outcrops of rock exposed on the shores of all of these lakes, excepting Young Loon, which lies in the middle of the largest patch of muskeg occurring in the area.

Sturgeon River Waters

The largest lake belonging to this system is Anima-Nipissing, which flows out through Red Squirrel to Lake Timagami at Sandy inlet. This splendid body of water, which has a length, northeast and southwest, of about ten miles, has a number of deep bays extending northwest or southeast nearly at right angles to the principal axis. Both of these directions represent probably the strike of fault planes along which the basins of this and other lakes in the area were formed.

The area drained by Anima-Nipissing is very small, the watershed lying often less than half a mile inland and seldom exceeding a distance of two miles. Apart from small creeks entering from Whitewater, Pickerel, and Breeches lakes, the amount of water draining into Anima-Nipissing is insignificant. The whole intake appears to be insufficient to supply the river of considerable size which flows out of the foot of McLean lake, and this suggests that Anima-Nipissing, noted for its clear cold water, may be fed by many underground springs.

Concerning the depth of the water, A. E. Barlow states:[1]—

> Several soundings were taken in places reported to be exceedingly deep. One of these, situated about the middle of the lake opposite Crow rock and a little over a mile from its northern end, showed a depth of ninety-three feet, while another sounding, taken about the middle of the large open space in the central part of the lake, gave 100 feet.

Extensive rock exposures of Nipissing diabase and the various members of the Cobalt series form the greater part of the shoreline, and the lake cutting across these formations affords an excellent geological section of the central part of the area.

The smaller lakes draining into Timagami are nearly all of the rocky-shore type; swampy lakes are practically non-existent. Chambers lake, known locally as Lost lake, shows on its south shore numerous exposures of Keewatin greenstone in contact with granite, and the navigable stream flowing out to Ko-ko-ko lake makes a good section through various types of volcanic rocks of Keewatin age.

[1]Geol. Surv. Can., No. 962, 1907, pp. 253-54.

Matabitchuan River Waters

Most of the water flowing into the Matabitchuan river is gathered in Net lake, on which there are occasional outcrops of volcanic rocks, granite, and diabase. Much of the shoreline is drift covered; and this in less extent is true of Cedar lake to the west on which the Nipissing diabase shown on the map is well exposed and, as it overlies Keewatin rocks, is worth prospecting for silver around the margins. The large creek flowing from Jackpine lake into the west end of Cedar lake is navigable for canoes in high-water seasons. Travelling by canoe is also possible over considerable stretches of the stream entering Net lake from the northwest, particularly in the upper part. From the headwaters of this stream, Mannajigama and Snare lakes, Anima-Nipissing is reached by portages less than half a mile in length. However, the route is seldom used except by trappers in times of high water. The largest creek entering Net lake rises in Mountain lake and affords a convenient base from which to examine the greater part of Best township. On Mountain lake there are many exposures of basic volcanic rocks and dark-coloured granitic types, while in other places along the route the numerous outcrops consist altogether of pink granite with ridges of intrusive diabase.

Summary of Natural Resources

Parts of the area possess groups of rocks associated in a manner that has been found to produce economic deposits of minerals in other places. Such a locality exists in the middle of Banting township, where Keewatin and Cobalt series rocks are intruded by Nipissing diabase, the rock responsible for silver deposits in Ontario. Similar associations exist in Strathy and Brigstocke townships, where the footwall side of the diabase is in contact with basic Keewatin lavas in the case of the former and with greywacké of the Cobalt series in the latter case. A few veins containing cobalt minerals and low silver values have been found in these rocks. Crossing the southern townships there is a contact of granite, considered to be of Algoman age, and Keewatin volcanics. In the volcanics there are veins, which, while they show a low gold content, are mostly narrow. Little recent prospecting has been done owing to the restrictions imposed on account of the area being in a forest reserve.

The chief source of revenue at the present time is from the tourist traffic, which will doubtless increase in volume when the government road connecting North Bay and Cochrane is completed. The Timagami Forest Reserve has long been a favourite resort for visitors from the United States. The natural beauty of its many lakes and the great abundance of game and fish, together with the facilities offered by the railways and the inhabitants of the district all contribute in making the region ideal for the tourist. Salmon and grey trout are caught in the deeper lakes, and black bass abound in all, especially in the smaller rocky ones so plentiful in the area.

Principally owing to the efforts of an efficient fire-ranging organization, a large area surrounding Lake Timagami is still covered with a virgin growth of timber in spite of the dozens of bush fires started in the reserve each summer by careless and inexperienced campers. Practically all of the high ground in the Anima-Nipissing area is covered with a valuable growth of white, red, and banksian pine, while spruce is plentiful in lower ground, especially in the northern part of the area. At the present time lumbering operations are being carried on in Kittson township by the McLennon Lumber Company of Latchford.

Previous Geological Work

All previously existing maps of the area are based on the work of A. E. Barlow, whose Report on the Geology and Natural Resources of the Nipissing and Timiskaming Map-Sheets, published in 1899,[1] contains descriptions of the rocks observed along the principal canoe routes. Revised editions of his maps were published by the Geological Survey of Canada in 1908 on a scale of four miles to the inch.

In 1899, A. P. Coleman[2] examined the Big Dan and other properties in the neighbourhood of Net lake, having entered the region by way of the Matabitchuan river from Lake Timiskaming.

The rocks adjacent to the east side of Ko-ko-ko lake are described by W. G. Miller in a report on the Iron Ores of Nipissing District, published in 1901.[3]

J. S. DeLury[4] made a trip through Anima-Nipissing to Whitewater lake in 1906 and mentioned an occurrence of pyrrhotite on the east shore of Anima-Nipissing lake.

The geology of the area to the west of Lady Evelyn lake, in the Maple Mountain region and to the north, was mapped by C. W. Knight, whose report was issued in 1907.[5] A part of the map of the Cedar and Net lakes area published in 1920,[6] also made by Knight, is included in the Anima-Nipissing Lake map-sheet.

Accompanying Map

The extent of the different rock formations occurring in the Anima-Nipissing area is shown on the scale of one mile to the inch on the geological map No. 35*c* which accompanies this report. The area covered is approximately 280 square miles. The location of all surveyed mining claims is shown, and sections illustrating the structural relationships of the various rocks accompany the map. Contacts were determined by means of compass-pacing traverses, spaced about half a mile apart and made from fixed points on surveyed lines and waterways.

An enlargement of surveys made by A. E. Barlow was used for parts of Anima-Nipissing, Red Squirrel, and Mountain lakes. It was found necessary, however, to resurvey a considerable part of the shoreline of these lakes in order to supply the detail required in plotting the geology. Micrometer-compass surveys of other lakes, excepting Lady Evelyn, were made during the course of the examination, and for this lake the 948.5 contour line run by the Northern Ontario Power Company was used. A storage dam was being built by this company during the summer of 1925 at the falls on the Mattawapika river, situated about four miles to the north of the northeast corner of Dane township; on completion of the dam, the shores of Lady Evelyn lake will occupy a position essentially as shown on the map. At the time the geological examination was made, the lake was at a considerably lower level than shown; but it was considered useless to map the old shoreline, since it would be submerged in a short time. Geological sections were made from points located by means of micrometer-compass traverses tied to township lines.

The elevations of the other lakes in the area, where given, were mostly copied from the map of A. E. Barlow.

[1]Geol. Surv. Can., Vol. X, 1897, pt. I.
[2]Ont. Bur. Mines, Vol. IX, 1900, pp. 172-73.
[3]Ibid, Vol. X, 1901, pp. 171-72.
[4]Ibid, Vol. XVI, pt. 2, 1907, p. 146.
[5]Ibid, pp. 117-28.
[6]Map No. 29*c*, Ont. Dept. Mines, Vol. XXIX, pt. 1, 1920.

The geology of a small part of Coleman township was shown on the map-sheet in order to indicate the location of the Crescent Silver Cobalt mine, the only property operating in the district.

Lakes not surveyed by micrometer are shown with broken lines.

GENERAL GEOLOGY

With the exception of the Timiskamian series, all of the rock formations found in the pre-Cambrian of northeastern Ontario are represented in the Anima-Nipissing area. The geology is therefore similar in many respects to that of well-known areas, such as Cobalt, South Lorrain, and Gowganda. In the following table, the rocks are classified according to their relative age relationships, the youngest being placed at the top.

Legend

QUATERNARY	
GLACIAL AND RECENT:	Sand, gravel, and swamp of glacial and recent origin.
	Unconformity
PRE-CAMBRIAN	
KEWEENAWAN:	Olivine and quartz diabase dikes. *Intrusive contact* Nipissing diabase: Red rock aplite dikes. Nipissing diabase: Quartz-diabase sill.
	Intrusive contact
ANIMIKEAN: (Cobalt series)	Upper Cobalt series: Quartzite, arkose. Lower Cobalt series: Slate-like greywacké. Lower Cobalt series: Conglomerate, quartzite, greywacké.
	Unconformity
MATACHEWAN:	Diabase dikes.
	Intrusive contact
ALGOMAN:	Syenite. Massive pink and grey granite. Quartz and feldspar porphyry.[1]
ALGOMAN-KEEWATIN COMPLEX:	A complex mixture of dark-coloured granitic rocks, Keewatin volcanics, and pink granite.
HAILEYBURIAN(?):	Serpentine, diabase.
	Intrusive contact
KEEWATIN:	Altered basalt and diabase, amygdaloidal lavas, acid volcanics, agglomerate, banded tuff.

Keewatin

Extending in an east and west direction across the northern part of Chambers and occupying most of the township of Strathy, there is a belt of rock consisting chiefly of altered basic volcanics. Imbedded in this body of greenstones there are indefinite bands of greatly metamorphosed diabase and masses of volcanic breccia or agglomerate. Some light-coloured bands of fissile sericitic rocks, probably representing lava flows of acid composition, occur north of Chambers

[1]Some of the quartz and feldspar porphyry may be older than the Algoman.

lake. In the middle of Chambers township the greenstone belt is interrupted by a southward extension of the pink massive granite of Algoman age which occupies most of the northern part of the township. The margin of the Keewatin mass in this locality is frequently highly silicified through hydrothermal action produced at the time of the granite invasion. In places hornblende has been altered to biotite, producing a marginal band of mica schist. Near the northeast corner of Chambers township Keewatin rocks have been re-crystallized to form a massive hornblende rock resembling coarse diorite. The greenstones are penetrated by narrow dikes of feldspar and quartz porphyry, lamprophyre, and other basic material.

The volcanic rocks do not extend westward beyond Ko-ko-ko lake, on the west shore of which they are overlain by the Cobalt series, while to the south they extend beyond the northeast arm of Lake Timagami, having a width of from 8 to 12 miles. The geology of this district to the south is shown on map No. 944, issued by the Geological Survey of Canada in 1907. Keewatin rocks do not extend in any appreciable extent to the east beyond the Temiskaming and Northern Ontario railway, except in the region of Net lake where they reach the middle of Cassels township.[1]

Crossing Banting township in an easterly direction, there is a less extensive belt of Keewatin rocks consisting of water-lain tuffs showing persistent bands of light and dark coloured material. This mass of volcanic fragmental rocks gradually tapers down toward the west side of the township, where it is overlain by conglomerate of the Lower Cobalt series; from the shape of the band it probably pinches out in the vicinity of Red Squirrel lake. Near the eastern side of the township the belt, which is about a mile in width, is cut off sharply by granite, the contact lying in a valley running a little east of north. The depression is occupied in part by a chain of small lakes and possibly represents a fault with the upthrow side to the east. This valley, which terminates the belt of Keewatin rocks, is in line with the northeast arm of Anima-Nipissing lake and lies parallel to other well-developed lines of weakness, as may be observed by a glance at the map. Along the strike of the belt of tuffaceous rocks, similar banded material occurs at James lake, suggesting that these rocks once extended across the townships of Best and Banting in a continuous band. This conception is substantiated by the occurrence of large blocks of the tuff included in the intervening granite mass in Best township.

The junction of the Keewatin and granite is in places sharply defined, while in others there is a contact phase consisting of a mixture of the two rocks. The larger masses of this type are differentiated on the map under the name "Algoman-Keewatin Complex." A considerable area in the vicinity of Mountain lake is occupied by this hybrid rock, in which there are many masses of basic rocks, which with a great amount of work could be mapped separately. In this locality the granite itself is altered through assimilation of basic materials into a granodiorite type of extremely diversified appearance.

Basic Lavas

The most prevalent type in the Keewatin belt in Strathy and Chambers townships is a dark green rock resulting from the alteration of basalt and other basic material. In general, these rocks are rather massive with narrow schistose zones of shearing, which frequently are marked by the presence of rusty materials resulting from the oxidation of sulphides. These sheared zones are more common

[1]E. W. Todd, The Matabitchuan Area, Ont. Dept. Mines, Vol. XXXIV, pt. 3, 1925, Map No. 34*b*.

to the east and south of Net lake, where considerable work has been done from time to time on deposits containing auriferous mispickel and nickeliferous pyrrhotite, which are described by C. W. Knight in his report on the Cedar and Net lakes area.[1] Apart from these localized schistose bands, a slight parallelism is developed in a general easterly direction. Near the contacts with the intrusive granite, however, the strike of the schistosity conforms rather closely to the edge of the granite masses, a fact often useful in tracing contacts. Thus, south of Chambers lake, the strike is about east; while in the northwest corner of Strathy township, it swings to an approximately northerly direction in conformity with the periphery of the granite mass lying to the west. Pillow structures are observed frequently to the west and south of Cedar lake, and amygdaloidal phases occur to the southwest of Chambers lake and in the rocks surrounding the west end of Cedar lake, as well as at numerous other points in the Keewatin of Strathy and Chambers. These structures serve to demonstrate that these basic rocks are volcanic flows, which were poured out on a surface in early pre-Cambrian times.

A systematic study of a probable succession of flows cannot be undertaken feasibly on account of the dense growth of timber and thick coating of moss which cover the region. The ropy fragmental top of one lava flow was observed 15 chains west of the north arm of Cedar lake.

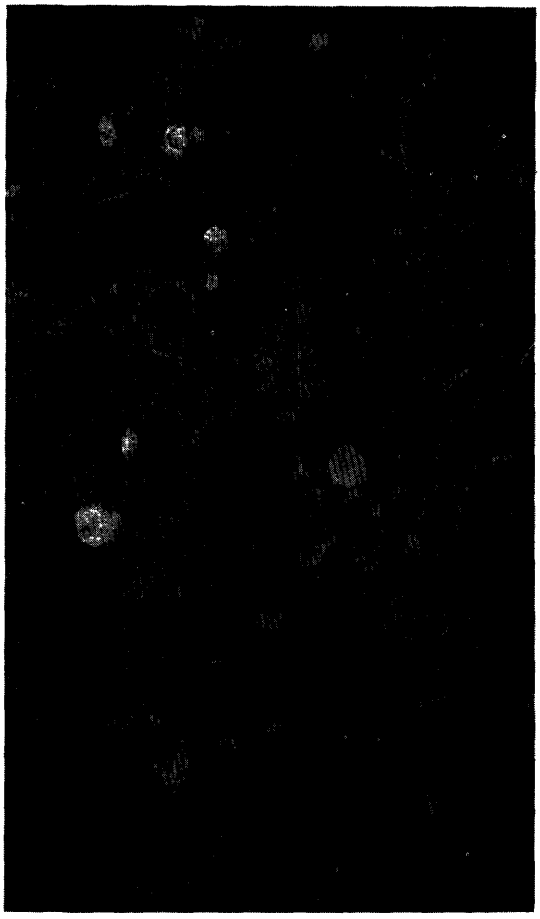
To the northwest of Cedar lake, a peculiar type of porphyritic rock occurs in bands which strike at about N. 15° E. One such band is exposed, on the west bank of the small creek that crosses the north line of Strathy township, for a distance of about 20 chains along the strike of the formation. The rock contains many white-weathering phenocrysts of feldspar, which stand out in contrast to the dark groundmass, partly on account of the difference in colour and partly because of their higher relief due to differential weathering effects. A few of the phenocrysts show sharp crystal outlines, but most of them have irregular, rounded borders, imparting to the rock a fragmental appearance. Some of these white masses are as much as 2½ inches in diameter. With the microscope the phenocrysts are seen to be composed of a mixture of secondary minerals consisting principally of epidote, plagioclase, and quartz. Very little evidence of lamellar twinning has been preserved, and the material is evidently saussuritized anorthite. An analysis of a sample showing crystal faces follows:—

	Per cent.
Silica	44.21
Alumina	28.76
Ferric oxide	3.04
Ferrous oxide	.60
Lime	19.67
Magnesia	.22
Potash	.48
Soda	.77
Titanium dioxide	trace
Carbon dioxide	.95
Water	1.67
	100.37

The dark chloritic groundmass shows in places an igneous structure suggestive of diabase, and the general appearance of the rock is similar to the material composing some of the porphyritic dikes of the Matachewan series. However, no definite boundaries suggestive of a dike could be found; instead, a gradual transition occurs, by diminution in the number of phenocrysts, from the por-

[1]Ont. Dept. Mines, Vol. XXIX, pt. 1, pp. 211 *et seq.*

phyritic type to a basic volcanic rock showing pillow structure. Five chains west of the creek mentioned above, and half a mile south of the township line, pillow structures occur in which are imbedded some of the white phenocrysts. Here, there is a width of 50 feet of porphyritic material in which the phenocrysts constitute over one-half of the whole. The same type is exposed 30 chains east of the creek on the north side of T.R. 2,691; on the township line near the northwest corner of Strathy township; in the small mass of Keewatin imbedded



Ellipsoidal Keewatin rock with large phenocrysts of basic plagioclase, northwest of Cedar lake.

in the Nipissing diabase southwest of Thieving Bear lake in Best township; and in Chambers township close to the eastern boundary, about one mile north of the southern edge of the map-sheet.

This rock appears to be similar to the porphyritic lava described by D. G. H. Wright,[1] which occurs in Cook township in the Black River area.

Acid Lavas, Agglomerate

To the north of the first lake up Chambers creek there are exposures of felsitic material which weather to a light-green colour in contrast to the dark-

[1]Ont. Dept. Mines, Vol. XXX, pt. 6, 1921, p. 42.

coloured basalt outcropping to the south of the lake. This rock is extremely schistose, the strike being E. 15° N. In thin section with the microscope, it is seen to consist of a fine-grained aggregate composed chiefly of sericite and quartz with certain patches of the sericite occurring in the section, probably representing the remains of feldspar phenocrysts. To the north this material passes into a less sheared phase showing in places feldspar and quartz phenocrysts and occasionally amygdules composed of calcite and quartz. The same type is exposed on the south end of the second lake on the creek.

The rocks on the north arm of the second lake have the composition of andesite and show in many places conspicuous phenocrysts of plagioclase and ellipsoidal structure. Surrounding the creek joining this lake with the one to the north and also on the island in the latter, the rocks are fragmental in character. This agglomerate is composed of fragments of green material enclosed in a more easily weathered groundmass, which is slightly darker in colour. With the microscope the fragments and matrix of this volcanic breccia are seen to consist of much the same minerals, which are all secondary, consisting chiefly of epidote, chlorite, carbonates, and leucoxene, or some other amorphous decomposition product. A band of similar fragmental material occurs in Chambers township, 35 chains north of the three-mile post on the eastern boundary.

Tuff

The prevailing type of rock found in the Keewatin belt in Banting township is a volcanic tuff consisting of ash materials which were deposited under water. The rock has the appearance of a sediment, consisting of grey siliceous material and a darker chloritic substance. Due to differential weathering, the siliceous bands stand out, thus imparting to the surface a corrugated structure which is frequently contorted and crumpled as a result of compressive earth movements. Interbedded with this material, there are masses of true volcanic rocks and dikes of feldspar porphyry cutting both types of Keewatin.

Surrounding the south part of James lake, the strike of the tuff is about north, conforming to the periphery of the granite. A specimen examined with the microscope shows the gritty bands to be composed essentially of quartz and sericite. The quartz occurs in small rounded and angular fragments, leaving no doubt that the rock is fragmental in character; the section examined might readily pass for greywacké. An analysis of the banded rock follows:—

	Per cent.
Silica	65.10
Alumina	17.01
Ferric oxide	2.75
Ferrous oxide	2.35
Lime	4.85
Magnesia	1.84
Potash	2.42
Soda	.98
Titanium dioxide	.60
Carbon dioxide	.09
Water	2.37
	100.36

In the Matabitchuan area there are considerable masses of lavas altered to sericitic rocks which have a similar chemical composition.[1]

Exposures of banded tuffaceous material also occur on the north line of Strathy township about a mile from the northwest corner, and the small outcrop

[1]E. W. Todd, Ont. Dept. Mines, Vol. XXXIV, pt. 3, 1925, pp. 7, 8.

of Keewatin rock southwest of Lenore lake is composed of this material. In the latter case the stratified rock passes to the west into a massive type which has been recrystallized by the intrusion of granite.

Haileyburian (?)

A mass of serpentine and altered diabase intrusive in the Keewatin occurs to the south of Cedar lake, which is of some economic interest because of the occurrence of nickel ore associated with it. This exposure has been described by C. W. Knight as follows:[1]—

> The intrusive may be called serpentine rock, although it passes in places into a diabase. It is fine to medium in grain. Thin sections examined under the microscope show that some of it, at any rate, is an altered peridotite; the outlines of the original olivine crystals are readily recognized, now altered to serpentine. A little calcite or dolomite, or some similar carbonate, is present. Thin sections also show that in places much of the rock is made up of fibrous hornblende. The serpentine rock is somewhat similar to that at the Alexo mine near Porcupine.

A smaller mass of somewhat similar material outcrops on the south bank of Chambers creek. The surface of this ultrabasic rock is decomposed for a depth of over a quarter of an inch to a rusty talcose substance, which is much pitted due to removal of carbonates. The fresh surface is dark green and traversed by minute veinlets of asbestos. With the microscope it is seen to be composed chiefly of carbonates and serpentine resulting from the alteration of olivine, the oval outlines of some of the crystals of olivine being preserved. Scattered through the section are numerous masses and grains of chromite, the edges of which are reddish-brown by transmitted light.

In the same vicinity there are small exposures of altered diabase, intrusive in the Keewatin, which probably belong to the same age as the serpentine mass. These could not be differentiated on the map without an unwarranted expenditure of time.

Algoman

Granite

The Algoman series, consisting principally of massive pink granite, outcrops in large masses in the southern and middle part of the Anima-Nipissing area. This great intrusion cuts the Keewatin and Haileyburian (?) rocks but is older than the Cobalt series and the Nipissing diabase. The most common type of rock represented is a flesh-coloured, medium-grained granite which shows in places a slight development of gneissic structure. A porphyritic phase is sometimes developed near the margins, a condition observed on the south shore of Chambers lake. Biotite is the prevailing dark-coloured constituent, but as a rule the amount of ferromagnesian minerals present is small. Certain restricted areas, however, are occupied by more basic phases. A considerable patch of hornblende rock occurs, associated with pink granite, adjacent to the east end of Jackpine lake where the rock merges from coarse dark-green material, in which hornblende predominates, into the normal type of light-weathering granite. Farther to the east somewhat similar material has been formed by assimilation and recrystallization of basic Keewatin rocks, and it is possible that the whole of this mass of hornblende rock originated in this way.

An early basic phase of the granite occurs in Best township near the south boundary, on the east side of Net lake. Dikes of pink granite penetrate this dark-coloured rock, which is itself massive and fresh in appearance, medium

[1]Ont. Dept. Mines, Vol. XXIX, pt. 1, 1920, p. 210.

grained and granitic in texture, while in composition it varies from a dioritic type containing very little quartz to hornblende granite in which small quartz crystals are a prominent constituent. This early product of differentiation from the granite magma occurs in small masses at various points in the area, of which the southwest shore of Hansen lake is worthy of mention. Here the rock resembles diabase in colour and texture; the dark-coloured minerals consist, however, of primary hornblende and its alteration products.

Basic granitic rocks of Algoman age, formed in part by assimilation of materials derived from the Keewatin, make up a large part of the areas shown on the map as Algoman-Keewatin Complex.

Quartz Porphyry

Cutting the Keewatin rocks in all parts of the area there are narrow dikes of light-coloured felsitic material, sometimes exhibiting phenocrysts of quartz and feldspar. These masses, which seldom exceed 20 feet in width, are usually somewhat schistose and older in appearance than the granite dikes found cutting the margins of the Keewatin.

A sample taken from a feldspar porphyry dike on the west side of James lake near the south end has the following chemical composition:—

	Per cent.
Silica	69.22
Alumina	15.06
Ferric oxide	1.64
Ferrous oxide	2.55
Lime	3.19
Magnesia	.98
Potash	1.00
Soda	4.07
Titanium dioxide	.53
Carbon dioxide	.33
Water	1.39
	98.96

It is not known whether these acid rocks are of the same age as the Algoman granite masses exposed to the north or are connected with some earlier intrusion.

In common with prophyries associated with gold ores in other parts of the country, this rock is richer in soda than in potash. With the microscope in thin section, a distinctly porphyritic structure is apparent, although the greater part of the minerals is secondary. Patches of sericitic material containing remnants of undecomposed feldspar are plentiful in the section, and some of these show the multiple twinning of acid plagioclase. Much of the groundmass consists of minute crystals of secondary quartz occurring in patches and veinlets.

Quartz porphyry masses occurring south of Cedar and Net lakes are described by C. W. Knight as follows:[1]—

> The quartz porphyry and quartz porphyry-schist are tentatively classed with the Algoman. They resemble the grey porphyries and porphyry-schist of Porcupine and elsewhere. There is one large mass, coloured deep red on the geological map, at the southwest end of the area. The rock is grey in colour and occurs both massive and altered to a schist. The outlines shown on the map must be considered to be approximate, as there was not sufficient time to work out the contacts in detail.
>
> In addition to this large area of quartz porphyry there are many small dikes or irregular masses of rock which evidently are intrusive into the Keewatin series. One of these dikes occurs on W.D. 271, a claim known as the Big Dan. There are also dikes of felsite or quartz porphyry cutting the Keewatin at the entrance to the deep south arm of Cedar lake; these dikes are very irregular in outline and show rounded eyes of quartz phenocrysts as much as one-quarter of an inch in diameter.

[1]Ont. Dept. Mines, Vol. XXIX, pt. 1, 1920, p. 210; Map No. 29*c*.

Algoman-Keewatin Complex

In the region surrounding Mountain lake, there are large masses of an unusual variety of rock which appear to have resulted from assimilation of basic Keewatin rocks in granite. This hybrid type, which forms zones lying between the volcanic rocks and the normal pink granite, is extremely varied in appearance and composition. It is dark coloured, fine grained, and massive as a rule, with hornblende, which is always present, sometimes constituting the greater part of the rock. In some places it resembles fine-textured diorite, in others hornblende syenite, and within a short distance it may change into a basic granite type in which quartz is an important constituent. Blocks of various sizes composed of partly assimilated Keewatin rocks form a prominent part of the complex, and some of the largest of these might be shown on a map; this, however, would entail an unwarranted expenditure of time. The presence of these large roof pendants over areas of considerable extent around Mountain lake indicates that the present surface constitutes the roof of a granite batholith from which erosion has removed the Keewatin rocks which were at a slightly higher horizon.

Similar materials make up other masses of this hybrid type of rock found associated with the Keewatin in Strathy and Banting townships.

Matachewan

A series of vertical diabase dikes cuts the Keewatin and Algoman formations but not the Animikean. These dikes, which have a remarkably consistent north strike, seldom exceed 200 feet in width, and while somewhat older in appearance than the Nipissing diabase, the rock is still fairly fresh in appearance. It weathers to a rusty colour and is frequently, although not always, characterized by the presence of rounded phenocrysts of a light-green tinted material, which has resulted through alteration of basic plagioclase. With the microscope the groundmass usually shows some interstitial quartz.

As far as is known, this pre-Cobalt series diabase is of no economic importance, and care should be taken by prospectors not to confuse it with the Nipissing diabase, which is the silver-bearing formation.

Animikean (Cobalt Series)

The Animikean consists of a series of sediments identical with those of like age described in geological reports on various areas situated in the districts of Timiskaming, Sudbury, and Nipissing. The series is composed of a conformable succession of conglomerate, greywacké, and quartzite formations which have been subjected to little disturbance of a regional character since the time of their deposition. Locally there are brecciated zones caused by faulting and by the intrusion of the Nipissing diabase. The bedding planes dip gently to the north and northwest, away from the large granite mass on which they were laid down, at angles seldom exceeding 15 degrees. In the southern part of the area, erosion has removed the entire series, which at one time extended across the townships of Best, Strathy, and Chambers, a point proved by the presence of small patches of Cobalt conglomerate, a few feet in diameter, still remaining at certain points in these townships. One such remnant occurs in the north arm of Granite lake and another on the southwest shore of Hansen lake. In the central section the basal formation represented by a boulder conglomerate is preserved in outcrops of considerable magnitude, while in the northern part

erosion has penetrated only to the lower beds of the quartzite, which is the uppermost formation in the Animikean.

Lower Cobalt Series

The Lower Cobalt series is divisible for purposes of mapping into two formations: (1) conglomerate; (2) slate-like greywacké. The two types, which are quite different in character and easily distinguished in the field, where intruded by Nipissing diabase are considered favourable ground for the discovery of silver.

Conglomerates.—In general, the exposures of the conglomerate have no great thickness, being simply isolated remnants that have escaped erosion. Patches of the underlying rocks are sometimes seen protruding through the sedimentary masses. There is great lack of uniformity in the number and size of the pebbles, which are composed almost entirely of granite in the Anima-Nipissing area, except locally in the base immediately overlying Keewatin rocks. At a point about half a mile due east of the south end of McLean lake, the base of the Cobalt conglomerate is composed to a large extent of blocks and fragments of banded tuffs quite evidently derived from the underlying series. The matrix of the conglomerate in this section is, for the area, exceptionally dark in colour, due probably to the greater admixture of materials derived from the Keewatin. However, the matrix is more often light in colour, being composed of a fairly coarse quartzitic material representing broken-down granite. This type composes the mass to the southwest of Whitewater lake, where the contact with granite is sometimes difficult to place exactly, the granite gradually giving place to arkose a little darker in colour in which, somewhat higher up, pebbles appear.

The thickness of the conglomerate in Brigstocke and in the northern part of Best township is limited in places to a few feet, the overlying greywacké being found resting practically upon the surface of granite and other crystalline rocks.

Slate-like Greywacké and Quartzite.—Northward from the vicinity of Anima-Nipissing lake the greywacké and quartzite composing the upper formation in the Lower Cobalt series is exposed in masses of considerable extent. Slate-like greywacké is found underlying the quartzite of the Upper Cobalt series in Dane and Kittson townships, in valleys where erosion has cut through the thin layer of the latter rock which covers the greater part of the northern half of the a ea. The transition from the one rock to the other is seen in cliffs bordering the valleys. The lower flat-lying beds of laminated greywacké pass upward through a gritty greywacké phase, gradually becoming more massive and lighter in colour until a white or pink weathering quartzite is reached, which shows but slight evidence of stratification. The change takes place across a vertical distance of 50 feet or less.

That the greywacké has no great thickness is suggested by the occurrence to the northwest of Trout lake of a protruding mass of granite representing a high spot on the pre-Cobalt series surface exposed by erosion.

To the south of the western part of Anima-Nipissing lake, the transition downward into boulder conglomerate is marked by a rock containing boulders of granite in a matrix of thinly bedded greywacké. However, in general, the formation is free from pebbles.

A considerable part of the mass of Lower Cobalt series bordering Anima-Nipissing lake in Best township consists of impure grey quartzite. This well-stratified rock represents the transition phase between slate-like greywacké and the upper massive quartzite found to the northwest of the lake.

Upper Cobalt Series

This series is represented by a light-weathering impure quartzite in which poorly developed bedding planes are sometimes discernible. The beds are close to horizontal, and the series is usually less than 100 feet in thickness, as is shown clearly by the exposures of underlying slate-like greywacké found on the sides of shallow valleys in the quartzite. The greatest thickness, about 250 feet, occurs adjacent to the middle of the south boundary of Dane township, where hills of the quartzite rise about 300 feet above the level of Lady Evelyn lake.

Due to the horizontal attitude of the Upper Cobalt series in the Anima-Nipissing area, the rocks composing it lie in about the same horizon, which results in less variation in the lithological character than is usually found in other areas of equal extent. It consists throughout of white or pinkish-weathering quartzite in which undecomposed feldspar can be detected with the microscope. The rock is usually from fine to medium in grain, coarse arkose types being uncommon. The sea-green quartzite typical of higher horizons in the series is lacking, as are also the beds of quartz conglomerate.

Keweenawan

Nipissing Diabase

Normal Type.—From the economic standpoint the most important rock is the Nipissing diabase, since the silver deposits of Cobalt, South Lorrain, Gowganda, and other localities are associated with this formation. The masses of this rock exposed in the Anima-Nipissing area are similar structurally and petrographically to those found in the localities mentioned, and they have been so thoroughly described by various authors who have mapped surrounding areas that little need be added here. Briefly stated, the common or normal phase is a medium to coarse grained quartz diabase, dark grey in colour, occurring in sill-like masses which cut all of the rocks previously described in this report. Field evidence indicates that these bodies were once joined in a single great sill, parts of which have been removed by erosion, while other parts remain buried beneath the older formations.

Aplite Dikes.—Light-weathering aplite dikes, seldom exceeding two feet in width, are found occasionally in the normal diabase. This fine-grained rock, composed principally of quartz and an acid plagioclase, is considered to be a late product of differentiation from the diabase magma. In the Gowganda area it sometimes contains veins in which silver and arsenides occur along with calcite.[1]

Dikes of this aplitic material were observed cutting most of the masses of Nipissing diabase and appeared to be more plentiful than usual in the area lying to the west of the north end of Net lake; as a rule they are of rather rare occurrenc .

Red Rock.—The northern edge of the large mass of diabase which crosses Brigstocke township consists of a granophyric phase much more acid in appearance and composition than the normal diabase. The rock weathers to a rather bright red colour, while the fresh surface usually has a brownish cast. As the contact with the quartzite to the north is neared, the red rock as a rule becomes lighter in colour, and it is often difficult to determine the boundary of the intrusive rock. The acid phase extends in places a distance of three-quarters of a mile away from the edge of the quartzite. The diabase along this

[1]A. G. Burrows, Ont. Dept. Mines, Vol. XXX, pt. 3, 1921, p. 21.

contact dips to the north at a low angle beneath the quartzite, and it appears that the red rock occurs only on the hanging-wall side of the sill where it is in contact with quartzite. The footwall contacts do not show any development of red rock; nor do hanging-wall contacts, with rocks more basic than quartzite, show any appreciable quantity of the granophyric type, a fact which suggests that the change in composition of the diabase is due more particularly to assimilation of acid materials from the quartzite than to differentiation within the magma. The process of differentiation should not be affected by the nature of the overlying formations.

The analysis of a sample of red rock about a mile east of the north end of Pickerel lake follows:—

	Per cent.
Silica	64.63
Alumina	14.22
Ferric oxide	1.34
Ferrous oxide	5.71
Lime	2.44
Magnesia	2.67
Potash	.14
Soda	4.21
Titanium dioxide	1.11
Carbon dioxide	1.42
Water	2.37
	100.26

With the microscope, the red rock is seen to be composed principally of somewhat cloudy acid plagioclase abundantly intergrown with quartz, while chlorite is the most common ferromagnesian mineral. There is also present a brown mica and some augite, partially altered to chlorite. Needles of apatite penetrate the quartz and feldspar crystals, and considerable magnetite occurs associated with the ferromagnesian minerals.

Olivine Diabase and Quartz Diabase Dikes

The youngest formations consist of olivine diabase and quartz diabase which occur always in the form of vertical dikes seldom exceeding 200 feet in width. These dikes, which intrude all of the other rocks in the area, including the Nipissing diabase, as a rule strike in a northeast direction, a feature also quite marked in the Matabitchuan area.

A characteristic of the olivine diabase, often found useful in its identification, is the presence of large plagioclase phenocrysts which are sometimes as much as three inches in length. These lath-shaped crystals always possess sharp angular boundaries, in contrast to the phenocrysts found in the Matachewan diabase which are generally somewhat rounded and much more altered in appearance. Some of the olivine diabase dikes, especially the very narrow ones, are not porphyritic, in which case recourse to the microscope must be taken for positive identification.

A fine-grained rusty dike found cutting the quartzite in Brigstocke township, west of Gullrock lake, is composed of normal diabase with a little interstitial quartz visible in thin section under the microscope.

Quaternary

Glacial and Recent

The largest area of unconsolidated materials is found in the vicinity of the boundary line between Kittson and Dane townships. This deposit, consisting

of oval hills of glacial drift, fills a large, pre-glacial valley that extends from Lady Evelyn lake southward into Cole township.

Esker ridges are a prominent feature on Lady Evelyn lake near the east extremity, some of the oddly shaped islands shown on the map being of this esker type of glacial deposit. Sand ridges also cover considerable areas to the south of Eagle lake and west of Red Squirrel lake.

A stretch of swamp about two miles in diameter surrounds Young Loon lake, but apart from this area of muskeg, the amount of low ground is insignificant. Young Loon lake represents the remnant of a much larger body of water which has been replaced by an accumulation of vegetable materials, thus giving rise to the patch of muskeg.

ECONOMIC GEOLOGY

Contact Relationships of Nipissing Diabase

The knowledge gained in recent years, relative to the occurrence of silver ores in the productive areas, has established the fact that the ore shoots, in a great majority of cases, are confined to zones lying adjacent to the edges of the diabase sill, either within the diabase itself or in rocks above or below it.[1] In Cobalt, about 90 per cent. of the silver produced has been derived from the vicinity of the lower diabase contact and chiefly from rocks underlying the sill. At Gowganda and South Lorrain, on the other hand, the productive zones lie adjacent to the upper contact and mostly within the diabase itself. At South Lorrain, however, high-grade silver veins have been developed on the Maidens claims in rocks underlying the diabase sill.

Since it appears to be a fairly well established fact that the silver was deposited near the margins of the Nipissing diabase sill, it becomes necessary in prospecting new areas to obtain an intelligent understanding of the relationship of the diabase masses to the surrounding formations. In following paragraphs, field observations made in examining the contacts of some of the diabase bodies are noted.

Brigstocke and Cole Townships

A large body of Nipissing diabase, with an average width of over one and a half miles, extends across Brigstocke in a westerly direction into Cole township. This mass of igneous rock forms part of a sill, which in this locality dips to the north at low angles, conforming in a general way to the dip of the bedding planes in the surrounding Cobalt series sediments. The southern margin of the diabase forms a footwall contact with slate-like greywacké, while the northern edge constitutes a hanging-wall contact with quartzite and greywacké.

Footwall Contact.—Footwall contacts are well exposed at several points, particularly in the neighbourhood of Whitewater and Diabase lakes. On the former, at the narrows leading to the northwest arm, well-bedded greywacké is exposed at the water's edge in low outcrops, which are overlain by a considerable cliff of diabase with vertical columnar jointing. The contacts observed appear to be horizontal. Similarly, at the extreme southwest end of Diabase lake, the diabase dips over greywacké at about 10° W., and along the contact extending from Diabase to Anima-Nipissing lakes the footwall is exposed in many places near the base of a continuous cliff which marks the southern margin of the diabase. At a point 12 chains north of the east end of Diabase lake, the

[1] A. G. Burrows, Gowganda Silver Area, Ont. Dept. Mines, Vol. XXXV, pt. 3, 1921; C. W. Knight, Cobalt and South Lorrain Silver Areas, Ont. Dept. Mines, Vol. XXXI, pt. 2, 1922.

sill dips to the northwest over greywacké at an angle of 10 degrees. Farther east, near the end of the portage leading to Harris lake, the diabase rises in a conspicuous cliff over slate-like greywacké. The face of the cliff shows nearly vertical columnar jointing, rather well developed, and the inclination of the sill is again about 10° N.W. For some distance eastward from this point the actual contact between the diabase and underlying greywacké is covered by a deposit of glacial materials. However, situated close to the west side of the bay leading to Pickerel lake, one outcrop shows the footwall dipping about 5° N.

On the west side of the northeast arm of Anima-Nipissing lake, the map shows a narrow band of greywacké and quartzite in contact with the diabase. At several points along this contact, the footwall of the sill may be observed dipping to the west at angles ranging from 15 to 40 degrees.

The smaller masses of diabase, shown near the south shore of the central part of Anima-Nipissing lake, are remnants of the sill that have escaped complete erosion. They probably do not exceed 200 feet in thickness, as at several points the footwall is in horizontal contact with the greywacké.

In Cole township an excellent exposure of the lower edge of the sill occurs at the base of a cliff, 200 feet in height, which is situated 15 chains southeast of Eagle lake. The underlying rock is composed of thinly bedded grey quartzite, over which the diabase lies at an angle of 10 degrees inclined to the northeast. From the nature of this contact, it appears that the edge of the sill shown to the east of Little Eagle lake is also the footwall side.

Hanging-Wall Contact.—The southern or footwall margin of this large mass of diabase in Brigstocke and Cole townships is marked by a conspicuous cliff along its entire length. This is in great contrast to the character of the north edge which slopes gently down to the contact with overlying quartzite and greywacké. Exposures showing the actual junction of the hanging-wall of the diabase with these rocks are also considerably more difficult to find than in the case of the footwall contact, as over considerable distances the margin of the sill is covered with shallow deposits of glacial origin. In addition to this handicap, there has been much assimilation, along the margin of the diabase, of materials from the quartzite, resulting in the formation of a band of red rock sometimes showing a width of over half a mile. The presence of this hybrid rock often makes it impossible to determine the exact location of the contact. However, its presence offers good evidence that the edge of the diabase, which is shown extending from the north end of Turner lake eastward to Anima-Nipissing lake, represents the hanging-wall side of the sill, since in other localities[1] the red rock occurs on the upper side of diabase masses.

An exposure showing a definite contact of the diabase with greywacké occurs on the township line six chains south of Shallow lake. The hanging-wall of the diabase is inclined to the north 15 degrees, in conformity with the bedding of the sedimentary rock. Similarly, at the west end of this lake, the diabase is seen dipping beneath the same formation at about 10°N.

The small patch of quartzite, shown on the map bordering the small lake to the northeast of Turner lake, is resting on the upper side of the sill, as several exposures around the edge of the quartzite mass show the diabase dipping at low angles beneath the sediment. Another sharp contact with quartzite occurs at the east end of the large island near the north end of Anima-Nipissing lake; the junction is vertical in this case.

[1]A. G. Burrows, op. cit., p. 13.

The several masses of greywacké found in the eastern part of Brigstocke, between claims W.S. 41 and H.S. 1,058, occupy the tops of rather prominent hills with diabase showing at the bottom. On the east side of the small creek, which flows past the western edge of the larger greywacké mass, the hanging-wall of the diabase is exposed in contact with brecciated sediments. The dip is about 5° E. The presence of these patches of sedimentary rock overlying the diabase indicates that in this locality there is a considerable area in which the sill has not been eroded to any appreciable extent.

The diabase outcrops shown near the northwest corner of Brigstocke township appear to be high spots on the sill, which presumably underlies all of the surrounding quartzite. Two contacts observed, one on the north boundary of Brigstocke and the other a mile to the west on the north line of Cole, show the diabase dipping beneath quartzite at angles of about 60 degrees.

Banting and Chambers Townships

A linear mass of diabase extends across the northwest corner of Chambers township and northward through the middle of Banting to Whitewater lake, where it joins the large body referred to in preceding paragraphs. Situated near the centre of Banting township, there is a small area, meriting particular attention from prospectors, where rocks of Keewatin age as well as conglomerate of the Cobalt series are overlain by the diabase sill. Although actual contacts between the Keewatin and the diabase are not well exposed, evidence was obtained farther to the north and to the south which indicates that both edges of the diabase mass form footwall contacts with the other formations.

Footwall Contacts.—A contact indicating the attitude of the eastern side of the sill is exposed east of the small lake draining into the west end of Chambers lake. The diabase here dips over coarse conglomerate at an angle of 30° N.W. Half a mile to the east of this point, granite forms a vertical contact with the diabase; farther to the north, at a point five chains south of Lenore lake, the sill terminates in a cliff which shows columnar jointing, indicating a contact dipping to the west. The actual junction with the bordering granite is covered with an accumulation of talus which has dropped from the cliff. Still farther north, on the east side of this mass of diabase, an outcrop situated 10 chains north of Tyndall lake shows the footwall of the sill resting on conglomerate and dipping steeply to the west. Again, on Anima-Nipissing lake 30 chains south of the outlet from Whitewater lake, an excellent contact with greywacké conglomerate is exposed, extending diagonally up the face of a cliff. The lower wall of the sill is seen plainly, resting on the conglomerate and inclining to the southwest at an angle of 15 degrees. Other exposures at the base of this cliff, which extends westward to Whitewater lake, show the footwall of the sill dipping to the southwest over conglomerate at about the same angle.

A contact showing the footwall of this same mass of diabase on its western edge is exposed 20 chains west of McLean lake where the sill is inclined to the northeast over granite at a high angle. Farther south, on the northwest shore of Lenore lake, the diabase rests on granite at an angle of about 35 degrees dipping to the east. Similarly, at a point 25 chains along the contact to the north, the dip is to the east at an angle of about 45 degrees. Another footwall contact observed half a mile north of the northwestern extremity of Chambers lake shows the diabase dipping to the southeast over granite at a steep angle.

Strathy and Best Townships

The southwest corner of Best township and a part of Strathy township lying chiefly to the north of Cedar lake are underlain by a considerable mass of Nipissing diabase. From Net lake the diabase extends to the north in the form of a circular-shaped ridge, which encloses a large mass of granite in the central part of Best township. The contacts observed indicate that the diabase dips towards the centre of the circle beneath the enclosed granite, while the outer edge of the intrusive mass is found to overlie the rocks in contact with it. The outer margin, therefore, constitutes the footwall of the sill, while the inner side is the hanging-wall. Apart from a few small patches of Cobalt series and Keewatin rocks, the diabase in Best township is enclosed by granite and accordingly offers little prospect for the discovery of silver-bearing veins. The most attractive locality, geologically, is situated in Strathy township where the footwall of the sill rests upon rocks of Keewatin age.



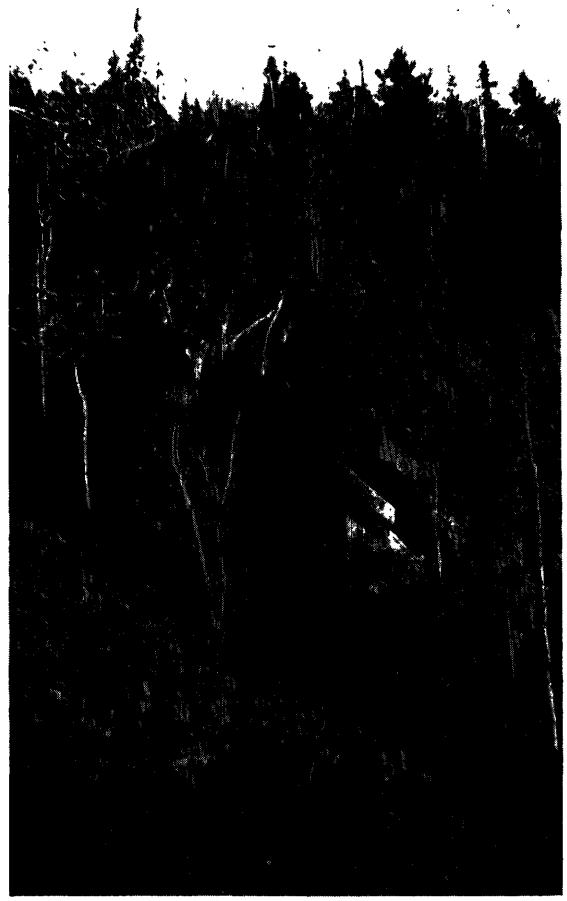
Footwall of Nipissing diabase resting on granite to the west of the pond draining into the southwestern part of Mountain lake.

Footwall Contact.—At a point 10 chains east of the middle of Alfreda lake, the diabase dips to the east, at about 25 degrees, over schistose greenstone, probably altered basalt; 15 chains from this point, at the southern extremity of the diabase mass, the sill is inclined to the northeast at an angle of about 15 degrees. Thirty chains farther along the contact to the northeast, the inclination appears to be to the northwest at an angle of about 70 degrees; while 10 chains still farther along, the diabase dips over the Keewatin to the west at a much lower angle. Directly east of this point, at the bottom of a perpendicular cliff facing west, the footwall of the sill is exposed in horizontal contact with altered basalt.

Following the outer edge of the diabase mass to the northeast of Cedar lake, an exposure showing the contact dipping to the northwest is located due north of the east end of the 5-chain portage connecting Net and Cedar lakes. Farther to the east, near the opposite shore at Net lake, the footwall forms a contact with granite in the face of a low cliff, the dip being about 35° N.E.

To the south of Mountain lake the diabase rises, in a cliff 200 feet in height, over Keewatin and granite. The face of the cliff shows excellent columnar jointing, which is inclined slightly to the south from the vertical, and the actual contact observed at several points indicates an inclination of the sill to the south of about 15 degrees.

The masses of diabase shown on the map to the east of Anima-Nipissing lake are remnants of the sill which at one time occupied the whole of the intervening space at a horizon a little higher up. Near the narrows leading into the



Cliff of diabase with columnar jointing, south of Mountain lake.

north arm of this lake, the diabase is seen in the face of a cliff resting upon slate-like greywacké, the contact dipping to the southeast at about 10 degrees.

Hanging-Wall Contact.—The upper side of the sill is exposed at a point 25 chains west of Net lake on the township line between Strathy and Best; the diabase appears to dip under the granite to the east at an angle of about 50 degrees. Farther to the north, in the southwest bay of Thieving Bear lake, horizontal contacts between diabase and overlying granite are exposed, while on the south side of the large peninsula the hanging-wall dips 10° N.W.

Another contact observed 120 chains due west of this lake shows the diabase dipping to the north beneath granite.

Veins in the Nipissing Diabase

About twenty years ago, following the discovery of silver at Cobalt, some prospecting was done in the diabase surrounding Anima-Nipissing and Whitewater lakes, Most of the claims appear to have been staked in the middle of the diabase mass, and no systematic exploration of the rocks along contacts has been made up to the present time. The rocks in the central section of Banting township and in the northern part of Strathy appear to have received little attention.

A number of calcite veins carrying arsenides of cobalt and nickel were discovered, chiefly in Brigstocke township, and evidence of work done exists in the form of trenches and test pits which now are filled with debris. Shafts



Large quartz vein in Nipissing diabase, Thieving Bear lake.

were put down, in some instances, as in the case of the Kreisman claims, T.C. 705 and T.C. 706, situated adjacent to the west side of Pickerel lake. A shaft was sunk on each of these claims in the diabase near the contact with quartzite, and vein-material found on the dumps consisted of calcite and crushed diabase with some cobalt bloom, chalcopyrite and hematite being in evidence. It is reported that a strong vein was followed in both shafts, carrying massive arsenides and native bismuth, and giving low assays in silver.

On W.S. 41 and H.S. 1,011, situated near the northern edge of the diabase east of Pickerel lake, vein material found on dumps consisted of white calcite containing chalcopyrite; no bloom was observed.

On L.O. 161 a shaft was sunk on the contact between diabase and grey quartzite, and material on the dump indicated a vein three to four inches wide, consisting of calcite and quartz containing chalcopyrite, pyrite, and hematite.

From the northeast corner of Dane township, a narrow band of diabase extends to the north along the west shore of the bay leading to the outlet of

Lady Evelyn lake. Material found on dumps situated on a small island at the entrance to the bay consists of sheared diabase containing stringers of calcite considerably stained with cobalt bloom. In Klock township along the west side of this bay, conspicuous veins of quartz fill fissures and irregular cavities in the diabase and also in the greywacké in contact with it. A. E. Barlow[1] describes these deposits and reports the presence of galena, cerussite, sphalerite, chalcopyrite, pyrite, and hematite as occasional constituents in the veins. On assay, one of his samples gave 8.75 ounces of silver per ton.

There is a somewhat similar occurrence at the outlet of Thieving Bear lake on the west shore. A quartz vein, having a width of three feet in places, lies parallel to nearly horizontal joint-planes in Nipissing diabase. The quartz contains a small amount of chalcopyrite and pyrite. Veins of this character in the Nipissing diabase are of rather rare occurrence in this part of Ontario.



Entrance to adit and engine-house, Crescent Silver Cobalt Mining Company, Limited.

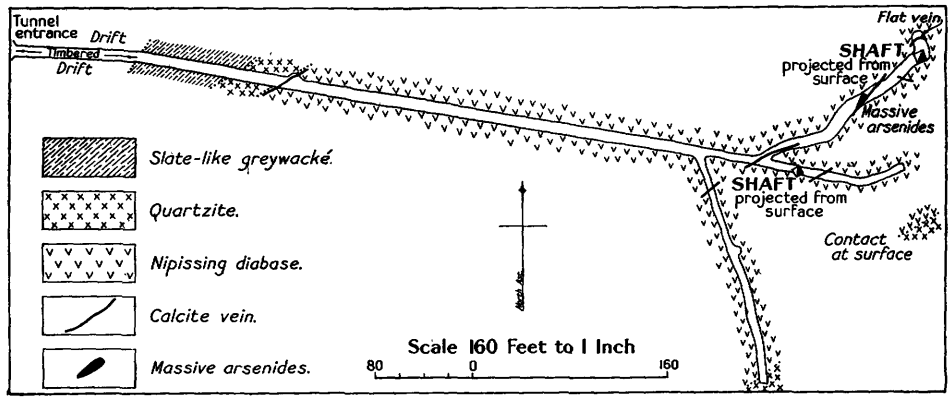
In the writer's opinion, the localities most worthy of prospecting are as follows: (1) the central part of Banting township, where the footwall side of the sill is in contact with Keewatin and conglomerate; (2) the southern margin of the diabase in Strathy township, where the sill also rests upon Keewatin rocks; (3) the vicinity of the greywacké masses east of Pickerel lake, where the hanging-wall of the sill is exposed; (4) the southern or footwall side of the diabase mass north of Anima-Nipissing lake and east of Little Eagle lake.

Crescent Silver Cobalt Mining Company, Limited

This company was incorporated on February 27, 1923, with a capital of $2,500,000, and is operating on a group of claims adjacent to Trout lake in Coleman township. The numbers are as follows: H.M.7, H.M.8, L.O.3, L.O.60, J.S.61, J.S.73, H.F.6, H.F.7. The rocks exposed are quartzite, slate-like greywacké and diabase, the last occurring in the form of a crescent-shaped ridge, which rises in places about 200 feet above the level of Trout lake.

[1]Geol. Surv. Can., No. 962, 1907, pp. 139-40.

A number of years ago, two shafts were sunk in the diabase to depths of 45 and 55 feet on a strong calcite vein containing pockets of massive arsenides of cobalt and nickel. To explore further this and other veins, an adit was driven recently from the foot of the ridge near Trout lake on L.O.3 in an easterly direction until the vein discovered on the surface was reached. Drifting on this vein has been proceeded with to a point directly beneath the most easterly shaft and a cross-fracture was followed to the southeast until the opposite wall of the diabase in contact with quartzite was reached. In addition to the main vein, several others were encountered in the tunnel, the principal vein mineral being calcite, often accompanied by masses of pale green actinolite. The main vein follows a very irregular fracture in which the calcite frequently bulges to a width of two feet or more. Seventy feet from the end of the drift, there is a short shoot of arsenides of cobalt, nickel, and iron, which occur mixed with calcite in masses up to ten inches in width. The strike of this vein, although varying considerably, is in general parallel to the edge of the diabase mass, while the dip is vertical in some places and steep to the southwest in others. In the adit, the vein is situated about 60 feet from the contact.



Plan of adit, Crescent Silver Cobalt Mining Company, Limited, claim L.O.3, Trout lake.

Both walls of the diabase, as seen in the tunnel and on the surface, appear to form approximately vertical contacts with the enclosing quartzite. The intrusive mass is, therefore, more like a dike than a sill, although it might assume a more nearly horizontal attitude at a lower horizon. The width of the dike is 415 feet as shown in the mine workings.

The rock encountered near the mouth of the adit is slate-like greywacké, which dips at an angle of 10° E., up to a point about 40 feet away from the diabase, where it is replaced by crushed quartzite. As the diabase is approached, the quartzite becomes darker in colour due to impregnation with basic materials from the diabase magma.

The plant consists of two 50 h.p. locomotive boilers and a 400 cubic foot Sullivan duplex compressor.

M. B. R. Gordon is consulting engineer.

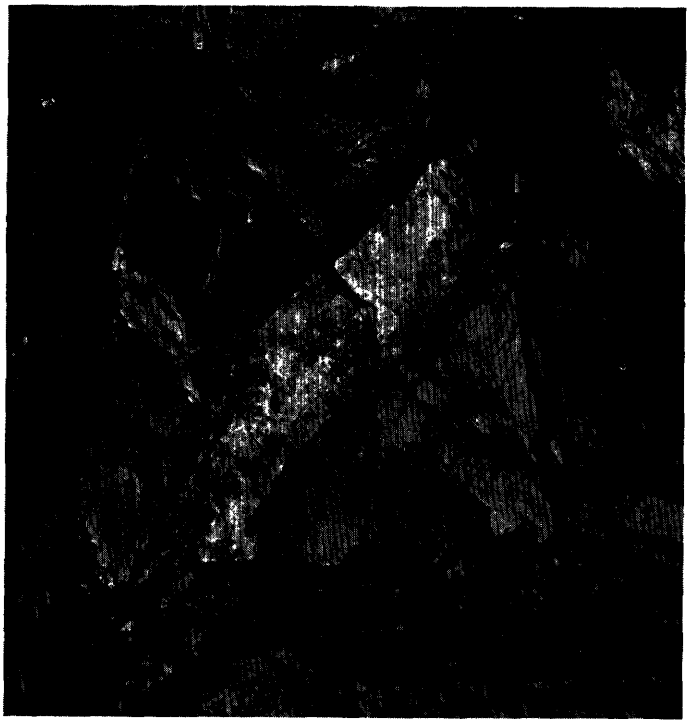
Description of the Arsenides.—The sample taken for examination consists of grey metallic material, which even in the hand specimen appears to be a mixture of two or more minerals. Certain fracture faces possess a pinkish cast, while an irridescent tarnish shows on parts of the specimen. Fractures in

the metallic minerals are filled with calcite containing radiated bunches of actinolite.

Examination of the polished surface with the microscope shows the presence of small masses of niccolite imbedded in a mixture consisting principally of gersdorffite, the sulpharsenide of nickel (NiAsS). In places the gersdorffite is intergrown with cobaltite, which also forms rims around the margin of masses of the nickel mineral.

An analysis of the arsenides separated from gangue minerals follows:—

	Per cent.
Iron	1.53
Nickel	25.11
Cobalt	7.48
Sulphur	16.85
Arsenic	48.41
Copper	.16
	99.54



Vein, 8 inches wide, showing a mixture of arsenides and calcite, Crescent Silver Cobalt mine. Photograph shows back of the drift.

The analysis shows the presence of a small amount of an iron mineral, probably arsenopyrite. A certain amount of diarsenide of nickel or cobalt not observed in the microscopic examination is also indicated by a recalculation of the analysis. The presence of these minerals was apparently masked by the large proportion of gersdorffite.

Ores in the Keewatin and Haileyburian (?)

For the past thirty years, considerable attention has been paid to an area in Strathy township situated chiefly to the south of Cedar and Net lakes. De-

posits of considerable importance containing auriferous mispickel (arsenopyrite) and nickel occur in this vicinity. One well known deposit, the Big Dan, is located near the railroad at mileage 74 in a sheared zone in Keewatin basalt, and a similar occurrence, known as the Little Dan, is situated at the east end of Arsenic lake.

On T.R. 1,623 and T.R. 3,187, a sulphide deposit; containing chalcopyrite and the nickel-bearing mineral pentlandite, occurs in a large gossan zone in serpentine of Haileyburian (?) age.

For a detailed description of these and other less important deposits in the Cedar and Net lakes section, the reader is referred to the report by C. W. Knight,[1] issued in 1920. No work has been done in this locality since that time.

Northland Pyrite Mine

This mine, situated on the west side of James lake near the south end, has sometimes been referred to in the literature as the Rib Lake iron pyrites deposits. The ore, consisting of pyrrhotite, pyrite, and some chalcopyrite, is located in a gossan zone running approximately north and south, parallel to the edge of a granite mass situated about 150 feet to the west. The rock enclosing the mineralized area consists of banded tuff, which strikes about N. 20° E. A porphyritic acid dike, described before in this report, occurs a few feet to the east of a large open cut. The dike appears to strike parallel to the banding in the Keewatin rock, although its exact outlines could not be ascertained on account of a covering of drift. At one point a small mass of serpentinous material is associated with the sulphides in the gossan zone.

A description by E. L. Fraleck,[2] given in 1907 during the time the mine was in operation, is in part quoted below:—

> The discovery was made in 1903, but active development was not instituted until December 1906.
>
> A shaft has been sunk to a depth of seventy feet with a drift on the vein of forty feet to the south and twenty to the north. A test pit twenty feet deep has been sunk on another lens about forty feet northeast of the main shaft.
>
> Another lens was being opened up by an open pit about two hundred and fifty feet to the southeast of the shaft. This showed a width of over twelve feet of solid pyrite. Three lenses have been located in a pyritous zone, four hundred and ten feet in length. The fahlband is fairly strong and traceable for a quarter of a mile.
>
> The lens lies in a soft green schist about one hundred feet east of the contact with a grey hornblende granite. The intrusion of the granite has caused planes of weakness and fracture in the schist, subsequently filled by pyrite.
>
> The only impurity in the ore consists of small veinlets of quartz and massive pyrrhotite on each wall of the lenses. Occasionally pyrrhotite is also finely disseminated through the pyrite. The ore breaks nicely, making very little fines in the course of mining. Shipments up to July 1, 1906, were 220 tons, averaging 42 per cent. in sulphur.

The following year E. T. Corkill[3] reported as follows:—

> It was in continuous operation during the past year. The underground development shows the shaft to have been sunk to a depth of 170 feet with the first level at 100 feet. On this level drifts have been driven north 110 feet and south 200 feet. North of the shaft stoping has been begun, a stope 80 feet in length by 25 feet in height having been made. South of the shaft stoping has also been commenced, the ore being stoped out for an area of 80 feet in length by 20 feet in height. North of the shaft 240 feet, the ore has been taken out by open-cut workings for a depth of 45 feet by a length of 75 feet. This stope has been connected with the first level by a raise and stoping from the level begun. The ore is hoisted to the shaft-house where it is broken and the rock cobbed out. It is then dumped direct from the storage bin to the cars, a siding from the Temiskaming and Northern Ontario railway having been built to pass under the ore bin.

At the present time most of the machinery has been removed and the rails have been taken up from the siding.

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[1] Ont. Dept. Mines, Vol. XXIX, pt. 1, 1920, pp. 207-19.
[2] Ont. Bur. Mines, Vol. XVI, pt. 1, 1907, p. 165.
[3] Ont. Bur. Mines, Vol. XVII, 1908, p. 82.

INDEX, PART III

A PAGE

Acid lavas. *See* Lavas.
Adinole.
  Gowganda silver area....13, 57
Agglomerate.
  Anima-Nipissing L. area.... 87
Alfreda l., rocks near.... 98
Algoman formation.
  Anima-Nipissing L. area.... 84
  Gowganda silver area.... 6, 9
Algoman-Keewatin complex....84, 89
Alpine silver m., Van Hise tp.
  Diabase ridge, altitude....2, 55
  Machinery; development; rocks....55, 56
Analyses.
  Anorthite, Strathy tp.... 86
  Arsenides, Coleman tp.... 103
  Red rock, near Pickerel l.... 94
  Tuff, Banting tp.... 88
  Vein material, Gowganda silver area.66-77
Anima-Nipissing lake.
  Area drained by, character.... 81
  Prospecting.... 100
  Report, by E. W. Todd, on area....79-104
  Rocks....92, 96-99
Animikean. *See* Cobalt series.
Anorthite.
  Anima-Nipissing L. area, notes and analysis.... 86
Antimony in Gowganda silver ores.... 77
Aplite dikes.
  Anima-Nipissing L. area.... 93
Arsenides.
  Coleman tp., notes and analysis...102, 103
  Gowganda silver area, notes and photos....24, 64-73
Arsenopyrite. *See* Mispickel.

B

Balsam, Gowganda silver area.... 3
Banting tp.
  Prospecting advisable....100, 101
  Rocks....82, 85, 88, 91, 97
Barbara silver m., Haultain tp.
  Mineralization; vein.... 38
Barlow, A. E....83, 101
  On depth of Anima-Nipissing l.... 81
Bartlett s. m. *See* Crews-McFarlan s. m.
Bartlett Mines Co.... 49
Best tp., rocks....85-99
  See also Anima-Nipissing l.
Big Dan mispickel m....90, 104
Bishop silver m., Calcite l., development 48
Bishop silver m., N.W. of Bloom l.... 58
Bishop silver m., N.W. of Gowganda l... 49
Bishop Mining Co., work by....48, 49
Bloom l.
  Diabase.... 17
  Granite, notes.... 9
  Silver mg. near. *See* Bishop s. m., N.W. of Bloom l.
Bonsall, Percy.... 25

Bonsall silver m., Haultain tp. PAGE
  See also Miller Lake O'Brien s. m.
  Description; development; history..25-27
  Production (1920).... 4
  Rocks....17, 20
  Veins, position of.... 22
Bowen, N. L....13-15, 20
Boyd-Gordon s. m., Milner tp.
  Diabase.... 22
  Production (1910).... 4
  Taken over by Mann s. m.... 53
Breithauptite.
  Gowganda vein material.... 77
  Symbol.... 77
Brett l.... 8
Brigstocke tp.
  Cobalt and nickel.... 100
  Rocks....80-97
Burke l.
  See also Cobalt-Nugget s. m.
  Rocks.... 19
  Waterpower.... 6
Burk-Remey s. m., W. of Gowganda l.
  Production (1910).... 4
Burrows, A. G....62, 93-96
  Report by, on Gowganda silver area.. 1-61

C

Calcite lake, silver mg.... 48
Calcite Lake s. m.
  Production (1911).... 5
Calcite Lake Mining Co.... 48
Caleta Mining Co.... 48
Campbell, C. L.
  Chapelle s. m. optioned to.... 41
Canadian Gowganda silver m.
  Diabase W. of.... 20
  Production (1911).... 5
Capitol silver m., Haultain tp.
  Description; development....32, 33
Cassels tp., rocks.... 85
Castle silver m., N.W. of Miller l.
  See also Castle-Trethewey s. m.
  Development; rocks; veins....40, 41
Castle-Trethewey silver m., Haultain tp.
  Arsenides, notes and photo....64, 75-77
  Diabase, structure.... 19
  Hanging-wall contact.... 17
  Ore shoots and reserves....25, 38
  Photo.... 1
  Production (1920-25)....3, 37
  Report with section, plans, and flow-sheet.... 33
  Veins, character....22-24
Cedar l., Strathy tp.
  Photo.... 87
  Rocks....82, 86, 89, 90, 98
Chambers creek, rocks.... 89
Chambers (or Lost) l....81, 86, 89, 97
Chambers tp., rocks....84-88, 97
Chapelle silver m., Leroy l.
  Rocks; veins; fault.... 41

PAGE

Charters tp.
Rocks... 11
Sand deposits... 3
Silver... 22
mg. *See* Garvey s. m.; Haines s.m.
Chloanthite.
Gowganda silver area (?)... 73
Cobalt.
Cobalt (Ont.) silver area, origin of veins... 23
Gowganda silver area, amount paid for (1910-25)... 5
Cobalt, Ont.
Silver-cobalt veins, origin... 23
Cobalt bloom. *See* Erythrite.
Cobalt series.
Anima-Nipissing L. area... 84, 91-93
Gowganda silver area... 6, 10-13
photos... 11, 12
Cobalt Nugget silver m., N.E. of Burke l.
Fault; veins; rocks... 40
Cobaltite.
Gowganda silver area, in vein material... 66-77
Symbol... 77
Cole tp.
Glacial drift... 95
Nipissing diabase... 95, 96
Coleman, A. P... 83
Coleman tp.
See Crescent Silver Cobalt Mg. Co.
Coleroy silver m., Leroy l.
Description; plan of workings; mineralization... 44-46
Temiskamite... 76
Collins, F. H... 44
Collins, W. H... 14,15
Collins l., Donovan tp. *See* Wilder s. m.
Collins s. claim, Leroy l. *See* Coleroy s. m.
Conglomerate.
See also Cobalt series.
Gowganda s. area, notes and photo .. 11
Cook tp., lava... 87
Corkill, E. T.
Notes on Northland pyrite m... 104
Corkill tp.
Rocks... 11
Sand deposits... 3
Silver mg. *See* Gowganda Keora s. m.
Craig, Ernest... 44
Crawford silver m., striae... 3
Crescent Silver Cobalt Mg. Co.
Description, plan and photos of claim. Coleman tp... 101-103
Crews-McFarlan silver m., Gowganda l.
Diabase... 15, 22
Ore, photo... 49
Production (1918-19)... 4, 5
Report... 49, 50
Crews-McFarlan Mining Co... 49
Crown Reserve Mining Co.
Walsh s. m. optioned to... 43

D

Dane tp.
Diabase... 100
Quartzite... 80, 92, 93
Recent deposits... 94
Davidson l... 9, 18, 19
Dendrite, Gowganda silver area... 72, 76
Diabase. *See* Nipissing diabase.

PAGE

Diabase l., Brigstocke tp... 95
Diabase l., Van Hise tp... 17, 19
Dickenson, J. G... 20, 32
Dinny, L., Haultain tp... 18
Dobbins, W. S... 33
Donovan tp.
Silver mg. *See* Duggan s. m.; Wilder s. m.
Duggan, Howard... 58
Duggan silver m., Donovan tp.
Development; mineralization... 58
Dyscrasite.
Gowganda silver ores... 77

E

Eagle l... 80, 95
E.D. 123½ silver loc., Charters tp. *See* Garvey s. m.
Elkhorn, l... 8, 17-19
Erythrite.
Gowganda vein material... 77
Symbol... 77
Everett l.
See also Millcrest s. m.
Rocks... 8, 9, 15
diabase, photo... 16
Everett silver m. *See* Miller Lake; Everett Mines, Ltd.

F

Fairburn, W. H... 40
Chapelle s. m. optioned to... 41
Feldspar porphyry.
James l., analysis... 90
Fish.
Anima-Nipissing L. area... 82
Flanagan l., Cobalt series... 13
Forest fires.
Gowganda silver area... 3
Fralech, E. L.
Description by, of Northland pyrite m. 104
Frying-pan l... 11

G

Game.
Anima-Nipissing L. area... 82
Gamey-Thompson silver m., Van Hise tp. *See* Alpine s. m.
Garvey silver m., Charters tp.
Cobalt bloom; veins... 56
Gates silver claims, N.W. of Miller l. *See* Miller Lake O'Brien s. m.
Geology, general and economic.
Anima-Nipissing L. area... 84-104
Gowganda silver area... 6-25
Gersdorffite.
Coleman tp... 103
G. G. 3,541-42 silver locs., Donovan tp. *See* Wilder s. m.
G. G. 4,108 silver loc., N. of Irene l.
Diabase, photo... 14
G. G. 4,124-45 silver locs., Lady Isabel l. *See* Kell s. m.
G. G. 4,149 silver loc., Leith tp. *See* Silverado s. m.
G. G. 4,628 and 4,838 silver locs., S.W. of Wigwam l. *See* Haultain s.m.
Gilbert, G... 79

PAGE
Glacial and Recent. *See* Quaternary period.
Glacial striae.
Gowganda silver area..... 3
Glendinning, George..... 27
Gordon, M. B. R..... 102
Gowganda.
Rocks.....10, 12
of area W. of..... 17
Soil..... 3
Gowganda l.
Access to..... 2
Conglomerate, notes and photo.....11, 13
Diabase W. of.....15-19
Fault..... 18
Quartz porphyry N.E. of..... 9
Quartzite..... 11
Gowganda silver area.
Map, index.....*facing* 1
Report by Burrows.....1-77
Vein minerals, report by Todd.....62-78
Gowganda Keora silver m., Calcite l.
Developments; mill started..... 48
Granite.
Anima-Nipissing L. area. *See* Algoman formation.
Granite l..... 91
Gull l., Brigstocke tp., rocks..... 94

H

Haileyburian formation.
Anima-Nipissing L. area.....84, 89
Haines silver m., Charters tp.
Development; mineralization..... 57
Hanging-stone l.....6, 18, 61
Hansen, W. H..... 79
Hansen l..... 91
Harris l..... 96
Hart silver m., Nicol tp..... 17
Optioned to Tonopah Canadian Mines Co..... 41
Plan, surface; development..... 46
Haultain silver m., S.W. of Wigwam l.,.38, 39
Haultain tp.
Forest fires..... 3
Rocks.....7, 9, 15
Silver, high-grade ore..... 22
mining.....33-40
See also Bonsall s. m.
Hedlund, L. O. *See* Hedlund s. m.
Hedlund silver m., McLoughlin l.
Development; rocks..... 56
Hewitt silver m., W. of Gowganda l...17, 50
Hewitt Lake Mg. Co..... 50
H.F. 6 and 7 mineral locs., Coleman tp. *See* Crescent Silver Cobalt Mg. Co.
H.F. 209 silver loc., W. of Leroy l..... 10
H.F. 221-24 silver locs., Gowganda l. *See* Crews-McFarlan s. m.
H.F. 243-45 silver locs., N.E. of Burke l. *See* Cobalt Nugget s. m.
H.F. 250 silver loc., W. of Leroy l..... 10
Hints to prospectors.
Anima-Nipissing L. area.....97, 101
Gowganda silver area..... 22
H.J.B. 46 silver loc., E. of Gowganda l. 15
H.M. 7 and 8 mineral locs. *See* Crescent Silver Cobalt Mg. Co.
H.R. 292 silver loc., Gowganda l..... 18
H.R. 311 silver loc., W. of Obushkong l.. 13

PAGE
H.R. 439 silver loc., Charters tp. *See* Haines s. m.
H.R. 451 silver loc., Gowganda l..... 18
H.R. 458 silver loc., Van Hise tp. *See* Alpine s. m.
H.R. 499 silver loc., Lost l. *See* Wigwam s. m.
H.R. 715 silver loc., Leroy l. *See* Chapelle s. m.
H.R. 716 silver loc., S.E. of Leroy l.... 17
H.R. 720 silver loc., Donovan tp. *See* Duggan s. m.
H.S. 351, 363 silver locs., Haultain tp. *See* Capitol s. m.
H.S. 359 silver loc. *See* Crawford s. m.
H.S. 371 silver loc., Milner tp. *See* Boyd-Gordon s. m.
H.S. 451 silver loc., Gowganda l..... 18
H.S. 602 silver loc., Gowganda l..... 55
H.S. 695-96 and 716 silver locs., Leith tp. *See* Hudson Bay s. m.
H.S. 712 silver loc., S.E. of Flanagan l.. 13
H.S. 723-24 s. loc. *See* South Bay s. m.
H.S. 1,011 mineral loc., Pickerel l..... 100
Hudson Bay silver m., Leith tp.
Arsenides, notes and photo.....70, 71
Development..... 57
Huronian Belt silver m., Nicol tp.
Development; rocks..... 44
Hydraulic power. *See* Waterpower.
Hylands-Johnston-Gardner silver m., Nicol tp..... 44
Irene lake.....10, 14, 17
See also Barbara s. m.
Iron pyrites. *See* Northland pyrite m.

J

Jackpine.
Gowganda silver area..... 3
Jackpine l., rocks..... 89
James l.
Pyrite. *See* Northland pyrite m.
Rocks.....85, 88
porphyry, analysis..... 90
J.S. 61 and 73 mineral locs., Coleman tp. *See* Crescent Silver Cobalt Mg. Co.
J.S. 282 mineral loc., Milner tp. *See* Northcliff s. m.
Keewatin formation.
Anima-Nipissing L. area.....84-89
Gowganda silver area..... 6-9

K

Kell, Hugh..... 60
Kell silver m., Corkill tp.
Geology; explorations; cross-section..58-60
Kell silver m., Lady Isabel l.
Mineralization; rocks.....60, 61
Kennedy, H. G..... 32
Kennedy, Murray..... 38
Keweenawan formation.
Anima-Nipissing L. area.....84, 93, 94
Gowganda silver area..... 6
Kittson tp.
Lumbering..... 82
Recent deposits..... 94
Rocks.....80, 92
Klock tp.
Quartz veins in diabase..... 101

PAGE
Knight, C. W.....14, 83, 86, 104
Description by, of rocks on Cedar and Net lakes.....89, 90
Ko-Ko-Ko l.....85
Kreisman nickel claim, Pickerel l.....100

L

La Brick silver m., W. of Gowganda l...17
Lady Evelyn l.
Glacial drift.....95
Rocks.....81, 101
Lady Isabel l., Corkill tp.
Silver mg. *See* Kell s. m.
Lakes and streams.
Anima-Nipissing L. area.....80
Gowganda silver area, parallelism in..2
Lava.
Anima-Nipissing L. area.....85-88
Lawson tp.
Sand deposits.....3
Silver.....22
mining.....48, 49
See also Bishop, Gowganda Keora, Powerful and Sanderson m's.
Ledingham, J.....79
Leith tp.
Rocks.....8, 11
adinole.....13
Silver.....22
mining.....57
See also Hudson Bay s. m.; Silverado s. m.
Lenore l., rocks.....89, 97
Leroy l.
Calcite veins, N. of.....24
Diabase, notes and photo.....16-18
Silver mg. *See* Capitol, Chapelle, Coleroy, and Silver Bullion s. m's.
Leslie, H. T.....1
Little Dan mispickel m., rocks.....104
Little Eagle l.
Prospecting advisable.....101
L.M. 105 silver loc., Everett l.
Diabase sill, photo.....16
L.M. 108 silver loc., Haultain tp.....15, 20
L.O. 3 and 60 mineral locs., Coleman tp. *See* Crescent Silver Cobalt Mg. Co.
L.O. 161 mineral loc., Pickerel l.....100
L.O. 305 silver loc., Morel tp. *See* Bishop s. m., N.W. of Bloom l.
L.O. 316 silver loc., Lost l. *See* Wigwam s. m.
L.O. 357-58 silver locs. *See* Gowganda Keora s. m.
Löllingite.
Gowganda silver area.....65-77
photos.....70, 72
Symbol.....77
Long l., Milner tp.....17
Lost l., Haultain tp...10, 13, 15, 17, 19, 22
See also Wigwam s. m.
Lost (or Chambers) l.....81
Lumbering.
Kittson tp.....82
Lundy, S.....79

M

McIntosh, F.....49
McLaughlin, S.....49
McLean l., rocks near.....92, 97
McLennon Lumber Co.....82
McLoughlin l., Van Hise tp.....56
McNeill, W. K.....79
Mann, Robert.....5
Mann silver m., W. of Gowganda l.
Arsenides.....71
photo.....72
Diabase.....17, 22
Ore, high-grade, width.....24
shoots.....25
Production.....4
Veins, character.....23
system of, plan and section.....51, 52
Maple mt.....12
Maps.
Anima-Nipissing l., geological....*in pocket*
Gowganda silver area.
index.....*facing* 1
geological.....*in pocket*
key plan of mines.....26
Margueratt l., Milner tp.....17
Matabitchuan r.
Waters in valley, notes on.....82
Matachewan series.
Anima-Nipissing L. area.....84, 91
Gowganda silver area.....6, 10
Mattawapika r.
Falls, waterpower.....81
Mercury.
Gowganda silver ores.....79
Millcrest silver m., Haultain tp.
Calcite veins; development.....39, 40
Miller, W. G.....83
On origin of silver veins, Cobalt.....23
Miller creek.....25
Miller l.
Diabase.....14, 20
Keewatin rocks.....17
See also Millcrest s. m.
Miller Lake section.
Diabase.....20
economic importance.....22
structure.....15, 22
Ore shoots.....25
Vein filling, photos.....63, 77
Miller Lake and Everett Mines, Ltd.
Operations; shipment.....38
Production.....4, 5
Rocks on claim, Haultain tp.....15
Miller Lake O'Brien silver m.
Arsenides, notes and photo..64, 65, 68, 73
Description; history; developments and surface plan.....27, 28
Diabase.....19-22
Flow-sheet.....30
Ore, photo.....24
shoots.....25
Photo.....28
Production (1910-25).....4, 5
Section, projected.....32
Serpentine.....8
Veins, character.....23, 24
Waterpower plant.....6
Workings, plan of part.....31
Miller Lake O'Brien Co.
Bonsall m. worked by.....25-27
Millerett m. worked by.....27
Millerett silver m.
See also Miller Lake O'Brien s. m.
Conglomerate.....22
Ore shoot, size.....25
Production.....3, 4

PAGE

Milner tp.
Lava and greywacké....8, 11
Silver ore, high grade....22
mining....49-55
Mispickel.
Gowganda vein material....77
Strathy tp....104
Symbol....77
Montreal r.
Diabase (W. branch)....18
Waters in area, notes....81
Morel tp.
Silver....22
mining. *See* Bishop s. m., N. of Bloom l.
Mountain l.
Rocks....82, 85, 91
photos....98, 99
M.R. 2,239 silver loc., Leith tp. *See* O'Gorman s. m.
Muskego r., Lady Evelyn l.
Valley, character....81
Myrtle l.
Glacial striae....3
Greywacké....11

N

Natural resources.
Anima-Nipissing L. area....82
Net. l., rocks....82-99
Nicolite.
Coleman tp....103
Gowganda vein material....77
Symbol....77
Nicol tp.
See also Wilson l.
Forest fires....3
Rocks....7, 9, 11, 15
plan showing diabase dike....21
Silver ore, high grade....22
mining....40-49
Nipissing diabase.
Anima-Nipissing L. area....79-82, 93, 94
contact relationships....95, 99
veins in, notes and photo....100, 101
Gowganda silver area....13, 14
Noranda Mines, Ltd.
Option on shares in Plata Mines, Ltd. 44
Northcliff silver m., Gowganda l.
Development; veins....53
Northern Canada Power Co....38
Northland pyrite m., James l.
Description....104

O

Obushkong l.
Cobalt series....2, 12, 13
Diabase....19, 20
Serpentine near....8
O'Gorman silver mine, Leith tp.
Adinole....13
Olivine diabase.
Anima-Nipissing L. area. *See* Keweenawan formation.
Gowganda silver area....20
Ottawa Gowganda silver m., near Lost l., Haultain tp....38

P

P.B. 140 silver loc., S.E. of Leroy l.
Diabase, notes and photo....17, 18
Pentlandite, Coleman tp....104

PAGE

Pickerel l....94, 96
Nickel and silver prospecting....100
Plata Mines, Ltd....44
Poplar, Gowganda silver area....3
Powerful silver m., S.E. of Calcite l.
Production (1910)....5
Workings described....48, 49
Prospectors, hints to. *See* Hints to prospectors.
Pyrites. *See* Iron pyrites.

Q

Quartz diabase dikes.
Gowganda silver area....20
Quartz porphyry.
Anima-Nipissing L. area, notes and analyses....90
Gowganda silver area, notes....9
Quaternary period.
Anima-Nipissing L. area....94
Gowganda silver area....2, 3
Quinze r., waterpower....38

R

Rammelsbergite.
Gowganda silver area (?)....73
Red Squirrel l., rocks near....85
Reeve-Dobie silver m., Milner tp.
Feldspar in diabase....15
Ore, notes; ore shoots....25, 53
Production (1910-19)....5
Vein system, plan....54
Reid, J. A....32
Rickaby, H. C....1
Rogers, Geo. R....52, 53
Rogers, W. R....3
Rothwell, T. E....62, 79
R.S.C. 92 and 106 silver locs., N.W. of Miller l. *See* Castle s. m.
R.S.C. 135-36 silver locs., Leroy l. *See* Hart s. m.

S

Safflorite.
Gowganda silver area....65-68, 73-77
photos....70, 71
Symbol....77
Salmon.
Anima-Nipissing L. area....82
Scottish Nigeria Mg. Co....49
Serpentine.
Gowganda silver area in Keewatin....7
Serpentine l....8
Shallow l....96
Shanty l....15
Shaw, John....46
Silver.
Coleman tp. *See* Crescent Silver Cobalt Mg. Co.
Gowganda silver area....20-61
production....4, 5
veins....23
workings....25-61
Silver Bullion silver m., N.E. of Leroy l.
Ore, rich in Keewatin....22
Plan, surface....46
Report and section....46, 47
Silverado Mining Co.
Work by, in Leith and Charters tps.. 57

Skutterudite. PAGE
Gowganda silver area.....67-77
photos.....70, 72
Symbol..... 77
Smaltite.
Gowganda silver area, in vein material 77
Symbol..... 77
Smith, Leonard..... 44
South Bay, Gowganda..... 38
South Bay silver m., arsenides..... 69
South Bay Mining Co..... 65
South Bay Power Co.....6, 61
Spawning l.
Diabase..... 17
Greywacké ridge, S.W. of, altitude... 2
Spruce, Gowganda silver area..... 3
Strathy tp.
Prospecting advisable.....100, 101
Rocks.....82, 84-91, 98, 99
Striae. *See* Glacial striae.
Strong, Horace.....39, 47
Stuart l..... 17
Sturgeon r.
Waters in area of, notes on..... 81
Superficial deposits. *See* Quaternary period.
Symmes-Young silver m. *See* Capitol s. m.

T

T.C. 129 silver loc..... 18
T.C. 136 silver loc., Gowganda l. *See* Bishop s. m.
T.C. 141 silver loc., Gowganda l. *See* Hedlund s. m.
T.C. 156 silver loc., Myrtle l..... 11
T.C. 162 silver loc., near Gowganda.... 18
T.C. 204 and 315 silver locs., S.E. of Miller l. *See* Morrison s. m.
T.C. 418 silver loc., Donovan tp. *See* Duggan tp.
T.C. 458 silver loc., W. of Leroy l..... 10
T.C. 705, 706 mineral locs. *See* Kreisman nickel claim.
Temiskamite.
Coleroy s. m.; symbol.....76, 77
Thieving Bear l.....87, 99
Quartz vein in diabase, notes and photo.....100, 101
Thompson, E. J.....56, 62
Timagami l.
Rocks, volcanic..... 85
Timagami Forest Reserve.
See also Gowganda silver area.
Tourist traffic..... 82
Timber in Gowganda silver area..... 3
Todd, E. W.....1, 31
Report by, on Anima-Nipissing Lake area.....79-104
Report by, on Gowganda vein minerals.....62-78
Tonopah silver mine.
Arsenides..... 68
Diabase, argentiferous..... 22
Production (1925)..... 5
Vein structure, notes and photo.....63, 66
Tonopah Canadian Mines Co.
See also Hart, Morrison, and Walsh s. m's.
Claims optioned to.....41, 44
Topography.
Anima-Nipissing L. area..... 80
Gowganda silver area..... 2
Tourist traffic. PAGE
Anima-Nipissing L. area..... 82
T.R. 1,623 mineral loc., Strathy tp..... 104
T.R. 2,691 mineral loc., Strathy tp..... 87
T.R. 3,187 mineral loc., Strathy tp..... 104
Trethewey Silver Cobalt Mines, Ltd.
See also Castle-Trethewey s. m.
Castle s. m. worked by..... 40
Trout, grey.
Anima-Nipissing L. area..... 82
Trout l., Coleman tp.
Rocks near..... 92
Silver mg. *See* Crescent Silver Cobalt Mg. Co.
Tuff.
Banting tp., notes and analysis..... 88
Turner l., rocks..... 96

V

Van Hise tp.
Algoman rocks..... 9
Diabase ridge, altitude..... 2
Forest fires..... 3
Greywacké..... 11
Keewatin rocks..... 7
Silver..... 22
mining.....55, 56
Vegetables.
Gowganda village..... 3
Vein minerals.
Gowganda silver area, report by Todd.....62-78
Victoria Syndicate, Ltd.
Walsh s. m., worked by..... 43

W

Walker, Dr. T. L..... 76
Walsh silver m., Nicol tp.
See also Crown Reserve Mg. Co.; Tonopah Canadian Mines Co.
Report, section, and plan of workings 41-44
Walsh Mines, Limited..... 43
Walsh and Morrison. *See* Tonopah s. m.
Waterpower.
Gowganda silver area.....6, 61
W.D. 271 mispickel loc. *See* Big Dan mispickel m.
W.D. 961-64 silver locs., N.E. of Gowganda l. *See* Big Four s. m.
Whitewater l.
Prospecting..... 100
Rocks at and near.....92, 95, 97
Wigwam l., diabase..... 22
Wigwam silver m.
Development; vertical section..... 39
Production (1924)..... 5
Wilder, Frank..... 58
Wilder silver m., Donovan tp..... 58
Wilson l., Nicol tp.....9, 11, 13
W.J. 1 silver loc., Leroy l. *See* Silver Bullion s. m.
W.J. 6 and 13 silver locs., S. of Leroy l. 17
W.J. 7 silver loc., S.W. of Leroy l..... 8
W.J. 9 silver loc., Nicol tp. *See* Huronian Belt s. m.
Wright, D. G. H..... 87
W.S. 41 mineral loc., Pickerel l..... 100

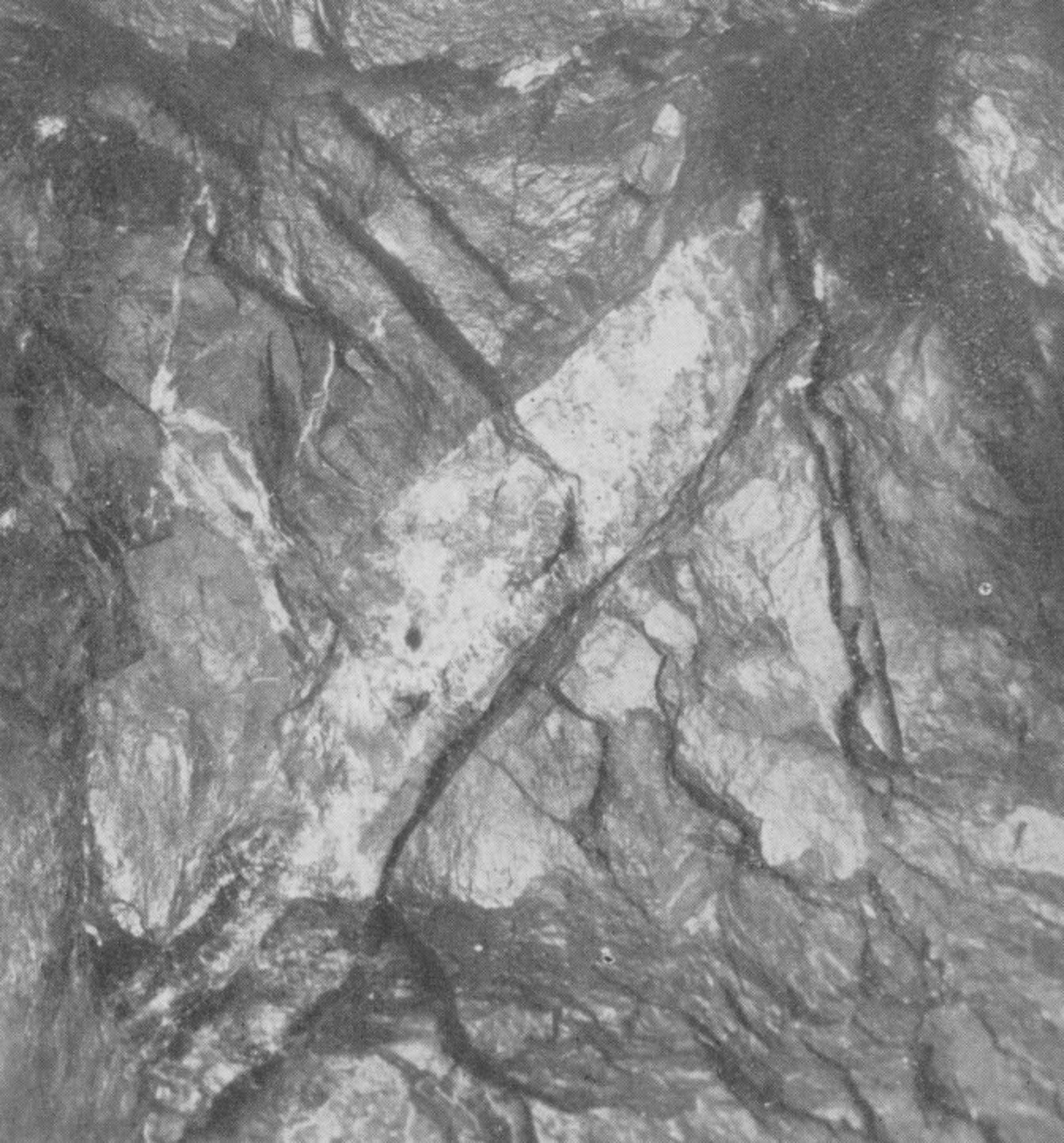
Y

Young, Horace G..... 38
Young Loon l., muskeg.....81, 95







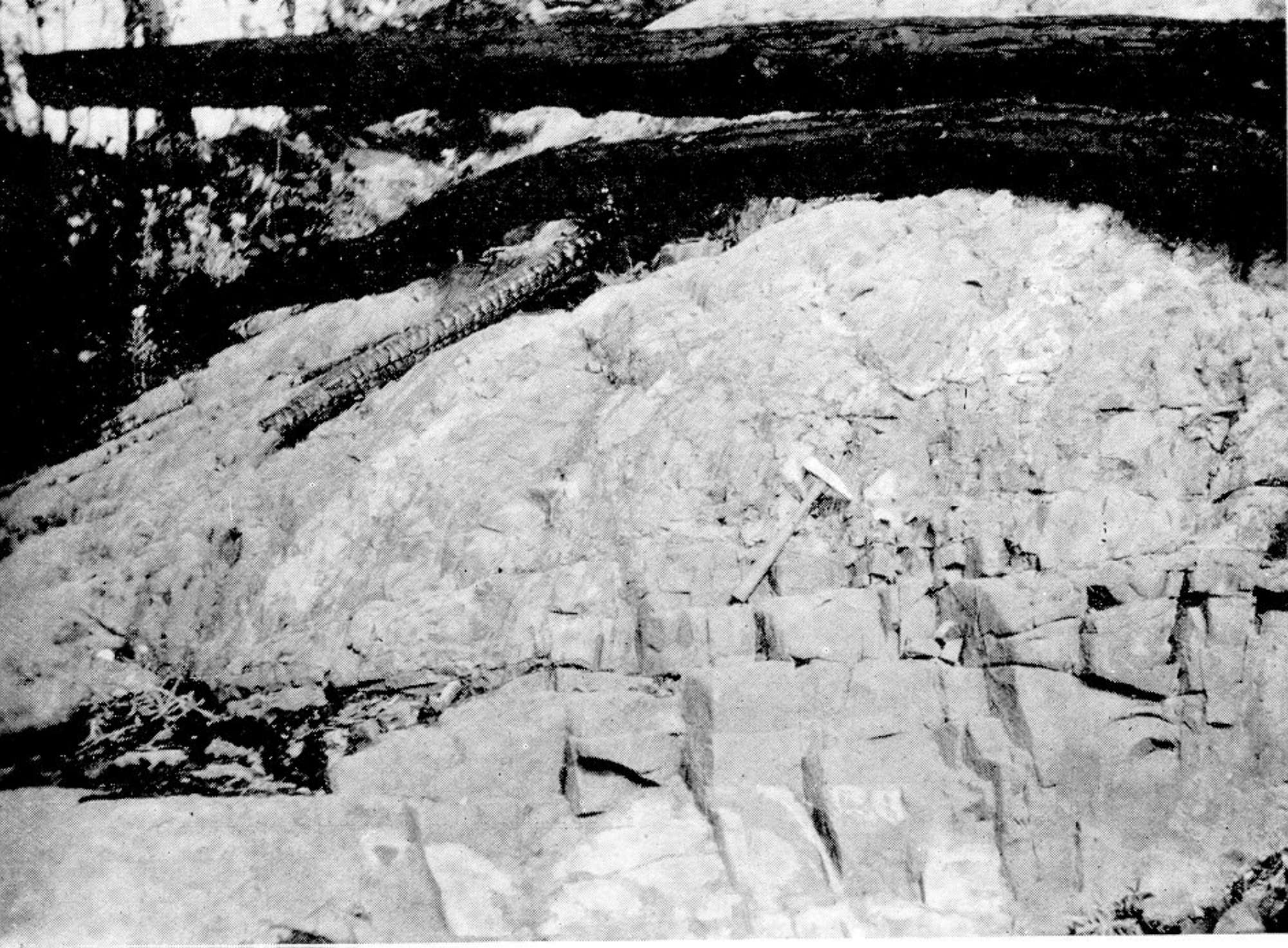






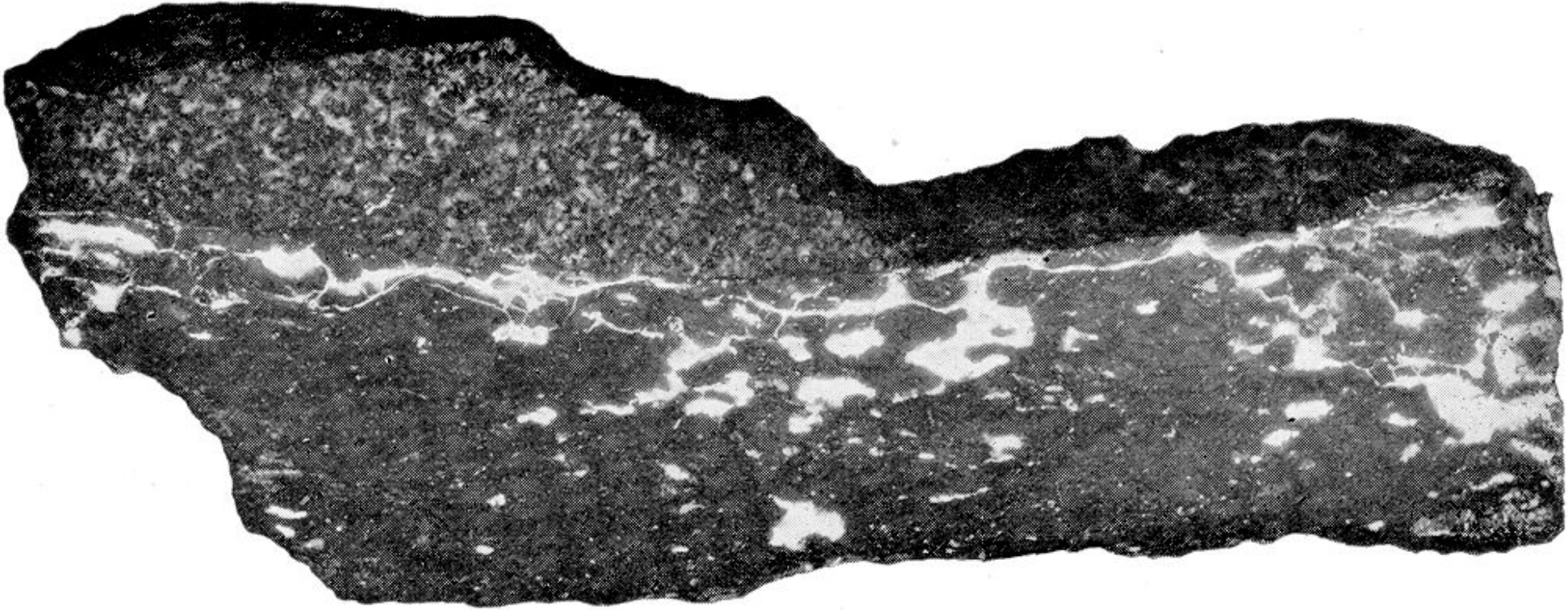


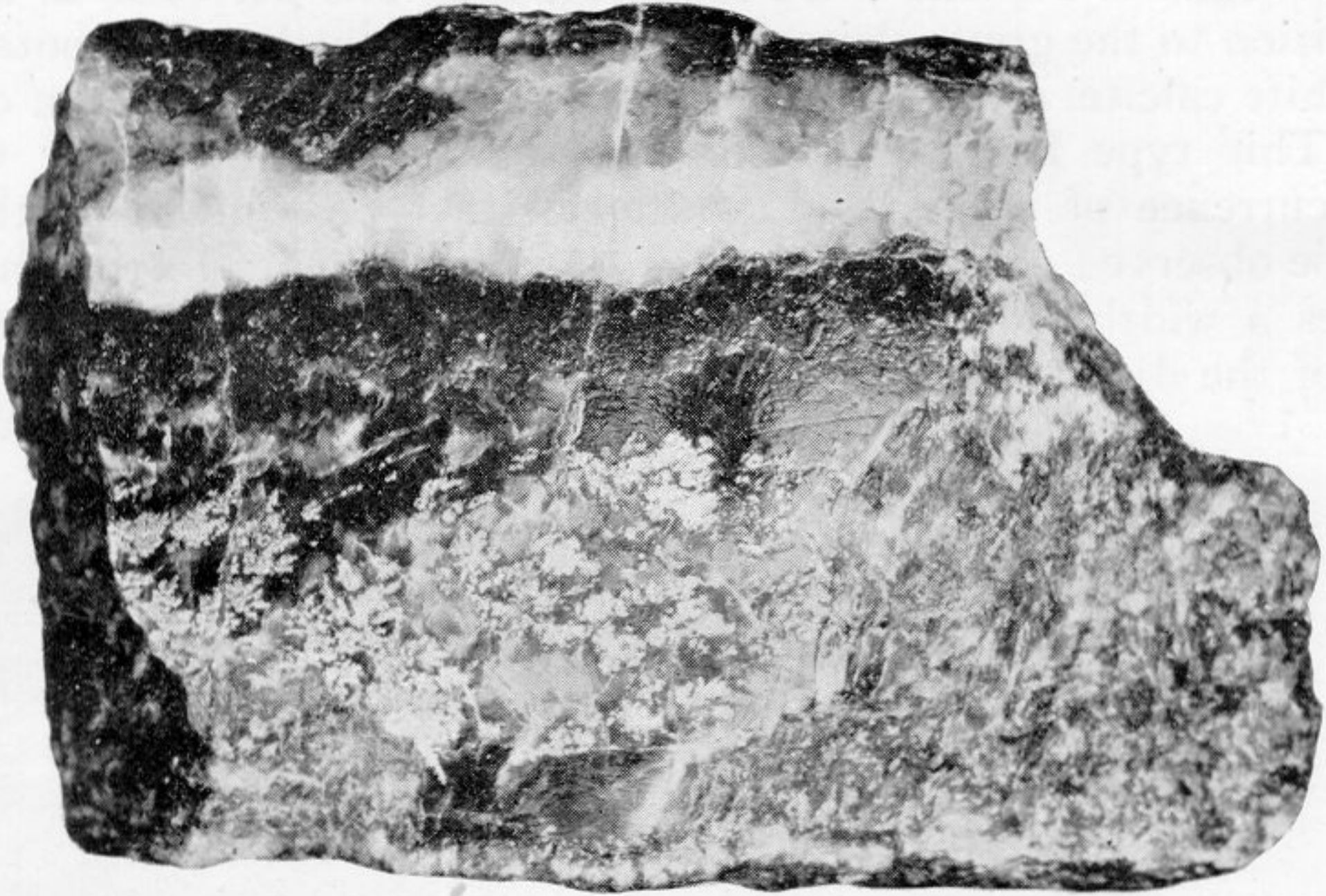




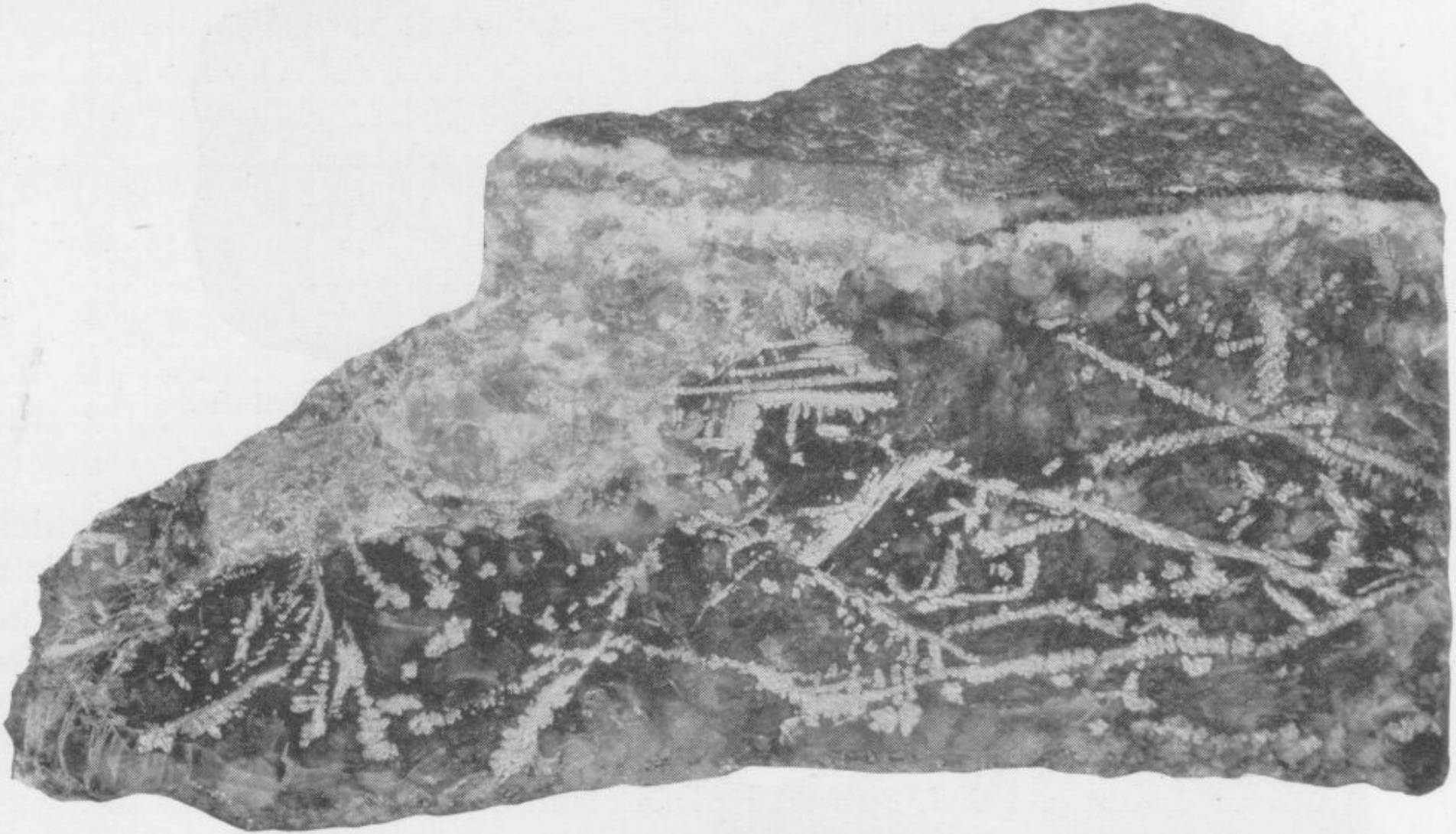


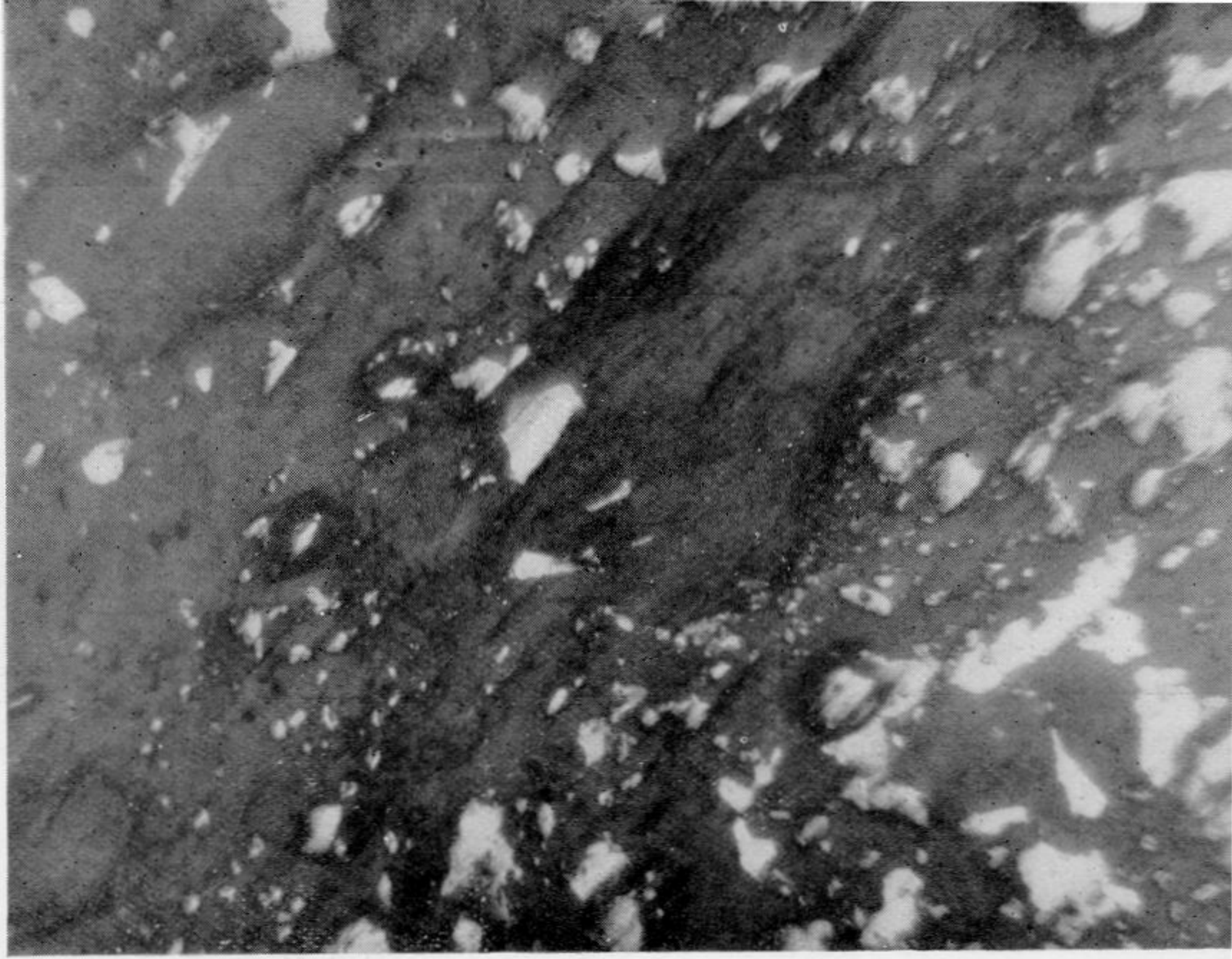


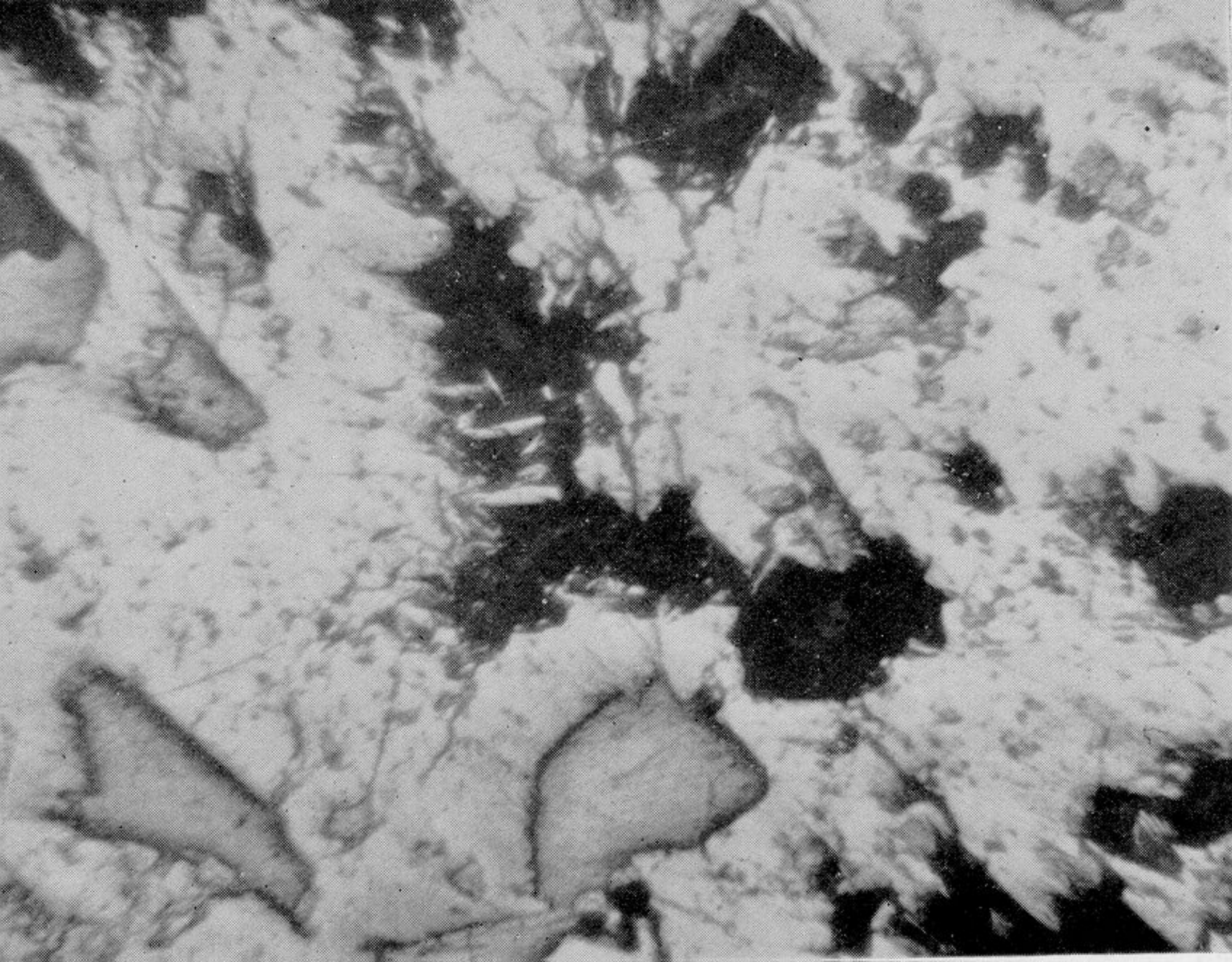


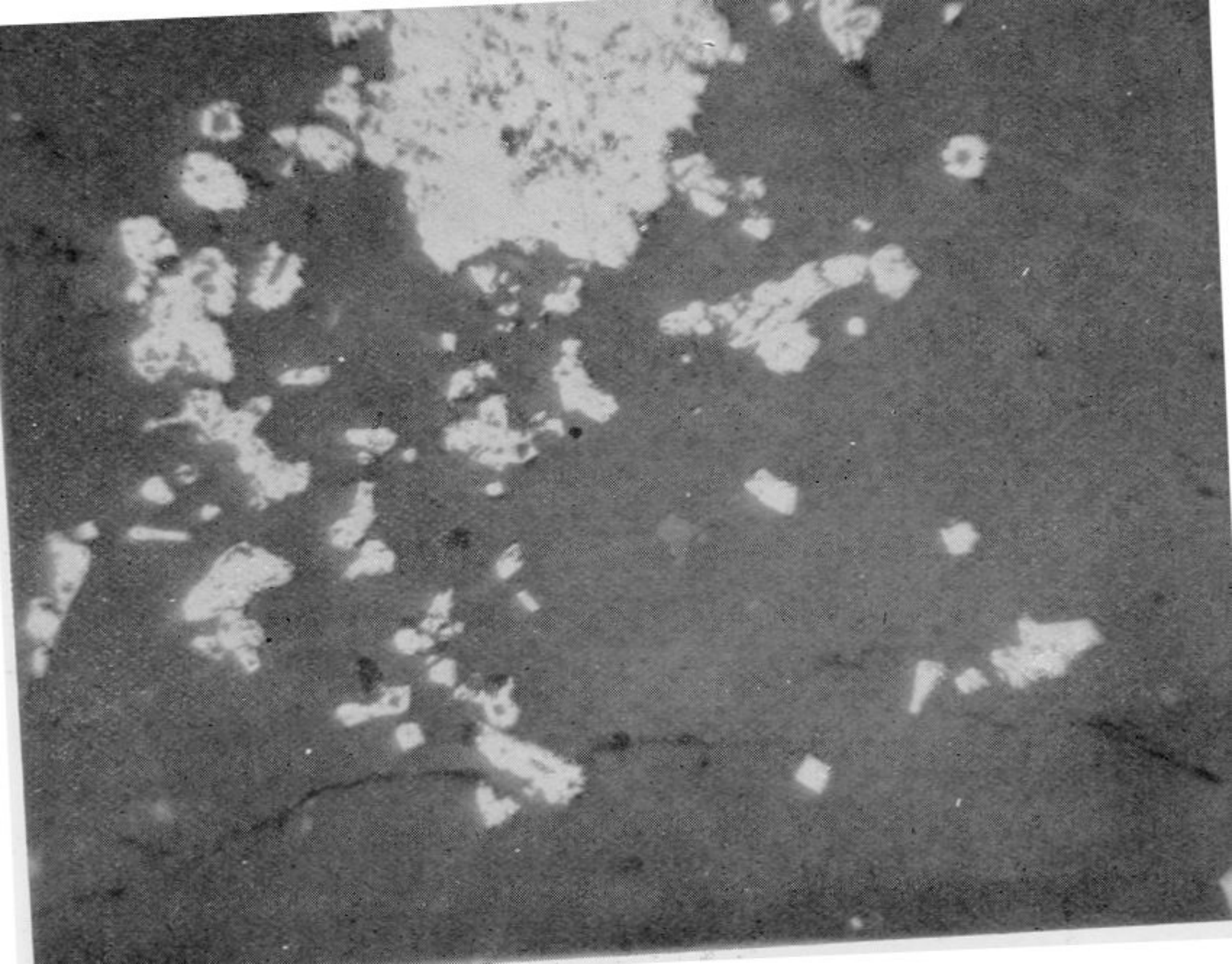


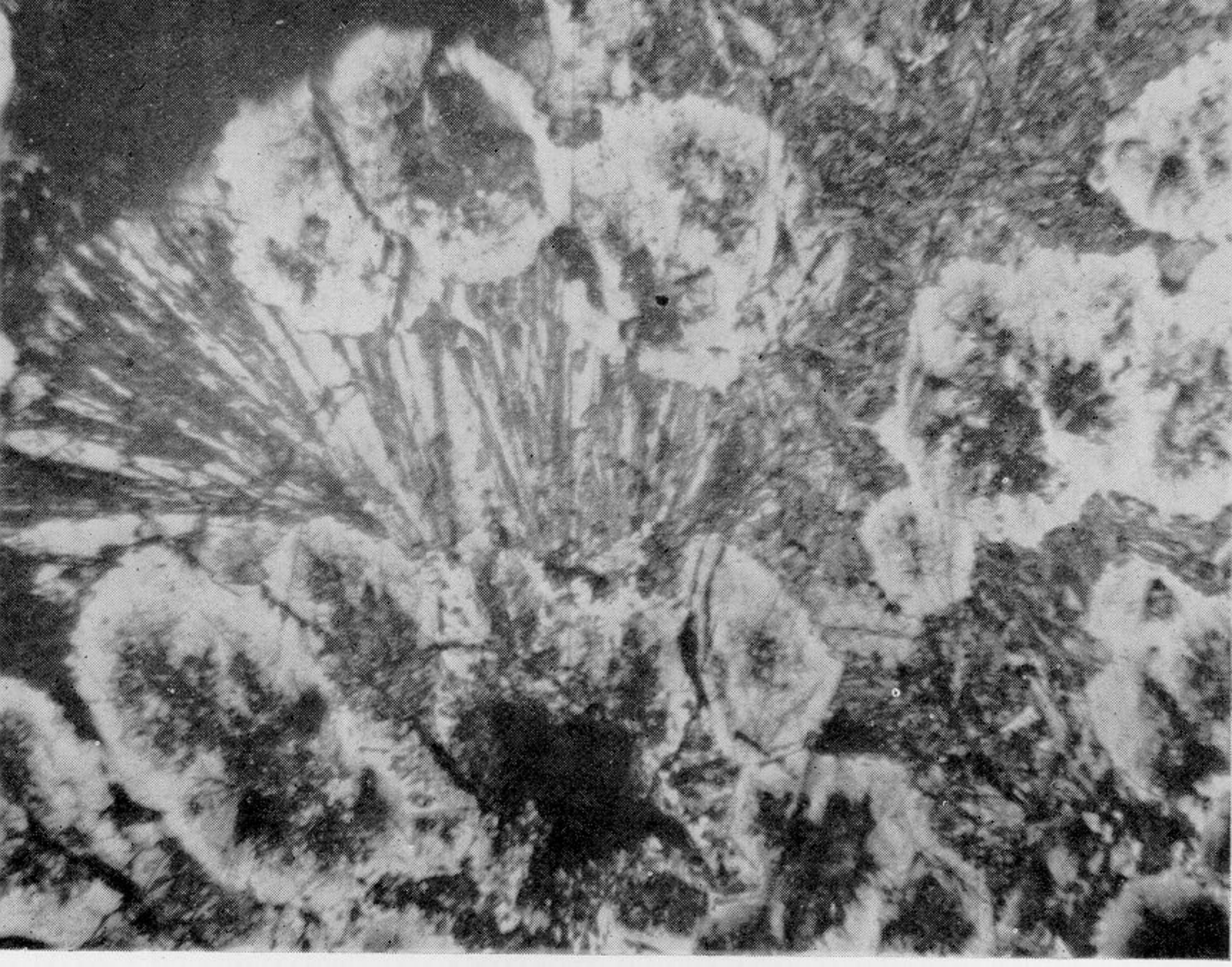




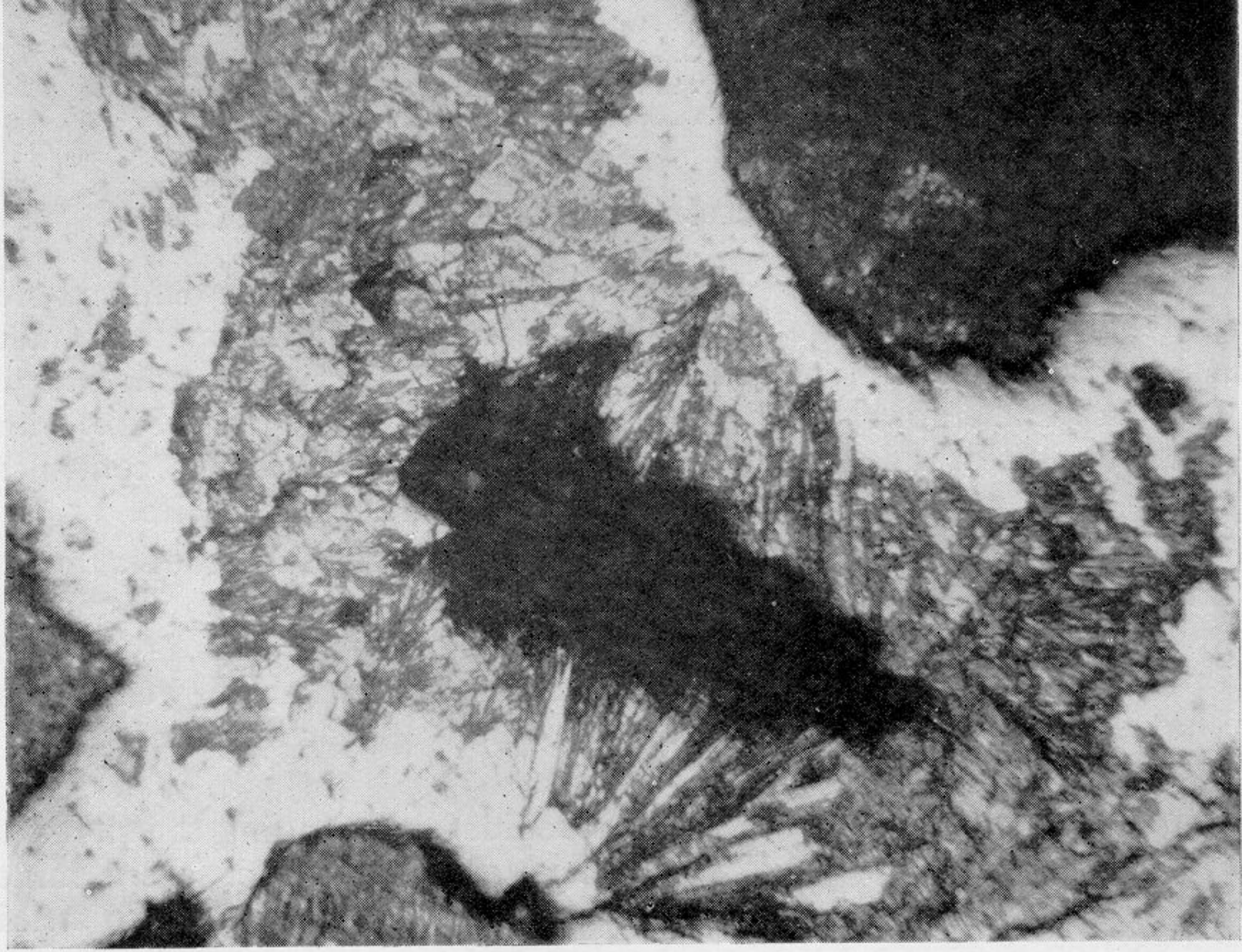


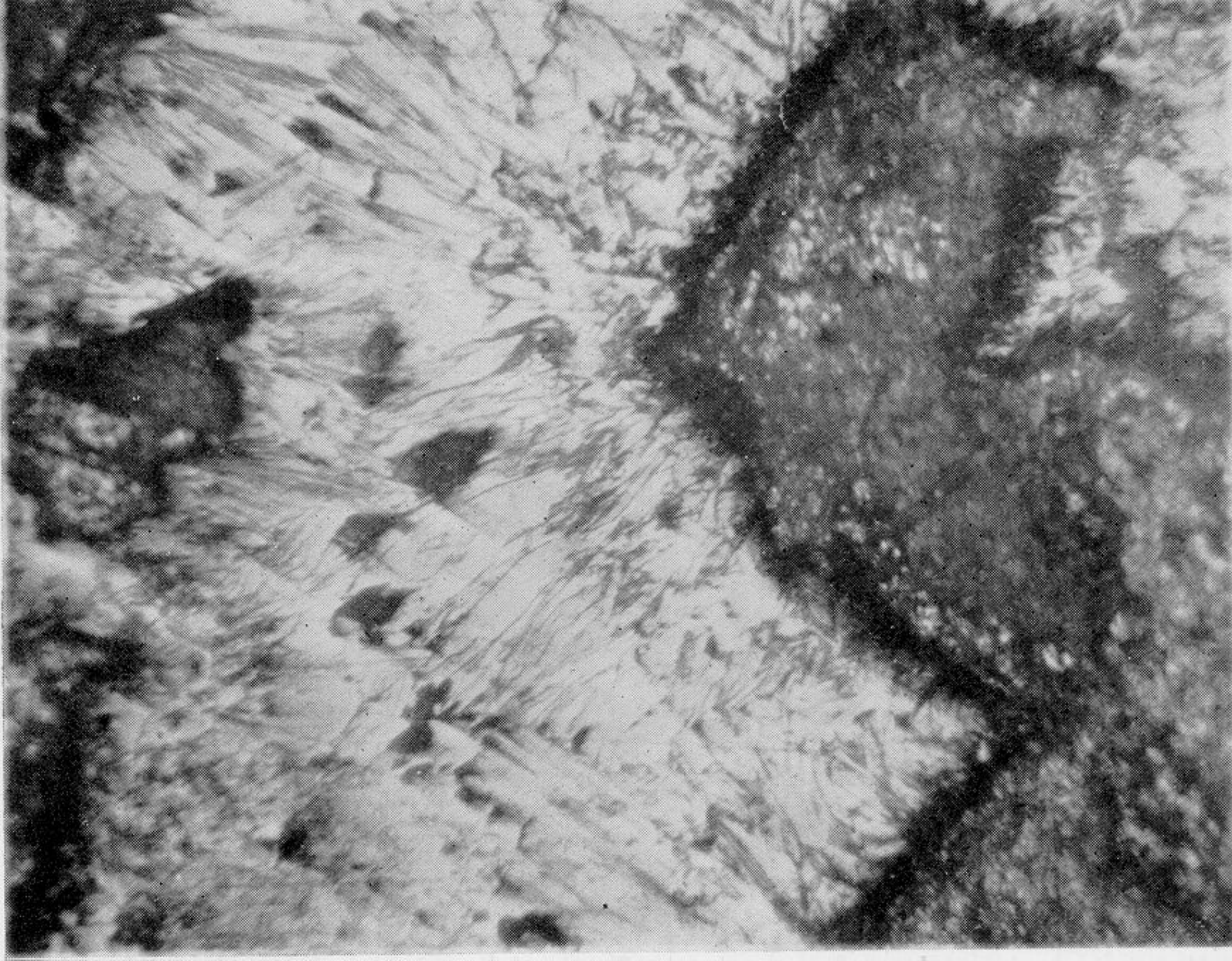


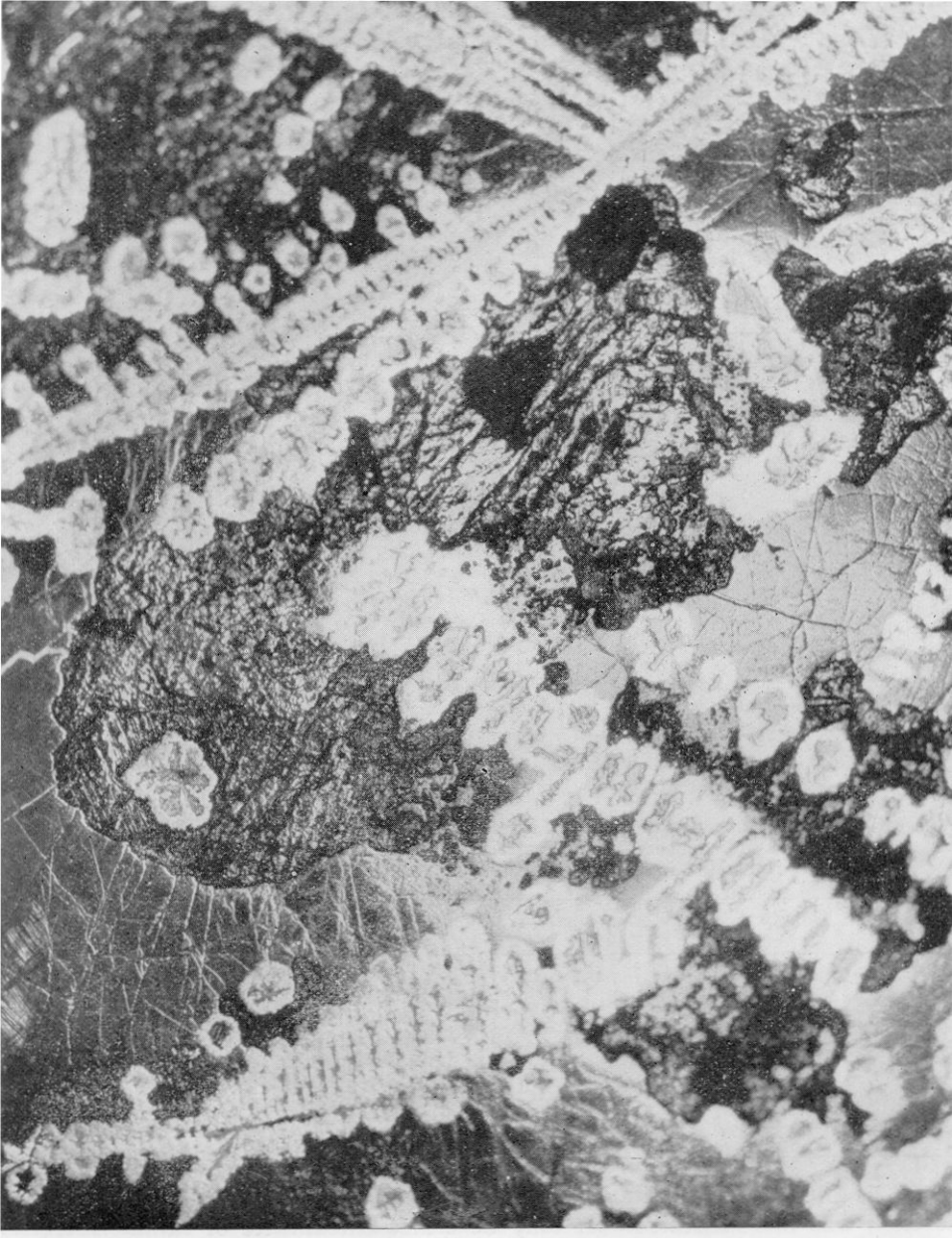
















PROVINCE OF ONTARIO
DEPARTMENT OF MINES

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

THIRTY-FIFTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXV, PART IV, 1925

Reconnaissance from Red Lake to Favourable Lake, District of Patricia

By

G. Vibert Douglas

APPENDIX: FAUNA AND FLORA

By

L. F. Kindle

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TABLE OF CONTENTS

Vol. XXXV, Part IV

	PAGE
Introduction	1
Acknowledgments	1
Previous Work	1
Methods	1
Topography	3
General Features	3
Glaciation	5
Table Showing Magnetic Declination and Dip, 1925	6
General Geology	6
Lithology	10
Structure	15
Economic Geology	17
Inhabitants	19
Saulteaux Indians at Pikangikum	19
Deer Lake Indians	21
Appendix: Fauna and Flora, by L. F. Kindle	22
Fish and Game	22
Birds and Smaller Animals	22
Molluscs	22
Trees	23
Plants	23
Table showing Occurrence of Some Plants and Animals between Lac Seul and Severn River, Summer, 1925	24

ILLUSTRATIONS

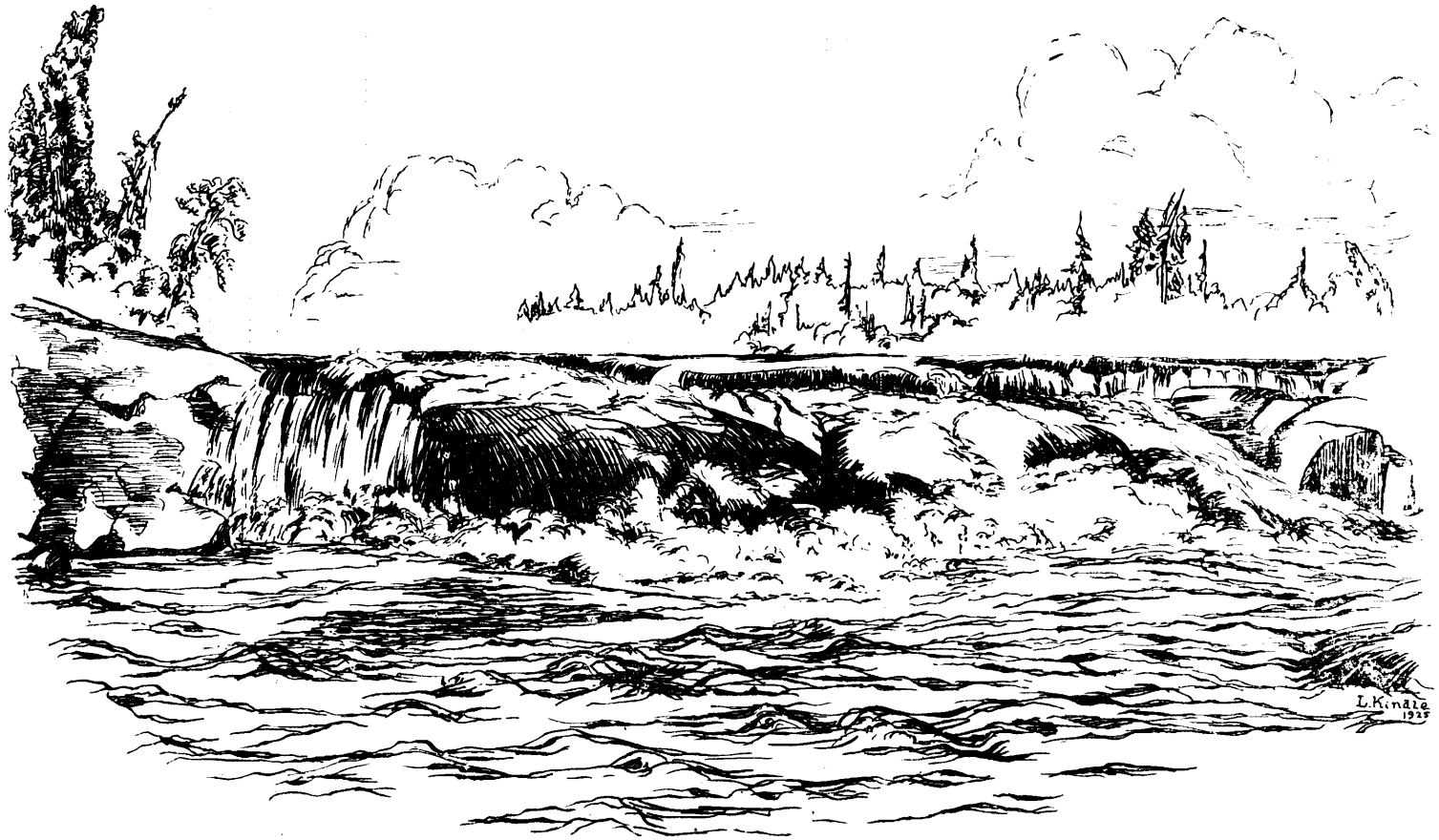
Falls on Crooked-mouth river	*facing* 1
Aeroplane photograph of Favourable lake	2
View of Borel lake, showing the two peneplain surfaces	3
Headland on small lake south of Deer lake	4
Inclusion of old sediments in granite at entrance to Pikangikum lake	8
Northern contact of granite and old sediments at Favourable lake	9
Two views of southern contact zone at Favourable lake	10
Typical *lit par lit* injection at Favourable lake	12
A *lit par lit* injection at Favourable lake	13
Foliated gneiss just south of Deer lake	14
Pikangikum Indian types (Saulteaux)	17
Saulteaux woman and child, Pikangikum lake	18
Saulteaux Indians, Pikangikum lake	18
The Indians' manner of showing respect for slain animals which happen to be their totems	19
The Utamin at Pikangikum lake, near the entrance of Berens river	20
Treaty Indians of the Deer Lake band	21
Potatoes at Pikangikum, July 30, 1925	23

DIAGRAMS

Comparison curves of magnetic dip and magnetic declination near the 94th meridian	7
Pegmatite cutting gneiss at the outlet of Valhalla lake	16
Pegmatite cutting gneiss between Valhalla lake and Odin lake	16
Plan showing the Utamin	20

COLOURED GEOLOGICAL MAPS
(in pocket at back of report)

Map No. 35*e*—Red Lake Gold Area, District of Patricia, Ontario. Scale, 2 miles to the inch.
Map. No. 35*f*—Reconnaissance, Red Lake to Favourable Lake, District of Patricia, Ontario. Scale, 4 miles to the inch.



Falls on the Crooked-mouth river.

Reconnaissance from Red Lake to Favourable Lake

(District of Patricia)

By G. Vibert Douglas

Introduction

The writer was instructed by Thos. W. Gibson, Deputy Minister of Mines for Ontario, to accompany J. W. Pierce, D.L.S., O.L.S., as geologist on a traverse of the water routes, which roughly parallel the 94th meridian west of Greenwich, from Red lake to Island lake. Owing to the short time that the writer could spend in the field, the geology was only mapped up to Favourable lake (about 53° N. lat.).

Acknowledgments

The writer was very ably assisted throughout the season by L. F. Kindle. Mr. Kindle showed great keenness, and the notes on conchology, fauna, and flora which appear as an Appendix to this report are the result of his work. The writer also wishes to thank Mr. Pierce for his assistance in many matters, and he is indebted to K. S. McCusker, D.L.S., for the opportunity of going with him to Onepine lake. To A. O. Gorman, D.L.S., he is indebted for the table of magnetic declinations, and to Professors R. A. Daly and E. S. Larsen for advice in the preparation of this report. The officers of the Hudson's Bay Company have been of the greatest assistance in many ways, and thanks are due to Messrs. Moar, Douglas, Paterson, and McIntosh.

Previous Work

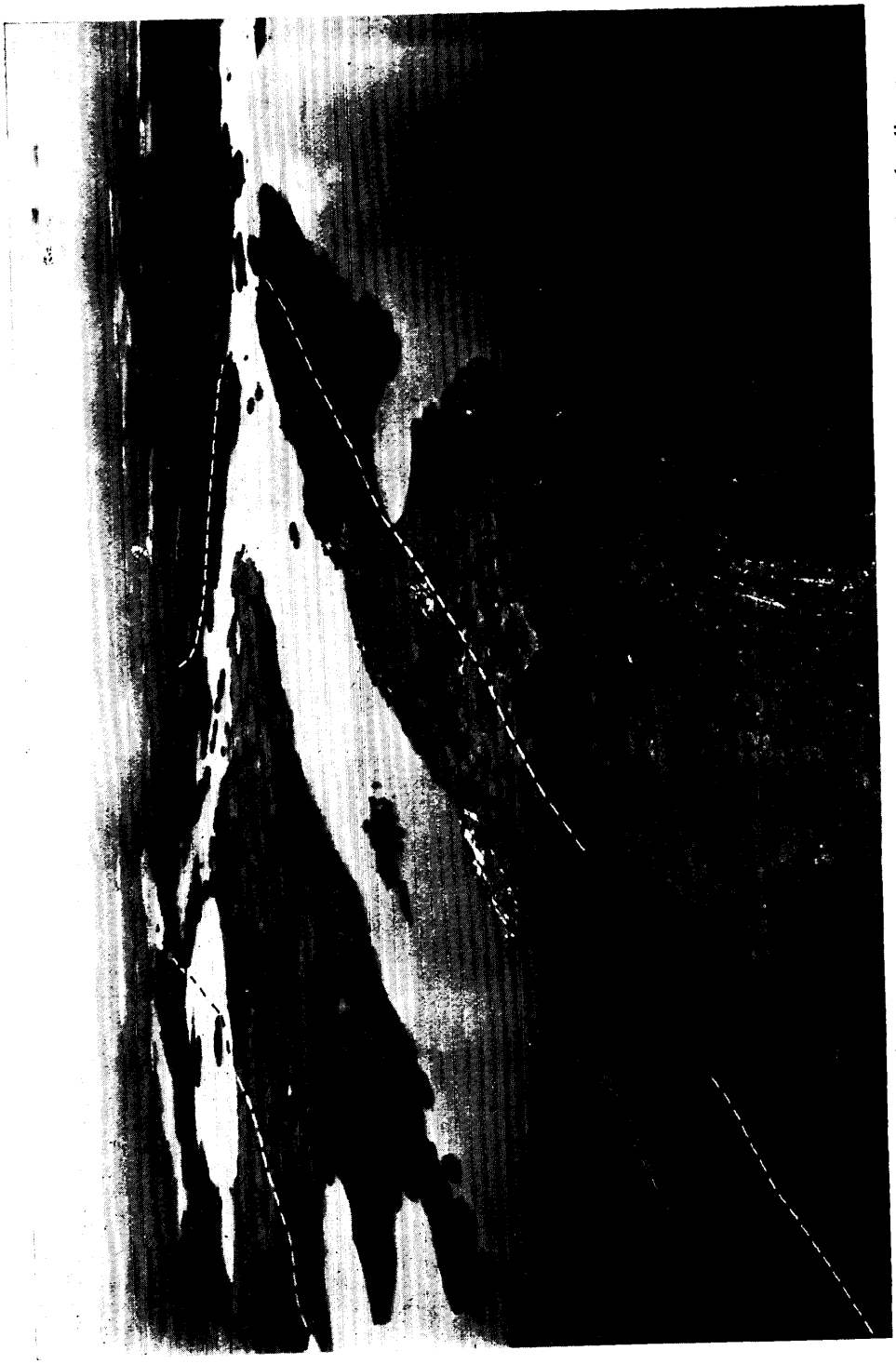
Earlier work in this area has been done by D. B. Dowling,[1] A. W. G. Wilson,[2] J. B. Tyrrell,[3] E. M. Burwash and H. C. Rickaby,[4] and E. L. Bruce.[5]

The work carried out by the writer was a northward extension of the Red Lake area mapped by Bruce[6] and includes some of the areas previously examined by the aforementioned authors.

Methods

The object of the Topographic Survey of Canada was to run a stadia traverse line across the area in order that a base might be established to govern the plotting of the aerial photographs of the district which had been taken by the Royal

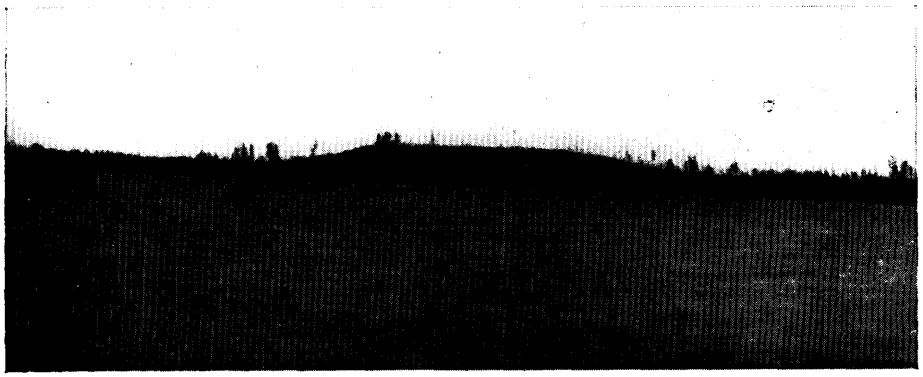
[1]Geol. Surv. Can., Vol. VII, pt. F, 1894.
[2]Geol. Surv. Can., No. 1006, 1911.
[3]Ont. Bur. Mines, Vol. XXII, pt. 1, 1913.
[4]Ont. Dept. Mines, Vol. XXXII, pt. 2, 1923.
[5]Ont. Dept. Mines, Vol. XXXIII, pt. 4, 1924.
[6]Maps Nos. 33*e* (Red Lake) and 33*f* (English River) accompanied the report by E. L. Bruce in Vol. XXXIII, pt. 4, 1924. As a result of the gold rush to Red Lake during the winter of 1925-26, a heavy demand arose for this report and the maps, with the result that the supply was soon exhausted. A new map of the Red Lake Area (No. 35*e*), embracing Bruce's geological work, but covering a larger area, was issued in the early spring of 1926 by the Ontario Department of Mines. It accompanied Bulletin No. 56, "District of Patricia, Red Lake and Adjacent Areas," prepared by W. R. Rogers, in which was given an outline of early and recent reports, means of access to Red Lake, and suggestions for prospector's outfit, together with a brief bibliography of geological reports on the district of Patricia issued by the Geological Survey of Canada and the Ontario Department of Mines. This bulletin was only of ephemeral interest, but it was thought advisable to place map No. 35*e* with Vol. XXXV, pt. 4, in order that it might find a permanent place among Ontario departmental publications. During the field season of 1926, E. L. Bruce and J. E. Hawley did further geological work in the vicinity of Red Lake, as a result of which a new report and map will be issued in 1927.



Aeroplane photograph of Favourable lake. The area between the dotted lines is underlain by ancient metamorphosed sediments.

Canadian Air Force. The system employed in taking the pictures and in plotting the map is described by J. W. Pierce in the Annual Report of the Association of Ontario Land Surveyors, 1925.

The map so plotted from an aerial photograph, on a scale of one mile to the inch, gives an outline of the lakes and rivers, and when this plot is connected by various ground measurements the result is a true map which is excellent for geological work in the field. It is highly advisable for the geologist to have the photographs themselves as well as the map for the following reasons: The photographs show where the outcrops of bare rock lie and they also show up in a striking manner features which are not obvious on the ground; for example, faults sometimes may be seen by lines running through a forested area. Again, the nature of the rock can sometimes be ascertained by the tint, but this should be carefully checked before any reliance is placed upon this evidence. The character of the timber is also indicated, poplar and birch showing light and conifers dark; brulé is easily recognized by its bareness.



View of Borel lake, showing the two peneplain surfaces, the difference of elevation here being 50 feet.

Topography

General Features

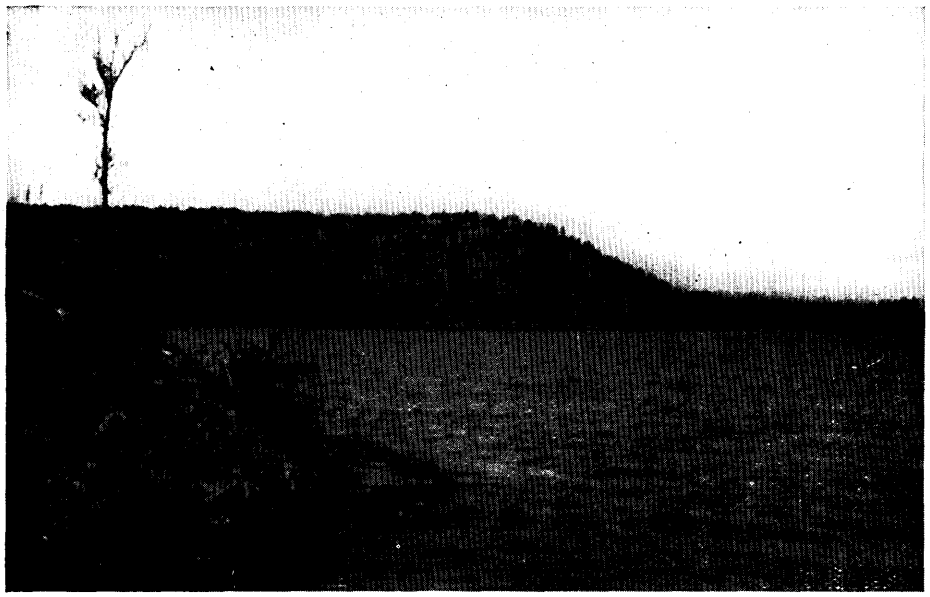
The area herein described lies between Red lake and Favourable lake along the line of the waterways which roughly parallel the 94th meridian in the district of Patricia. It can be reached by canoe from Hudson on the Canadian National railway or from Lake Winnipeg via the Berens river.

The area lies well north of the continental height of land and the river routes are broken by two divides, one at the headwaters of the Chukuni river, which drains into the English river and thence by the Winnipeg river to Lake Winnipeg. On the north side of this divide, the Dowling river takes the water to Pikangikum; thence it flows by the Berens river to Lake Winnipeg. The second divide lies at the head of the Crooked-mouth river and its chain of lakes. This river empties into Stout lake and thence joins the Berens river. The waters of the northern side flow into the Severn river, which itself runs into Hudson bay.

Innumerable lakes and streams and areas of muskeg are on either side of these main channels. It has been estimated that one-fifth of the total area is water. The area as a whole forms part of the great Laurentian plateau and has a fairly low relief. It is a land of ice-rounded hills, lakes, and streams. Flat

outwash sand-plains were seen in places; in other places, there are areas of moraine where sand and boulders have been left by the melting ice. Where the streams traverse an area covered by Pleistocene sand and clay, they meander and occasional ox-bow lakes of small dimensions are to be found. The streams usually build out deltas, which are being built up faster than they are being worn away, with the result that these meandering streams have very narrow mouths. This would indicate an old-age topography. However, where the streams are in solid rock, they run fairly straight from one reservoir to another. This type of drainage is by far the most common on the plateau: lake, stream, rapids, lake.

The courses of the streams are usually determined by structural weaknesses, such as glacial troughs or pre-glacial river courses. A few places were noted



Headland on small lake south of Deer lake (N. lat. 52° 34′).
The two peneplain surfaces are again seen.

where there is evidence that the river has cut a notch or channel to seek an outlet from some lake.

The valley of the Berens river presents features which are worthy of some comment. Below Pikangikum, the river has many branching arms—a dendritic or fern-like pattern such as one would expect to find in a mature valley system. This would point to such a valley on the western slopes of the northern protaxis which was carved into the hard rock during long geological periods. Possibly we have here a valley system which began in the early Paleozoic and had reached maturity before the Pleistocene ice sheet covered the land. The ice wore away a portion of the land area, leaving only the troughs of the valleys. There has been very little post-glacial erosion. It is doubtful if this area has ever been submerged since pre-Cambrian time; for, if it had, it would be reasonable to expect that some remnants of the formations which lie on the west side of Lake Winnipeg would be found on the north side of the arms and embayments of this old river system. So far no such outliers have been found.

Throughout the whole area it is possible to recognize two peneplain surfaces, the older peneplain and the present peneplain. Generally the older peneplain surface lies 50 to 100 feet above the present surface and is represented by the summits of the mounds of hard rock which can be seen in all directions and which have an accordance of elevation[1] (see photographs on pages 3 and 4).

These observations point to the fact that the amount of rock removed by the ice was not excessive. The surface of this area was lowered not by thousands of feet but by possibly less than one hundred feet.

Glaciation

Roches moutonnées or ice-rounded mounds with abrupt lee slopes and usually gentle stoss slopes are widely scattered. Sometimes it will be found that some of the steep hill faces are not on lee sides, but that the steep face has been polished by the ice, indicating a pre-ice cliff or line of weakness along which the ice moved. On the sides of some lakes, scratches or glacial striae will be seen on the face of a cliff inclined to the horizontal as much as 30 degrees, again indicating a pre-existing channel-way into which the ice moved. The glacial striae which were observed over the area covered by this report show that the ice moved in a general southwesterly direction.

A table of the observed directions of glacial striae is given below. Excellent examples of chatter marks were seen at Onepine lake.

GLACIAL STRIAE

Place	Astronomic azimuth (true)	Magnetic azimuth	Declination	Bearing
Little Vermilion lake, south end	237°	229°	8° E.	W. 41° S.
Little Vermilion lake, west end	237	229	8	W. 41° S.
Little Vermilion lake, north shore	238	230	8	W. 40° S.
Little Rathouse lake	237	230	7	W. 40° S.
Rathouse lake, east side	246	240	6	W. 30° S.
Odin lake	245	240	5	W. 30° S.
Pikangikum	231	224	7	S. 44° W.
Pikangikum	237	230	7	W. 40° S.
Onepine lake	241	235	6	W. 35° S.
Onepine lake, northern part	246	240	6	W. 30° S.
Herod (Kakakupp) lake	245	239	6	W. 31° S.
Old Shoes (Moose) lake	262	254	8	W. 16° S.
Favourable lake, entrance	228	220	8	S. 40° W.
Lemonade lake	234	226	8	W. 44° S.
Favourable lake, outlet	240	232	8	W. 38° S.
Favourable lake, east side	247	239	8	W. 31° S.

When the ice retreated, it left behind heaps of material in the form of moraines and also outwash sand-plains. The sand-plains are formed by the streams coming from the melting ice which carry the sand and gravel. These materials are spread out as a stratified deposit beyond the ice front. These outwash plains can generally be told at once by their flat surfaces, stratification, and absence of thick undergrowth.

In places, as on Little Vermilion lake and the lower reaches of the Dowling river, the sand-plains have clay and marl beds associated with them.

[1]A. W. G. Wilson, The Laurentian Peneplain, Jour. Geol., 1903, p. 615 *et seq.*

Table Showing Magnetic Declination and Dip, 1925

Place	Latitude	Longitude	Declination east[1]	Magnetic dip[2]
Lake (small)	50° 04′	93° 02′	6° 40′	.....
Wend portage	50 10	93 05	6 10	.....
Cedar lake	50 11	93 07	6 21	.....
Wabaskang lake	50 24	93 09	7 30	.....
Wabaskang lake	50 27	93 12	6 26	.....
Cedar river	50 30	93 14	6 49	.....
Junction English and Cedar rivers	50 35	93 23	7 01	.....
Pakwash lake	50 42	93 29	6 05	.....
Pakwash lake	50 46	93 27	6 17	.....
Chukuni river	50 53	93 29	5 38	.....
Chukuni river	50 55	93 34	5 56	.....
Keg lake	50 59	93 40	7 34	.....
Red lake	51 07	93 49	3 46	.....
Mouth of Chukuni river	51 10	93 46	7 16	.....
Chukuni river	51 10	93 47	7 33	.....
Little Vermilion lake	51 14	93 52	8 01	69° 15′
Rathouse lake	51 16	93 54	6 23	69
Chukuni river	51 20	94 03	6 14	68
Chukuni river	51 21	94 03	5 13	64
Lake (small)	51 24	94 04	6 54	72

feet. Dikes of pegmatite and aplite cut the granite rocks in all directions. The width of these dikes is usually less than a foot.

On the shores of Little Vermilion lake gneissoid granite is found, and except for the few inclusions, there is very little to be noted. The sand and marl at the northern narrows are of limited extent. The south end of the southwest arm of the lake is composed of a dark green schist (strike of the schistosity 301° true). This may prove to be an outlier of the Red Lake sediments.

Muskeg extends from Little Vermilion lake up to Rathouse lake where granitic rocks are exposed. An outwash sand-plain extends from Rathouse lake to the southern Odin lakes and westward to the second of the four small lakes on the route to Valhalla lake.

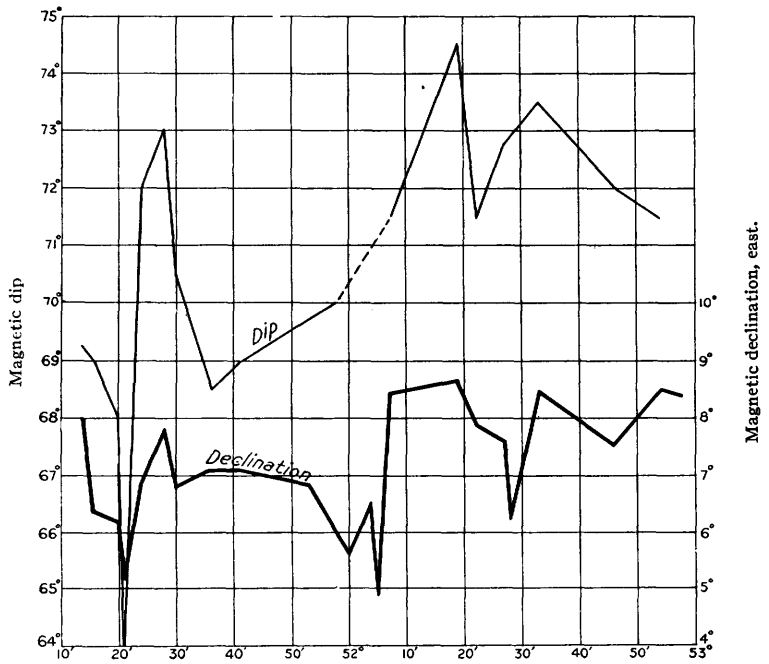


FIG. 1—Comparison curves of magnetic dip and magnetic declination taken at points near the 94th meridian between Red lake and Favourable lake.

At the outlet from Valhalla lake, there is an area of foliated gneiss which passes gradually into the surrounding granite. On the north side of Trough lake, there is a decidedly porphyritic phase of the granite. The feldspars are up to two inches in length, and the whole mass has a roughly gneissic structure. It is intruded by an aplite which traverses the porphyritic granite in all directions, producing little metamorphism. Veinlets of epidote are seen here, as elsewhere, cutting all the granitic rocks. The strike of the gneissic foliation is 346° true. The rock is somewhat exfoliated. The rock exposures about Odin lake are of the normal granite, except three small islets and a small area on the main shore in the northwest end of the lake, which are of green schist older than the granite. Across the divide on Borel lake, granite is found everywhere except on a small islet in the centre of the lake. The rock on the south side of this island is specially interesting. Xenoliths of a dark rock with a

poikilitic arrangement of feldspars in them are to be seen, held in a grey granite. The whole has been cut by pegmatite.

To the north of Borel lake, granite, gneiss and pegmatite with the earlier inclusions continue. To the east of the main river and beyond Elizabeth lake, there is a high ridge (100 feet) of rock, which has a steep cliff facing northwest. This face as well as the summit of the ridge is glaciated. The rock is a normal biotite granite cut by a very coarse pegmatite. The pegmatite occurs as flatly and steeply dipping dikes and also as segregated masses. It contains the coarsest potash feldspar seen in the area. Some of the crystals measured six inches. If more favourably situated, this feldspar would probably be worth quarrying. At the head of the falls on the Dowling river, about half way between Harding lake and Hornblendite lake, there is a small body of green schist. According to



Inclusion of old sediments (bottom) in granite (top) at entrance to Pikangikum lake.

Mr. Pierce, this extends a little way to the east. The granite is gneissic around this inclusion, which is probably an early sediment.

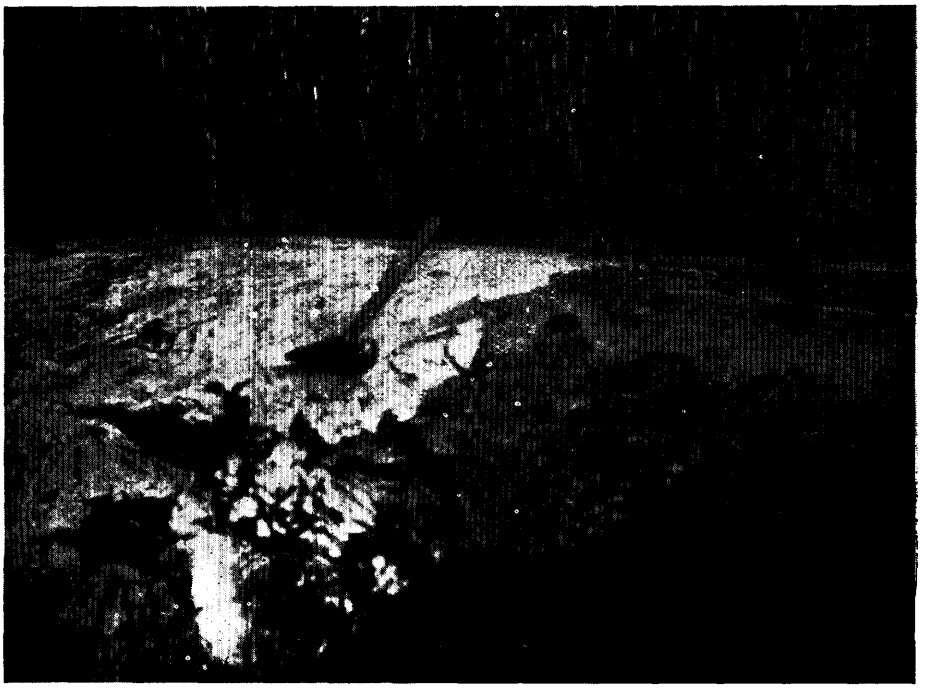
On the northwest shore of Hornblendite lake, there is a small mound of a hornblende rock which contains minute flakes of molybdenite as well as pyrites. The rock is probably a solution product of some earlier rock and the granite. The mound rises about 100 feet above the lake and has a width of 520 feet. The eastern contact runs in a northerly direction and is soon lost beneath the mantle of drift. In the opinion of the writer the slight mineralization observed here is of no economic value.

Between Hornblendite lake and Pikangikum, the rocks become more gneissic, but this change is so gradual that it is difficult to say which is granite and which is granite gneiss. In the Pikangikum area, the inclusions of earlier formations are more numerous and larger, some of them being up to 20 feet in length.

The shores of Pikangikum lake are low and rocky, but the land rises gradually from the lake to the general level of the plateau. Pleistocene clay is found on the point where the Indian reserve is situated. The Indians cultivate potatoes, carrots, and turnips. On July 30, 1925, the potatoes were two feet high and were in flower. From Pikangikum to Moar lake and from Stout lake to Favourable lake there is little variation. Gneissoid granite with inclusions and foliated granite gneiss are found on the rock outcrops which front the water routes.

From Moar lake to Onepine lake, gneissoid granite and porphyritic granite gneiss are exposed and present no features of special interest.

Favourable Lake.—This lake was the northern limit of our exploration during the summer of 1925 and presented by far the most interesting geological features

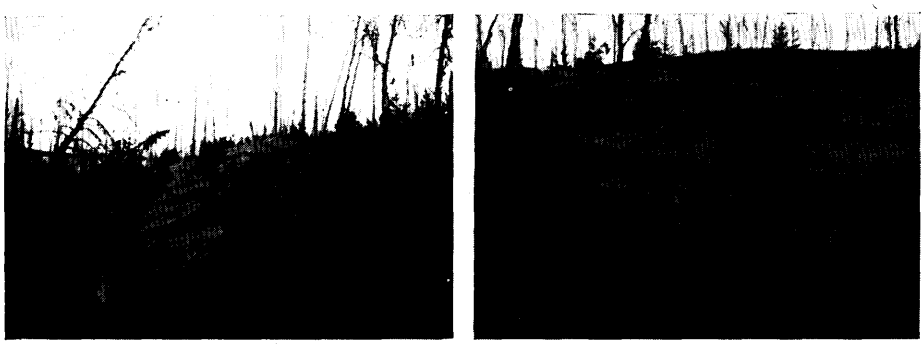


Northern contact of granite and old sediments at Favourable lake.

seen during the summer. Favourable lake evidently lies in a synclinal area, such as has been described by Bruce in his report on Red lake.[1] The syncline is occupied by much metamorphosed sediments which have been intruded by the granite magma. No volcanics were seen, but as our time was very limited these may have been overlooked. The width of the area occupied by the sediments is usually less than three miles. On map No. 1089, published by the Geological Survey of Canada in 1910, patches of these early rocks are shown as far east as the 90th meridian west of Greenwich on the same general northeasterly strike. The southern contact of these sediments runs along the narrow tongue of land which divides the lake into two long east-west troughs. The general strike of the contact is 133° true along this tongue. On the east side of this lake, the

[1]Geology of the Basin of Red Lake, Ont. Dept. Mines, Vol. XXXIII, pt. 4, 1924.

contact swings to the northeast and runs off with a general strike of about 91° true. The direction of both the schistosity and the foliation of the gneiss parallels this contact. Quartz veins slightly mineralized are found in the gneiss and also in the schist. There is one large barren quartz vein on the east shore of the lake in line with the tongue. The northeast arm of Favourable lake is dotted with islands, which have many interesting features. On one of the islands, which might be taken as typical, the schist was both silicified and carbonatized. Thin veinlets of calcite parallel the planes of schistosity. In places the carbonate is granular. Quartz veins about six inches in width cut across the schistosity as well as parallel it. One vein, in which there was both quartz and calcite, carried small radiating crystals of clinozoisite, a silicate of



Two views of southern contact zone at Favourable lake, showing long tongues of granite intruded into the schist.

calcium, aluminum, iron, and magnesium. No mineralization of economic importance was observed. As the granite contacts on either flank of the sediments are approached, the rock passes into a hornfels.

Lithology

Under this section will be found descriptions of some of the various rock types encountered in the area. As by far the most interesting rocks were found in the area about Favourable lake, most of the types are taken from that vicinity.

A specimen was taken of the rock which lies to the northwest of the northeast arm of Favourable lake, on the narrow strip of land between Favourable and Lemonade lakes. Megascopically the rock is a dense siliceous brown schist. In weathering, it leaves whitish quartz units which stand out, ***en échelon***, thus giving a rough surface. Microscopically the rock is composed principally of quartz with long streaks of biotite and a few individuals of orthoclase. The quartz grains show a little straining and occasionally are developed in biotite fragments. The rock appears to be a metamorphosed sediment, very probably an impure sandstone.

Another specimen was taken in the same area but to the west and about one hundred yards from the granite contact. Megascopically the rock has the same general appearance as the one just described, but the quartz crystals are so much smaller that there is not the roughness on the weathered surface which the other displays. The rock appears to be highly siliceous and breaks with a fairly smooth fracture. There appears to be a gradation from the schist described in the previous paragraph to the type seen in this specimen. This schistose

rock is composed of fine granular quartz, a pale green hornblende, augite, orthoclase, biotite, calcite, and magnetite. The quartz shows a little straining and is in layers, with the hornblende, augite, biotite, calcite, and magnetite forming the intervening layers. The orthoclase is associated with the quartz. Some of the quartz is secondary, as it forms small veinlets traversing older quartz grains. The calcite is later than the feldspar with which it is associated. The presence of the pyroxene, amphibole, and magnetite indicate contact-metamorphic effects.[1] Originally the rock was probably an impure sandstone.

Another specimen is typical of the dense, greyish-green hornfels on the east side of the northeast arm of Favourable lake. This horn-like rock weathers to a smooth surface and is quite brittle, giving an almost conchoidal fracture. It has been thermally metamorphosed so completely that the schistosity is barely apparent. Microscopically the rock is composed of albite, quartz, orthoclase, muscovite, calcite, and hornblende. The albite, which is the most abundant constituent, is altered, and secondary muscovite has been developed. The orthoclase is fairly free from alteration and is in small grains. The calcite is chiefly interstitial. The hornblende is green in colour and scattered throughout the section in small crystals. There are a few plates of muscovite which seem to be original, that is, are not developed from the alteration of the albite; some of these plates are now changed to chlorite. The rock might be called an albitized hornfels; that is, it was originally an impure sandstone or sandy shale which has suffered intense metamorphism with the addition of feldspar.

An examination was made of a representative specimen of a rock which is found intimately associated with the granite gneiss on the tongue of land which divides Favourable lake into the two long east-west expanses. Tongues of granite of various sizes have penetrated the mass so minutely that the veins and veinlets may range from many feet to a small fraction of an inch in width from wall to wall. Megascopically the typical rock has a dark greenish colour. Hornblende can be distinguished by the unaided eye. A microscopic examination reveals the presence of hornblende, zoisite, sphene, orthoclase, quartz, albite, and limonite. The hornblende is greenish to bluish green and is altered in places to zoisite. The zoisite is evidently later and appears to fill in around the earlier minerals and to cut across the rock in small veinlets. One grain shows very clearly the albite in process of alteration to zoisite, and the same may be said of the orthoclase. It is possible that this alteration to zoisite is due to the action of albite and orthoclase, in solution, with the existing hornblende in the rock.[2] In this case there would be a loss of soda and potash, for there appears to be little if any paragonite or other mineral containing soda and potash present. The rock at present might be termed an amphibolite and is probably a very highly altered sediment.

A specimen was taken at the west end on the north side of the long tongue of land in Favourable lake. The rock has a granitic appearance, with a definite streakiness, which parallels the schistosity of the original rock, such as is described in the preceding paragraph. The layers or streaks are chiefly alternate layers of feldspar and quartz. In some of the layers there are little red garnets. Very minute plates of biotite may be seen with a lens. A microscopic examination shows that the following minerals are present: potash feldspar, plagioclase feldspar, probably albite, quartz, biotite, zoisite, and a little iron ore. The association is as follows: a layer of clear quartz grains, which show very little straining; a layer of large potash feldspars; then a fine-grained layer composed of

[1] J. P. Iddings, Rock Minerals, 1911, p. 315.
[2] F. W. Clarke, Data of Geochemistry, U.S. Geol. Surv., Bull. No. 770, p. 595.

potash feldspar, albite, and quartz. The mica and iron ore occur in between these various layers. The zoisite is with the finer grained layers. Some of the potash feldspars may be microcline and some of it is orthoclase. In the opinion of the writer, this rock indicates an injection of the kind known as *lit par lit*. It is very similar in appearance to some material from Pala, California, shown to the writer by Professor E. S. Larsen. This has been described by W. T. Schaller in the American Journal of Science, 1925.

A rock which is typical of the gneissoid granite found in the Pikangikum area was sampled. To the unaided eye the rock shows a gneissic structure in one direction; in a direction normal to this one, it appears to be an ordinary granite. The colour is predominantly light pinkish. The minerals to be seen



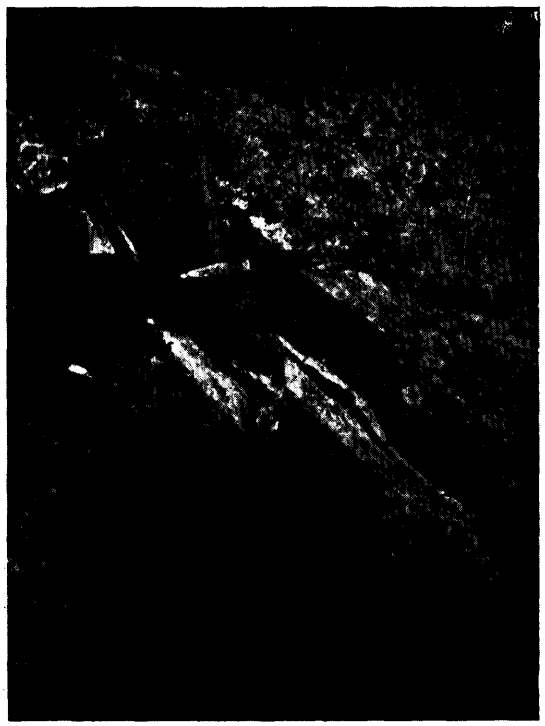
Typical *lit par lit* injection at Favourable lake.

are quartz, feldspar, and mica. Under the microscope are seen the following minerals: orthoclase, microcline, quartz, a plagioclase feldspar which may be as basic as andesine, biotite, pleonaste, hornblende, garnet, and iron ore. The feldspars are slightly kaolinized. Some of the quartz appears to be fractured. The other minerals are in lesser amounts and are fresh.

A specimen was also taken of the gneissoid granite which is encountered on the Chukuni river south of Little Vermilion lake, but which has undergone very little change throughout the area to the north. Near Pikangikum, the gneissic structure is better developed, but the rock is essentially the same. Megascopically the rock is identical with that described in the preceding paragraph. Microscopically a thin slice of this rock shows potash feldspar, a zoned plagioclase, quartz, biotite, and hornblende. There is a little epidote, which is

apparently later and was seen in the field as fine veinlets traversing the granites and gneisses. There are also small patches of micropegmatite or a graphic intergrowth of quartz and orthoclase. The feldspars are slightly altered, but the rock is quite fresh on the whole. It is probably more basic than a true granite and might be termed a granodiorite, but as the older writers have referred to it as granite, their terminology will be adhered to.

Thin sections were not made of the various included bodies which have been mentioned; but as they so closely resembled the sediments herein described, it is probable that they are somewhat akin.



A *lit par lit* injection at Favourable lake. Note small post-granite fault below the hammer.

The foliated gneiss is seen at various places: at the outlet of Valhalla lake, on the Berens river between Pikangikum and Poplar hill, and on a small lake just south of Deer lake. Rocks of this character have been described by many authorities.

J. J. H. Teall in describing the Lewisian gneisses of the northwest Highlands of Scotland suggests four modes of origin:[1] (1) a foliated granite, (2) a granite modified by dynamic action, (3) a gneissoid complex, (4) a metamorphosed grit.

F. D. Adams in a report of the fundamental gneiss of Logan in the Laurentian uplands north of Montreal ascribes a dynamic origin to these gneisses.[2]

[1]Memoir of the Geological Survey of Great Britain, The Geological Structure of the North-West Highlands of Scotland, p. 65. *See also* W. G. Miller, A Geological Trip in Scotland, Ont. Bur. Mines, Vol. XX, pt. 1, p. 259.

[2]Report on the Geology of a Portion of the Laurentian Area Lying to the North of the Island of Montreal, Geol. Surv. Can., Vol. VIII, pt. J, 1895.

C. N. Fenner has contributed a paper on "The Mode of Formation of Certain Gneisses in the Highlands of New Jersey."[1] In the opinion of the present writer, the ideas presented by Fenner are of the utmost importance and are applicable to these foliated gneisses found in the district of Patricia. Following the work of Michel-Lévy, Lacroix, and Sederholm, Fenner believes that these gneisses are the result of *lit par lit* injection. He writes: "The advance of the main body of magma was preceded by that of a more attenuated portion, which was probably similar in composition to that of the main body but characterized by the presence of a large percentage of volatile ingredients." At Valhalla lake, the foliated gneiss passed gradually into granite. At Favourable lake,



Foliated gneiss just south of Deer lake. It is thought that this structure represents the end product of *lit par lit* injection.

the foliation of the gneiss paralleled the strike and contact of the older schists. It has also been shown that near the granitegneiss the schists have been intensely metamorphosed and that there has probably been an addition of material. Many small inclusions of schist seen in the area have been replaced by granitic material, and what is now seen is a small mass of schist which passes into gneiss and then into the gneissoid granite. The gneissoid granite has probably developed its structure by its own movement, but whenever this gneissic foliation becomes more pronounced, so that there is a definite layering, then the layer is due to the replacement of some pre-existing structure. The illustrations shown on pages 10, 12, 13, and 14 bear a marked similarity to those from New Jersey in Fenner's paper.

[1]Jour. Geol., Vol. XXII, 1914.

In a personal conversation which the writer had with Arthur Keith of the United States Geological Survey, Mr. Keith said that he believed that some of the gneisses of the Adirondacks were formed by the processes described by Fenner.

Furthermore, the present writer believes that these gneisses cannot be the result of dynamic metamorphism, for the following reasons: (1) In the same area both gneissic and non-gneissic rocks occur, and they are gradational. (2) Small dikes of pegmatite and aplite are common to the gneissic and non-gneissic rocks. These dikes are fresh and, as will be shown in the next section, are in the same position now as when they were injected.

Structure

Two synclinal areas, one through Red lake and the other through Favourable lake, are the main structural features of the region. The strike and dip of the gneissic foliation and schistosity is given in the accompanying table.

STRIKE AND DIP OF THE GNEISSIC FOLIATION AND SCHISTOSITY OBSERVED AT VARIOUS PLACES

Location and rock	Strike (true)	Dip
1½ miles east from Hudson, C.N.R.—mica schist	68°	73° N.
At Northpines mine—schist	19	54 N.
Southwest arm of Little Vermilion lake—green schist	121	90
Trough lake, west of Chukuni river—gneiss	165	90
Outlet of Valhalla lake—foliated gneiss	145	90
Lake south of Odin lake—gneiss	148	90
Upper Elizabeth lake—gneiss	130	90
At south entrance to Pikangikum—schist	122	15 N.
West side Pikangikum—gneiss	182	40 W.
Above Poplar hill on Berens river—gneiss	128	85 S.
Herod lake—gneiss	131	90
On Crooked-mouth river above Old Shoes lake—inclusion of green schist	118	47 S.
Crooked-mouth river—gneiss	144	90
Onepine lake—gneiss	146	90
Southeast end of Lemonade lake—green schist	98	90
East side Lemonade lake near portage—green schist	91	90
Outlet Favourable lake—green schist	122	90
At west end of Favourable lake—green schist	119	90
Same locality, nearer lake—green schist	141	90
On north side great tongue, Favourable lake—green schist	133	70-90 N.
On island, northeast arm Favourable lake—green schist	63	90

It will be seen that throughout this area there is a tendency to a similarity of strike. When the foliation is due to the replacement of small bodies, there may be local differences in the general strike. The porphyritic phases which have been mentioned and also the phenomena shown on the island in Borel lake, which has been described, indicate that throughout the area we are near the surface of the granitic magma when it came to rest and cooled.[1] This fact may account for the general plateau which has been described under topography; for it is difficult to imagine that there has been much erosion in an area in which the rocks are so hard that chatter marks and striae have not yet been removed from the polished surfaces since the withdrawal of the Pleistocene ice sheet, and therefore the present surface is a peneplain because the upper contact of the granite with its veneer of sediments was fairly even.

[1]Petrology of the Alkali-Granites and Porphyries of Quincy and the Blue Hills, Proc. Amer. Acad. Arts and Sciences, Vol. XLIX, No. 5, Sept., 1913, p. 203 *et seq.*

Throughout the area, common to all the phases of the granite we find pegmatite dikes, usually a few inches in width, rarely up to six feet. Wherever these were inclined, as shown in Fig. 2, the coarser crystallization was found against the hanging wall. Where the dip was vertical, the coarser crystallization was in the centre (see Fig. 3). The coarser texture is usually attributed

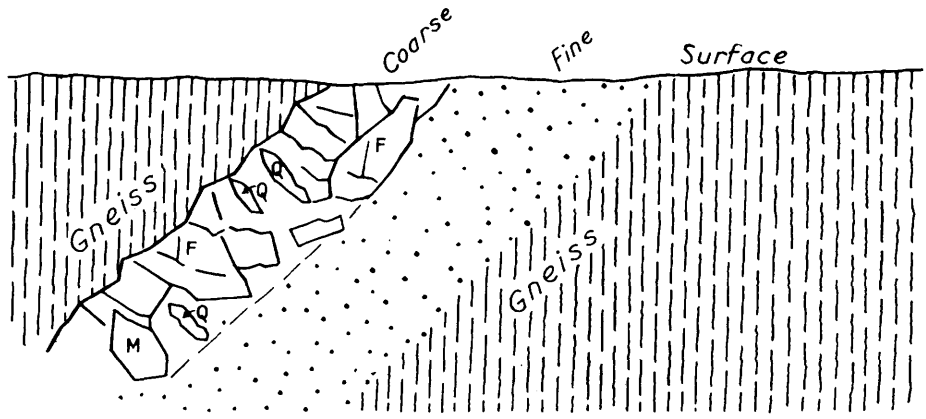


FIG. 2—Pegmatite cutting gneiss at the outlet of Valhalla lake. The coarse crystallization is against the hanging wall. Strike of foliation of gneiss 326°, dip vertical; strike of dike 289°, dip 45° W.

to the presence of mineralizers or volatile constituents, and as these are lighter than the ordinary magmatic solutions, they will be found on top. As the magma cools, these mineralizers are the last to crystallize and hence there is a coarse texture on the upper side. In the case of the vertical dikes, the mineralizers have no reason to favour either wall and will be held by the earlier crystallizing minerals in a central position.

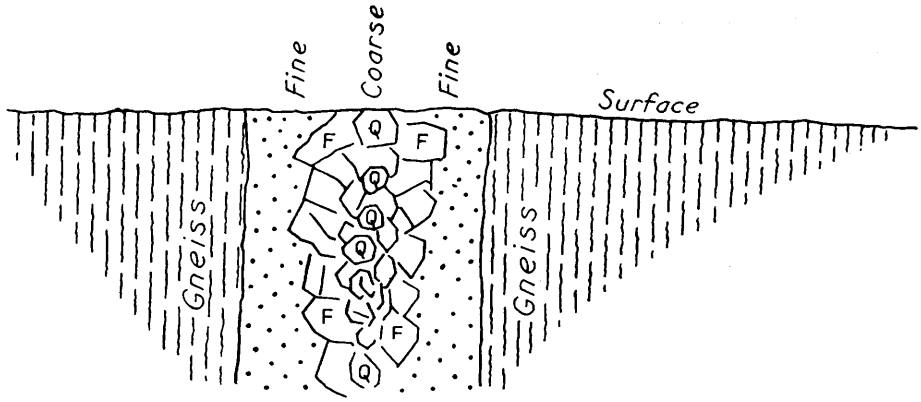


FIG. 3—Pegmatite cutting gneiss between Valhalla lake and Odin lake. The coarse crystallization is in the centre. The dike cuts across the foliation of the gneiss and has a vertical dip.

The facts gathered in the field with regard to the pegmatite dikes of this area show that these textural relations hold. The conclusion is that they are in the same position now as when they were injected and that therefore since Algoman (?) times that part of the Laurentian plateau has not been strongly flexed. If there had been any movement, the dikes would have been involved,

but the largest displacement seen during the summer was a matter of 13 inches on the west shores of Pikangikum. If there had been any remelting of the granites, the pegmatites would hardly have remained so fresh as they are. If there had been two periods of granite up-welling, the second producing the
ers in the first, and the pegmatites being the offshoots of the
ıen it is inconceivable that hair-like stringers could penetrate
ıa in all directions as well as the later magma, while nowhere
magma appear as a boss intruding the first.
gical conclusion is that granite and gneiss are contemporaneous
ıve remained as they crystallized since pre-Cambrian times.



Pikangikum Indian types (Saulteaux).

Economic Geology

little hope of finding economic deposits between Red lake and lake. North of Herod lake, an Indian reported a mineral that answers to the description of molybdenite, and the occurrence is probably similar to that which the writer found on Hornblendite lake and which was of no value.

As has been pointed out, the Red lake sediments probably have outliers to the north as far as Little Vermilion lake, but no mineralization was observed.

The Favourable Lake area is the most promising area seen by the writer. No valuable deposits were seen during his trip, but a sample from the north side of the tongue gave eighty cents in gold. The time will come when the area will be prospected. At present it is doubtful if prospecting would be a sound economic investment unless something extraordinarily rich was found. The southeastern contact appears to be better mineralized than the northwestern.



Saulteaux woman and child, Pikangikum lake.



Saulteaux Indians, Pikangikum lake.

Inhabitants

Saulteaux Indians at Pikangikum

There are about one hundred in this tribe at the present time. They are a race of hardy little men. The average height is five feet six inches. They are slightly built and have neither the thickset shoulders nor the high cheek bones of the Ojibways to the south. Their eyes are set fairly far apart and they have straight noses. The women have a comely appearance. See photographs on pages 17 and 18.

None of the men could speak English nor could they understand Cree. Some of them were able to write in syllabic characters. The name of the person addressed was written in English. Numbers are written in Arabic numerals.



The Indians' manner of showing respect for slain animals which happen to be their totems.

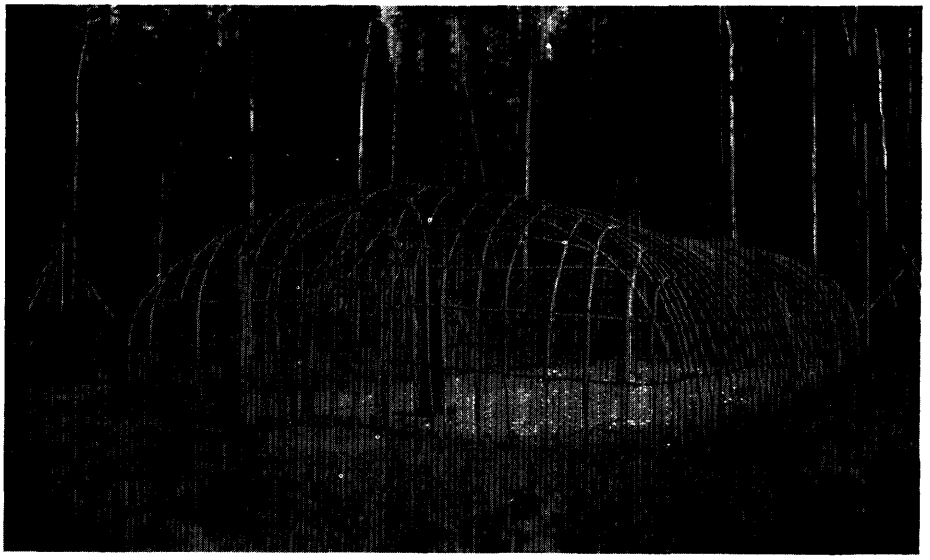
The Indians live on fish chiefly and game when it can be procured. They appear not to be Christians but to adhere to a form of totem worship. The totem for some of the Indians at Pikangikum is the loon. Their place of worship or perhaps amusement is called the Utamin.[1] It measures 42 feet by

[1]The following description is by J. W. Pierce, D.L.S., in charge of the topographical survey party:—

Native Sun Dance (?) Pavilion.—This remarkable construction is used by the Ojibways in connection with their Sun Dance (?) ceremony during the month of June. Here the original customs, language, and religion of the natives have not as yet been affected by civilization; English is unknown, and even the Hudson's Bay Company's post is in charge of an Indian who cannot speak a word of English.

The pavilion is entirely constructed of slender spruce poles bound together with withes. Perfect symmetry and some attempt at simple ornamentation characterize this frame-work which when in use is covered with green boughs. The design is rectangular in form with rounded corners, fifty by fifteen feet and eight feet high. The floor is perfectly level and covered with clean white sand. A row of five posts with two additional posts, one on either side of the centre post and at right angles to the row, all equidistant and of the same height and size, are symmetrically located, in relation to the enclosure. The centre post, which occupies the centre of the enclosure, is painted red. At its base there is a birch-bark basket containing several wooden carvings of birds that are roughly coloured. The two other posts within the enclosure are painted white and have at their bases a large round boulder, while the outside posts are unpainted. The direction of the main row of posts and of the structure is exactly east and west, even allowing for magnetic declination.

As no person could talk English, the significance of this notable arrangement is a matter of speculation. It may be a conjuring house.



The Utamin at Pikangikum lake, near the entrance of Berens river. For description, see text.

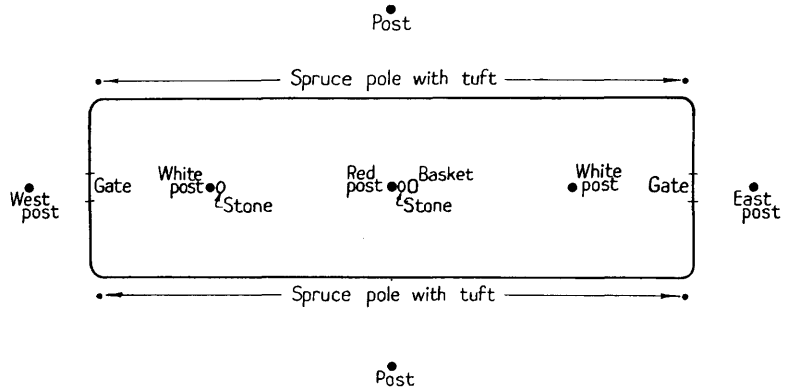


FIG. 4—Plan showing the Utamin, 50 feet long by 15 feet wide, with posts placed equidistant.

15 feet by 7½ feet high and is a framework of young spruce, 1¼ inches in diameter which are set 17 inches apart and bent over to meet, being fastened with withes. There are two entrances, one at either end. There are various posts arranged as shown in Fig. 4.

The longer axis of the hall is east and west. Skins and blankets are used to lay over the framework, when the dance is held, but are removed when that period is over. On the east side of the central post, there is a smooth boulder and placed just to the east of that a birch-bark basket, which contains four



Treaty Indians of the Deer Lake band, probably partly Cree.

wooden birds—one painted green and one black, and two the colour of the natural wood. The ground around the posts was well beaten down (see photograph on page 20).

Deer Lake Indians

The Deer Lake Indians are probably a mixture of Cree and Saulteaux. They are much larger in stature but have not the energy that the Saulteaux exhibit (see photograph above).

Appendix

FAUNA AND FLORA

By L. F. Kindle

Fish and Game

Pike and pickerel fishing was excellent from Lac Seul northward to the upper lakes of the Chukuni river. In these lakes some young perch were seen. Over the divide in the Dowling river, fishing was not so good. In Pikangikum lake, the Indians catch lake whitefish and dry a reserve supply; they also get sturgeon.

During May and June, members of the surveying party encountered deer in great numbers between Hunter on the Canadian National railway and Pakwash lake.

The country appears to be a paradise for moose, though few were seen. Their tracks are common, and many drying racks, left by Indians after preparing moose hide and meat, were seen.

Birds and Smaller Animals

Woodpeckers were rarely observed, but pitted bark on numerous trees showed how great their activity had been. Their vacated nesting-holes are common along Berens river. Sand-pipers and kingfishers were especially numerous on the Severn river between Deer and Favourable lakes in early September. Mr. Douglas, Factor at Berens River Post, says he has seen robins remain throughout the winter. A bittern was also noticed there. In June, Harding and Lambert saw a circle of about a dozen great blue heron's nests in the tops of pines. Leeches several inches long were commonly seen swimming out in the open lakes. Ant-hills were occasionally seen. A large one on Pikangikum lake measured about sixteen feet long by six feet high on the side of a fine clay-sand bank. Frogs were seen in favourable localities throughout the summer. Flies resembling the housefly gather around camps in the woods. A snake, about two and a half feet long, brown and copper coloured, striped lengthwise, was reported by Campbell, a member of Pierce's party,

Molluscs

The gastropods noticed were those few living on the banks, chiefly of granite or gneiss, a variety of species being found on the sand beaches. Frank C. Baker, University of Illinois, very kindly examined some of the specimens. He remarked on the interesting difference between the Canadian lakes' fauna and that of the United States.

The pelecypods were less numerous and showed fewer species. *Lampsilis luteolus* lives in all the rivers but was not noticed in the Severn, and this last fact was noted by McInnes.[1]

A doubtful *Unio complanatus* was picked up with a *L. luteolus* in the Chukuni river. *Anodonta fostiana* (?) in the Crooked-mouth and Severn rivers is seen only from place to place. Several species of *Sphaerium* may be commonly found in the Berens and Dowling rivers.

[1]W. McInnes, Geol. Surv. Can., No. 1080, 1911.

Trees

Black spruce and jackpine grow all over the country traversed. Spruce covers much of the swampy areas, pine usually growing on drier ground. Vast expanses of formerly burned areas are now spread with young jackpine all of uniform height. Excellent groves of pine lie west of Borel lake on a gently sloping sand-plain. Here old decayed logs are strewn about, many torn apart by bears in search of ants. Pine seedlings two feet high are scattered about fairly uniformly. These are shaded by evenly spaced sticks of straight jackpine, 60 and 75 feet high. Areas of black spruce regrowth were not noticed so often as those of jackpine. A heavy growth of lichen covers a great many dead and half-dead evergreens, spruce, etc. Dead jackpines riddled vertically by canals, oval in section, are probably affected by the work of boring beetles.

At Stout lake, birch reaches one foot in diameter; balsam and jackpine still more. The larger trees as far north as Deer lake reach like dimensions.



Potatoes at Pikangikum, July 30, 1925.

Poplar attains its best development on the lower stretches of the Dowling river and Pikangikum lake; it is very abundant on Berens river, and especially in an area just above Stout lake. Mr. McIntosh, Factor at Deer Lake, says that no living tamarac can be found anywhere near the Post; some young tamaracs grow within ten miles on the Severn river.

White oak grows along the Berens river near its mouth and upstream fully twenty-five miles.

Plants

Potatoes grown by the Indians make a fair crop at Pikangikum and Deer lake. At Little Grand rapids, in Manitoba west of Moar lake, potatoes will be dug about October 6. On July 30, at Pikangikum, potatoes were just blossoming and 18 inches high; turnips 9 to 12 inches high.

Hazel-nut bushes grow near Little Grand rapids. Labrador tea and moss, especially the latter, grow over great expanses of wet land, forming muskegs.

Occurrence of Some

Plants and Animals

Noticed Between

Lac Seul and Severn River

Patricia District, Ontario

Summer, 1925

	Hudson, C.N.R., and Vermilion L.	West end Lac Seul	English & Mattawa rivers	Little Vermilion L.	Rathouse L.	Valhalla L.	Upper Chukuni lakes	Borel L.	Dowling R. to Harding L.	East Br. Dowling R.	Hornblendite L.	Lower East Br. Dowling R.	Pikangikum L.	Berens R., Stout L.	Aug. 5-12, Little Grand rapids, Onepine L. trip.	Return up Berens R.	Crooked-mouth R. to height of land	Height of land	Severn waters to Deer L. and return	Lakes north of height of land	Little Grand rapids via Crooked-mouth R.	Berens R. to L. Winnipeg
	June			July										August						September		
	25	28	30	5	7	9	14	17	21	23	25	26	31	2	3	14	20	21	30	4	9	13
BIRDS																						
Red-winged blackbird—*Agelaius phoeniceus*	C	....	S	S	S	....	1	....	....	....	1	6	....	....	6	flocks	S	....	....	....	5	flock
Crow—*Corvus brachyrhynchos*	....	S	S	S	S	....	7	2	....	....	2	....	5	S	20	C	S	1	....	2	16	S
Hawk, red-tailed—*Butee borealis* (?)	....	1	....	2	....	1	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....
Hawk, duck—*Falco peregrinus* (?)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	6	....	....	....	1	....	1
Hawk, pigeon—*Falco columbarius* (?)	....	2	4	7	....	....	....	3	2	2	2	....	3	....	2	....	....	?	?	1	9	2
Flicker—*Colaptes auratus*	....	....	....	....	....	....	1	....	....	....	?	?	....	....	....	....	....	....	....	1	S	8
Canada jay—*Perisoreus canadensis*	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	2	4
Night hawk—*Chordeiles virginianus*	....	....	....	....	1	1	....	2	....	....	....	....	5	3	7	S	3	1	....	1	....	....
Duck, canvass-back—*Marila valisineria*	....	S	S	C	....	C	14	....	3	3	....	....	fam.	....	....	S	....	....	....	....	17	8
Duck, fish (black)—*Anas rubripes* (?)	....	1	....	3fam.	4	....	2fam.	....	....	1	1	1	5	....	....	....	2	....	....	....	....	20
Duck, mallard—*Anas platyrhynchos*	....	....	....	....	....	....	....	....	....	....	....	....	2fam.	6?	S?	14	....	fam.	12 Y	8 Y	45	140
Kingfisher—*Ceryle alcyon*	2	....	....	2	....	2	....	....	....	....	....	....	....	....	....	5	....	....	5	....	2	9
Sand-piper—*Actitis macularia*	....	1	8	S	....	....	....	1	....	1	1	....	3	S	15	C	S	2	9	....	15	C
Tern—*Sterna hirundo*	2	?	S	C	....	....	....	....	....	....	....	....	....	....	2	1	....	?	....	....	....	....
Gull—*Larus argentatus*	....	S	....	....	....	C	C	....	2	....	2	....	15	9	8	9	....	3	16	9	70	S
Eagle—*Haliaëtus leucocephalus* (?)	....	....	....	1	....	nest	7	1	....	....	?	....	1	....	....	....	....	....	1	....	....	....
Owl, screech—*Otus asio* (?)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5	2	2	....	2	....
Grouse—*Bonassa umbellus* (?)	....	....	....	?	....	....	2	1	1	....	....	....	....	....	....	....	....	....	1	....	....	....
Loon—*Gavia immer*	....	4	1	3	....	2	10	5	....	3	....	....	2	1	4	3	....	1	20	7	3	....
TREES																						
Tamarac—*Larix americana*	7	?	S	–C	....	C	C	....	C	VC	....	VC	....	....	C	–C	....	S	S	S	VC	?
Balsam—*Abies balsamea*	VC	....	....	C	....	C	?	....	–C	....	C	C	C	....	C	VC	....	N?	N?	N?	VC	C
Black spruce—*Picea canadensis*	VC	VC	VC	VC	....	VC	VC	....	VC	....	VC	....	VC	....	VC	VC	....	VC	VC	C	VC	VC
Jackpine—*Pinus banksiana*	VC	VC	VC	VC	....	VC	VC	....	VC	....	VC	....	VC	....	VC	VC	....	VC	VC	VC	VC	VC
Poplar—*Populus tremuloides*	VC	....	....	C	....	C	....	....	C	....	....	....	VC	VC	VC	VC	–C	S	S	S	VC	VC

Balm of Gilead—*Populs balsamifera*													S		S	S		N		S	?	?
Birch—*Betula alba*	VC	VC		C		-C	C		C				C							C	C	C
Maple, mountain—*Acer spicatum*	C	C		-C		-C	-C		-C				-C		C		C	?			C	C
Willow—*Salix*	VC		VC	C		VC	VC		VC				C		VC	VC	C	C		-C	-C	C
Alder—*Alnus incana*	VC	VC		C		VC	VC		VC				VC	VC	C		C	C		C		C
Cherry—*Prunus pennsylvanica*	C	C				C	C		C				C	C	C	C		?	S		S	
Ash—*Fraxinus sambucifolia*											12		S		S	S			S		8	
Ash, mountain—*Pyrus americana*			S	-C		-C	-C		-C						S			2	-C	?		-C
Juniper—*Juniperus communis*											S		S					N	C	C	-C	C
Cedar—*Thuja occidentalis*	VC		VC	-C	N																	
ANIMALS																						
Deer, red (jumpers)—*Odocoileus virginianus borealis*	1		8	6	4		2	1	1	3												
Moose—*Alces americanus*	1		1	1	1	1		2		1												
Beaver—*Castor fiber*							house			dam3						cuttings						
Porcupine—*Erethizon dorsatus*				?																		
Rabbit—*Lepus americanus*						1				1												
Squirrel—*Sciurus hudsonicus*				1	1	1			1	?												
Chipmunk—*Tamias striatus*									1					1								
Ground-hog—*Marmota monax canadensis*							1									1						
Skunk—*Mephitis mephitica*							2															
Water-rat—Muskrat? (reported)								2?														
Mouse—*Peromyscus maniculatus*							1					1			S							
Mink—*Putorius vison*															1							
Coyote—*Canis latrans* (?)									yelps													
Bear—*Ursus americanus*								report					Indian's stew						Favourable L.			
Snake, garter—*Thamnophis sirtalis*				1			1	1	1				1									S
GASTROPODS																						
Limnea stagnalis, Linné	VC						4				1	1	C		S	S	C	C	S		3	1
Limnea palustris, Müller					1										S							
Limnea palustris michiganensis, Walker (?)							3								S	S					S	
Limnea catascopium, Say (?)													S						S		S	
Planorbis trivolvis, Say	C	S									1		C		C	1					S	
Planorbis campanulatus rudentis, Dall*		C		2							1		VC			C					C	C
Planorbis parvus, Say		S		1							S		C	C	S	C					S	
Planorbis bicarinatus, Say							1			1	1	1			S	C					S	
Physa heterostropha, Say	S			1			2				C	C	C					C				
Succinea ovalis, Say							1															
Planorbis exacuous, Say													S									
Planorbis binneyi, Tryon*	S			4							?		S									

C—common. -C—not so common. VC—very common. S—several. N—none. Y—young. Fl.—flock.
fam.—family. 1 to 140—number seen. *Identified by Frank C. Baker.

Equisetum grows almost half way across sluggish reaches of the Chukuni river and under similar conditions all through the country. Wild rice and rushes grow over immense shallow water areas in the lakes.

June 30—Yellow water-lily blossoms opening up.
July 3—Wild roses in full bloom.
July 22—White water-lily in blossom.
July 27—Wild roses in full bloom—Pikangikum.
August 4—Blueberries ripe.
August 8—Myriads of cranberries in muskegs of height-of-land country—red but unripe.
September 5—Cranberries nearly ripe.
September 13—Yellow of fall appearing on poplars and birches to a degree similar to that seen on height-of-land trees, September 5.

I am indebted to Professor A. B. Klugh, Queen's University, Kingston, for criticism of the table and notes.

INDEX, PART IV

PAGE

A

Adams, Dr. F. D. 13
Adirondack mtns, N.Y.
  Gneiss, origin 15
Aerial photographs, advantages of 3
Animals. *See* Fauna.
Ants 22, 23

B

Baker, Frank C 22
Balsam 23, 24
Bears 23, 25
Beetles, boring 23
Berens river.
  Fauna and flora 23-25
  Magnetic declination 6
  Rocks 13
  Valley, features of 4
Birds 22
Bittern 22
Black spruce 23, 24
Blue heron 22
Borel lake.
  Fauna and flora 23-25
  Photo 3
  Rocks 7, 8
Boring beetles 23
Bruce, E. L 1
Burwash, E. M 1

C

Cedar lake 6
Cedar river 6
Chukuni lakes 24, 25
Chukuni river 6, 12, 22
Clarke, F. W 11
Clinozoisite 10
Cocos lake 6
Cree Indians 21
Crooked-mouth r.
  Fall, drawing of ..... *facing* 1
  Fauna and flora 24, 25
  Magnetic declination 6
  Rocks, dip and strike 15

D

Daly, R. A 1
Deer lake.
  Flora and fauna 23-25
  Gneiss S. of, photo 14
  Indians, photo 21
  Photo of small lake S. of 4
Douglas, G. Vibert.
  Report on country between Red l. and Favourable l. 1-21
Douglas, Mr. (H. B. Co.) 1, 22
Dowling, D. B 1
Dowling river.
  Fauna and flora 23-25
  Magnetic declination 6
  Marl and clay beds 5
  Rocks 8

PAGE

E

Elizabeth lake 8, 15
English river 6, 24, 25

F

Fauna 22
Favourable lake.
  Aeroplane photo 2
  Glacial striae 5
  Gold 17
  Magnetic declination 6
  Rocks 6
    lithology 10
    photos 9-13
    strike and dip 15
  Syncline 15
Fenner, C. N 14
Fish 22
Flora 22
Frogs 22

G

Game 22
Gastropods 22
Geology, economic 17
  General 6-10
  Structural 15-17
Gibson, Thomas W 1
Glacial striae 5
Glaciation 4
Gneiss. *See* Geology, general.
Gold 17
Gorman, A. O 1, 6

H

Harding lake 11, 24, 25
Hawley, J. E 1
Hazel-nuts 23
Herod lake 5, 15, 17
Heron, blue 22
Hornblendite lake 24, 25
Hudson 15, 24, 25
Hudson's Bay Co 1

I

Iddings, J. P 11
Indians.
  See also Saulteaux Indians.
  Deer l., photo 21
Inhabitants, notes and photos 17-21
Island lake 1

J

Jackpine 23, 24
Joint lake 6

K

Kakakupp lake. *See* Herod l.
Keg lake 6
Keith, Arthur 15
Kindle, L. F 1, 6
  Report by, on flora and fauna of country between L. Seul and Severn river 22-26

PAGE

Kingfisher 22
Klugh, A. B 26

L

Labrador tea 23
Lac Seul 22
Lampsilis 22
Larsen, E. S. 1, 12
Leeches 22
Lemonade lake 5, 10, 15
Lewisian gneisses, origin 13
Lichen 23
Lithology 10-15
Little Drum lake 6
Little Grand rapids 23-25
Little Rathouse lake 5
Little Trout lake 6
Little Trout river 6
Little Vermilion lake 5-7, 15

M

McCusker, K. S. 1
McInnes, W. 22
McIntosh, Mr (H. B. Co.) 1
Magnetic declination 6, 7
Maria bay 6
Mattawa river 24, 25
Moar lake, rocks 9
Molluscs 22
Molybdenite 17
Moose 22
Moose l. *See* Old Shoes l.
Moss 23
Muskeg 3, 7

N

Northpine pyrite mine 15

O

Oak, white 23
Odin lake 5, 7
Onepine lake 5, 9, 15

P

Pakwash lake 6, 22
Pala, Cal 11
Paterson, Mr. (H. B. Co.) 1
Pelecypods 22
Perch 22
Pickerel 22
Pierce, J. W. 1, 3, 19
Pikangikum.
  Glacial striae 5
  Indians 17-21
  Potatoes, photo 23
  Rocks 12, 15
Pikangikum lake.
  Clay 9
  Fauna and flora 23-26
  Indians. *See* Saulteaux Indians.
  Rocks 8, 17

PAGE

Pike 22
Pine 23
Plants 23, 24
Poplar 23, 24
Poplar hill, Berens river 15
Potatoes 23

R

Rathouse lake 5-7, 24, 25
Red lake 6, 15
Rickaby, H. C 1
Robins 22
Rogers, W. R 1

S

Sagewitchewan river 6
Sand-pipers 22
Saulteaux Indans.
  Notes and photos 17-21
Schaller, W. T 12
Seul lake 22-26
Severn river 6, 24-26
Sphaerium 22
Spruce 23, 24
Stout lake 6, 23-25
Striae, glacial 5
Sturgeon 22
Sun Dance pavilion.
  Description, plan and photos 19, 20

T

Tamarac 23-25
Teall, J. J. H 13
Topography 3-5
Totem worship 19
Trees 23-25
Trough lake 7, 15
Turnips 23

U

Unio complanatus 22
Utamin (Indian building).
  Notes, photo and plan 19, 20

V

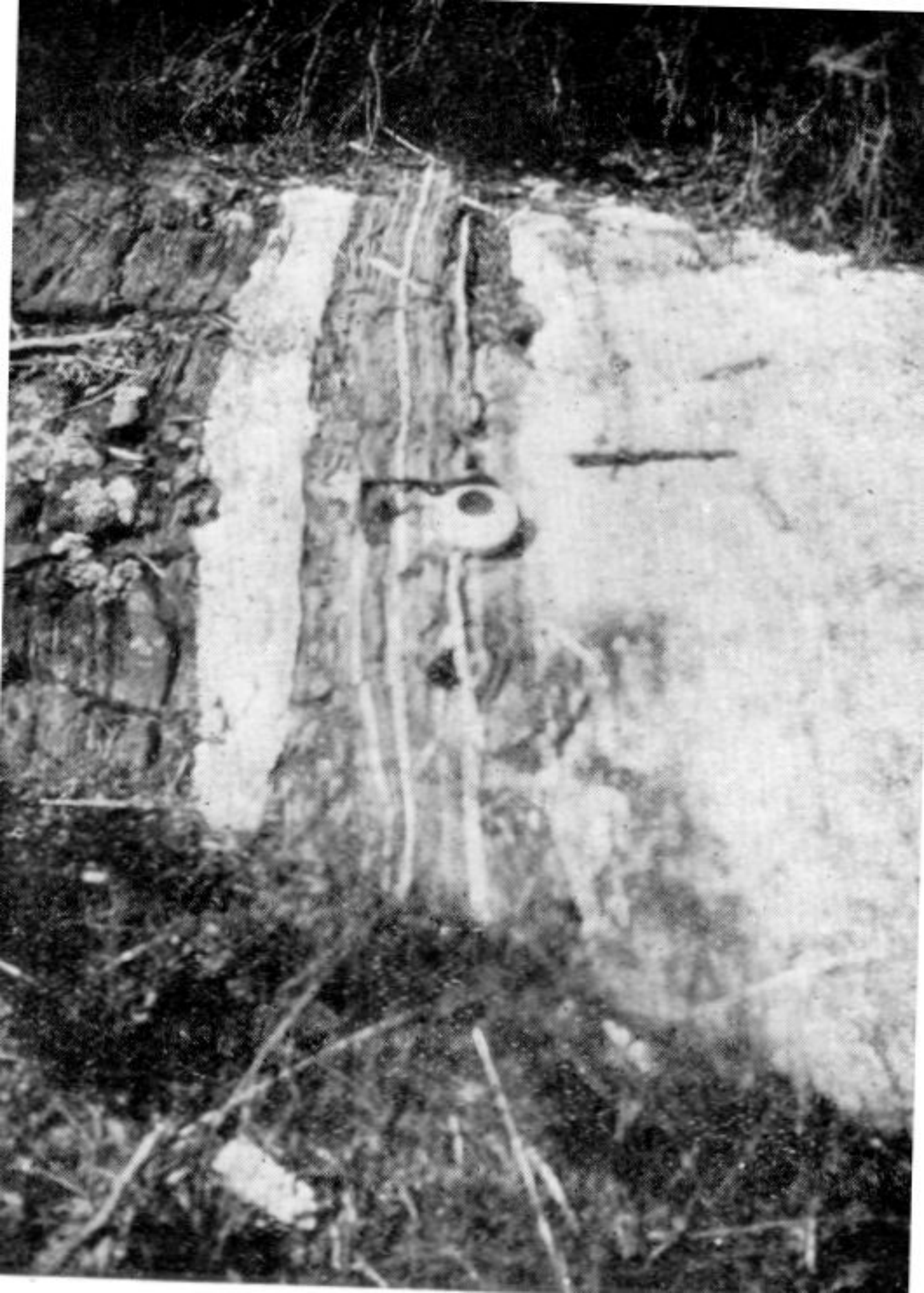
Valhalla lake.
  Fauna and flora 24, 25
  Rocks 7, 13, 14
    dip and strike 15
    section 16
Vegetables 23
Vermilion lake 24, 25

W

Wabaskang lake 6
Wend portage 6
Whitefish 22
Wilson, A. W. G 1, 5
Woodpeckers 22







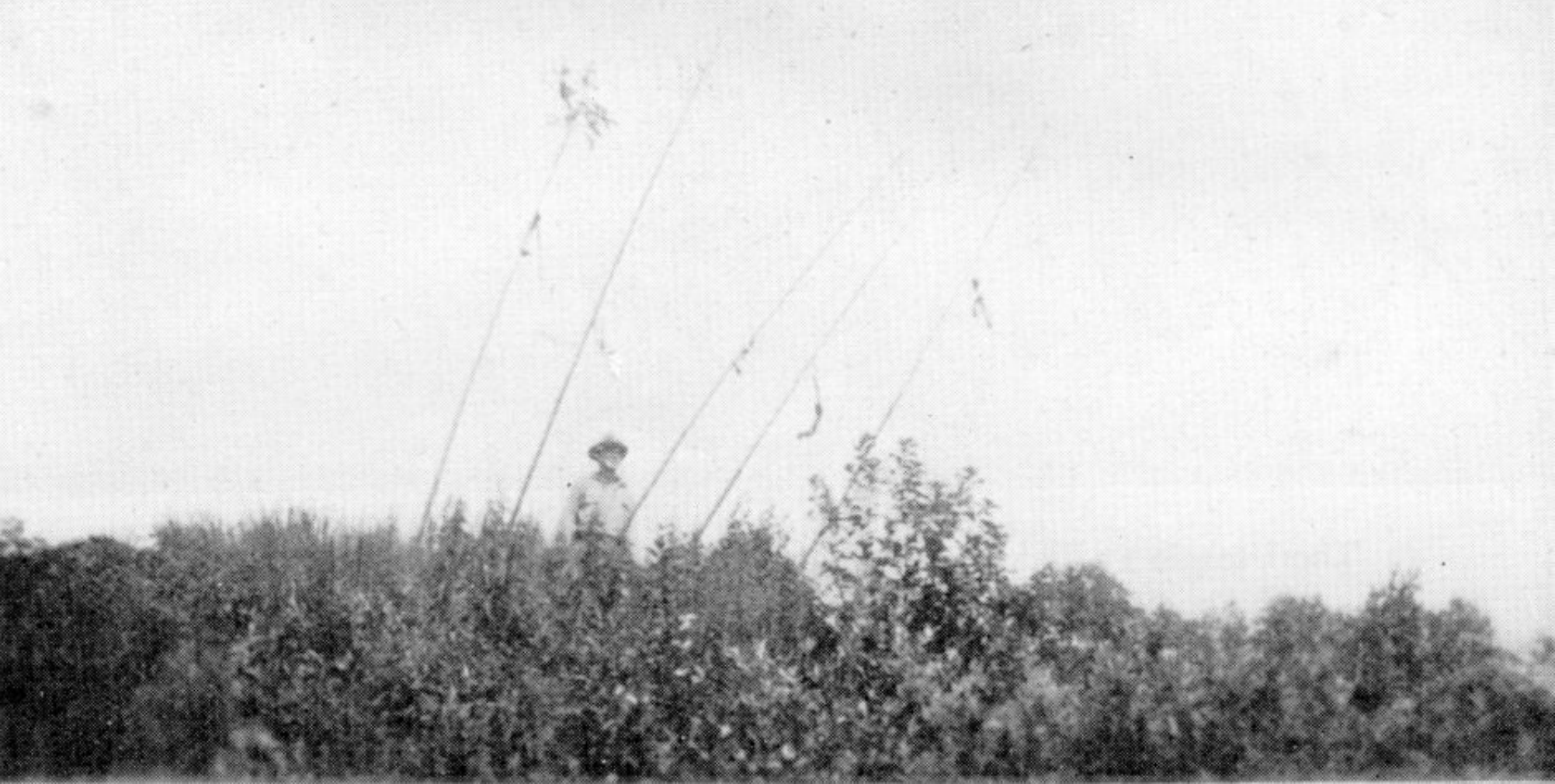




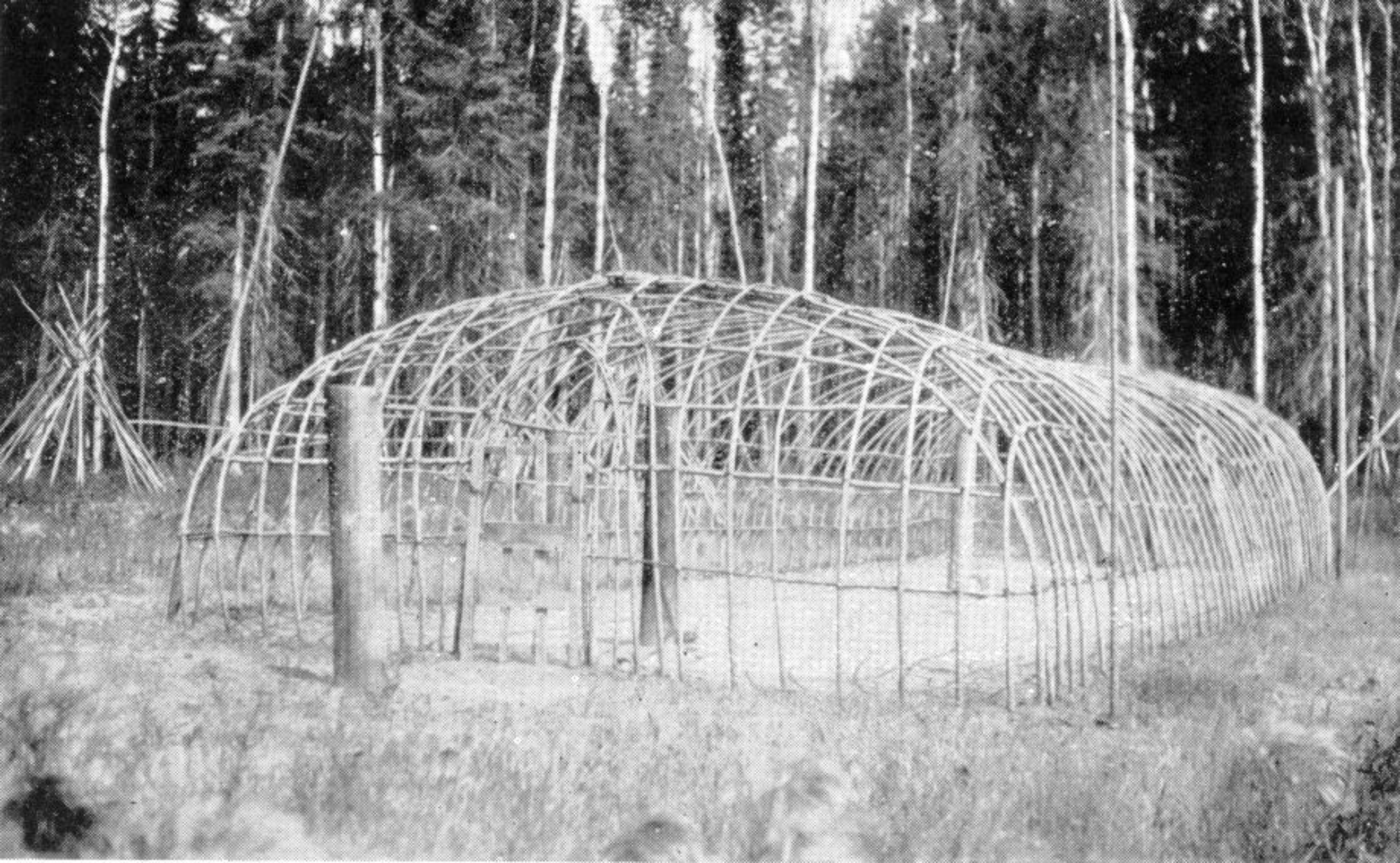









Clay















PROVINCE OF ONTARIO
DEPARTMENT OF MINES

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

THIRTY-FIFTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXV, PART V, 1926

Natural Gas in 1925

AND

Petroleum in 1925

By
R. B. Harkness, Commissioner of Natural Gas

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CANADA

CONTENTS

Vol. XXXV, Part V

NATURAL GAS IN 1925

PAGE

General 1
Table I—Natural Gas Production by Fields in 1924 and 1925 1
Table II—Sales of Gas from Kent, and Norfolk—Haldimand Fields ... 2
Work of the Year 3
Exploratory Work 4
Analysis of Gas Consumption 5
Table III — Gas Consumption in Towns and Cities, 1925 5
Table IV—Gas Consumption in Townships, 1925 7
Orifice Meters 8
Pipe Corrosion 9
Helium in Ontario 10
Table V—Helium in Ontario Gas Wells 10
Gas versus Electricity 15
Table VI—Comparisons of Gas and Electricity 15
Improvements Made during the Year .. 16
Leakage 18
Table VII—Leakage in Distribution Plants, 1925 19
Table VIII—Leakage on Rural Lines, 1925 20
Table IX—Leakage in Transmission Lines, 1925 20
Gas Wells and Their Production 21
Table X—Gas Wells and Their Production, 1925 22
Licenses Issued in 1925 24
Table XI—Operators Licensed to Lease and Prospect for Natural Gas, 1925 24
Table XII—Operators Licensed to Drill or Bore for Natural Gas, 1925 25
Table XIII—Operators Licensed to Produce Natural Gas, 1925 26
Table XIV—Operators Licensed to Distribute Natural Gas, 1925 26
Table XV—Operators Licensed to Operate Pipe Lines, 1925 26
Logs of Wells 28
Brant County 28
Haldimand County 29
Lambton County 38
Lincoln County 38
Norfolk County 39
Peel County 41
Welland County 41
Wentworth County 42

PETROLEUM IN 1925

General 43
Table I—Oil Wells and Their Production, 1925 44
Table II—Oil Produced in Ontario by Fields, 1918 to 1925 44
Price of Crude Petroleum 45
Exploratory Work 45
Refining Operations 46
Table III—Petroleum Refining Operations, 1921-25 47
Petroleum and Refined Products Imported 47
Table IV—Petroleum and Refined Products Imported in 1924 and 1925 48
Oil Recovery 48
General 48
Laboratory Experiments 49
Oil Production per Thousand Feet of Gas 50
Restoring Gas Pressure 51
Systematic Flooding of Oil Fields 52
Unwatering 52
Oil Mining 53
Cost of Mining 61

ILLUSTRATIONS

A crude method of preventing water from freezing in winter 9
Travelling instruction equipment used by the Union Natural Gas Company to demonstrate economical methods of using natural gas 21
Site of the original oil well in the stream valley east of the town of Petrolia 43
Wooden tank used for hauling crude oil from the small fields to the railway 46
Edge of bank at Rock Glen, Ausable river, showing shales of Hamilton formation overlying Onondaga limestone 62

INSERT MAP

Oil and Gas Fields of Southwestern Ontario ..... *facing* 58

NATURAL GAS IN 1925

By R. B. Harkness

General

Of the minerals produced in Ontario in 1925, natural gas stands fifth in value. The year's production was 7,257,274 thousand cubic feet with a value of $4,083,341. The order is as follows:—

Gold	$30,206,432
Nickel	15,946,673
Silver	6,964,325
Copper	4,739,124
Natural gas	4,083,341

The production for 1925 is less than 1924 by 113,639 thousand cubic feet, but the value is increased by $7,327.

The comparison by fields is shown below.

TABLE I—NATURAL GAS PRODUCTION BY FIELDS IN 1924 AND 1925

County	Field	1924	1925
		M cu. ft.	M cu. ft.
Essex	Kingsville	4,757,849	4,966,207
Kent	Tilbury		
	Dover	199,770	126,687
Lambton	Dawn	73,577	50,913
	Oil Springs		
Middlesex	Crumlin	2,649	2,030
Elgin	Bayham	150,672	140,231
Norfolk	Norfolk	1,595,625	1,544,348
Lincoln	Lincoln		
Haldimand	Haldimand		
Wentworth	Wentworth		
Brant	Onondaga	8,926	979
Welland	Welland	456,961	294,843
Bruce	Amabel	591	650
Wells in surface drift	Howard	64,295	70,386
Private wells		60,000	60,000
Total		7,370,914	7,257,274

The winter of 1925-26 was much longer and probably more severe than the previous year, and the demands for gas in March, April, and May were much greater on account of the cold weather in these months.

TABLE II—SALES OF GAS FROM KENT AND NORFOLK-HALDIMAND FIELDS

Month	Kent field		Norfolk-Haldimand field	
	1924-25	1925-26	1924-25	1925-26
	M cu. ft.	M cu. ft.	M cu. ft.	M cu. ft.
December	576,409	526,723	158,755	160,475
January	592,893	587,993	182,637	189,298
February	513,724	562,932	170,622	179,330
March	457,409	592,465	143,548	173,832
April	379,276	553,386	115,498	189,244
May	271,788	322,687	98,104	150,213

The supreme test of good service is the delivery of gas from the field in the late spring months, when furnace fires are lighted in the early morning hours and are allowed to go out during the day. This demand coming at the breakfast hour is a very severe test, but the pressures at the larger cities indicate no shortage of gas.

This improvement in service is partially attributable to the improvement in distribution plants, where the diameter of the mains has been increased, making it possible to deliver the same quantity of gas to the consumer at a lower pressure. As only a relatively small quantity of gas is used for heating during the night, it is possible to allow the pressures in the transmission lines to drop. This allows the pressure to build up at the gas wells; and when the peak demand comes, there is an immediate supply available.

During the years 1924 and 1925, most of the gas wells in the Kent (Tilbury) field were cleaned out by exploding a charge of dynamite at the gas horizon. This has removed the accumulated salt and paraffin, and to some extent shattered the limestone, thereby increasing the flow of gas. This is the second cause of the improved service during the late winter and early spring months. It can scarcely be expected that this increase in the gas flow will be maintained for a very long time; the flow will undoubtedly diminish very rapidly, as the rock pressure had no corresponding increase.

The opening up of a new gas field in Middleton township has relieved a serious shortage of gas in Tillsonburg; and by connecting this field to the pipe line which feeds into Simcoe, the service in that city has been greatly improved. The Dominion Natural Gas Company now have all their gas fields interconnected in the counties of Elgin, Norfolk, Haldimand, Welland, Lincoln, and Wentworth, and a sudden demand in any one area can be satisfied by diverting gas from any one of the other fields in these counties.

A pipe line has been laid by the Chippewa Oil and Gas Company, Limited, from Smithville to Grimsby to serve the residents of Grimsby with gas. It can scarcely be said that it was in operation in 1925, as the company had connected only about half a dozen consumers.

At the end of February, the United Gas and Fuel Company of Hamilton discontinued distributing natural gas in Hamilton; previous to this date, they had purchased natural gas and mixed it with manufactured gas in varying proportions. Hamilton is now supplied solely with manufactured gas with the exception of a few residents who live along the streets on which are laid the lines which supply several industries with natural gas.

The success achieved in the gas field some three miles west of Ridgetown in Harwich township, where gas is found in an astonishing volume at a depth of about 120 feet in the surface drift, stimulated drilling in this section. There

are now about 69 of these wells extending from Ridgetown to the outskirts of the town of Blenheim. The volume produced in 1924 and 1925 is shown in Table V.

The total investment in plant and property used in producing, transmitting, and distributing natural gas in Ontario is $29,206,753. The number of employees in all branches of the industry was 1,265, and the wages paid them $876,606. These figures have been arrived at in part by estimate, as there seems to be a great reluctance on the part of the small operator to give this information. The totals are believed to be nearly correct; certainly they are not over-estimated.

Work of the Year

The aim of this department is to conserve the small supply of natural gas that is left to us in the province, and to assist in every way to search for new supplies by keeping a careful record of all wells drilled and at intervals publishing any information which may be of use in this connection. Samples of drill cuttings are examined carefully, and the results sent to the operator. A map is now being made from these records that will show the areas where gas may be found in the different formations.

The present supply of gas is being carefully guarded against loss, and all distribution plants are inspected by Inspector B. D. Burn for leakage and all other deficiencies. Those inspected during the year were:—

Dunnville (2)[1]	Canfield	Aylmer	Merlin
Port Colborne (2)	Tilbury	Essex	West Lorne
Cayuga	Courtright	Chatham (2)	Bridgeburg
Ridgetown (2)	Fenwick	Caledonia (2)	Rodney
Comber	Dutton (2)	Kingsville	Blenheim
Sarnia	Hagersville (2)	Jeannettes Creek	Morpeth
Thorold	Jarvis	Niagara Falls	Cedar Springs
Port Dover	Tilbury	Leamington	Ruscom
Wallaceburg	St. Joachim	Windsor (2)	St. Catharines
Welland (2)	Sombra	Simcoe (2)	

All processes of the production and transmission of gas were inspected. The gas used in blowing aud pumping wells was investigated with a view to ecuring the greatest econo ny.

Inspector B. D. Burn inspected the plugging of a great many wells abandoned during the year, but it was impossible for him to inspect every one of the 176 wells abandoned.

Transmission lines having excessive leakage, as shown by the measurement of the gas that passes into and out of a pipe line, were patrolled. Although, in most cases, only a few small leaks were found, it was apparent that the leakage must undoubtedly be due to a very large number of these small leaks. Reducing the pressure cuts the leakage down considerably.

In the homes where gas is used, many inspections have been made and the equipment and methods of burning gas thereby improved. The gas companies have carried this work out in a most satisfactory manner. Almost every householder in Ontario who uses natural gas has now been instructed in the best methods of burning natural gas.

Tests have been made of new burners. Tests have also been made of the relative value of natural gas and electricity as a fuel when used under proper conditions.

[1]NOTE.—Where the figure (2) appears the inspection has been made twice.

In order that small producers may have the best instruments for measuring the rock pressure and open flow of their wells, an open-flow meter and a steam gauge of good quality have been secured and are loaned to those who ask for it. By gauging each well every year (in fact gas wells should be tested by the minute pressure test as often as every day), the operator is at once aware of any underground trouble in his well, such as water encroachment; leaky casing, packer, etc.; an accumulation of salt or paraffin in the tubing or the rock itself, and many other ills that gas wells are subject to, such as a gas leak past the packer, or through the tubing. All those who were unaccustomed to measuring the flow of gas with this device were given instruction.

The work done last year with the free consumers[1] was continued during the past year, and at the end of the year a comparison was made of the quantity of gas used by these free consumers, by consumers who were allowed a limited quantity, and by those who paid for all of the gas that they used. The size of the house, number in the family, condition of the building, and all factors that would affect the quantity of gas consumed were considered; then an order was sent to all those who had used what was considered more gas than they reasonably required, stating what was considered to be a reasonable quantity and directing them to limit their demands to the fixed amount.

Following the discovery of helium-bearing gas in commercial quantities in Peel county (see page 10), many samples of gas were collected from new wells drilled in areas not previously tested.

Many applications have been received at this office for examinations to be made of localities where oil is reported to be escaping from the ground. In cases where the facts given or stated made it appear that the report might be authentic, the locality was visited. No seepage of oil was noted, however, during the year 1925.

Exploratory Work

During the year 1925, there has probably not been as much exploratory work carried on as in other years for several reasons; the unsatisfactory results obtained in one particular territory, where other conditions were favourable, have probably been the main cause for the curtailment in "wildcatting." The success achieved in reviving old wells is probably another cause, the crews being fully employed on this work and in developing the present known fields.

The test for gas or oil at Arkona on lots 2 and 3, South Boundary, Bosanquet township, which was begun in 1922 and which has been carried on intermittently since that date, is still uncompleted. The first well was abandoned through an accident with casing, and a new well was commenced a few feet away. The second one had reached a few feet into the Trenton limestone when the walls above caved in and it was necessary to remove the casing and replace it at a greater depth. This has not yet been accomplished.

The Colchester Oil and Gas Company deepened a shallow oil well in lot 5, concession III, Zone township, through the Trenton to the pre-Cambrian. The result was a small gas flow and a fair oil well, probably five barrels per day, but not sufficient to be of commercial value. The well has been abandoned.

John H. C. Durham is drilling a well for gas on his own property at Bond lake, lot 64, concession I, Whitchurch township. Production is looked for in the Trenton limestone.

The Six Nations Indian Reserve, comprising all of Tuscarora township, Brant county, has been leased by Senator E. L. Michener; drilling has begun

[1]Ont. Dept. Mines, Vol. XXXIV, pt. 5, pp. 14-17.

on lot 13, concession III. Senator Michener states that he has determined the presence of both oil and gas in different sections of this township, by means of a divining rod. He is now drilling to confirm this discovery.

Another well that is being drilled for gas and oil on lot 20, concession III, Logan township, Perth county, by the Mitchell Oil Producing Syndicate was located by means of a divining rod, the property of Frederick Heitbohmer of Stratford. Mr. Heitbohmer stated that oil and gas would be encountered at 1,800 feet depth.

There are now three individuals or groups searching, by means of divining rods, for oil and gas in Ontario, but neither of these have been found in commercial quantities.

Analysis of Gas Consumption

Tables III and IV give details which show everything of interest concerning the gas consumed in Ontario. By comparing these tables with those published in previous years, the history of prices and quantity consumed can be traced from year to year. It will be found of interest to note the changes in the ratio of gas used to the price charged from year to year.

TABLE III—GAS CONSUMPTION IN TOWNS AND CITIES, 1925

Town or city	Population	No. of consumers		Quantity consumed, M cu. ft.			Distance from gas field	Net rate per M cu. ft.
		Pay	Free	Pay	Free	Industrial		
							miles	
Aylmer	2,300	675	....	30,412	.....	.....	16	$0.90-1.10
Bartonville	100	78	....	3,397	.....	.....	18	.50
Belle River	600	158	....	16,769	.....	695	29	.50- .85
Belmont	340	60	....	1,806	.....	.....	9	.85-1.00
Binbrook	100	13	....	2,319	.....	.....	1	.25
Blenheim	1,560	517	1	55,034	136	995	20	.50- .75
Brantford	30,190	3,309	3	84,505	1,606	6,013	140	.80
Bridgeburg and Fort Erie	4,112	974	5	34,307	866	94	8	1.00-1.50
Brigden	300	152	....	12,548	.....	1,655	30	.45- .50
Cainsville	400	52	....	2,444	.....	.....	4	.80
Caledonia	1,326	487	....	56,496	.....	.....	6½	.50- .60
Canfield	186	30	....	3,094	.....	.....	1	.35- .40
Cayuga	740	210	1	23,681	67	336	6	.50
Chatham	15,100	3,521	....	465,515	.....	4,814	22	.50- .75
Chippawa	1,078	183	....	3,436	.....	.....	5	1.00-1.50
Comber	608	146	....	16,833	.....	1,685	19	.50- .75
Courtland	400	31	....	279	.....	.....	3	.60
Courtright	441	124	1	14,617	238	258	49	.50- .75
Crystal Beach	252	99	....	8,278	.....	.....	1	1.00-1.50
Delhi	750	245	....	19,360	.....	1,061	4	.60
Dorchester	360	98	....	7,850	.....	.....	95	.60- .85
Dresden and Tupperville	1,450	481	1	52,538	77	607	30	.50- .75
Dundas	5,070	1,021	2	34,220	213	817	172	.70
Dunnville	3,605	968	7	114,570	1,030	14,284	7	.45- .50
Dutton	825	257	2	27,584	59	1,004	52	.55- .80
Echo Place	200	121	....	5,687	.....	.....	3	.80
Eden	88	28	....	1,995	.....	.....	11	.45
Essex	1,590	447	1	62,868	81	4,447	33	.50- .85
Fairground	40	14	....	659	.....	.....	1	.50
Fenwick	164	86	....	5,885	.....	.....	18	.75
Fingal	460	54	1	4,924	77	1,013	71	.55- .80
Fisherville	72	49	....	4,863	.....	591	2	.50
Fonthill	740	175	....	8,267	.....	.....	25	.95-1.20
Galt	13,222	967	1	40,069	234	3,989	147	.80
Grimsby	1,901	13	....	520	.....	.....	14	1.20

TABLE III—GAS CONSUMPTION IN TOWNS AND CITIES, 1925—*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	
Hagersville	1,200	386	....	37,650	.....	.....	13½	.50
Hamilton	120,234	23,085	....	[1]52,343	.....	253,719	47	.60-1.00
Hamilton West	.....	94	....	176	.....	.....	47	.75
Hepworth	330	20	....	650	.....	.....	1	.60
Highgate	410	117	1	13,991	118	.....	32	.50- .75
Ingersoll	5,000	982	1	55,672	191	1,375	100	.80
Jarvis	500	194	....	23,388	.....	.....	9	.50
Kingsville	2,500	688	3	102,211	642	2,646	30	.40- .50
Lambeth	475	98	....	6,385	.....	.....	84	.60- .85
Lake Shore	.....	300	....	7,706	.....	.....	16	1.00
Leamington	4,000	1,312	....	230,089	.....	2,518	20	.50
Lyndoch	151	43	....	4,447	.....	.....	2	.45
Mabee	82	9	....	679	.....	.....	14	.45
Merlin	350	145	1	18,030	296	1,095	2	.40- .65
Nelles	55	25	....	1,980	.....	.....	1	.50
Niagara Falls	15,400	2,193	....	35,770	.....	1,206	11	.65-1.00
Oil Springs	500	140	....	8,722	.....	.....	2	.75
Paris	4,345	479	....	17,538	191	1,471	129	.80
Petrolia	2,836	731	1	99,173	.....	1,202	60	.55- .80
Port Burwell	700	217	....	16,341	.....	.....	3	.60
Port Colborne and Humberstone	5,500	1,515	1	82,261	200	10,734	5	.80-1.00
Port Dover	1,575	532	....	57,590	.....	806	1	.45
Port Rowan	640	248	....	18,684	.....	.....	1	.60
Ridgetown	2,000	624	1	67,973	280	849	28	.50- .75
Ridgeway	700	255	....	14,823	.....	54	1	.65- .70
Rodney	676	248	2	26,563	606	497	40	.55- .80
Rosehill	.....	42	....	1,693	.....	.....	18	.65- .70
Ruthven	438	53	....	8,987	.....	.....	25	.40- .65
St. Ann	90	30	....	1,247	.....	.....	7	.90
St. Catharines	22,000	3,722	2	176,611	659	4,580	35	.75
St. George	569	127	....	4,992	.....	200	148	.80
St. Williams	319	102	....	6,658	.....	887	1	.60
Sarnia	15,176	4,178	....	377,212	.....	2,429	69	.50- .75
Selkirk	585	133	1	15,282	111	2,163	0	.50- .60
Shedden	409	89	....	8,105	.....	.....	63	.55- .80
Shetland	80	19	....	2,530	.....	.....	3	.40
Simcoe	4,000	1,463	3	210,728	371	13,656	20	.45
Smithville	332	170	....	9,045	.....	.....	6	.80
Sombra and Port Lambton	2,000	171	....	17,327	.....	696	45	.55- .80
Stevensville	423	81	....	6,995	.....	.....	1	.65- .70
Straffordville	215	84	....	8,822	.....	.....	6	.45
Tecumseh	1,200	208	....	25,304	.....	.....	50	.50- .75
Thorold	7,624	640	....	29,825	.....	.....	35	.75
Tilbury	2,000	384	1	43,404	234	589	717	.50- .75
Tillsonburg	3,086	951	1	69,633	165	1,096	16	.60- .85
Vienna	284	78	1	5,890	40	.....	1	.80-1.00
Vittoria	260	72	....	5,762	.....	.....	3	.45
Welland	8,646	2,059	3	88,320	205	.....	3	1.00-1.50
Wallaceburg	4,530	1,022	1	122,168	110	27,93?	27	.50- .75
Wallacetown	254	56	1	4,616	24	708	60	.55- .85
Wellandport	141	31	1	953	210	.....	3	.75
West Lorne	818	227	3	26,048	278	1,131	49	.55- .80
Wheatley	647	233	....	29,125	.....	833	12	.50- .75
Windsor (Border Cities)	60,625	9,015	....	973,953	.....	12,912	44½	.55- .80
Woodstock	10,196	1,677	1	67,686	352	1,972	110	.80
Total	.....	77,640	56	4,577,385	9,967	4,981,666	.....	.....

[1]Natural gas ceased to be used in Hamilton in March, 1925; it was mixed with manufactured gas during this period.

TABLE IV—GAS CONSUMPTION IN TOWNSHIPS, 1925

Township	Population	No. of consumers		Quantity consumed, M cu. ft.			Rate per M cu. ft.
		Pay	Free	Pay	Free	Industrial	
ESSEX:							
Gosfield, North	2,190	158	4	20,770	347	.....	$0.40- .50
Gosfield, South	2,301	242	.....	37,042	.....	25,424	.40- .50
Maidstone	2,099	19	6	8,030	1,254	.....	.55- .80
Rochester	1,951	185	1	15,887	101	1,347	.55- .80
Sandwich, South	1,423	68	.....	7,609	.....	703	.55- .80
Sandwich, West	2,764	11	.....	1,687	.....	.....	.55- .80
Sandwich, East	1,090	150	2	20,056	310	.....	.55- .80
Mersea	3,835	282	2	42,654	617	60,163	.40
Tilbury, North	1,788	17	1	1,533	159	58	.50- .75
Tilbury, West	1,543	16	.....	1,185	.....	.....	.50- .75
LAMBTON:							
Enniskillen	2,666	70	.....	6,610	.....	1,115	.55- .80
Moore	3,215	300	.....	27,529	.....	2,288	.50- .75
Sombra	2,857	53	.....	4,270	.....	926	.50- .75
Sarnia	2,540	5	9	500	2,015	.....	.45
Euphemia	1,385	.....	8	.....	2,000	.....	.45
Dawn	2,317	35	4	3,351	816	.....	.40- .65
KENT:							
Raleigh	3,671	646	52	74,584	12,643	392	.35- .75
Tilbury, East	2,914	123	86	25,356	32,070	11,869	.40- .65
Romney	1,500	104	17	11,975	4,672	.....	.40- .65
Harwich	4,372	418	9	40,189	2,684	.....	.50- .75
Orford	1,870	26	3	4,806	418	.....	.50- .75
Howard	2,768	192	7	23,057	2,961	.....	.50- .75
Chatham	4,935	82	.....	9,097	.....	1,375	.50- .75
Camden	2,078	10	.....	715	.....	.....	.50- .75
Dover	3,606	389	1	45,240	160	1,660	.40- .65
ELGIN:							
Aldborough	2,837	27	.....	2,669	.....	.....	.55- .80
Dunwich	2,522	59	1	6,029	51	.....	.55- .80
Southwold	3,510	119	.....	9,671	.....	1,482	.55- .80
Malahide	2,953	60	.....	2,462	.....	.....	.60
Bayham	3,112	69	25	4,374	3,709	.....	.45
MIDDLESEX:							
Westminster	6,122	138	.....	15,437	.....	.....	.60- .85
Dorchester, North	3,056	27	1	1,792	14	.....	.60- .85
NORFOLK:							
Middleton	2,037	4	4	355	732	.....	.60
Walsingham, South	1,481	7	7	317	1,279	.....	.60
Walsingham, North	1,424	4	4	288	753	.....	.50
Charlotteville	2,512	4	4	193	728	.....	.45
Windham	3,005	2	2	180	357	.....	.45
Woodhouse	1,964	163	13	16,107	2,366	.....	.45
Townsend	3,694	34	.....	4,336	.....	.....	.45
BRANT:							
Onondaga	1,017	55	16	3,030	3,253	.....	.60
Dumfries, South	2,532	6	.....	212	.....	.....	.80
Brantford	7,220	12	.....	290	.....	.....	.60
Burford	3,833	4	.....	302	.....	.....	.60
OXFORD:							
Oxford, West	1,724	22	.....	1,448	.....	.....	.80
Oxford, East	1,810	7	.....	518	.....	.....	.80

TABLE IV—GAS CONSUMPTION IN TOWNSHIPS, 1925—*Continued*

Township	Population	No. of consumers		Quantity consumed, M cu. ft.			Rate per M cu. ft.
		Pay	Free	Pay	Free	Industrial	
HALDIMAND:							
Canborough	902	83	43	7,069	8,543	432	.50
Moulton	1,628	194	47	14,360	9,721	.....	.50
Seneca	1,561	138	49	13,924	8,815	.....	.50
Cayuga, North	1,309	46	20	4,733	3,499	.....	.50
Cayuga, South	509	63	21	4,250	4,243	.....	.50
Rainham	1,690	150	29	16,611	5,515	52	.50
Sherbrooke	277	48	11	5,213	1,745	.....	.45- .50
Dunn	796	112	12	11,038	2,198	.....	.50
Walpole	3,042	291	51	31,709	9,147	1,215	.50
Oneida	1,287	66	13	7,718	2,418	.....	.50- .60
LINCOLN:							
Caistor	1,220	43	3	4,816	589	79	.50
Gainsborough	2,091	16	.....	1,261	.....	.....	.75
Grimsby	2,236						.75
Louth	2,548	9	.....	639	.....	.....	.75
Grantham	4,175	15	1	1,103	291	.....	.75
WELLAND:							
Wainfleet	2,357	60	34	2,802	6,397	.....	.40- .70
Humberstone	2,047	137	50	10,954	7,540	.....	1.00-1.50
Bertie	3,298	133	76	11,601	11,324	.....	1.00-1.50
Pelham	2,359	31	7	2,232	2,038	.....	.75
Thorold	3,369	5	1	330	209	13,786	.35- .50
Willoughby	865	32	29	2,687	4,356	.....	1.00-1.50
Crowland	3,748	66	28	4,704	5,504	.....	1.00-1.50
Stamford	4,896	268	3	3,844	456	.....	1.00-1.50
WENTWORTH:							
Binbrook	1,098	65	29	8,077	5,667	418	.50
Glanford	1,417	119	11	17,223	1,910	616	.50
Barton	7,658	1,044	.....	78,129	.....	14,424	.50
Ancaster	4,524	53	.....	3,898	.....	.....	.40- .70
Saltfleet	4,682	15	.....	1,715	.....	412	.50
Total	.....	7,783	857	776,382	178,594	140,774	.....

SUMMARY	M cu. ft.
Total distribution	6,077,416
Used by private well owners	74,000
Used by companies for all purposes	64,586
Leakage on transmission lines	432,728
Leakage in distribution plants	544,260
Leakage on rural lines	64,284
Total amount of gas produced	7,257,274

Orifice Meters

An exhaustive study of the theory and use of orifice meters for measuring large volumes of gas at high pressure is being made at the present time. Tests are being carried out at many points on this continent and the work of the different makers of orifice meters correlated. The work to date is proving the merits of this instrument for the purpose that it was intended to fulfil, but it is pointing out conditions under which it will not register accurately and the simple means by which these conditions may be avoided. Many meters were incorrectly installed in the past and did not register accurately.

Pipe Corrosion

The need of using some material or some method to prevent corrosion of the pipe lines that convey the natural gas has become apparent. Tests are being carried out and different materials are being experimented with. An examination of pipes that have been in use from one to fifteen years shows that loamy soils, where the water level constantly rises and falls, accelerate corrosion, while dry, sandy soils retard it. There are, however, many exceptions to this, and it is believed that the material used in the pipe may contribute to corrosion, but that in the main, it is caused by weak electrical currents set up between the pipe and certain chemicals in the soil and that this action is accelerated by rising and falling water levels. Cinders, broken brick, and tile are especially to be avoided for back-filling trenches in which pipes are laid; dry sand is best for this purpose, and it should be tamped under the pipe in order to prevent water from finding its way along the bottom of the pipe and using the trench



A crude method of preventing water from freezing in winter—one way in which the use of free gas was formerly abused in Kent county. The gas flame from end of pipe is projected against the side of the metal water-tank and a piece of sheet iron protects the flame from the wind. Note carbon black on the tank due to partial combustion.

for a channel. This was demonstrated in the case of a section of large-sized pipe, laid in clay but buried deeper than the pipe on either end of the section; the earth was not tamped under the pipe, which was found lying in water, while that on either end was above the water. It was apparent that water had accumulated all along the bottom of the pipe, causing deep pit-holes, while on the top and sides it was in perfect condition; in fact, it was practically the same weight as when laid. The pipe on either end of this section was laid in the same sort of clay, but not so deep; it was in a good state of preservation. Where pipes are laid through "made" soils in places that have been filled in, the corrosion is found to be serious and the pipes are deeply pitted. There is a depth at which pipe should be laid if it is to be preserved. This is, apparently, below the frost-line and above the line of saturation. It may be profitable to drain wet places where ditches would be inexpensive. Where these conditions cannot be found

and if the pipe is to remain for many years, it is best to coat the pipe with some material that will prevent or retard corrosion. It may also be advisable to analyse soils and water, mainly for sulphides, carbon dioxide, and chlorides.

The gas industry is now turning its attention to materials that prevent corrosion. The problem in coating new pipes is to find a material that is easily applied, will not rub or chip off when the pipe is being lowered into a trench, and is inexpensive. In treating second-hand pipe, there is an additional problem, that of removing the rust and leaving a clean surface on which to apply the coating. Most materials in use are varieties of tar and are put on hot; in some cases the pipe is wrapped with a fabric or tough paper to prevent damage while the pipe is being handled.

Helium in Ontario

One mile north of the village of Inglewood in Caledon township, Peel county, there are three gas wells. The gas in these wells contains eight-tenths of one per cent. helium. These are the only gas wells in the British Empire from which helium may be obtained in commercial quantities with our present knowledge and technique.

The gas in Woodhouse township contains four-tenths of one per cent. helium, and the helium in the remainder of the natural gases of Ontario ranges from 0.33 per cent. to a mere trace.

In 1916, a survey of the gases of Ontario for helium was made by Professor J. C. McLennan,[1] of Toronto University, to secure a supply of helium, for war purposes, within the Empire.

In 1923, another survey was made by R. T. Elworthy[2] to bring this information up to date. In this latter survey many small fields previously overlooked and all occurrences of gas in the surface drift were examined; the analysis of these and the helium content can be found by referring to Elworthy's report, a summary of which is given below.

[1]Report on Some Helium Resources of the British Empire, Mines Branch, Dept. Mines, Canada, Bull. No. 31, 1920; Trans. Chem. Soc., Vol. 117, 1920.

[2]R. T. Elworthy, Helium Resources of Canada, Mines Branch, Dept. Mines, Canada, July 27, 1925.

TABLE V—HELIUM IN ONTARIO GAS WELLS

Well	Township	Con.	Lot	Producing formation[1]	Depth	Helium per cent.
		LAMBTON COUNTY				
					feet	
L. Wilson, Craig No. 1	Sarnia	VII	13	Onondaga	465	0.06
" Griffin No. 1	"	VII	8	"	470	0.07
" Griffin No. 2	"	VII	8	"	471	0.20
" Blunden No. 1	"	VII	19	"	585	0.04
Dominion Alloy Steel Corpn	"	R.R.	2	Surface drift	100	0.03
Oil Springs Oil & Gas Co., No. 7	Enniskillen	II	19	Trenton	3,571	0.19
" " " No. 6	"	II	19	Whirlpool sandstone	2,035	0.19
Fairbanks well	"	II	18	" "	1,898	0.15[2]
Oil Springs Oil & Gas Co., No. 2	"	II	18	.....	1,800	0.14[2]
Union Nat. Gas Co., No. 7	Dawn	VIII	25	Niagaran	1,842	0.29
" " " No. 6	"	V	24	"	1,905	0.21
" " " No. 4	"	IV	23	"	1,614	0.18
" " " No. 3	"	V	24	"	1,615	0.14
" " " No. 1	"	VII	24	"	1,580	0.14

See footnotes on page 14

TABLE V—HELIUM IN ONTARIO GAS WELLS—*Continued*

Well	Township	Con.	Lot	Producing formation[1]	Depth	Helium per cent.
					feet	
KENT COUNTY						
Union Nat. Gas Co., No. 13	Dover W.	III	3	Trenton	3,000	0.13
" " " No. 112	Tilbury E.	XIV	8	Guelph or Salina	1,398	0.08
" " " Askew well.	"	Talbot Rd.	173	" "	1,372	0.18[2]
" " " Haliday well	"	XIII	10	" "	1,260 1,383	0.11[2]
" " " Haliday No. 216.	Romney	Talbot Rd.	183	" "	1,285	0.19
" " " Declout	Raleigh	Talbot Rd.	146	" "	.....	0.11
" " " No. 105	"	"	162	" "	1,405	0.10
J. B. Bennett No. 2	Howard	XI	4	Surface drift	100	0.03
Pipe line gas, Port Alma (unpurified)	.....	.....	....	.....	.....	0.11
ESSEX COUNTY						
B. Jasperon, Kingsville	Gosfield S.	I	2, 3	Guelph or Salina	900	0.15
ELGIN COUNTY						
Medina Nat. Gas Co., main line	Bayham	Vienna	....	Clinton	.....	0.25
" " " Richmond No. 1	"	V	1	"	1,275	0.26
" " " No. 2	"	II	14	"	1,398	0.22
" " " No. 5	"	III	10	"	1,308	0.24
NORFOLK COUNTY						
					feet	
Dominion Nat. Gas Co., Port Rowan.	Walsingham S.	VIII	12	Clinton	1,271	0.37
Dom. Nat. Gas Co., J. B. Brown No. 1.	Walsingham N.	XIV	21	"	1,175	0.38
" " " Charlton No. 1	Windham	XIII	24	"	1,113	0.33
Port Dover Town well	Woodhouse	I	12	Grimsby sandstone	961	0.34
Dom. Nat. Gas Co., Port Ryerse Boyd	"	I B.F.	12	" "	1,100	0.43
" " " Wedlake, Port Dover	"	.....	....	Clinton	1,018	0.32
" " " Dixon No. 1.	"	I	7	Grimsby sandstone	1,021	0.42
" " " H. Williams	"	B.F.	4	Grimsby & Whirlpool sandstone	1,058	0.45
" " " W. Holloway.	"	IV	6	Clinton and Grimsby	990	0.30
" " " J. Livesay No. 1.	"	III	7	Grimsby sandstone	1,039	0.35
" " " P. Boulter	"	II	7	Clinton and Grimsby	1,027	0.39
" " " W. Mitchell	"	VI	15	Clinton & Whirlpool sandstone	890 930	0.42

TABLE V—HELIUM IN ONTARIO GAS WELLS—*Continued*

Well	Township	Con.	Lot	Producing formation[1]	Depth	Helium per cent.
NORFOLK COUNTY						
					feet	
Dom. Nat. Gas Co., J. Fisher No. 1	Middleton	II	16	Clinton	1,253	0.27
" " " A. Teller	"	II	15	"	1,246	0.29
" " " A. Quance	"	II	43	"	1,109	0.39
" " " L. Oakes	Charlotteville	III	24	"	1,129	0.38
" " " Roberts No. 1	"	XI	4	"	1,204	0.40
" " " Yomans No. 1	Townsend	XIV	16	Clinton & Whirlpool sandstone	.....	0.52
Pipe line gas, Simcoe from Delhi-Lyndoch field	.....	.....	....	.....	.....	0.38
Pipe line gas, Simcoe from Woodhouse tp	.....	.....	....	.....	.....	0.39
Pipe line gas, Simcoe	.....	.....	....	.....	.....	0.39
BRANT COUNTY						
Pipe line gas, Onondaga main, taken at Brantford	Brant	.....	....	.....	.....	0.25[2]
Pipe line gas, Onondaga-Middleport main	.....	.....	....	.....	.....	0.32[2]
H. Hunter, No. 1	Oakland	I	2	Clinton	730	0.31
WELLAND COUNTY						
Dom. Nat. Gas Co., W. Wills	Wainfleet	V	31	Medina-Cataract	.....	0.34
" " " J. Snyder	"	V	30	" "	.....	0.26
Sterling Gas Co., Menoah No. 1	Humberstone	III	31	" "	.....	0.25
" " pipe line to Port Colborne	"	.....	....	" "	.....	0.31
Prov. Nat. Gas Co.'s main pipe line to Niagara Falls.	Humberstone and Bertie	.....	....	.....	.....	0.24
Prov. Nat. Gas Co., Pt. Abino well	Bertie	.....	....	Whirlpool	902	0.34
" " " Port Abino well	"	.....	....	.....	.....	0.26[2]
" " " No. 471	"	XIII	7	Medina-Cataract	700 800	0.23
" " " No. 382	"	.....	....	.....	.....	0.28[2]
" " " No. 61	Willoughby	IV	2	Trenton	2,940	0.09
" " " No. 61	"	IV	2	"	2,940	0.11[2]
" " " No. 199	Crowland	IV	3	Clinton	700	0.25
Main pipe line, Niagara Falls, average seven analyses	.....	.....	....	.....	.....	0.24
PEEL COUNTY						
G. Henry farm, well 1	Caledon W.	I W.C.R.	4	Dundas shale (Lorraine)	350 500 935	0.79
" " well 2	"	I W.C.R.	5	" "	590	0.80
J. Graham farm, well 1	"	W.C.R.	6	" "	545	0.82

TABLE V—HELIUM IN ONTARIO GAS WELLS—*Continued*

Well	Township	Con.	Lot	Producing formation[1]	Depth	Helium per cent.
HALDIMAND COUNTY						
					feet	
Dom. Nat. Gas Co., Laidlaw No. 2	Walpole	VII	18	Clinton	790	0.33
" " " Shoup No. 1.	"	III	14	Whirlpool sandstone	1,005	0.30
" " " E. A. Wright.	"	VIII	16	Grimsby sandstone	800	0.29
" " " W. Edsel....	"	Peacock pt.	15	Clinton	900	0.26
Pipe line between con. V and VI fed by 12 wells.....	"	.....	....	.....	.....	0.28
Gas from regulating station, Selkirk.....	"	.....	....	.....	.....	0.35
Gas from Selkirk-Caledonia pipe line.....	"	.....	....	.....	.....	0.26
Dom. Nat. Gas Co., W. Austin...	Rainham	I	24	Clinton	850	0.26
" " " J. J. Hoover No. 1.....	"	I	2	Grimsby	815	0.28
" " " G. Nagel No. 1.....	"	II	13	"	790	0.24
Dom. Nat. Gas Co., 6-in. line, Rainham road between con. I and II.....	"	.....	....	.....	.....	0.30
Dom. Nat. Gas Co., H. Kramp...	Cayuga S.	VI	18	Clinton	800	0.28
" " " J. Bowden, Earlstract.	Dunn	XVI, XVII	18	"	.....	0.30
" " " W. Burch....	Moulton	N.F.R.	15	Whirlpool sandstone	676	0.27
" " " F. Speck....	"	II	1	.....	.....	0.26
" " " W. Dolan....	"	I	15	.....	.....	0.26
" " " C. Ackland..	"	II	15	Whirlpool sandstone	720	0.30
" " " A. Riley.....	"	N.F.R.	24	.....	.....	0.22
Maple Leaf Oil & Gas Co., F. Dicout.....	"	III	10	.....	.....	0.24
Dom. Nat. Gas Co., C. VanKuren	Canborough	III	5	Whirlpool sandstone	650	0.26
" " " J. M. Allen..	"	II	14	.....	.....	0.33
" " " H. A. Lymburner....	"	III	3	.....	.....	0.27
" " " T. Finch No. 1.....	"	I	15	Whirlpool sandstone	535	0.38
" " " J. Potts, No.2	"	I	11	" "	600	0.26
Main line Canboro Gas and Oil Co., meter house.....	"	.....	....	.....	.....	0.31
Bird Road regulating station.....	"	.....	....	.....	.....	0.22
Winger regulating station.....	"	.....	....	.....	.....	0.31
Dom. Nat. Gas Co., C. K. Medlicott.	Cayuga N.	III	7	Clinton and Grimsby	590 625	0.35
" " " W. Martin No. 1...	Oneida	III	24	Clinton	680	0.32
" " " J. Thompson No. 1...	"	R.R.	64	Medina-Cataract	543	0.34
" " " P. Yuile No. 1	"	B.F.	38	Clinton and Whirlpool	589	0.32
Collecting line feeding Selkirk-Caledonia pipe line.....	"	.....	....	.....	.....	0.31
Dom. Nat. Gas Co., W. Robinson.	Seneca	II	15	.....	.....	0.29
" " " 15 wells.....	"	V	....	Clinton	.....	0.32
A. Emerson.....	"	Young	3	Clinton and Grimsby	523 589	0.26
4-inch pipe line to Blackheath....	Seneca and Oneida	.....	....	Clinton and Grimsby	.....	0.31

TABLE V—HELIUM IN ONTARIO GAS WELLS—*Continued*

Well	Township	Con.	Lot	Producing formation[1]	Depth	Helium per cent.
					feet	
LINCOLN COUNTY						
Dom. Nat. Gas Co., W. C. Lymburner.	Caistor	.....	....	Clinton and Whirlpool	422 522	0.24
6-inch line to Blackheath.....	"	.....	....	Clinton and Whirlpool	.....	0.26
Prov. Nat. Gas Co., W. Beattie...	Binbrook	IX	26	Grimsby and Whirlpool	395 460	0.35
" " " H. Johnston.	"	IV	5	" "	430	0.21
Dom. Nat. Gas Co., J. Berry No. 1	"	IX	31	Clinton and Whirlpool	.....	0.33
Gas from Blackheath regulating station.....	"	.....	....	" "	.....	0.31
Dom. Nat. Gas Co., J. Walker No. 3.....	Glanford	VIII	14	Clinton	363	0.25
SIMCOE COUNTY						
M. Jackson farm.....	Tecumseth	.....	1	Surface	250	0.01

[1]The latest nomenclature has been used in naming the producing formations. In order that those unaccustomed to these may identify them easily, the following equations in terms are given:—

New Name	Old Name
Grimsby sandstone.....	Red Medina sandstone.
Whirlpool sandstone.....	White Medina sandstone.
Dundas shale.....	Lorraine (Hudson River) shale.
Medina-Cataract.....	All formations below the Clinton and above the Queenston red shale.

[2]J. C. McLennan, Mines Branch, Dept. Mines, Canada, Bull No. 31, 1920. The rest of the data in the last column is taken from the Mines Branch Investigations on Natural Gas, August, 1925, by R. T. Elworthy.

NOTE.—A fair index to the presence of helium in a natural gas appears to be a high nitrogen content and a fairly shallow depth.

Following the 1916 survey, an experimental plant was built outside Hamilton. A process for extracting helium was developed here, but the gas was found to contain too great a percentage of heavy hydro-carbons. The gas from the Bow Island field in Alberta was found to be more suitable, and the plant was moved to Calgary, Alta. Considerable helium was recovered. The plant was closed down in 1919, as there was no further necessity for operating it after the European war had ceased.

The gas in the Inglewood field is more suitable for helium extraction than most natural gases, on account of the very small quantity of ethane and higher hydro-carbons in it. The open flow of the three wells now capable of producing natural gas is 385,000 cubic feet per day, and the rock pressure is about 50 pounds. The gas is found in the Dundas (Lorraine) shales of Ordovician age at from 400 to 600 feet below the surface. There does not appear to be any particular underground structure that would tend to form a point of accumulation. It is presumed that bands of crystalline limestone or sandy shales form the reservoir, such limestone and sandy shales being known to exist in this formation.

The rock pressure is not sufficient to force gas through a pipe line for any distance, and any hope of developing a commercial gas field was given up. The wells were for sale, and as no scientific body could be induced to purchase the property, it was bought by the Province of Ontario in order to keep the helium for future scientific use. At the time of writing there is every probability that the University of Toronto, with the assistance of the Honorary Advisory Council for Scientific and Industrial Research, the Mines Branch at Ottawa, and some other bodies, will erect a plant for recovering helium and using it for research work.

The principal use for helium at present is for inflating airships; the gas is non-inflammable and is almost as buoyant as hydrogen. The total world's supply for this purpose is in the United States. An atmosphere of oxygen and helium is used instead of oxygen and nitrogen in deep sea diving and in all places where men work with compressed air. It is said that the danger of "compressed air" sickness is to a large extent eliminated with the use of this gas. Helium is also used for obtaining very low temperatures in laboratory work. It becomes liquid at 268.5 C. (—451.3 F.). On account of its conductivity and its non-inflammability its uses are manifold; it is used especially for cooling electrical generators and other electrical equipment. In the liquid state or solidified (if it can be solidified) scientists speculate that helium, which as a gas is inert, may become metastable and that many valuable chemical combinations may yet be found. As an aid to research it presents a new and vast field, the future of which can only be predicted.

There have been only four wells drilled in this gas field at Inglewood, all of which were producers, but of these one has since been abandoned on account of an accident to the casing which allowed water to flood the gas horizon. Where the limits of the field are, no one knows; and only by drilling more wells can it be discovered.

Gas versus Electricity

Table VI gives the results of tests made by the Chatham Gas Company, comparing the service rendered by gas and electricity on a basis of time, quantity used, and cost. On the average, electricity will give the same service with less heat, but the cost of electricity is greater than the cost of gas.

TABLE VI—COMPARISONS OF GAS AND ELECTRICITY

Test	Time	Gas used	Electricity used	B.t.u.	Cost of gas	Cost of electricity
	hr. min.	M cu. ft.	k.w. hrs.		cents	cents
No. 1	19	3	.....	3,120	0.225	.....
No. 1 (a)	26	.....	0.6	2,049.6	.....	0.75
No. 2	10	4⅓	.....	4,506.6	0.325	.....
No. 2 (a)	26	.....	1,600	5,466	.....	.2
No. 3	54	30	.....	31,200	2.5	.....
No. 3 (a)	2 21	.....	8	27,328	.....	10

Gas was valued at 75 cents per thousand cubic feet.

Electricity was valued at 1¼ cents per kilowatt hour.

Nos. 1 and 1 (a) were tests of increasing the temperature of water in a vessel on top of a gas range, beginning at 44°F. and finishing at 210°F.

Nos. 2 and 2 (a) were tests of increasing the temperature of a range oven from 100°F. to 450°F. The oven thermometer was checked with a standard mercurial thermometer.

Nos. 3 and 3 (a) were tests of increasing the temperature in a 30-gallon hot-water tank, not insulated, from 40°F. to 160°F. The gas heater was a copper-coil type, and the electric heater was a totally immersed element.

As an equivalent of 1,000 cubic feet of gas, S. S. Wyer[1] gives 322 k.w. hours of electricity. He does not say how this comparison is made, but no doubt it is an average figure.

In the above tests the ratio would be:—

1. For heating water on the top of a cook-stove, 1,000 cubic feet of gas equals 266 k.w. hours.

2. For heating an oven, 1,000 cubic feet of gas equals 369.5 k.w. hours.

3. For heating water in a hot-water tank, 1,000 cubic feet of gas equals 266.6 k.w. hours. This averages 311 B.t.u. and compares very favourably with Wyer's figures.

The difference in case No. 2 is explained by the fact that the burnt gas goes directly through the oven, whereas in No. 1 and No. 3 much of the heat may escape through the flue without being transmitted to the water that is to be heated; otherwise the electrical appliances did the work with less heat (B.t.u.) but at a greater cost.

Improvements Made during the Year

As a result of the frequent inspections of plants, the surveys for leakage and the general reduction in gas pressures, great improvements have resulted, some of which are noted hereunder:—

The Union Natural Gas Company, having purchased the distribution plant of the Sarnia Gas Company at Sarnia, proceeded to make the many improvements which the latter company had planned but which they had not sufficient finances to carry out.

Two new regulators were added to the intermediate pressure system in new sections of the city and the following pipe was laid: 800 feet of 8-inch and 6,600 feet of 4-inch. This completes a circle of intermediate pressure line around the border of the city.

To the low pressure plant 600 feet of 2-inch pipe was added, and some 119 services of 1-inch and 1¼-inch pipe were renewed.

The consumers in Sarnia now have good service even if the pressure in the transmission lines drops as low as eight pounds at the outskirts of the city. Before improvements to the plant were commenced two years ago, the pressure necessary to give good service was 25 pounds, or three times the present necessary pressure.

In Chatham, the Chatham Gas Company laid 1,000 feet of 3-inch pipe to replace 2-inch pipe.

The Wallaceburg Gas Company reports having laid 103 feet of 4-inch pipe to replace 3-inch and 6,244 feet of 2-inch, about half of which replaced smaller sizes, the remainder being in streets that previously had no cross-connection. The company also installed a new 2-inch regulator for summer use only.

The Southern Ontario Gas Company in Kingsville relaid 500 feet of 1-inch pipe with 2-inch pipe and replaced 26 service lines with 1¼-inch pipe.

The failing service in Aylmer was restored by the addition of three wells drilled in Middleton township and connected to the mains of the Central Pipe Line Company by the laying of 8 miles of 5-inch pipe. This work was completed on January 29, 1926.

The Manufacturers Gas Company in Hagersville laid half a mile of 3-inch line to replace smaller sizes in a portion of the town where pressure and service had been poor in cold weather.

[1]Ont. Dept. Mines, Vol. XXXI, pt. 5, p. 32.

The Port Colborne-Welland Company in Caledonia laid 1,800 feet of 3-inch pipe to replace the same length of 2-inch pipe and to connect some "blind ends," thereby securing service from two directions and doubling the flow in small pipe lines. "Services" into houses, numbering in all 15, were relaid with larger pipe.

In St. Catharines, the United Gas Companies renewed one mile of 2-, 3-, and 4-inch pipe that was in poor repair and laid 65 services.

In Port Colborne, the Sterling Gas Company laid 400 feet of 4-inch pipe and 1,600 feet of 2-inch, to improve the service in a new district, and 750 feet of 2-inch pipe was laid to replace 1-inch. One hundred new houses were supplied with gas service.

The Provincial Natural Gas and Fuel Company, facing a small flow of gas at lower field pressures each year and supplementing their supply with manufactured gas purchased from Buffalo,[1] find it necessary to make a most particular survey of their distribution plants in order to deliver sufficient gas to their consumers at these lessened pressures.

In Welland, 1,400 feet of 6-inch and 2,800 feet of 3-inch pipe were laid as an intermediate pressure line to a new regulator installed on the northwest side of the Welland river. Twelve new services were laid.

In Bridgeburg and Fort Erie, some 2,000 feet of 3-inch pipe line was laid on Queen Street, making a double line and greatly improving the service. Twelve new services were installed.

In Niagara Falls, extensive plans for improvements are being made; the work will probably be begun during the next summer season.

The Union Natural Gas Company relaid most of the 3-inch field lines in the Dover (Kent) gas field with 4-inch, and are taking steps to continue this work over the transmission lines. This company purchased about six miles of privately owned lines and relaid them with larger and better pipe. These private lines had become very leaky and were a source of great waste.

The purification plant built at Port Alma last year and put into service in December of 1924 has been improved, as a result of the experience of one winter and summer. This is the first attempt to purify a large volume of gas at high pressure and is somewhat in the nature of an experiment. It has been a source of relief to gas consumers, who have suffered from the odour of this gas for nineteen years.

The educational work among all consumers has been carried on as in past years, and a much better feeling has been created.

As noted on page 43, the Union Natural Gas Company and the Southern Ontario Gas Company plugged back the oil in their deep Trenton gas wells in order to give improved service to their gas consumers.

The pipe line from the Petrol Oil and Gas Company's wells to Glenwood was removed following the termination of the agreement under which it was laid. The gas from these wells is now taken into the pipe line that conveys gas to Sarnia.

The Union Natural Gas Company report the following improvements:—

Highway improvements necessitated the removal of about 25 miles of 8- and 10-inch high pressure line from the Kent field to Windsor. This was repaired before being put back.

In the town of Tecumseh they replaced 700 feet of 2-inch with 3-inch pipe and added about 2,000 feet of 2-inch pipe by way of extension and "tie-ins" to complete circuits; also in Belle River, 600 feet of 2-inch pipe was added for the same reason. In St. Joachim village, pipes were enlarged from 2-inch to 3-inch;

[1]Ont. Dept. Mines, Vol. XXXIV, pt. 5, p. 18.

and in Courtright, 3,500 feet of 5 5/8-inch was replaced by 4- and 6-inch pipe. In Brigden, half a mile of 2-inch pipe was relaid with 3-inch, and 800 feet of 6-inch intermediate pressure line was laid. The Sombra line was renewed. A group of gas consumers at Pillette, who had been served individually from the high pressure main, were given a separate low pressure system, consisting of half a mile of 3-inch line.

The leaks repaired by the Union Natural Gas Company during the year on their system numbered 1,256; of these, 707 required renewed pipes and the remainder repairs of a temporary nature, clamps, etc. Some 585 leaks in service lines were repaired.

The Dominion Natural Gas Company report as follows: Low pressure distributions have been laid in the village of Courtland in Middleton township, and in West Hamilton, Ancaster township. Meters were installed at the town borders of Mount Hamilton and Wheatley, and an orifice meter was put in at Winger Station to check the leakage on the St. Catharines high pressure line. The Port Alma meter was rebuilt for the same purpose. A 6-inch pipe line, 5 miles in length, was laid to connect the new gas field in Middleton township to Tillsonburg. Systematic leakage surveys were conducted over all these distribution systems. An engineering department is being organized to improve the method of burning gas so that more consumers may be served with a lesser volume of gas. A start was made by attempting to improve the method of burning gas in tobacco kilns at a much lower pressure.

Leakage

The following tables show the leakage of natural gas from distribution and transmission lines, separated into three parts, based on the pressure carried The rural distribution is again separated from the urban distribution on a pressure basis.

This is not by any means all of the leakage in Ontario, but only that which can conveniently be measured. Where gas wells are widely scattered, as in Norfolk, Haldimand, and Welland counties, it is out of the question to measure the gas, as at best only a very small percentage of the pipe line could be included in the leakage. All the towns and cities have measuring stations at the town border, and a very close check is kept on the leakage.

Since the last report published, much has been learned about the use and setting of orifice meters, which has resulted in the rebuilding of practically all of these in use. New devices have been invented, and more accurate methods of recording and calculating have been found. This, along with the discovery that a very considerable quantity of gas was leaking through closed valves and was not being measured, has greatly increased the measured leakage. There is no such increase in the total leakage as a comparison of years would show, but the full extent of the leakage has been discovered, where the gas is measured both into and out of a pipe line or distribution plant.

The natural gas industry has made great strides in checking leakage during the past year. The practice of surveying distribution plants has been instituted in Ontario; this is done by entirely closing off all consumers and segregating a section of a plant from the remainder of the system with the exception of one point; at this point a meter and pressure gauge or pressure-gauge, dead-weight tester is placed, and any gas that passes through must represent leakage. Occasionally this discloses an unknown connection or "tie-in," or the fact that some one is stealing gas. This method of measuring leakage has been used for many years in England and in the United States in the manufactured gas industry. It is perhaps one of the most useful contributions of that industry to the natural gas industry.

TABLE VII—LEAKAGE IN DISTRIBUTION PLANTS, 1925

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 per sq. in.
					Actual	Allowable			
			M cu. ft.	M cu. ft.	M cu. ft.	M cu. ft.		cu. ft.	
Belle River	Union Natural Gas Co	3.25	17,757	17,462	295	650	158	1,867	5
Blenheim	Union Natural Gas Co	11.1	62,171	56,165	6,006	2,225	517	11,616	5
Brantford	Brantford Gas Co	91.53	107,967	92,124	15,843	18,306	3,307	4,791	4-5
Chatham	Chatham Gas Co	54.5	568,146	470,329	97,817	10,900	3,600	27,171	4-5
Dresden	Union Natural Gas Co	12	62,785	53,222	9,563	2,400	483	19,799	5
Dundas	Dominion Natural Gas Co	11.83	45,037	35,056	9,981	2,366	1,015	9,833	2-4
Dunnville	Dominion Natural Gas Co	13.17	130,869	117,814	13,055	2,634	973	13,417	4-6
Eden	Dominion Natural Gas Co	.48	2,161	1,997	164	96	28	5,857	5
Essex	Union Natural Gas Co	7.5	75,138	67,396	7,742	1,475	447	17,320	4-6
Fenwick	Dominion Natural Gas Co	2.09	7,327	6,429	898	418	93	4,494	5
Galt	Dominion Natural Gas Co	30.59	50,516	44,292	6,224	6,118	995	6,256	4-6
Hagersville	Dominion Natural Gas Co	7.24	52,858	37,650	15,208	1,448	388	39,196	6
Ingersoll	Ingersoll Gas Light Co	22.14	58,200	55,808	2,392	4,428	926	2,583	4-5
Kingsville	Southern Ontario Gas Co	14.59	114,768	103,732	11,036	2,918	690	15,994	4-5
Leamington	Corp. Town of Leamington	25.47	246,937	232,607	14,330	5,094	1,316	10,888	6-10
Paris	Dominion Natural Gas Co	13.54	23,751	19,418	4,333	2,708	471	9,200	4-8
Petrolia	Petrolia Utilities, Ltd	26.5	111,152	100,375	10,777	5,300	739	14,583	5
Port Burwell	Dominion Natural Gas Co	3.82	11,977	10,823	1,154	764	147	7,850	5
Ridgetown	Union Natural Gas Co	19	83,008	69,102	13,906	3,800	624	22,285	5
Sarnia	Sarnia Gas Co	78.25	466,661	379,641	87,020	16,560	4,178	20,828	5
Shedden and Fingal	Southern Ontario Gas Co	5.15	16,648	14,119	2,529	1,030	128	1,969	7
Simcoe	Dominion Natural Gas Co	29.26	227,164	219,512	7,652	5,852	1,465	5,223	4-6
St. Catharines	United Gas Companies	52.98	192,306	181,850	10,456	10,596	3,749	2,788	3-6
St. George	Dominion Natural Gas Co	2.11	5,867	4,976	891	422	115	7,748	5
Straffordville	Dominion Natural Gas Co	1.34	9,752	8,922	830	268	85	9,871	5
Thorold	United Gas Companies	10.97	36,792	29,827	6,965	2,194	640	10,883	5
Tilbury	Union Natural Gas Co	8.5	47,150	44,227	2,923	1,700	383	7,632	5
Tillsonburg	Dominion Natural Gas Co	23.05	74,215	70,892	3,323	4,610	962	3,454	2-4
Vienna	Dominion Natural Gas Co	1.04	1,970	1,256	714	208	18	34,111	5
Wallaceburg	Wallaceburg Gas Co	22	146,189	125,459	20,730	4,400	1,022	20,281	5-8
Windsor	Windsor Gas Co	151.50	1,139,631	986,865	152,766	30,300	8,418	18,147	4-8
Woodstock	Woodstock Gas Light Co	47.81	76,708	69,971	6,737	9,562	1,621	4,156	3
Total					544,260				

TABLE VIII—LEAKAGE ON RURAL LINES, 1925

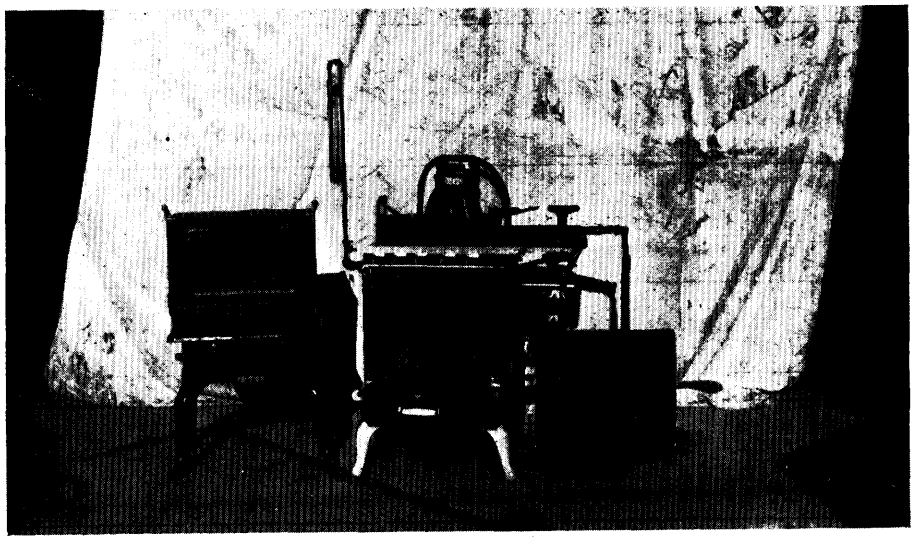
Township	Equivalent feet of 3-inch pipe in all rural lines	Volume received	Volume delivered	Leakage for year		Average No. of consumers	Leakage per consumer	Average pressure on pipe lines	
				Actual	Allowable			Low pressure	High pressure
		M cu. ft.	M cu. ft.				cu. ft.	oz.	lb.
Chatham	8,968	7,818	7,508	310	340	61	5,573	6	3
Dover	92,817	38,215	32,528	5,687	3,476	255	22,302	7	7
Enniskillen	7,541	10,214	8,434	1,780	284	45	6,311	6	8
Harwich	96,504	38,278	34,227	4,051	3,656	338	11,988	6	5
Howard	16,363	10,975	10,718	257	620	91	2,826	6	4
Moore	21,972	18,789	15,491	3,298	832	206	16,087	6	3
Raleigh	99,926	46,375	39,870	6,505	3,780	223	2,915	7	5½
Raleigh, Blake system	67,531	44,656	10,488	34,168	2,588	127	269,039	14	20-45
Rochester	30,652	24,506	22,606	1,900	1,163	167	11,377	6	10
Sandwich, East	15,542	3,355	2,865	489	588	16	30,563	6	..
Sandwich, South	2,111	3,604	2,903	701	80	22	31,861	6	10
Sandwich, West	2,508	2,604	2,526	78	95	18	4,333	6	..
Sombra	3,042	1,025	1,105	80	116	13	6,154	6	..
Sibury, East	32,191	23,286	20,150	3,136	1,220	144	21,777	5	5
Tiuirkirk line	4,963	5,334	3,490	1,844	188	22	83,818	8	10
Total	502,631	279,034	214,909	64,284	19,026	1,748			

TABLE IX—LEAKAGE IN TRANSMISSION LINES, 1925

Transmission line	Size of pipe line	Equivalent miles of 3-in. pipe	Volume received	Volume delivered	Actual leakage	Average pressure on pipe lines
			M cu. ft.	M cu. ft.	M cu. ft.	lbs. per sq. in.
Dundas to Hamilton	6-inch	7.6	51,771	49,465	2,306	12
Kingsville to Hamilton	6-, 10-, 12-inch	710.5	1,491,247	1,389,511	101,736	40-120
Dunnville to St. Catharines	8-inch	57	267,770	258,520	9,250	50
Gas field to Sarnia and Petrolia			1,070,461	1,029,753	40,708	40-60
Gas field to Chatham	8-inch	40.5	657,496	572,746	84,750	40-80
Gas field to Windsor	8-, 10-inch	227.8	1,482,378	1,328,690	153,688	40-120
Gas field to Ridgetown	6-inch	54	273,282	232,992	40,290	40-80
Total					432,728	

Gas Wells and their Production

The number of gas wells reported in the year 1925 and their production is shown in Table X. As nearly as possible this is shown by townships, but where fields extend over a number of townships, it is shown by counties. The decline in production, by fields, has been tabulated on page 1. There has been a similar decline in the acres under lease and in the rentals paid, which is due to the negative results obtained from drilling in Essex county.



Travelling instruction equipment used by the Union Natural Gas Company to demonstrate economical methods of using natural gas, March, 1925.

TABLE X—GAS WELLS AND THEIR PRODUCTION, 1925

County	Township	No. of wells producing	No. of wells abandoned	Wells drilled			Production	Rock pressure, lbs. per sq. in.	Acres under lease	Rental paid
				No. dry	No. producing	Open flow				
						M cu. ft.	M cu. ft.			
Essex	Gosfield, South	10			3	90		353		
	Mersea	3	1					346		
Kent	Romney	102	3		2	1,622	4,966,207	300	33,659	$57,080.00
	Tilbury East	135	9		5	1,846		273		
	Raleigh	18	2					299		
	Harwich							18	6,914	
	Howard							10		
	Dover	6	2	1			126,687	431	4,812	400.00
Lambton	Dawn	5					35,561	690	11,905	
	Enniskillen	3					8,722	100	730	
	Euphemia	6					4,530			
	Sarnia	17					2,100	71	4,622	500.00
Middlesex	Dorchester, North	3					2,030	55	15	
	Adelaide								2,000	
Elgin	Bayham	43	9				140,231	191		
	Malahide	2						327		
Norfolk	Houghton	3						342		
	Middleton	26	1	3	8	600		487		
	Walsingham, South	13			2	119		395		
	Walsingham, North	6						431		
	Windham	4						203		
	Charlotteville	16						271		
	Woodhouse	53	7	1				206		
Haldimand	Townsend	1			1	105				
	Walpole	146	17	3	6	850		254		
	Rainham	97	20	3	13	1,427		187		
	Cayuga, North	65	4	2	14	1,436		179		
	Cayuga, South	58	4	1	4	171		194		

	Oneida	28	6	1			1,544,348	136	168,517	47,858.30
	Seneca	136	31					124		
	Canborough	142	17					117		
	Dunn	14	3	2	3	913		224		
	Moulton	113	7	3	4	155		78		
	Sherbrooke	13						153		
Wentworth	Binbrook	49	14					70		
	Glanford	23	2					66		
Lincoln	Caistor	35	5					154		
	Gainsborough	6			3	190		152	1,729	
Welland	Wainfleet	43	4	1	2	55		96		
	Humberstone	96	2	1	3	75		62		
	Crowland	50					294,843	131	26,289	7,509.17
	Willoughby	39						50		
	Bertie	91						92		
Brant	Onondaga	32	5		2	36	979	107	300	225.00
	Oakland	0	1							
Bruce	Amabel	2					650	128	800	
Peel	Caledon	3							2,500	
Surface wells	Howard and Harwich	69					14,000[1] 56,386[2]		69	
Private wells[3]		300[4]					60,000[4]		300	
Total		2,125	176	22	75	9,690	7,257,274		265,161	113,572.47

[1]This gas is not metered, and therefore must be estimated. The wells are owned by private individuals and the gas is used for their own domestic purposes.

[2]This gas is sold to the Union Natural Gas Company, and all of it was used in Ridgetown.

[3]Principally Haldimand, Norfolk, and Welland counties.

[4]Estimated.

Licenses Issued in 1925

The Natural Gas Conservation Act, 1921, and the Well Drillers' Act, 1925, provide that all operations connected with natural gas and the drilling of oil wells shall be carried on under license. Tables XI, XII, XIII, XIV, and XV show to whom these licenses were issued.

TABLE XI—OPERATORS LICENSED TO LEASE AND PROSPECT FOR NATURAL GAS, 1925

License No.	Name	Address
187	Abray, Thos	Kingsville, Ont.
191	Ajax Oil & Gas Co	509 Lumsden Bldg., Toronto.
194	Allied Oil & Gas Co	Welland, Ont.
218	Bermingham, T. F	55 John St. S., Hamilton, Ont.
197	Blain, E. B	684 Main St. E., Hamilton, Ont.
211	Central Development Co	Chatham, Ont.
195	Dominion Natural Gas Co	518 Jackson Bldg., Buffalo, N.Y.
202	Heath, W. O	Nelles Corners, Ont.
207	Heitbohmer, F	Stratford, Ont.
204	Henderson, R. I	1407 Northern Ontario Bldg., Toronto.
201	Hoover, A. E	Selkirk, Ont.
199	Industrial Natural Gas Co	Thorold, Ont.
192	Irvin, J. J	Dunnville, Ont.
217	McQuillen, M. W	Dunnville, Ont.
208	McWilliams, David B	370 Victoria Park Ave., Toronto.
198	Medina Natural Gas Co	Chatham, Ont.
216	Metropolitan Development Co	2 King St. E., Toronto.
212	Newton, Roy	Box 263, Petrolia, Ont.
193	Patterson, W. C	Dunnville, Ont.
190	Pilkington Bros	Thorold, Ont.
210	Port Colborne-Welland Natural Gas and Oil Co	Port Colborne, Ont.
205	Premier Development Co., Ltd	9 Richmond St. E., Toronto.
209	Provincial Natural Gas Co	Niagara Falls, Ont.
214	Rodgers, Alex	Tillsonburg, Ont.
203	Schweyer, O	Nelles Corners, Ont.
213	Snively, F. L	90 Melrose Ave., Hamilton, Ont.
196	Southern Ontario Gas Co	518 Jackson Bldg., Buffalo, N.Y.
206	Sullivan, Patrick	c/o Iroquois Hotel, Toronto.
200	Union Natural Gas Co	Chatham, Ont.
188	Willit, G. E	Bothwell, Ont.

TABLE XII—OPERATORS LICENSED TO DRILL OR BORE FOR NATURAL GAS, 1925

License No.	Name	Address
168	Featherstone, C. W.	Dunnville, Ont.
169	Featherstone, C. W.	Dunnville, Ont.
170	Featherstone, C. W.	Dunnville, Ont.
171	Featherstone, C. W.	Dunnville, Ont.
166	Hoover, A. E.	Selkirk, Ont.
167	Hoover, A. E.	Selkirk, Ont.
164	Industrial Natural Gas Co.	Thorold, Ont.
163	Kervin & Dawson	Merlin, Ont.
154	Kiser Bros.	Chatham, Ont.
155	Kiser Bros.	Chatham, Ont.
156	Lauer, D.	Tillsonburg, Ont.
157	McCutcheon, T. W.	Dunnville, Ont.
158	McCutcheon, T. W.	Dunnville, Ont.
159	McCutcheon, T. W.	Dunnville, Ont.
175	McCutcheon, T. J.	Dunnville, Ont.
160	McKechnie, S.	Dunnville, Ont.
174	McLister, J. J.	Dunnville, Ont.
178	Peat, J., & Son	Petrolia, Ont.
173	Shepley Bros.	Ridgetown, Ont.
152	Snively, F. L.	90 Melrose Ave., Hamilton, Ont.
153	Snively, F. L.	90 Melrose Ave., Hamilton, Ont.
176	Snively, F. L.	90 Melrose Ave., Hamilton, Ont.
177	Snively, F. L.	90 Melrose Ave., Hamilton, Ont.
172	Sullivan, Patrick	c/o Iroquois Hotel, Toronto.
165	Union Natural Gas Co.	Chatham, Ont.
179	Wesner, O. A.	Tillsonburg, Ont.
151	Willit, G. E.	Bothwell, Ont.

TABLE XIII—OPERATORS LICENSED TO PRODUCE NATURAL GAS, 1925

License No.	Name	Address
303	Allied Oil & Gas Co	c/o Raymond & Spencer, Welland, Ont.
324	Attercliffe Gas Co	Wellandport, Ont.
302	Azoff Gas Co	Canboro, Ont.
313	Bennett, J. D	Ridgetown, Ont.
294	Bertie Natural Gas Co	Ridgeway, Ont.
326	Canboro Gas & Oil Co	Selkirk, Ont.
325	Castle Oil & Gas Co	Niagara Falls, Ont.
319	Chippewa Development Co	Chippawa, Ont.
330	Chippewa Oil & Gas Co	c/o A. E. Ratz, 93 King St. W., Kitchener, Ont.
301	Coleman, J. A	Wellandport, Ont.
305	Dominion Natural Gas Co	518 Jackson Bldg., Buffalo, N.Y.
300	Dunn Natural Gas Co	Dunnville, Ont.
318	Fisherville Gas Co., No. 2	Fisherville, Ont.
314	Fisherville Gas Co., Nos. 1 and 3	Fisherville, Ont.
322	Hamilton Gas & Oil Co	c/o S. H. Brinker, 54 Huxley Ave. N., Hamilton, Ont.
311	Industrial Natural Gas Co	Thorold, Ont.
293	Jasperson, Bon	Kingsville, Ont.
307	Jones, J. S	Port Maitland, Ont.
329	Maple Leaf Oil & Gas Co	c/o J. E. Schrom, Box 1256, Welland, Ont.
308	Medina Natural Gas Co	Chatham, Ont.
315	Midfield Natural Gas Co	9 Maple Ave., Hamilton, Ont.
323	Oil Springs Oil & Gas Co	Oil Springs, Ont.
316	Patterson, W. C	Jamestown, N.Y.
298	Petrol Oil & Gas Co	301 York Bldg., Toronto.
297	Pilkington Bros	Thorold, Ont.
321	Port Colborne-Welland Natural Gas and Oil Co	Port Colborne, Ont.
296	Progressive Gas & Oil Co	Imperial Bank Bldg., Hamilton, Ont.
320	Provincial Natural Gas Co	Niagara Falls, Ont.
306	Southern Ontario Gas Co	518 Jackson Bldg., Buffalo, N.Y.
327	Springvale Gas & Oil Co	Springvale, Ont.
317	Sterling Gas Co	Port Colborne, Ont.
292	Stevensville Gas Co	Stevensville, Ont.
309	Sundy Gas Well Co	Dunnville, Ont.
312	Union Natural Gas Co	Chatham, Ont.
304	United Gas Companies	St. Catharines, Ont.
299	Vacuum Gas & Oil Co	509 Lumsden Bldg., Toronto.
310	Yager, J. J	Selkirk, Ont.

TABLE XIV—OPERATORS LICENSED TO DISTRIBUTE NATURAL GAS, 1925

License No.	Name	Address
233	Bertie Natural Gas Co	Ridgeway, Ont.
245	Brantford Gas Co	Brantford, Ont.
249	Central Pipe Line Co	Chatham, Ont.
259	Chatham Gas Co	Chatham, Ont.
260	Chippewa Development Co	Chippawa, Ont.
269	Chippewa Oil & Gas Co	c/o E. E. Ratz, 190 King St. W., Kitchener, Ont.
240	Coleman, J. A	Wellandport, Ont.
246	Dominion Natural Gas Co	518 Jackson Bldg., Buffalo, N.Y.
239	Dunn Natural Gas Co	Dunnville, Ont.
264	Erie Beach Gas Co	Chatham, Ont.
253	Fisherville Gas Co., Nos. 1 and 3	Fisherville, Ont.
238	Fonthill-Ridgeville Gas Co	19 King William St., Hamilton, Ont.
251	Industrial Natural Gas Co	Thorold, Ont.
242	Ingersoll Gas Light Co	Ingersoll, Ont.
267	Lake Shore Natural Gas Co	Buffalo, N.Y.
263	Leamington Corporation	Leamington, Ont.
248	Leamington Corporation	Leamington, Out.
244	Manufacturers Gas Co	Hamilton, Ont.
254	Midfield Natural Gas Co	9 Maple Ave., Hamilton, Ont.
256	Niece, Hosea, & Son	Lowbanks, Ont.
265	Oil Springs Oil & Gas Co	Oil Springs, Ont.
232	Petrolia Utilities, Ltd	Petrolia, Ont.
262	Port Colborne-Welland Natural Gas and Oil Co	Port Colborne, Ont.
261	Provincial Natural Gas Co	Niagara Falls, Ont.
237	Rosehill Natural Gas Co	14 City Hall Sq., Buffalo, N.Y.
236	Sarnia Gas Co	Sarnia, Ont.
255	Shetland Gas Co	Florence, Ont.
247	Southern Ontario Gas Co	518 Jackson Bldg., Buffalo, N.Y.
266	Springvale Gas & Oil Co	Springvale, Ont.
257	Sterling Gas Co. (natural)	Port Colborne, Ont.
252	Union Natural Gas Co	Chatham, Ont.
243	United Gas Companies	St. Catharines, Ont.
258	Wallaceburg Gas Co	Wallaceburg, Ont.
250	Windsor Gas Co	Windsor, Ont.
241	Woodstock Gas Light Co	Woodstock, Ont.

TABLE XV—OPERATORS LICENSED TO OPERATE PIPE LINES, 1925

License No.	Name	Address
55	Central Pipe Line Co	Chatham, Ont.
53	Dominion Natural Gas Co	518 Jackson Bldg., Buffalo, N.Y.
54	Southern Ontario Gas Co	518 Jackson Bldg., Buffalo, N.Y.
56	Union Natural Gas Co	Chatham, Ont.
52	United Gas Companies	St. Catharines, Ont.

Logs of Wells

The following logs of oil and gas wells drilled in Ontario in 1925 are given on the pages following. They show the formation, total depth, and occurrences of gas, oil, and water as reported by the drillers.

These logs are on file in the office of the Natural Gas Commissioner, and they give the length of casing used as well as other information regarding the texture of formations. In many cases samples of drill cuttings are available to the public. The source of the information for the logs that follow is the company or the person whose name appears at the top of each log.

Abbreviations

Tp	Township.
Con	Concession.
Pt	Part.
W.½	West half.
E.½	East half.
S.½	South half.
W.½	West half.
NE.¼	Northeast quarter.
SE.¼	Southeast quarter.
20 E.½	East half of lot 20.
T.R.	Talbot Road.
S.T.R.	South of the Talbot Road.
N.T.R.	North of the Talbot Road.
E.S.C.R.	East of Stoney Creek Road.
S.S.C.R.	South of Stoney Creek Road.
N.D.R.	North of Dundas Road.
S.F.R.	South of Forks Road.
R.R.	River Range.

Brant County

Log No. 1.—Dominion Natural Gas Co., Brantford
Lots 9-11, con. III, Onondaga tp.

Completed September 11, 1925.
Open flow: 12,000 cu. ft.
Rock pressure: 225 lbs.

Formation	Thickness, ft.
Surface	120
Lime	50
Niagara	225
Grey shale	35
Clinton	20
Red Medina	25
Blue shale	50
White Medina	21
Red shale	39
Total depth	585

Gas at 440 and 539 feet.

Log No. 2.—Dominion Natural Gas Co., Brantford
Lot 12, con. III, Onondaga tp.

Completed December 31, 1925.
Open flow: 8,670 cu. ft.
Rock pressure: 155 lbs.

Formation	Thickness, ft.
Surface	96
White lime	49
Niagara	225
Grey shale	40
Clinton	25
Red Medina	25
Blue shale	45
White Medina	20
Red shale	40
Total depth	565

Gas at 415 and 525 feet.

Log No. 3.—Dominion Natural Gas Co., Brantford
Lots 12-14, con. III, Onondaga tp.

Completed November 28, 1925.
Open flow: 24,000 cu. ft.

Formation	Thickness, ft.
Surface	98
Lime and shale	37
Niagara	245
Shale	45
Clinton	20
Red Medina	23
Blue shale	48
White Medina	25
Red shale	34
Total depth	575

Gas at 435 and 537 feet.

Log No. 4.—Dominion Natural Gas Co., Brantford
Lots 9-11, con. III, Onondaga tp.

Completed September 15, 1925.
Open flow: 10,000 cu. ft.
Rock pressure: 245 lbs.

Formation	Thickness, ft.
Surface	120
Brown lime	50
Niagara	225
Grey shale	35
Clinton	20
Red Medina	25
Blue shale	50
White Medina	21
Red shale	37
Total depth	583

Gas at 440 and 530 feet.

Log No. 5.—Canadian Dutch Oils, Ltd., Toronto
Lot 8, con. III, Onondaga tp.

Completed March 3, 1925.
Rock pressure: 160 lbs.

Formation	Thickness, ft.
Clay	74
Lime	22
Niagara lime	254
Blue shale	10
Slate	28
Clinton	24
Red Medina	21
Grey shale	33
White Medina	37
Red shale	147
Total depth	650

Gas at 76, 391, 495, and 596 to 602 feet.

Haldimand County

Log No. 6.—Dominion Natural Gas Co., Brantford
Lot 1, Dochstader tract, Canborough tp.

Completed July 13, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	65
Lime and shale	211
Niagara	228
Shale	54
Clinton	30
Red Medina	40
Grey shale	59
White Medina	11
Red shale	10
Total depth	708

Log No. 7.—W. C. Patterson, Jamestown, N.Y.
Lot 21, con. II S., Cayuga N. tp.

Completed August 8, 1925.
Open flow: 166,000 cu. ft.
Rock pressure: 340 lbs.

Formation	Thickness, ft.
Surface	60
Lime and shale	237
Niagara	230
Shale	48
Clinton	33
Red Medina	40
Grey shale	55
White Medina	16
Red shale	4
Total depth	723

Gas at 625 feet.

Log No. 8.—W. C. Patterson, Jamestown, N.Y.
Lot 20, con. I S., Cayuga N. tp.

Completed July 6, 1925.
Open flow: 318,000 cu. ft.
Rock pressure: 350 lbs.

Formation	Thickness, ft.
Surface	65
Lime and shale	232
Niagara	230
Shale	48
Clinton	30
Red Medina	40
Grey shale	55
White Medina	16
Red shale	4
Total depth	720

Gas at 612 feet.

Log No. 9.—W. C. Patterson, Jamestown, N.Y.
Lot 19, con. I S., Cayuga N. tp.

Completed September 8, 1925.
Open flow: 17,000 cu. ft.
Rock pressure: 350 lbs.

Formation	Thickness, ft.
Surface	78
Lime and shale	232
Niagara	230
Shale	50
Clinton	30
Red Medina	40
Grey shale	53
White Medina	14
Red shale	3
Total depth	730

Gas at 644 feet.

Log. No. 10.—W. C. Patterson, Jamestown, N.Y.
Lot 20 E. ½, con. I S., Cayuga N. tp.

Completed December 20, 1925.
Open flow: 183,000 cu. ft.
Rock pressure: 340 lbs.

Formation	Thickness, ft.
Surface	72
Lime and shale	226
Niagara	230
Shale	50
Clinton	30
Red Medina	40
Grey shale	52
White Medina	14
Red shale	2
Total depth	716

Gas at 588 and 620 feet.

Log No. 11.—W. C. Patterson, Jamestown, N.Y.
Lot 20 W. ½, con. I S., Cayuga N. tp.

Completed November 10, 1925.
Open flow: 149,000 cu. ft.
Rock pressure: 330 lbs.

Formation	Thickness, ft.
Surface	67
Lime and shale	233
Niagara	230
Shale	50
Clinton	30
Red Medina	40
Grey shale	53
White Medina	15
Red shale	4
Total depth	722

Gas at 594 and 625 feet.

Log No. 12.—Dominion Natural Gas Co., Brantford
Lot 10, con. III, IV, Cayuga N. tp.

Completed December 31, 1925.
Open flow: 27,000 cu. ft.
Rock pressure: 280 lbs.

Formation	Thickness, ft.
Surface	100
Lime and shale	195
Niagara	218
Shale	57
Clinton	27
Red Medina	41
Shale	59
White Medina	11
Red shale	40
Total depth	748

Gas at 701 feet.

Log No. 13.—Dominion Natural Gas Co., Brantford
Lot 7, con. III, Cayuga N. tp.

Completed September 21, 1925.
Open flow: 72,000 cu. ft.
Rock pressure: 252 lbs.

Formation	Thickness, ft.
Surface	75
Lime and shale	205
Niagara	226
Shale	63
Clinton	27
Red Medina	41
Grey shale	59
White Medina	11
Red shale	35
Total depth	742

Gas at 626 and 698 feet.

Log No. 14.—Dominion Natural Gas Co., Brantford
Lot 6, con. III, Cayuga N. tp.

Completed November 2, 1925.
Open flow: 25,000 cu. ft.

Formation	Thickness, ft.
Surface	57
Lime and shale	218
Niagara	223
Shale	68
Clinton	29
Red Medina	37
Grey shale	58
White Medina	10
Red shale	6
Total depth	706

Gas at 573 feet.

Log No. 15.—Canfield Natural Gas Co., Canfield
Lot 8 N. ½, con. I, S.T.R., Cayuga N. tp.

Completed April 8, 1925.
Open flow: 30,000 cu. ft.
Rock pressure: 220 lbs.

Formation	Thickness, ft.
Surface	37
Lime and shale	220
Niagara	213
Shale	40
Clinton	30
Red Medina	35
Grey shale	51
White Medina	13
Red shale	48
Total depth	687

Gas at 520 feet.

Log No. 16.—Canboro Gas & Oil Co., Selkirk
Lot 4, con. I, S.T.R., Cayuga N. tp.

Completed September 23, 1925.
Open flow: 27,000 cu. ft.
Rock pressure: 155 lbs.

Formation	Thickness, ft.
Surface	60
Lime and shale	120
Niagara	296
Shale	40
Clinton	25
Red Medina	35
Grey shale	60
White Medina	15
Red shale	49
Total depth	700

Gas in Red Medina.

Log No. 17.—Canboro Gas & Oil Co., Selkirk
Lot 4, con. II, Cayuga N. tp.

Completed November 3, 1925.
Open flow: 42,400 cu. ft.
Rock pressure: 230 lbs.

Formation	Thickness, ft.
Surface	60
Lime and shale	215
Niagara	208
Shale	40
Clinton	30
Red Medina	40
Grey shale	50
White Medina	12
Red shale	50
Total depth	705

Gas in Clinton and White Medina.

Log No. 18.—Azoff Gas Co., Canboro
Lot 6, con. I, S.T.R., Cayuga N. tp.

Completed September, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	52
Lime and shale	160
Niagara	200
White lime	56
Shale	35
Clinton	30
Red Medina	35
Shale	55
White Medina	10
Red shale	7
Total depth	640

Log No. 19.—Azoff Gas Co., Canboro
Lot 9, con. I, N.T.R., Cayuga N. tp.

Completed December 28, 1925.
Open flow: 66,088 cu. ft.
Rock pressure: 210 lbs.

Formation	Thickness, ft.
Surface	55
Shale and lime	135
Niagara	200
White lime	58
Shale	35
Clinton	28
Red Medina	35
Shale	60
White Medina	17
Red shale	27
Total depth	650

Gas at 529 and 635 feet.

Log No. 20.—Nelles Corners Gas Syndicate, Nelles
Lot 57, con. I S., Cayuga N. tp.

Completed April 2, 1925.
Open flow: 40,000 cu. ft.
Rock pressure: 400 lbs.

Formation	Thickness, ft.
Surface	3
Lime and shale	427
Niagara	238
Shale	55
Clinton	27
Red Medina	35
Blue shale	55
White Medina	17
Red shale	39
Total depth	896

Gas at 743, 765, and 845 feet.

LOG NO. 21.—DOMINION NATURAL GAS CO., BRANTFORD.
Lot 6, con. III, Cayuga N. tp.

Completed May 9, 1925.
Open flow: 121,000 cu. ft.
Rock pressure: 340 lbs.

Formation	Thickness, ft.
Surface	86
Lime and shale	209
Niagara	223
Shale	53
Clinton	29
Red Medina	42
Grey shale	59
White Medina	11
Red Medina	35
Total depth	747

Gas at 590, 625, and 712 feet.

LOG NO. 22.—W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 7, con. V, Cayuga S. tp.

Completed April 18, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	73
Lime and shale	272
Niagara	225
Shale	55
Clinton	30
Red Medina	40
Grey shale	54
White Medina	16
Red shale	3
Total depth	768

LOG NO. 23.—W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 8, con. IV, Cayuga S. tp.

Completed June 26, 1925.
Open flow: 35,000 cu. ft.
Rock pressure: 275 lbs.

Formation	Thickness, ft.
Surface	64
Lime and shale	236
Niagara	225
Shale	55
Clinton	30
Red Medina	40
Grey shale	54
White Medina	12
Red shale	41
Total depth	757

Gas at 585, 630, and 711 feet.

LOG NO. 24.—W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 10, con. IV, Cayuga S. tp.

Completed August 3, 1925.
Open flow: 40,000 cu. ft.
Rock pressure: 275 lbs.

Formation	Thickness, ft.
Surface	74
Lime and shale	251
Niagara	225
Shale	55
Clinton	30
Red Medina	40
Grey shale	55
White Medina	18
Red shale	42
Total depth	790

Gas at 647 and 737 feet.

LOG NO. 25.—W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 7, con. IV, Cayuga S. tp.

Completed March 17, 1925.
Open flow: 65,000 cu. ft.
Rock pressure: 275 lbs.

Formation	Thickness, ft.
Clay	85
Lime and shale	260
Niagara	225
Shale	55
Clinton	30
Red Medina	40
Grey shale	55
White Medina	16
Red shale	76
Total depth	842

LOG NO. 26.—W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 8, con. IV, Cayuga S. tp.

Completed February 14, 1925.
Open flow: 50,000 cu. ft.
Rock pressure: 275 lbs.

Formation	Thickness, ft.
Clay	70
Lime and shale	275
Niagara	225
Shale	55
Clinton	28
Red Medina	40
Shale	56
White Medina	16
Red shale	77
Total depth	842

LOG NO. 27.—W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 4, con. II N., Dunn tp.

Completed November 19, 1925.
Open flow: 50,000 cu. ft.
Rock pressure: 320 lbs.

Formation	Thickness, ft.
Surface	77
Lime and shale	235
Niagara	225
Shale	55
Clinton	30
Red Medina	40
Grey shale	55
White Medina	16
Red shale	74
Total depth	807

Gas at 725 feet.

LOG NO. 28.—W. C. PATTERSON, JAMESTOWN, N.Y
Lot 4, con. II N., Dunn tp.

Completed December 20, 1925.
Open flow: 23,000 cu. ft.
Rock pressure: 310 lbs.

Formation	Thickness, ft.
Surface	75
Lime and shale	230
Niagara	225
Shale	55
Clinton	30
Red Medina	40
Grey shale	55
White Medina	15
Red shale	40
Total depth	765

Gas at 716 feet.

Log No. 29.—W. C. Patterson, Jamestown, N.Y.
Lot 4, con. II N., Dunn tp.

Completed October 8, 1925.
Open flow: 826,000 cu. ft.
Rock pressure: 360 lbs.

Formation	Thickness, ft.
Surface	76
Lime and shale	234
Niagara	225
Shale	55
Clinton	30
Red Medina	40
Grey shale	53
White Medina	15
Red shale	67
Total depth	795

Gas at 606 and 719 feet.

Log No. 30.—Dominion Natural Gas Co., Brantford
Lots 4, 5, con. III, Dunn tp.

Completed November 23, 1925.
Open flow: 25,000 cu. ft.
Rock pressure: 280 lbs.

Formation	Thickness, ft.
Surface	77
Lime and shale	223
Niagara	230
Shale	44
Clinton	30
Red Medina	40
Grey shale	53
White Medina	15
Red shale	3
Total depth	715

Gas at 596, 635, and 704 feet.

Log No. 31.—W. C. Patterson, Jamestown, N.Y.
Lot 1, con. II, N.D.R., Dunn tp.

Completed May 21, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	80
Lime and shale	250
Niagara	225
Shale	50
Clinton	28
Red Medina	40
Grey shale	53
White Medina	15
Red shale	2
Total depth	743

Log No. 32.—United Gas Companies, Brantford
Lots 9-15, con. IV, Moulton Tp.

Completed February 25, 1925.
Open flow: 45,000 cu. ft.
Rock pressure: 150 lbs.

Formation	Thickness, ft.
Surface	83
Lime and shale	177
Niagara	240
Shale	50
Clinton	30
Red Medina	40
Grey shale	54
White Medina	12
Red shale	3
Total depth	689

Gas at 570 and 605 feet.

Log No. 33.—United Gas Companies, Brantford
Lots 12, 13, con. IV, Moulton tp.

Completed April 9, 1925.
Open flow: 65,000 cu. ft.
Rock pressure: 120 lbs.

Formation	Thickness, ft.
Surface	94
Lime and shale	166
Niagara	240
Shale	50
Clinton	32
Red Medina	40
Grey shale	55
White Medina	16
Red shale	44
Total depth	737

Gas at 577 and 687 feet.

Log No. 34.—United Gas Companies, Brantford
Lots 9-15, con. IV, Moulton tp.

Completed June 30, 1925.
Open flow: 28,000 cu. ft.

Formation	Thickness, ft.
Surface	108
Lime and shale	167
Niagara	240
Shale	55
Clinton	32
Red Medina	40
Grey shale	54
White Medina	16
Red shale	10
Total depth	722

Gas at 590 and 701 feet.

Log No. 35.—United Gas Companies, Brantford
Lot 12, S.F.R., Moulton tp.

Completed May 18, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	92
Lime and shale	163
Niagara	240
Shale	50
Clinton	40
Red Medina	30
Grey shale	51
White Medina	18
Red shale	3
Total depth	687

Log No. 36.—Dominion Natural Gas Co., Brantford
Lots 6, 7, con. B, Moulton tp.

Completed August 6, 1925.
Open flow: 6,000 cu. ft.

Formation	Thickness, ft.
Surface	107
Lime and shale	193
Niagara	240
Shale	48
Clinton	30
Red Medina	40
Grey shale	53
White Medina	15
Red shale	2
Total depth	728

Gas at 613 feet.

Log No. 37.—United Gas Companies, Brantford
Lot 12, range 2, Moulton tp.

Completed September 19, 1925.
Open flow: 17,000 cu. ft.
Rock pressure: 274 lbs.

Formation	Thickness, ft.
Surface	89
Lime and shale	216
Niagara	240
Shale	47
Clinton	30
Red Medina	40
Grey shale	53
White Medina	16
Red shale	31
Total depth	762

Gas at 617 and 727 feet.

Log No. 38.—United Gas Companies, Brantford
Lot 13, S.F.R., Moulton tp.

Completed January 12, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	85
Lime and shale	165
Niagara	240
Shale	50
Clinton	30
Red Medina	40
Grey shale	53
White Medina	15
Red shale	2
Total depth	680

Log No. 39.—Dominion Natural Gas Co., Brantford.
Lot, pt. 23, con. III, Oneida tp.

Completed January 5, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	16
Lime and shale	354
Niagara	235
Shale	55
Clinton	25
Red Medina	35
Blue shale	50
White Medina	21
Red shale	3
Total depth	794

Log No. 40.—Erie Gas & Oil Syndicate, Fisherville
Lot 6, con. V, Rainham tp.

Completed April 30, 1925.
Open flow: 71,000 cu. ft.
Rock pressure: 425 lbs.

Formation	Thickness, ft.
Surface	11
Flint	95
Lime and shale	279
Niagara	215
Shale	40
Clinton	25
Red Medina	35
Grey shale	55
White Medina	12
Red shale	48
Total depth	915

Gas at 752 and 789 feet.

Log No. 41.—Erie Gas & Oil Syndicate, Fisherville
Lot 4, con. V, Rainham tp.

Completed February 4, 1925.
Open flow: 98,000 cu. ft.
Rock pressure: 425 lbs.

Formation	Thickness, ft.
Surface	6
Flint	69
Lime and shale	375
Niagara	240
Shale	54
Clinton	31
Red Medina	30
Grey shale	65
White Medina	12
Red shale	18
Total depth	900

Gas at 750 and 874 feet.

Log No. 42.—Erie Gas & Oil Syndicate, Fisherville
Lot 7 SE., con. VI, Rainham tp.

Completed September 5, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	15
Flint	79
Lime and shale	384
Niagara	231
Shale	26
Clinton	25
Red Medina	40
Grey shale	68
White Medina	12
Total depth	880

Log No. 43.—Erie Gas & Oil Syndicate, Fisherville
Lot 6, con. V, Rainham tp.

Completed June 4, 1925.
Open flow: 35,760 cu. ft.
Rock pressure: 390 lbs.

Formation	Thickness, ft.
Surface	17
Flint	79
Lime and shale	384
Niagara	224
Shale	26
Clinton	25
Red Medina	40
Grey shale	68
White Medina	12
Red shale	40
Total depth	915

Gas at 740, 770, and 868 feet.

Log No. 44.—Dominion Natural Gas Co., Brantford
Lot 3, con. IV, V, Rainham tp.

Completed September 21, 1925.
Open flow: 25,000 cu. ft.
Rock pressure: 390 lbs.

Formation	Thickness, ft.
Surface	12
Flint	50
Lime and shale	389
Niagara	231
Shale	65
Clinton	25
Red Medina	35
Grey shale	60
White Medina	22
Red shale	43
Total depth	932

Gas at 877 feet.

Log No. 45.—Erie Gas & Oil Syndicate, Fisherville
Lot 6, con. VI, Rainham tp.

Completed March 11, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	13
Flint	55
Lime and shale	412
Niagara	210
Shale	52
Clinton	31
Red Medina	30
Grey shale	65
White Medina	12
Total depth	880

Log No. 46.—W. C. Patterson, Jamestown, N.Y.
Lot 2, con. IX, Rainham tp.

Completed May 16, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	7
Flint	60
Lime and shale	373
Niagara	250
Shale	40
Clinton	25
Red Medina	40
Grey shale	51
White Medina	10
Red shale	3
Total depth	859

Log No. 47.—Dominion Natural Gas Co., Brantford.
Lot 4, con. V, Rainham tp.

Completed August 11, 1925.
Open flow: 414,000 cu. ft.
Rock pressure: 350 lbs.

Formation	Thickness, ft.
Surface	11
Flint	40
Lime and shale	403
Niagara	231
Shale	60
Clinton	25
Red Medina	35
Shale	55
White Medina	23
Red shale	12
Total depth	895

Gas at 763 feet.

Log No. 48.—Dominion Natural Gas Co., Brantford
Lots 4, 5, con. IV, Rainham tp.

Completed November 5, 1925.
Open flow: 25,000 cu. ft.
Rock pressure: 400 lbs.

Formation	Thickness, ft.
Surface	9
Flint	66
Lime and shale	375
Niagara	231
Shale	63
Clinton	25
Red Medina	35
Shale	60
White Medina	21
Shale	15
Total depth	900

Gas at 748 and 779 feet.

Log No. 49.—Dominion Natural Gas Co., Brantford
Lot 1, con. VIII, Rainham tp.

Completed May 30, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	12
Flint	50
Lime and shale	371
Niagara	239
Shale	58
Clinton	29
Red Medina	35
Shale	55
White Medina	17
Red shale	5
Total depth	871

Log No. 50.—Nelles Corners Gas Syndicate, Nelles
Lot 2, con. IX, Rainham tp.

Completed February 16, 1925.
Open flow: 240,000 cu. ft.
Rock pressure: 400 lbs.

Formation	Thickness, ft.
Surface	9
Lime and shale	421
Niagara	240
Shale	51
Clinton	29
Red Medina	35
Blue shale	53
White Medina	18
Red shale	5
Total depth	861

Gas at 741 and 758 feet.

Log No. 51.—Erie Gas & Oil Syndicate, Fisherville
Lot 7 N. ½, con. V, Rainham tp.

Completed August 8, 1925.
Open flow: 34,000 cu. ft.
Rock pressure: 390 lbs.

Formation	Thickness, ft.
Surface	28
Flint	47
Lime and shale	375
Niagara	235
Shale	40
Clinton	25
Red Medina	54
Grey shale	66
White Medina	20
Red shale	35
Total depth	925

Gas in Clinton, Red Medina, and White Medina.

Log No. 52.—Erie Gas & Oil Syndicate, Fisherville
Lot 7, con. VI, Rainham tp.

Completed July 10, 1925.
Open flow: 236,000 cu. ft.
Rock pressure: 390 lbs.

Formation	Thickness, ft.
Surface	27
Flint	79
Lime and shale	360
Niagara	224
Shale	40
Clinton	33
Red Medina	40
Grey shale	67
White Medina	13
Red shale	22
Total depth	905

Gas in Clinton, Red Medina, and White Medina.

Log No. 53.—Erie Gas & Oil Syndicate, Fisherville
Lot 3, con. V, Rainham tp.

Completed October 23, 1925.
Open flow: 62,760 cu. ft.
Rock pressure: 400 lbs.

Formation	Thickness, ft.
Surface	6
Flint	79
Lime and shale	515
Niagara	100
Shale	55
Clinton	30
Red Medina	35
Grey shale	55
White Medina	20
Red shale	20
Total depth	895

Gas in Clinton and Red Medina.

Log No. 54.—Dominion Natural Gas Co., Brantford
Lot 2, con. VIII, Rainham tp.

Completed May 1, 1925.
Open flow: 39,000 cu. ft.
Rock pressure: 410 lbs.

Formation	Thickness, ft.
Surface	6
Flint	50
Lime and shale	379
Niagara	237
Shale	57
Clinton	27
Red Medina	35
Shale	50
White Medina	18
Red shale	5
Total depth	864

Gas at 737 and 768 feet.

Log No. 55.—Erie Gas & Oil Syndicate, Fisherville
Lot 3, con. V, Rainham tp.

Completed November 20, 1925.
Open flow: 74,000 cu. ft.
Rock pressure: 400 lbs.

Formation	Thickness, ft.
Surface	4
Flint	71
Lime and shale	515
Niagara	110
Shale	46
Clinton	30
Red Medina	34
Grey shale	52
White Medina	23
Red shale	35
Total depth	920

Gas in Clinton, Red Medina, and White Medina.

Log No. 56.—Erie Gas & Oil Syndicate, Fisherville
Lot 4, con. V, Rainham tp.

Completed February 5, 1925.
Open flow: 98,000 cu. ft.
Rock pressure: 425 lbs.

Formation	Thickness, ft.
Surface	6
Flint	69
Lime and shale	375
Niagara	240
Shale	54
Clinton	31
Red Medina	30
Grey shale	65
White Medina	12
Red shale	18
Total depth	900

Gas in Clinton at 750, in white Medina at 874 feet.

Log No. 57.—Hoover & May, Selkirk.
Lot 12, con. III, Seneca tp.

Completed February 14, 1925.

Formation	Thickness, ft,
Surface	64
Lime and shale	120
Niagara	193
Shale	40
Clinton	28
Red Medina	31
Grey shale	56
White Medina	15
Red shale	6
Total depth	553

Gas at 425 feet.

Log No. 58.—Dominion Natural Gas Co., Brantford
Lot 5 W. ½, E.S.C.R., Nelles tract, Seneca tp.

Completed May 1, 1925.
Open flow: 247,000 cu. ft.
Rock pressure: 240 lbs.

Formation	Thickness, ft.
Surface	72
Lime and shale	100
Niagara	235
Shale	48
Clinton	25
Red Medina	30
Blue shale	55
White Medina	18
Red shale	50
Total depth	623

Gas at 477 and 579 feet.

Log No. 59.—Dominion Natural Gas Co., Brantford
Lot 15, con. VII, Walpole tp.

Completed August 13, 1925.
Open flow: 96,000 cu. ft.
Rock pressure: 485 lbs.

Formation	Thickness, ft.
Surface	24
Flint	87
Lime and shale	364
Niagara	284
Shale	27
Clinton	26
Red Medina	30
Shale	65
White Medina	12
Red shale	11
Total depth	930

Gas at 800 feet.

Log No. 60.—Dominion Natural Gas Co., Brantford
Lots 15, 16, con. VIII, Walpole tp.

Completed April 30, 1925.
Open flow: 241,000 cu. ft.
Rock pressure: 485 lbs.

Formation	Thickness, ft.
Surface	20
Flint	80
Lime and shale	365
Niagara	289
Shale	40
Clinton	30
Red Medina	40
Shale	48
White Medina	12
Red Shale	2
Total depth	926

as at 817 Gfeet.

Log No. 61.—Dominion Natural Gas Co., Brantford
Lot 12, con. VI, Walpole tp.

Completed July 31, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	24
Flint	80
Lime and shale	376
Niagara	270
Shale	50
Clinton	27
Red Medina	35
Shale	60
White Medina	13
Shale	5
Total depth	950

Log No. 62.—Dominion Natural Gas Co., Brantford
Lot 16, con. VII, Walpole tp.

Completed June 10, 1925.
Open flow: 78,000 cu. ft.

Formation	Thickness, ft.
Surface	13
Flint	87
Lime and shale	372
Niagara	290
Blue shale	40
Clinton	30
Red Medina	40
Shale	50
White Medina	12
Red shale	5
Total depth	939

Gas at 834 feet.

Log No. 63.—Dominion Natural Gas Co., Brantford
Lot 17, con. VI, Walpole tp.

Completed May 25, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	15
Flint	95
Lime and shale	350
Niagara	250
Shale	88
Clinton	25
Red Medina	35
Shale	55
White Medina	14
Red Shale	3
Total depth	930

Log No. 64.—Dominion Natural Gas Co., Brantford
Lot 22, con. VI, Walpole tp.

Completed September 25, 1925.
Open flow: 43,000 cu. ft.
Rock pressure: 420 lbs.

Formation	Thickness, ft.
Surface	16
Flint	110
Lime and shale	361
Niagara	250
Shale	50
Clinton	28
Red Medina	35
Shale	55
White Medina	13
Shale	5
Total depth	923

Gas at 802 and 838 feet.

Log No. 65.—Dominion Natural Gas Co., Brantford
Lot 16, con. VII, Walpole tp.

Completed January 23, 1925.
Open flow: 314,000 cu. ft.
Rock pressure: 500 lbs.

Formation	Thickness, ft.
Surface	17
Flint	84
Lime and shale	365
Niagara	290
Shale	35
Clinton	25
Red Medina	40
Shale	40
Total depth	896

Gas at 795 and 820 feet.

Log No. 66.—Dominion Natural Gas Co., Brantford
Lot 14, con. VII, Walpole tp.

Completed November 25, 1925.
Open flow: 5,000 cu. ft.

Formation	Thickness, ft.
Surface	35
Flint	80
Lime and shale	335
Niagara	240
Shale	96
Clinton	28
Red Medina	36
Shale	65
White Medina	12
Red shale	10
Total depth	937

Log No. 67.—Dominion Natural Gas Co., Brantford
Lot 23, con. VI, Walpole tp.

Completed November 19, 1925.
Open flow: 78,000 cu. ft.
Rock pressure: 455 lbs.

Formation	Thickness, ft.
Surface	17
Flint	100
Lime and shale	363
Niagara	250
Shale	50
Clinton	25
Red Medina	35
Shale	60
White Medina	13
Red shale	7
Total depth	960

Gas at 785 and 819 feet.

Kent County

Log No. 68.—Ajax Oil & Gas Co., Toronto
Lot 5 Gore, con. XIII, Camden tp.

Completed May 22, 1925.
Open flow: 25 bbls.

Formation	Thickness, ft.
Clay	40
Petrolia shale	178
Widder beds	6
Olentangy shale	50
Onondaga	111
Oriskany	35
Lower Monroe	177
Total depth	597

Oil at 220, 274, 363, and 580 feet.

LOG No. 69.—EAGLE OIL & GAS CO., TORONTO
Lot 4, con. XIII, Camden tp.

Completed June, 1925.

Formation	Thickness, ft.
Clay	52
Petrolia shale	159
Widder beds	6
Olentangy	45
Onondaga	110
Oriskany	35
Lower Monroe	212
Total depth	619

Oil at 363 feet.
Gas at 117 feet.

LOG No. 70.—EAGLE OIL & GAS CO., TORONTO
Lot 4, con. XIII, Camden tp.

Completed June, 1925.

Formation	Thickness, ft.
Clay	52
Petrolia shale	159
Widder beds	6
Olentangy	45
Onondaga	110
Oriskany	35
Lower Monroe	212
Total depth	619

Oil at 363 feet.
Gas at 117 feet.

LOG No. 71.—EAGLE OIL & GAS CO., TORONTO
Lot 4, con. XIII, Camden tp.

Completed July, 1925.
Open flow: 10,000 cu. ft. (estimated).

Formation	Thickness, ft.
Surface clay	58
Petrolia shale	178
Widder beds	6
Olentangy	32
Onondaga	111
Total depth	385

Gas at 217 and 233 feet.

LOG No. 72.—UNION NATURAL GAS CO., CHATHAM
Lot 3, con. III, Dover W. tp.

Completed October 7, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	86
Lime and shale	16
Soap and lime shell	158
Lime	705
Lime with gypsum	55
Lime	290
Showing red shale	5
Lime	635
Green shale	24
Brown lime	8
Green shale	4
Red shale	40
Grey shale and lime shell	74
Grey lime	45
Red shale	255
Grey lime	140
Lime shells	5
Grey shale	155
Brown shale	70
Black shale	86
Trenton	884
Sandy formation	34
Total depth	3,774

LOG No. 73.—UNION NATURAL GAS CO., CHATHAM
Lot 178, T.R., Romney tp.

Completed January 28, 1925.

Formation	Thickness, ft.
Surface	169
Hamilton	64
Corniferous	197
Salina	865
Guelph, Niagara	79
Total depth	1,374

Gas at 1,178, 1,195, 1,240, 1,295, and 1,322 feet.

LOG No. 74.—UNION NATURAL GAS CO., CHATHAM
Lot 186, T.R., Romney tp.

Completed July 13, 1925.

Formation	Thickness, ft.
Surface clay	155
Sand and gravel	7
Lime shell	13
Soap	2
Light grey lime	398
White sandy lime	5
Grey and brown lime	100
Grey lime	450
Blue and brown lime	45
Brown lime	15
Blue and brown lime	10
Brown lime	20
Blue lime	5
Brown lime	15
White sandy lime	15
Blue lime	45
Brown lime	15
White sandy lime	5
Total depth	1,320

Gas at 1,140, 1,185, 1,255, and 1,274 feet.

LOG No. 75.—SOUTHERN ONTARIO GAS CO., BRANTFORD
Lot 15, con. I, Tilbury E. tp.

Completed April 30, 1925.

Formation	Thickness, ft.
Drift clay	143
Gravel	3
Shale	29
Soapstone	145
Grey lime	205
Dark grey lime	55
Sharp sand	110
Water sand	99
Gypsum	3
Brown lime	358
Light grey lime	175
Dark grey lime	41
Total depth	1,366

Gas at 1,240, 1,270, 1,318, and 1,355 feet.

LOG No. 76.—SOUTHERN ONTARIO GAS CO., BRANTFORD
Lot 2 S. ½, con. XV, Tilbury E. tp.

Formation	Thickness, ft.
Drift clay	140
Shale	15
Soap	150
Grey lime	280
Sharp sand	115
Water sand	80
Grey lime	120
Brown lime	210
Light grey lime	70
Grey lime	64
Dark grey lime	128
Grey lime	5
Total depth	1,377

Gas at 1,245, 1,280, 1,338, and 1,357 feet.

Log No. 77.—Union Natural Gas Co., Chatham
Lot 172, T.R., Tilbury E. tp.

Completed June 4, 1925.

Formation	Thickness, ft.
Surface	183
Soap	81
Brown lime	301
Sharp lime	105
Brown lime	155
Grey lime with gypsum	105
Grey lime	195
Brown lime	125
Blue lime	60
White sand	5
Grey lime	40
Total depth	1,355

Gas at 1,218, 1,250, 1,310, and 1,320 feet.

Log No. 78.—Union Natural Gas Co., Chatham
Lot 173, T.R., Tilbury E. tp.

Completed May 5, 1925.

Formation	Thickness, ft.
Surface	181
Shell	9
Soap	62
Brown lime	333
Grey sharp lime	65
White sandy lime	25
Light brown lime	25
Brown lime and gypsum	75
Grey lime and gypsum	45
Brown lime	380
Blue lime	134
Total depth	1,334

Gas at 1,195, 1,230, 1,295, and 1,315 feet.

Lambton County

Log No. 79.—John Heal, Petrolia
Lot 77, Lake Shore, Bosanquet tp.

Completed May 30, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	86
Top rock	69
Soapstone	30
Middle lime	11
Soapstone	204
Lower lime	107
Total depth	507

Log No. 80.—E. B. Blain, Hamilton
Lot 20, con. XI, Plympton tp.

Completed November 1, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	90
Shale	45
Top rock	65
Upper soap	184
Middle lime	6
Lower soap	60
Big lime	126
Total depth	576

Log No. 81.—Elsom Proctor, Petrolia
Lot 10 E½, con. III, Sarnia tp.

Completed March 30, 1925.
Open flow: 7,000 cu. ft.

Formation	Thickness, ft.
Surface	120
Top rock	60
Soap	120
Middle lime	15
Soap	49
Lower lime	71
Total depth	435

Log No. 82.—Sarnia City Dairy, Sarnia
City of Sarnia, Sarnia tp.

Completed January, 1925.

Formation	Thickness, ft.
Clay	115
Shale	50
Rock	160
Soap	120
Middle lime	10
Soap	50
Lime	155
Total depth	660

Gas at 170, 510, 540, 605, and 660 feet.

Log No. 83.—Reuben Proctor, R.R. 2, Sarnia
Lot 3, con. X, Sarnia tp.

Completed February, 1925.
Open flow: 50,000 cu. ft.

Formation	Thickness. ft.
Surface	120
Top rock	60
Soap	120
Middle lime	8
Soap	52
Lower lime	40
Total depth	400

Gas at 390 feet.

Lincoln County

Log No. 84.—Lincoln Gas Co., Canfield
Lot 1, con. II, Caistor tp.

Completed February, 1925.
Open flow: 26,448 cu. ft.
Rock pressure: 220 lbs.

Formation	Thickness, ft.
Surface	78
Shale	82
Niagara	200
Shale	20
Clinton	30
Red Medina	35
Shale	55
White Medina	15
Total depth	515

Log No. 85.—Lincoln Oil & Gas Syndicate, Canfield
Lot 33, con. V, Gainsborough tp.

Completed July, 1925.
Open flow: 23,640 cu. ft.
Rock pressure: 195 lbs.

Formation	Thickness, ft.
Surface	87
Niagara	179
Shale	34
Clinton	30
Red Medina	30
Shale	55
White Medina	15
Red shale	20
Total depth	450

Log No. 86.—Lincoln Oil & Gas Syndicate, Canfield
Lot 8, con. I, Gainsborough tp.

Completed May, 1925.
Open flow: 28,992 cu. ft.
Rock pressure: 220 lbs.

Formation	Thickness, ft.
Surface	49
Shale	96
Niagara	200
Shale	20
Clinton	30
Red Medina	35
Shale	55
White Medina	15
Red shale	15
Total depth	515

Log No. 87.—Lincoln Oil & Gas Syndicate, Canfield
Lot 1, con. I, Gainsborough tp.

Completed January, 1925.
Open flow: 110,000 cu. ft.
Rock pressure: 220 lbs.

Formation	Thickness, ft.
Surface	68
Shale	92
Niagara	200
Shale	20
Clinton	30
Red Medina	35
Shale	55
White Medina	15
Total depth	515

Norfolk County

Log No. 88.—Dominion Natural Gas Co., Brantford
Lot 12, con. II, Middleton tp.

Completed October 9, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	245
Brown lime	135
Sharp lime	35
Flint	65
Sharp lime	40
Brown lime	45
Shale and lime	35
Brown lime	100
Brown lime	105
Shale	12
Lime	118
Niagara lime	255
Shale and lime	10
Shale	50
Clinton	20
Red shale	38
Total depth	1,318

Log No. 89.—Dominion Natural Gas Co., Brantford
Lot 18, con. II, Middleton tp.

Completed December 14, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	229
Lime and shale	190
Flint	111
Lime and shale	415
Grey lime	45
Niagara	205
Shale	38
Clinton	19
Red Medina	31
Grey shale	8
Total depth	1,291

Log No. 90.—Dominion Natural Gas Co., Brantford
Lot 14, con. II, Middleton tp.

Completed November 9, 1925.
Open flow: 94,560 cu. ft.
Rock pressure: 600 lbs.

Formation	Thickness, ft.
Surface	249
Brown and grey lime	151
Flint and lime	140
Grey lime and slate	390
Niagara lime	253
Grey lime and shale	30
Blue shale	31
Clinton	23
Red and grey shale	40
Total depth	1,307

Gas at 1,264 feet.

Log No. 91.—Dominion Natural Gas Co., Brantford
Lots 16, 15, con. II, III, Middleton tp.

Completed December 31, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	246
Lime	165
Flint	129
Slate	70
Brown and grey lime	320
Niagara lime	255
Shale	35
Brown shale	27
Clinton	21
Red Medina	20
Blue shale	65
White Medina	9
Red shale	5
Total depth	1,367

Log No. 92.—Dominion Natural Gas Co., Brantford
Lot 17, con. II, Middleton tp.

Completed March 18, 1925.
Open flow: 250,000 cu. ft.
Rock pressure: 640 lbs.

Formation	Thickness, ft.
Surface	243
Lime and shale	167
Flint	140
Lime and shale	375
Niagara	258
Shale	62
Clinton	23
Red Medina	10
Grey shale	30
Total depth	1,308

Gas at 1,257 feet.

Log No. 93.—Dominion Natural Gas Co., Brantford
Lot 17, con. III, Middleton tp.

Completed May 22, 1925.
Open flow: 266,000 cu. ft.
Rock pressure: 640 lbs.

Formation	Thickness, ft.
Surface	253
Grey lime	62
Brown lime	100
Flint	150
Shale and lime	110
Brown lime	160
Grey lime	100
Niagara	260
Shale	51
Clinton	21
Red Medina	30
Blue shale	60
White Medina	11
Big red shale	6
Total depth	1,374

Gas at 1,258 feet.

LOG No. 94.—DOMINION NATURAL GAS CO., BRANTFORD
Lots 14, 15, con. III, Middleton tp.

Completed September 14, 1925.
Open flow: 20,760 cu. ft.
Rock pressure: 525 lbs.

Formation	Thickness, ft.
Surface	235
Brown and grey lime	165
Flint and lime	150
Slate and lime	360
Niagara	260
Grey shale	50
Clinton	25
Red Medina	17
Blue shale	13
Total depth	1,275

Gas at 1,239 feet.

LOG No. 95.—DOMINION NATURAL GAS CO., BRANTFORD
Lot 13, con. II, Middleton tp.

Completed July 20, 1925.
Open flow: 110,000 cu. ft.
Rock pressure: 500 lbs.

Formation	Thickness, ft.
Surface	240
Brown lime	140
Sharp lime	35
Flint	65
Sharp lime	40
Brown lime	45
Shale and gypsum	35
Brown lime	205
Shale	12
Lime	118
Niagara lime	255
Shale and lime	10
Shale	50
Clinton	20
Red and blue shale	50
Total depth	1,320

Gas at 1,265 feet.

LOG No. 96.—DOMINION NATURAL GAS CO., BRANTFORD
Lot 16, con. III, Middleton tp.

Completed July 20, 1925.
Open flow: 200,000 cu. ft.
Rock pressure: 640 lbs.

Formation	Thickness, ft.
Surface	230
Brown lime	160
Flint	150
Grey lime	60
Shale and lime	80
Brown lime	100
Grey lime	90
Black lime	30
Niagara	260
Shale and slate	56
Clinton	22
Red Medina	10
Shale	36
Total depth	1,284

Gas at 1,230 and 1,235 feet.

LOG No. 97.—MEDINA NATURAL GAS CO., CHATHAM
Lot 16 SW. ¼, con. II, S.T.R., Middleton tp.

Completed September 7, 1925.
Open flow: 266,006 cu. ft.
Rock pressure: 610 lbs.

Formation	Thickness, ft.
Surface	245
Lime	150
Flint	140
Lime	35
Shale	375
Niagara	250
Shale	50
Clinton	25
Red Medina	20
Shale	32
Total depth	1,322

Gas at 1,259 feet.

LOG No. 98.—MEDINA NATURAL GAS CO., CHATHAM
Lot 16 SW. ¼, con. II, S.T.R., Middleton tp.

Completed October 28, 1925.
Open flow: 242,833 cu. ft.

Formation	Thickness, ft.
Surface	246
Lime	152
Flint	127
White lime	45
Shale	370
Niagara	255
Clinton	22
Red Medina	58
Total depth	1,326

Gas at 1,258 feet.

LOG No. 99.—MEDINA NATURAL GAS CO., CHATHAM
Lot 16 SE. ¼, con. II, S.T.R., Middleton tp.

Completed December 23, 1925.
Open flow: 208,000 cu. ft.
Rock pressure: 610 lbs.

Formation	Thickness, ft.
Surface	235
Lime	140
Flint	125
Lime	45
Shale	385
Niagara	240
Shale	52
Clinton	22
Shale	54
Total depth	1,298

Gas at 1,230 feet'

LOG No. 100.—DOMINION NATURAL GAS CO., BRANTFORD
Lots 15, 16, con. XIV, Townsend tp.

Completed February 25, 1925.
Open flow: 105,000 cu. ft.
Rock pressure: 400 lbs.

Formation	Thickness, ft.
Surface	44
Lime	16
Flint	90
Lime	60
Shale	195
Lime	40
Shale	60
Niagara	332
Shale	35
Clinton	22
Red Medina	16
Shale	82
White Medina	10
Red shale	22
Total depth	1,024

Gas at 884 and 997 feet.

Log No. 101.—Dominion Natural Gas Co., Brantford
Lot 8, con A, Walsingham S. tp.

Completed November 24, 1925.
Open flow: 36,000 cu. ft.
Rock pressure: 490 lbs.

Formation	Thickness, ft.
Surface	315
Lime	175
Flint	110
Sharp sand	45
Lime and shale	355
Niagara lime	255
Shale	69
Clinton	20
Red Medina	50
Grey shale	64
White Medina	8
Red shale	2
Total depth	1,468

Gas at 1,259 feet.

Log No. 102.—Dominion Natural Gas Co., Brantford
Lots 14, 15, con. A, Walsingham S. tp.

Completed August 26, 1925.
Open flow: 83,000 cu. ft.
Rock pressure: 368 lbs.

Formation	Thickness, ft.
Surface	274
Lime	176
Flint	110
Sharp sand	40
Lime and shale	375
Niagara lime	241
Rochester shale	57
Clinton	20
Red Medina	29
Grey shale	33
Total depth	1,355

Gas at 1,287 feet.

Log No. 103.—Dominion Natural Gas Co., Brantford
Lot 17, con. VI, Woodhouse tp.

Completed June 23, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	63
Flint	78
Lime and shale	400
Niagara	293
Grey shale	34
Clinton	25
Red Medina	35
Grey shale	62
White Medina	10
Big red shale	2
Total depth	1,002

Peel County

Log No. 104.—Patrick Sullivan, Toronto
Lot 17 E. ½, con. I, Albion tp.

Completed June 15, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	550
Blue shale	250
Limestone	300
Total depth	1,100

Welland County

Log No. 105.—Provincial Natural Gas Co., Niagara Falls
Lot 21, con. I, Cassidy's Point, Humberstone tp.

Completed October 3, 1925.
Open flow: 25,000 cu. ft.
Rock pressure: 60 lbs.

Formation	Thickness, ft.
Salina and Lockport	683
Rochester	42
Clinton	17
Cabot Head shale	3
Red Medina	65
Manitoulin	47
Whirlpool	11
Queenston	47
Total depth	915

Gas in White Medina.

Log No. 106.—Sterling Natural Gas Co., Port Colborne
Lot 33, con. I, Humberstone tp.

Completed August 21, 1925.
Open flow: 35,000 cu.ft.
Rock pressure: 375 lbs.

Formation	Thickness, ft.
Surface	10
Flint	50
Brown lime	60
Lime and shale	320
Niagara	225
Shale	50
Clinton	30
Red Medina	43
Grey shale	55
White Medina	18
Red shale	51
Total depth	912

Gas at 715 and 851 feet.

Log No. 107.—Sterling Natural Gas Co., Port Colborne
Lot 32, con. I, Humberstone tp.

Completed December 28, 1925.
Open flow: 10,000 cu. ft.
Rock pressure: 295 lbs.

Formation	Thickness, ft.
Surface	11
Flint	50
Brown lime	60
Lime and shale	321
Niagara	225
Shale	50
Clinton	30
Red Medina	45
Grey shale	56
White Medina	18
Red shale	52
Total depth	918

Gas at 717 feet.

Log No. 108.—Sterling Natural Gas Co., Port Colborne
Lot 32, con. I, Humberstone tp.

Completed October 26, 1925.
Dry hole.

Formation	Thickness, ft.
Surface	8
Flint	60
Brown lime	50
Lime and shale	327
Niagara	230
Shale	50
Clinton	30
Red Medina	45
Grey shale	64
White Medina	4
Red shale	3
Total depth	871

Log No. 109.—Sterling Natural Gas Co., Port Colborne
Lot 1, con. I, Wainfleet tp.

Completed June 2, 1925.
Open flow: 30,000 cu. ft.
Rock pressure: 295 lbs.

Formation	Thickness, ft.
Surface	20
Flint	50
Brown lime	65
Lime and shale	300
Niagara	225
Shale	55
Clinton	30
Red Medina	45
Grey shale	55
White Medina	20
Red shale	2
Total depth	867

Gas at 730 and 847 feet

Log No. 110.—Sterling Natural Gas Co., Port Colborne
Lot 1, con. I, Wainfleet tp.

Completed March 28, 1925.
Open flow: 30,000 cu. ft.
Rock pressure: 375 lbs.

Formation	Thickness, ft.
Surface	9
Flint	90
Brown lime	50
Lime and shale	296
Niagara	230
Shale	50
Clinton	30
Red Medina	40
Grey shale	53
White Medina	18
Red shale	46
Total depth	912

Gas at 740 and 862 feet.

Wentworth County

Log No. 111.—Premier Development Co., Toronto
Lots 20, 21, con. IV, Ancaster tp.

Completed September, 1925.

Formation	Thickness, ft.
Clay	95
Grey lime	85
Brown lime	35
Niagara	90
Grey shale	45
Clinton	5
Blue shale and Red Medina	20
Blue shale	65
White Medina	15
Red shale	570
Utica shale	85
Black shale	5
Hudson River	590
Black shale	145
Hudson River	30
Trenton	35
Total depth	1,915

PETROLEUM IN 1925

By R. B. Harkness

General

The production of petroleum in 1925 was 144,250 barrels, and the value $369,154. This is a decrease of 10,067 barrels from 1924. An examination of Table II will show the downward trend of production from year to year, and Table I will show the reason of the decline in the past year, which is mainly the loss of the deep Trenton production in the Dover field and in Romney. These wells produced gas as well as oil and are owned by gas companies. It was found that the pumps in the bottom of the several wells required repairs at frequent intervals, and this necessitated opening the head of the well, sometimes for days at a time, thereby losing the use of the gas on occasions when it might be most needed. The companies felt that satisfied gas consumers were more valuable to them than the oil produced; and the flow of oil was shut off with a plug,



Site of the original oil well in the stream valley east of the town of Petrolia, with John Scott, veteran inspector, in the foreground.

although this step meant an annual loss in revenue of about $10,000. These wells now produce gas only. Other than this, the main loss of production was in the Petrolia field. By referring to Table II, it will be noted that the Oil Springs field has held a fair average of 40,000 barrels for six years—a remarkable record for a field now 65 years old. The loss of the bounty of 1½ cents per Imperial gallon, paid by the Dominion of Canada on all petroleum produced in Canada since June 8, 1904, is another contributing cause to this decline. On July 1, 1924, this was reduced from 52½ cents to 26¼ cents per barrel, and all payments of bounty ceased on July 1, 1925.

The annual spring freshets caused a flood of water to enter the oil fields wherever the casing in the wells was seriously corroded. This caused both the operators and Inspector John Scott a great loss of time and much work and expense, until the source of the trouble was found. It was necessary to pump every well and test the casing for leaks in order to find the well or wells which were the cause of the trouble.

TABLE I—OIL WELLS AND THEIR PRODUCTION, 1925

Field	Wells			Wells drilled		Production		Gain or loss in 1924		Average production per well per year
	Operating	Not operating	Abandoned	Producing	Dry			Gain	Loss	
						bbls.	gals.	bbls.	bbls.	bbls.
Petrolia and Enniskillen	1,206	970	134	....	1	53,165	30	.....	7,750	44
Oil Springs	1,130	98	6	....	....	39,137	7	.....	2,183	34.6
Moore tp	70	40	19	....	....	8,195	16	3,713	.....	117.1
Sarnia tp	96	49	3	4	2	1,905	1	.....	163	19.8
Plympton tp	20	20	10	....	3	1,424	1	900	.....	71.2
Bothwell	249	44	2	....	....	26,242	26	.....	458	105.4
Dover West tp	4	0	3	....	....	2,957	1	.....	1,724	431
Raleigh tp	.....	26	.....	....	....	.....	....	.....	.....	.....
Onondaga tp	8	25	.....	....	....	261	0	.....	195	32.6
Mosa tp	74	23	13	1	1	8,397	....	.....	465	113.5
Thamesville	7	14	.....	6	....	289	5	289	.....	41.3
Euphemia tp	.....	117	.....	....	....	39	10	39	.....	.....
Dunwich tp	8	92	.....	....	....	1,000	31	.....	351	125
Dawn tp	.....	40	.....	....	....	.....	....	.....	.....	.....
Romney tp	1	.....	.....	....	....	1,235	6	.....	1,719	1235
Brooke tp	1	1	10	....	....	.....	....	.....	.....	.....
Belle River	.....	25	.....	....	....	.....	....	.....	.....	.....
Other fields	.....	.....	.....	....	3	.....	....	.....	.....	.....
Total	2,884	1,574	200	11	10	144,249	29	4,941	15,008	.....
								Net loss 10,067		

The above production is reported by the Imperial Oil Company, who also state the value to be $396,154. The Dominion Government paid a bounty of 26¼ cents per barrel of 35 Imperial gallons up until June 30, 1925; this is an additional value of $20,152.

The explanation of the wells drilled in "Other fields" in the above table will be found in the section on Exploratory Work, page —.

TABLE II—OIL PRODUCED IN ONTARIO BY FIELDS, 1918 TO 1925

Field	1918	1919	1920	1921	1922	1923	1924	1925
	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.
Petrolia and Enniskillen	65,467	70,087	65,082	68,484	64,935	64,159	60,916	53,166
Oil Springs	44,671	45,245	39,388	40,967	43,214	39,090	41,320	39,137
Moore tp	6,367	4,029	7,036	7,536	7,275	4,790	4,483	8,195
Sarnia tp	3,438	4,259	3,495	4,069	3,224	2,387	2,068	1,905
Plympton tp	412	560	531	481	695	872	525	1,424
Bothwell	29,116	29,425	25,563	26,877	25,681	27,665	26,700	26,243
Tilbury East tp	25,228	1,660	623	1,003	127	1,950	.....	.....
Dover West tp		16,705	12,171	7,473	5,482	5,618	3,898	2,957
Raleigh tp	.....	.....		3,320	663	302	783	887
Onondaga tp	1,186	197	341	566	489	237	456	261
Mosa tp	108,988	45,860	24,063	10,764	11,959	10,319	8,862	8,397
Thamesville	1,565	801	1,131	1,319	384	567	.....	289
Euphemia tp	.....	.....	.....	.....	.....	.....	.....	39
Belle River	447	.....	.....	.....	.....	.....	.....	.....
Dunwich tp	1,875	1,272	837	.....	387	594	1,351	1,001
Dawn tp	.....	.....	.....	.....	217	.....	.....	.....
Romney tp	.....	.....	.....	.....	.....	849	2,955	1,235
Total	288,760	220,100	181,750	172,859	164,732	159,399	154,317	144,249
Value	$781,097	$632,789	$724,145	$466,716	$466,587	$395,300	$390,423	$369,154
Average price	$2.70½	$2.87½	$3.98½	$2.68½	$2.65	$2.47	$2.51¼	$2.56

Price of Crude Petroleum

The following prices are published through the kindness of the Imperial Oil Company of Sarnia and show the fluctuations in the market price of oil in Ontario. The prices follow those of the United States very closely, as the price of imported oil controls the market. The variation of the prices as between fields is due to the specific gravity of the oil. The lighter oil or that containing most gasoline commands the highest price.

1925	Fluctuation	Price
January 1		$2.23
January 22	Increase 10 cents	2.33
January 23	Increase 15 cents	2.48
January 31	Increase 25 cents	2.73
March 24	Decrease 10 cents	2.63
July 11	Increase 10 cents	2.73
August 21	Decrease 10 cents	2.63
August 28	Decrease 25 cents	2.38
December 31		2.38

The price of crude petroleum from the Oil Springs field is 7 cents higher than the above prices, and from the deep Trenton field in Romney township 30 cents higher. The price of oil from the remainder of the fields, where most of the production is secured, is the same as Petrolia crude; some of the smaller fields have a slightly lower quality, and the price paid for it is a few cents less than Petrolia crude.

Exploratory Work

Very little drilling has been done within the limits of the old oil fields for many years, as they had been fully drilled in the past. The Glencoe field in Mosa township is an exception to this, as there have not been more than 200 wells drilled within an area of 4,200 acres or an average of one well for every 21 acres.

There has been very little exploratory work done during the last few years on account of the low price paid for oil, but it is encouraging to note that some 20 wells were drilled in all in outside territory.

The number of shallow wells in the vicinity of lot 10, concession III, Sarnia township, have produced a little oil, but principally gas. There appears to be a considerable gas field in this concession and due north in concessions VII and VIII. Most of the wells show some oil as well. A dry well was drilled on lot 16, concession II, Sarnia township, confirming previous information.

A dry well was drilled on lot 77, Lake Shore, East or West Survey, Bosanquet township.

Wm. Hussey drilled a dry well on lot 7, concession VIII, Mosa township; this is in the northern extremity of the oil field in this township.

Dr. Blain of Hamilton has been doing some exploratory drilling in lots 20 and 22, concession XI, of Plympton township, with indifferent results.

The Ajax Oil and Gas Company and the Eagle Oil and Gas Company, of Toronto, drilled five wells in Camden gore, due west of the Thamesville (old Klondike) oil field; a fair show of oil is reported, but apparently the wells have not been pumped for any length of time. A small well was drilled by Luke Smith, of Oakville, in lot 6, concession V, Zone township. Apparently there are many small domes in this vicinity, all carrying some oil.

A dry well was drilled in lot 6, concession V, Adelaide township.

The Premier Development Company drilled a well to the pre-Cambrian in lot 20, concession IV, Ancaster township, with a very small show of gas in the Trenton.

R. I. Henderson completed a dry hole near Downsview in lot 14, concession III, York township. This well penetrated the pre-Cambrian.

E. L. Michener has leased the petroleum and gas rights on the Six Nations Indian Reserve in Brant county; he is sinking a well in lot 13, concession III, Tuscarora township.

Patrick Sullivan drilled a well into the Trenton in the east half of lot 17, concession I, Albion township. The well was not completed on account of caving formation and other troubles.



Wooden tank (10-barrel capacity) used for hauling crude oil from small fields to the railway.

Refining Operations

Three refineries were in operation in Ontario in 1925; one was closed down during the year, and one commenced operations in the latter part of the year but has no commercial production for 1925.

PETROLEUM REFINERIES, 1925

Company	Location of refinery	Head office address	Days operated
British American Oil Co., Ltd.	Foot of Cherry St., Toronto.	Royal Bank Bldg., Toronto....	304
Canadian Oil Companies, Ltd.	Petrolia.....	Excelsior Life Bldg., Toronto...	300
Great Lakes Oil Co., Ltd.....	Wallaceburg.....	Wallaceburg.....	Not operating, 1925
Imperial Oil Refineries, Ltd...	Sarnia.....	Sarnia.....	365
McColl Bros.....	Foot of Cherry St., Toronto.	114 Don Esplanade, Toronto...	Under construction.

The average number of employees at the above refineries is 2,165, and the salaries and wages paid them amount to $2,702,034.

This does not include the staff of McColl Brothers who were employed for the last month of the year equipping and testing out the refinery being erected in Toronto. Operations commenced in January, 1926.

Table III gives a comparative summary of the operations in Ontario refineries for the years 1921-25, inclusive. These products added to the imported refined products, Table IV, represent the consumption of petroleum products in Ontario, a total of $28,480,955. These tables are made from information furnished by the Dominion Bureau of Statistics, Ottawa.

TABLE III—PETROLEUM REFINING OPERATIONS, 1921-25

Schedule	Unit of measure	1921	1922	1923	1924	1925
Canadian crude produced	Gallons	6,050,062	5,756,602	5,598,985	5,401,102	5,024,770
	Value	$466,716	$466,587	$395,301	$390,424	$367,524
Imported crude distilled	Gallons	150,692,113	152,888,816	138,527,971	151,381,481	161,895,295
	Value	$14,537,339	$13,834,118	$11,141,952	$11,575,058	$13,056,823
Canadian crude distilled	Gallons	5,880,086	5,612,645	5,837,827	5,123,683	4,859,148
	Value	$500,418	$462,346	$450,467	$394,398	$358,245
Percentage of total		3.75	3.54	4.04	3.27	2.92
PRODUCTS:						
Illuminating oil	Gallons	29,774,134	36,650,134	33,175,063	28,816,322	18,677,629
	Selling value	$3,335,200	$4,077,350	$3,758,185	$3,055,188	$2,222,569
Lubricating oil	Gallons	13,848,721	14,556,150	11,584,423	12,011,116	13,297,275
	Selling value	$2,351,975	$2,558,278	$2,107,530	$2,009,732	$2,364,320
Benzine, naphtha and gasoline	Gallons	51,033,337	59,223,186	50,884,894	61,493,214	73,083,022
	Selling value	$12,655,244	$13,920,089	$8,739,670	$9,392,837	$11,032,134
Still gas	M cu. ft			374,687	524,737	431,713
	Value			$131,745	$172,555	$167,869
Gas and fuel oil	Gallons	44,364,794	34,508,790	35,727,265	36,702,043	46,064,129
	Selling value	$2,130,685	$2,510,427	$2,367,050	$2,494,858	$2,947,378
Paraffin wax and candles	Lbs	10,777,994	12,063,768	10,484,436	9,112,143	15,502,029
	Selling value	$310,267	$329,147	$484,416	$551,434	$734,322
Tar and grease	Lbs	18,971,400	8,186,013	10,612,588	10,325,835	9,301,674
	Selling value	$142,285	$265,150	$222,675	$187,544	$177,474
Acid oil	Gallons			1,126,370	1,350,450	1,858,176
	Value			$62,006	$61,748	$85,761
Acid and petroleum coke	Short tons		38,016	31,505	5,464,484	3,733,772
	Value		$263,034	$249,425	$226,005	$212,085
Miscellaneous	Value				$29,261	$1,596
Total value of refined products		$20,925,656	$23,923,475	$18,122,702	$18,181,162	$19,945,508
Employees	Average No.	1,560	1,393	1,515	1,603	2,165
	Wages	$2,176,700	$2,018,765	$2,265,307	$2,453,082	$2,702,034

NOTE: Gallons refer to Imperial gallons.

Petroleum and Refined Products Imported

Table IV shows the quantity and value of crude oil and its refined products imported into Ontario during the years 1924 and 1925. It is practically all imported from the United States. The information is furnished by the Dominion Bureau of Statistics, Ottawa.

TABLE IV—PETROLEUM AND REFINED PRODUCTS IMPORTED IN 1924 AND 1925

	1924		1925	
	Imperial gallons	Value	Imperial gallons	Value
CRUDE PETROLEUM:				
Fuel and gas oils between 0.775 and 0.8235 specific gravity	39,455	$2,820	12,803	$2,482
Petroleum 0.790 specific gravity or heavier for refining	145,208,940	7,712,789	184,632,857	11,274,102
Total	154,704,244	$8,294,236	184,645,650	$11,276,584
REFINED PETROLEUM:				
Gasoline	38,825,722	$4,740,920	45,115,959	$6,471,301
Kerosene and other illuminating oils	2,338,526	202,769	2,908,759	249,011
Lubricating and other oils	4,072,163	1,223,563	4,124,186	1,254,658
Total	45,236,411	$6,167,252	52,148,904	$7,974,970
PETROLEUM PRODUCTS:				
Axle grease.....lbs.	1,707,334	$89,244	2,231,926	$138,669
Vaseline, toilet and medicinal petroleum	.....	142,812	.....	128,291
Paraffin wax.....lbs.	508,989	42,253	1,279,225	101,979
Paraffin wax candles.....lbs.	94,342	19,816	142,923	30,307
Other petroleum products.....gals.	929,773	177,297	883,267	160,431
Total	.....	$471,422	.....	$559,677
Total value	.....	$14,932,910	.....	$19,811,231

Total net value of petroleum and refined products imported in 1925	$19,811,231
Duty paid on the above in 1925, calculated on the existing tariff schedule	$1,441,243
Sales tax at 4 per cent	$1,062,624
Freight, approximately	$6,430,000
Total value delivered in Ontario	$28,745,098

A comparison of this total with the value of the products of our Ontario refineries shows that nearly 45 per cent. of refined petroleum products consumed in Ontario or passing through Ontario is imported.

Oil Recovery

General

As every gas or oil field decreases in production from the instant the drill penetrates the rock which contains the gas or oil, it necessarily follows that a time must come when the flow diminishes to a point where it becomes unprofitable to pump oil wells or operate gas wells. In such cases, it would appear that all the oil has been exhausted from the field, but recent investigation has shown that a large portion of the oil remains in the rock, the quantity varying with the character of the rock container, the specific gravity of the oil, and whether or not gas or water pressure is the force that expels the oil from the rock container. It is intended to discuss the known methods of recovering this remaining oil.

Dry sandy shale or sandstone fields will probably retain most oil after the gas has been exhausted, and dry limestone fields least oil, because in the case of limestone fields it would appear that most of the oil is found in cavities and

along the joints and bedding planes, while sands ones retain the oil between the small sand grains. It is claimed that much oil and gas is to be found in the interstices of dolomite. This may be truer of gas fields than of oil fields, for, judging from samples shot out of wells and from the evidence gained from the Kentucky oil mine,[1] it is probable that this is a small portion of the total, and also the most difficult to remove. The Guelph dolomite is perhaps a notable exception among our Ontario gas fields.

Oil is a sticky, viscous substance that adheres to the sides of the rock and resists movement. A propellent must therefore be present to make it flow towards a well; this is present in all commercial oil fields in the form of gas or water, and sometimes both.

Laboratory Experiments

Many laboratory experiments have been carried out to ascertain just what occurs underground when a well is drilled into an oil and gas pool, and it has been fairly well demonstrated that when a well penetrates the top of the pool, the oil is carried to the well by the escaping gas. Mills,[2] in an experiment in which he put oil saturated sand in a bottle along with soda and water and sealed it with the usual tin top, found that, when he pierced the tin stopper with a pin, gas and oil spouted out and that there was a general movement of the oil to the point of exit. In another experiment he watched the movement of oil, gas, and water through a box filled with oil-saturated sand and having one glass side. He put too much gas pressure in the box and the glass cracked; after the gas had escaped with considerable oil, he found that a quantity of the oil had moved to the vicinity of the crack in the glass. After making repairs and completing his original experiment, he found that by passing water through an an oil-saturated sand, a certain quantity of oil is carried through, but the moving water soon seeks the main channels and, after washing them, carries no more oil; but the addition of gas or air bubbles starts the oil moving again. When an air bubble, moving through rock under pressure of a stream of water, comes in contact with oil, a film of oil is absorbed on its surface between the water and the air; when this bubble next comes in contact with an oil globule, the surface tension of the oil is overcome, and the oil spreads over the surface of the bubble. As an air bubble will pass through a small opening more readily than an oil globule, the bubbles move through the rock container faster than the oil globules; when loaded with a heavy film of oil, these bubbles carry a considerable quantity with them, as well as materially assisting the movement of the globules through the rock.[3]

In time the gas or air, like the water, seeks the main channels, and it also loses its carrying quality. The action that takes place underground, where the gas pressure is probably 100 pounds for every pound used in the laboratory, can only be speculated on; but it is reasonable to suppose that when hydrocarbon gases are intimately associated with oil and when both are under pressure, the gas is absorbed in the oil and the viscosity of the oil reduced,[4] so that at the time the drill provides the means for a release of pressure, the gas contained

[1]W. R. Jillson, A New Method of Producing Crude Oil in Kentucky, Kentucky Geol. Surv.
[2]R. van A. Mills, Bull. Amer. Assoc. Pet. Geol., Vol. VII, No. I, 1923, p. 14.
[3]Harold V. Dodd, Migration of Oil, Econ. Geol., Vol. XVII, No. 4, p. 285.
[4]Beecher and Parkhurst are reported in the Oil and Gas Journal, October 21, 1926, as saying: "At a pressure of 500 pounds and a temperature of 70° F. it was found that a natural gas such as is associated with the oil would reduce the viscosity about 50 per cent., when a given crude oil was saturated with gas." Further: "Under such pressures (1,800 pounds) sufficient gas might dissolve in the oil to make the viscosity almost equal to that of kerosene."

in the oil immediately seeks an exit and carries considerable oil along with it to the well; also that as the gas pressure in the well decreases from year to year, this action continues, but at an increasing distance from the well. The action that takes place is supposed to be more or less the same as described in the above experiment, excepting the fact that a very considerable pressure of gas is necessary to force its way through several hundred feet of rock, no matter how porous, and that the greater distance that the gas must travel through the rock the less oil it will carry to the well.

Oil Production per Thousand Cubic Feet of Gas

It can be stated with reasonable certainty, based on the experiments just stated, from field experience[1] and from our knowledge of physics, that gas will move through a rock container much more rapidly than will oil and that in doing so it has a tendency to occupy the larger channels, thereby displacing the oil. This is evident in the early life of every oil well, especially very large wells, when the roar of gas attracts attention. The escape of the gas past the oil continues throughout the life of the well in a diminishing ratio. Field experiments have been made[2] by placing meters on a number of oil wells; it is found that in the majority of cases, where the gas was held back by partially closing the valve in the gas main, practically the same quantity of oil is produced as when the gas was allowed to flow unrestrainedly. Of course there are many instances where the flow of oil is considerably diminished, the result being apparently dependent on the texture of the rock, porosity, etc. The conclusion arrived at as a result of this experiment was that, in most cases where conditions favoured the escape of gas, if one-third of the closed-in pressure of the well was held back by a regulator or similar device, the greatest quantity oil per one thousand cubic feet of gas can be produced. As gas is, in most fields in North America, the means of moving the oil from its rock container to the well, it follows that the quantity of oil produced is dependent on the quantity of gas present to move it, and therefore a careful test and study of the rate of recovery of oil per thousand cubic feet of gas should be made. If the results are put into practice, the lifetime of the oil field and the quantity of oil that can be recovered by natural flow and by pumping will be greatly increased. All that is required is a gas meter and the use of the "trial and error method." This waste of gas is clearly shown by actual tests in the field[3] where wells are widely spaced and the gas is allowed an unobstructed flow; the wells do not produce as much oil per acre as those operated under similar conditions and closely spaced. No data have been published, to the writer's knowledge, on the production of oil from wells closely spaced, say one or two per acre, and operated under back pressure control; but it is very obvious from these published data that a maximum recovery per thousand cubic feet of gas can only be obtained under these conditions.

As stated in the opening paragraph of this section, it is intended to discuss the possibility of recovering additional oil from the old oil fields of Ontario, where the flow has diminished to such an extent that it has become unprofitable to pump oil from the surface under methods at present in use in Ontario.

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[1]T. E. Swigert, Experiments in Rock Pressure on Oil Wells, U.S. Bur. Mines, Tech. Paper No. 322.

[2]Ibid.

[3]American Petroleum Supply and Demand, McGraw Hill Co., pp. 74-77; Report on Hewitt Field, Oklahoma, U.S. Bur. Mines, pp. 31-35, 115; and J. O. Lewis, Oil & Gas Jour., Feb. 18, 1925, p. 75.

There are four known methods that have been tried out, more or less thoroughly. These are:—

1. Replacing the gas pressure after it has been exhausted.
2. Driving the oil to a well that is being pumped by allowing water to enter at another point.
3. Dewatering or pumping off accumulated water.
4. Mining.

Restoring Gas Pressure

As gas is the natural means by which oil is moved through the rock container, it seems obvious that it should be used to restore the pressure where it is exhausted. This may be accomplished by pumping gas or air down certain wells and pumping the ejected fluids from nearby wells. Air or gas[1] will penetrate most readily into the rocks of low porosity, and if a back pressure is held on the pumped wells it should tend to force oil out of these "tight" places. This is supposition, for very little is known of the character of dense rocks. The pressure must be built up very slowly, probably over a period of months or years, for apparently it takes time for gas or air to force its way through such very small openings and displace the fluid that they contain. This process is covered by patent and is known as the "Dunn-Lewis process." The nly objection to the process is that where there is a certain quantity of gas still recoverable and air is used, it renders the recovered gas to a great extent unfit for use. The process was tried and found successful in Ohio, but was discontinued on account of the objection just mentioned. Lewis[2] claims that, on an average, 50 per cent. more oil can be recovered by this method after the natural flow has stopped and the wells have ceased to respond to the pump.

Professor H. C. George, of Oklahoma University, conducted an experiment[3] calculated to reproduce field conditions in miniature with well spacing in proportion; he forced oil through a miniature well into a sandstone block and expelled it by forcing air through a similar miniature well into the sandstone block. The recovery was 60 per cent. These conditions are probably not parallel to practical normal field conditions, because (1) the gas pressure would decline under oil field conditions, and (2) in the majority of cases there would be some water in the rock and the sand grains would be water wet, which according to Dodd[4] decrease the recovery. On the other hand, this would be somewhat offset by the fact that when the oil was first forced into the sandstone block, theoretically it would fill the sandstone to points equidistant from the well. The air would act in the same manner until it had forced the oil back and reached the "oil well," when it would escape freely and would fail to expel the oil beyond this "oil well."[5]

On this and other experiments and field data, Professor George bases his opinion that the recovery of oil from most fields where gas is not lavishly wasted and where other conditions and operations are up to the general average, will be much greater than most authorities predict.[6]

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[1] *See* footnote (4) on page 49.
[2] J. O. Lewis, U.S. Bur. Mines, Bull. No. 148.
[3] Personal communication.
[4] Op cit.
[5] Stanley S. Herold has discussed this theory very fully in the Oil and Gas Journal, Oct. 28, 1926.
[6] American Petroleum—Supply and Demand, p. 59.

Systematic Flooding of Oil Fields[1]

Rather by accident than by design, it was discovered that the oil production in the Bradford field in the states of New York and Pennsylvania was increasing, after years of gradual decrease, and that the cause of this increase was due to a flood of fresh water. The rate of production from certain wells that had been producing only a few barrels per day showed a remarkable increase shortly after the casing in certain other wells in the vicinity had been removed and no plugs put in them; an investigation showed that where the surface water was entering these wells and penetrating the oil sand, the oil was being forced ahead of the water toward wells that were being pumped. The average depth to this Bradford oil sand was 1,600 feet, and the hydrostatic pressure exerted would be about 700 pounds per square inch. The system used in flooding this field is as follows: A number of wells are drilled along the property line about 250 feet apart; at the same distance, parallel rows are drilled, and the locations staggered. The first row is used for flooding, and the second row for pumping; as the water reaches the second row, the process is repeated. Without going into details, it is found that the greatest quantity of oil is produced, by flooding or water drive, where the porosity is between 15 and 17 per cent. Where the porosity is greater, viz., in the old "gusher" fields, the water drive no doubt follows the old channels and does not increase the oil output; and where the porosity is less, the water penetrates to a lesser degree, and not sufficient oil is recovered to pay the cost of drilling. It is noted that the flood avoids certain wells, which is considered fairly conclusive proof that more porous rock and better waterways are found in other directions. Lenses and structural conditions play their part, giving a point of accumulation. The rate at which the water penetrates the oil sand in the Bradford field is from 30 feet to 250 feet a year, depending of course on its porosity. The oil travels in advance of the flood, and the pumped wells produce oil up to the time that the water reaches them. The Bradford oil sand is probably unique in that the grains are slightly angular and uniform in size and in the quantity of cementing material between them; these conditions make for the greatest porosity.

The use of chemicals dissolved in the flood water has been advocated by the United States Bureau of Mines as the result of recent field experiments. Soda ash is given the preference. The chemicals overcome the surface tension of the oil and wash it free from the rock.

Dr. David White,[2] of the United States Geological Survey, in discussing this field estimates that 15 per cent. of the oil has been removed by natural flow and pumping and that 20 per cent. additional is being recovered by water drive, leaving 65 per cent., or 2,500,000,000 barrels, still in the rock. His investigation is of a preliminary nature, but cores have been taken and carefully examined for porosity and oil content and his estimates may be taken as authoritative. One operator states that the recovery by flooding is 10,000 to 12,000 barrels per acre flooded. This is more than was recovered by natural flow and pumping. Other operators claim from 1,600 to 10,000 barrels per acre recovery by flooding.

Unwatering

In abandoned fields that have been systematically flooded, the water may be pumped off and a further recovery of oil effected. Some results might be expected even in such a field as that at Bradford; for, provided that all old

[1]The writer is indebted to Mr. Hartnagel of the New York State Geological Survey for much unpublished information on the Bradford oil fields.

[2]David White, Plan for Recovering Oil in Bradford Oil Field, Oil and Gas Jour., Nov. 20, 1924

wells are plugged off or silted full enough to reduce very much the incoming water, pumping will lower the water level throughout the sand, and after the main water channels have been drained much oil should be recovered from the denser portions of the "sands," which are between 10 per cent. and 15 per cent. porosity.

The Tidoute oil field in Pennsylvania offers some reliable data on this subject.[1] The field was discovered in the early days of oil development and was intensely drilled; when production became unprofitable, most of the field was abandoned without the formality of removing the casing. In a few years the casing gave way and allowed water to enter the oil "sand." When the advance in the price of oil came, about the year 1904, an adventurous operator attempted to bring the field back into production. He pumped nothing but water for six months, and patiently bore the ridicule of everybody, and then oil appeared, and the flow increased from day to day. No record is available which gives the subsequent production, but it is known that the field was operated for some years.

The Pioneer oil field of Pennsylvania has practically the same history excepting that in addition to pumping it, the operator installed a vacuum pump, and gasoline was recovered from the gas withdrawn with the oil.

A 100-acre lease shows the following production:—

1919	47,000 barrels oil.
1920	56,000 barrels oil.
1921	43,500 barrels oil.

In addition to this, one of three gasoline-extraction plants recovered 32,000 gallons of gasoline in November, 1922, and has been averaging 500 gallons per day since September, 1919.

These are only two of several fields that have been unwatered and have paid a handsome dividend as a result.

Oil Mining[2]

Oil mining is probably the most ancient method of obtaining oil by any means other than skimming it from springs or collecting it where it seeped from the ground more or less mixed with the earth.

About 1735, at Pechelbroon in Alsace,[3] France (no doubt after collecting the available supply of oil that had seeped from the hillside), the oil-saturated sand was quarried and two inclined galleries were run into the hillside 30 and 50 feet, respectively. Oil was extracted by washing the sand in hot water. From about 1786 to 1802, shafts were sunk from 100 to 150 feet deep, and in 1865 had reached 216 feet. In 1888 the shafts had reached 300 feet, and beginning in 1917 three shafts were sunk to 450, 600, and 750 feet, respectively.

The material penetrated in sinking the shafts consists of alternate beds of clay and sand. In the galleries this sandstone, being saturated with oil, is consolidated, but yields readily to the pick. When the oil drains from it, it disintegrates and must be supported by heavy timbers or by brick and reinforced concrete. Up until about 1865, practically all the oil produced was by mining the sand and washing it; but as the shaft was deepened lighter oil

[1]Geol. Surv. Pennsylvania, Bull. No. 56.

[2]The writer has drawn freely from information given in Memorandum Series No. 10, Mines Branch, Department of Mines, Canada, by C. Camsell and Arthur Buisson; from a paper by W. A. J. M. Van W. Van der Gracht in the Oil and Gas Journal, October 23, 1924; and from a report of the Geological Survey, Kentucky, 1923, "A New Method of Producing Crude Oil in Kentucky," by Willard Rouse Jillson.

[3]Camsell and Van der Gracht.

was encountered, and the principal recovery gradually changed from washing oil from the mined sandstone, to a natural flow of oil into the galleries. In recent years many wells have been drilled that were productive.

Mining for oil by the same methods as described, and under similar conditions, was begun at Weitz,[1] near Hanover, Germany, in 1917. Mining for oil in Kentucky[2] has been carried out in Ravinna, Esthill county, where the formations are identical with our Ontario shallow fields. The oil in both is found in the Onondaga limestone. In the Kentucky mine the limestone was used as a fertilizer and sold at $3 per ton. Our Ontario limestone is very pure and commands the highest price for this purpose. Some sporadic attempts have been made to mine for oil at Sulphur mountain, Ventura county, California.

In the French and German mines, the galleries are driven in and through the oil sand, and the oil drains directly into the gallery; it is interesting to note that, although the oil horizon averages 7½ to 9 feet in thickness, only the basal 20 to 25 inches produces oil.[3] In a freshly exposed face the oil level gradually sinks, and as it sinks the production declines as in an oil well. The seepage usually lasts for a few weeks and on a rare occasion for a few months. Van der Gracht claims that oil drains into the galleries from only a short distance in the sand; the distance is variable. At the same time, Camsell states that under ideal conditions (with no lenses or obstruction), the galleries will drain 300 feet. When approaching an old well or in crosscutting between galleries, no difference was noted in the rate of seepage until within a few feet of the well or gallery. At Pechelbroon, the production is 20 to 25 barrels per foot of gallery with an end section of 45 square feet.

From 1908 to 1917, four wells in Pechelbroon produced 21,000 tons of oil. The same area, from March, 1917, to September, 1920, produced by mining methods 48,399 tons and is not nearly exhausted.

It is claimed that the Onondaga limestone in the Kentucky mine contains 25 per cent. oil. This is considered high. The University of Kentucky makes a very broad statement that the limestone when mined under proper methods may contain from 5 to 10 gallons of oil per short ton.

Nothing definite can be gained from this mine in regard to the saturation of the limestone, excepting that in the heavy beds there did not appear to be any oil; it was all found in fissures and in crevices along the joints and bedding planes of the rock. In this instance only a small fraction of the total thickness contained any oil.

Likewise in the French and German mines, the saturation is complete only in the bottom 20 inches; it also varies with the texture of the sand. Clay lenses and thin fissures, a fifth of an inch wide, filled with clay and cutting across the oil sand, changed the saturation apparently by cutting off the movement of oil through the sand. On the other hand, as the workings reached "edgewater," the saturation increased until the level of oil reached to the top of the gallery. There were found irregular alternating masses of saturated and dry sand throughout the workings, which occurred very much like concretions do in shales or sandstones. Where coarse sand was found, there was found the greatest saturation, which gave rise to these lenses or concretions.

It is very apparent, after reading the reports mentioned in this text, that it is impossible to form any opinion of the nature of the rock container by examining the drill cuttings from a churn drill. The only way of approaching accuracy

[1]Camsell and Van der Gracht.
[2]Jillson.
[3]Van der Gracht.

is by taking a core through the formation; even this may be misleading, for the drill may pass through a lens of either porous or non-porous, saturated or dry material that is not typical of the average rock. These are some of the chances that must be taken to be successful in the industry.

In the European mines, the gas enters the gallery along with the oil in tiny bubbles. There is also a constant influx of gas above the oil level; for when the upper part of the face is wetted with oil, tiny bubbles announce the presence of gas.

Some of the dangers of mining can be grasped from the fact that the following quantities of gas in air will explode: crude oil gases, from 0.8 to 1.3 per cent.; gasoline, 4.9 to 5.4 per cent.; methane (coal gas), 5 to 14 per cent.; methane with some gasoline vapour is explosive up to 14 per cent.

The breaking of an electric light bulb, the spark from a drill or from a horse's shoe striking a stone, or a pick striking against iron pyrites have caused explosions in oil mines. It can be seen that the coal miner's safety lamp is useless in oil mines. The only practical lights are storage-battery lamps with bulbs of 1½ candle-power. The ventilation in oil mines must be such that the volume of explosive gases is reduced to two-tenths of one per cent. The quantity of air per man used in the European mines is six cubic metres per minute. Some extracts from Van der Gracht's paper are interesting:—

> The more rapidly the air moves, the more rapidly the gasoline present in crude oil evaporates. . . . In oil mines the lighter gases travel along the roof of the galleries, while the very dangerous gasoline vapours travel sluggishly along the floor; consequently dead pockets are dangerous, both in the roof and in the floor, and supposedly safe workings may have a heavy dangerous gas layer on the floor. . . .
>
> In addition most oil gases become toxic at 0.5 per cent.; as this is below the danger point of explosion, it constitutes a safety warning, but it will scarcely show up the dangerous floor layer of gasoline vapours.

When it is considered that this European oil contains less than one per cent. gasoline, what may be expected with our Ontario oils that contain up to 30 per cent. gasoline?

Attempts to circumvent the danger of explosion in oil mines have been made by driving galleries above or below the oil. Patents have been issued to several inventors[1] of such methods, which vary only in details. A description of the Rich and Ranney methods will probably cover every development to date.

In the Rich method,[2] a shaft is sunk to a point either above or below the oil sand and galleries driven from this point to surround a selected acreage, say 640 acres or one square mile. Three additional tunnels are driven across this block at quarter-mile intervals, dividing it into four 160-acre blocks, a quarter of a mile wide and a mile long. A row of 27 wells are drilled along the centre of each of these 160-acre blocks to be used for flooding, as described on page 00. Slits or channels about three inches wide are then cut into the floor or roof of the gallery, as the case may be, deep enough to "transect" the oil sand; the channels are covered with a sheet of metal and sealed in both sides to prevent the escape of gas into the gallery. An exhaust fan draws any escaping gas through the channel and keeps the gallery free of gas at all times. There is a specially designed shield that can be built around the channelling machine as a special device to prevent the escape of gas into the galleries, should gas under pressure be encountered in channelling.

[1]Cosamajor, Paul: U.S. Pat. Nos. 50,902 and 50,903, 1865.
Ehrat, Adolph: French Pat. No. 528,061, Aug., 1921; British Pat. No. 175,116, Feb., 1922.
Rich, John: U.S. Pat. No. 1,507,717, Sept., 1924.
Wright, R. L.: U.S. Pat. No. 1,520,737, Dec., 1924.
Ranney, Leo: Canadian Pat. No. 256,025, Dec. 1, 1923; others pending.

[2]John L. Rich, Possibilities of Petroleum Recovery by Mining, Eng. & Min. Jour.-Press, June 6, 1925. *See* Addenda on page 64.

When the natural flow of oil into the channels diminishes, a flood of water is introduced through the 27 wells; this water may be hot or cold. Chemicals may be added or air introduced at the wish of the operator. These methods have all been discussed previously and would no doubt assist in removing the oil.

There is a sump provided for collecting and separating oil and water; pumps for lifting these fluids to the surface, exhaust fans for ventilation, power-houses, air compressors, etc., are provided for.

Another patent has been granted to Leo Ranney,[1] who assigned to the Standard Oil Company of New Jersey, on a process for mining oil. The same gallery system is used as in the Rich method; but instead of channelling up or down into the producing horizon, 3-inch holes are drilled to the top of the "oil sand" at 10-foot intervals, and a nipple is sealed in each hole by an air-tight seal, thus preventing gas from reaching the tunnel. A cross is screwed on the top of the nipple, and the oil-collecting line is connected through the side openings of these crosses. A drill is inserted, through a stuffing box in the top of the cross, into the sealed-in nipple and a hole drilled through the producing sand. This is termed a "mine well." These collecting lines lead to a sump at the bottom of the main shaft where water, gas, and oil are separated through a suitable device; each is raised to the surface through separate lines. It would appear that where the thickness of the oil sand or sands or the lift of the steam pump exceeds 25 feet, the galleries should be driven below the oil horizon and the oil allowed to drain to the sump by gravity. Ranney recommends that fields be laid off in 40-acre blocks and each block surrounded by a gallery. By this means, three-quarters of the oil is within an average distance of 165 feet, and three-tenths lies within an average distance of 43 feet of the mine wells. On a tract of four square miles, there would be 19,000 mine wells, as against 576 old surface wells. He estimates the cost to be about the same.

Ranney uses various methods of extracting the oil, two of which are: (1) by applying a partial vacuum; (2) compressed air and steam heat; the mine wells are pumped through the collecting lines, by an ordinary steam pump, located at the bottom of the main shaft and driven by compressed air. The lift would not ordinarily be more than ten feet, and while the oil entered the mine wells freely, the remaining gas in the oil "sand" when released would carry with it sufficient oil to keep the pump supplied. As the gas supply fails, vacuum is applied to the oil sand through the collecting line. At the same time compressed air is applied through a surface well centrally located in the 40-acre plot and drilled only to the top of the producing sand; when this is done, the 2-inch nipple is sealed just above the bottom of the oil sand in such a manner that the compressed air must find its way through the oil sand from the top to the bottom. This to some extent will avoid the difficulty encountered where air follows open channels in the "sand." Then if the "sand" should show signs of becoming clogged with paraffin, a steam line is run parallel to the collecting line and a 1½-inch plugged nipple inserted through the cross to the bottom of the sand; this nipple is not sealed in the sand. The nipple acts as a miniature steam radiator, heats up the rock, and renders the paraffin fluid. At the same time the main pump is drawing off the fluid and paraffin. Vacuum and pressure are applied alternately, and Ranney claims that the heat can be forced to the centre of the 40 acres. The heat expands the absorbed gas in the oil, renders it less viscous, and causes it to flow towards the mine well where the pump is drawing it.

Ranney estimates the cost of pumping oil to the surface at 25 cents per barrel, as against over $2 where it is pumped from the surface. He claims an

[1]Leo Ranney, Mining for Oil, Oil & Gas Jour., Oct. 26, 1925.

ultimate recovery of 50 per cent. and a possible 90 per cent. of the remaining oil. An experimental mine has been sunk at Jacksboro, Texas, where the process as described covers a host of conditions that may occur,[1] but which do not come within the scope of this article.

The merits of the two methods described must be left to the judgment of the reader; each has merits suited to certain conditions. The channels will intercept and drain more oil than will the wells; but on the other hand, the channels cost more. Whether or not Rich's method of flooding will extract as much oil as or more than Ranney's method of heating and air pressure will depend on the character of the rock. The cost of surface wells in the Ontario oil fields would be greatly reduced by using the old wells in this field.

Present Conditions of Ontario Fields[2]

In Lambton county the capital invested, represented by the 2,315 wells operating and the 1,069 wells fit to operate in the Petrolia and Oil Springs field, at $1,222.40 per well, totals $4,136,600. This is based on the equipment of a group of forty wells.[3] The cost of operating and renewals on an average well in Lambton county is $85 to $100 per year, and the interest on investment at 6 per cent. is $73 per well; and without any amortization of equipment, the amount per well that must be earned in order to make a reasonable return on investment amounts to $73 plus $85, which equals $158. The production of oil per well operated in 1925 as shown in Table I on page 00, is as follows:—

Field	Production per well per year	Value per barrel	Total value per well	Operating cost per well operated[4]
	bbls.			
Petrolia	44.1	$2.56	$112.89	$216.00
Oil Springs	35.2	2.63	94.34	164.00
Bothwell	105.0	2.56	266.80	203.00

It is therefore obvious that some method must be found to increase production, as the economic limit in operating costs has been reached; as a matter of fact the owners look for a low rate of return on their investment. There is little new material for replacements, and they use instead second-hand equipment salvaged from abandoned wells.

The Lambton oil fields have now been fully developed and in operation on a large scale for fifty years, and the methods of production have been kept fully abreast of recent developments. When the wells ceased to flow, pumping was resorted to; in fact the modern system of pumping many wells from a central power station (jerker line system), which has developed in the oil field of Lambton county,[5] is the most economical known at present.

Although there has been no organized system of flooding, such as there is in Bradford (see page 52), still there is sufficient salt water (about three barrels per well per day), in parts of the Petrolia field and more in Oil Springs, either with the oil or reaching it from above or below, to have the effect of a partial flood. There has been no attempt made to restore the gas pressure in the field;

[1]Personal communication from Mr. Ranney.
[2]The fields described are shown on map facing page 58.
[3]Information from Wm. McIntosh, Petrolia, Ont.
[4]This includes interest on investments in wells not operating, otherwise the cost per well in each case would be $158.
[5]J. H. Fairbanks, Mineral Resources of Ontario and Measures for Their Development, Rept. Roy. Com., 1890, p. 159.

in the early days gas was allowed to waste in a most appalling manner, as the operators considered gas a menace to the production of oil. Vacuum pumps are now used quite generally, and although a reduction of pressure by a few pounds at the well being pumped cannot have the effect that would be had by forcing air at a pressure of, say, 250 pounds into the rock and driving the fluids toward a well that is being pumped, still the fact that the rock is so cavernous that a partial vacuum of a very few pounds on a well is sufficient to draw air through the rock from a well several hundred feet distant,[1] would indicate that applying high pressure might not be much more beneficial than the partial vacuum process now in use. A combination of these pressures will be discussed now. If Mill's experiment can be taken as a guide, some oil might be recovered by restoring the rock pressure and allowing sufficient water into the "sand" to keep pumps working continually. In order to do this, a back pressure would be maintained on all wells, as in most of the fields under discussion the rock is so porous that air or gas would otherwise escape.

It would seem from the history of other fields that the oil removed by pumping is from 15 to 25 per cent.,[2] and the additional recovery by partial flooding would bring the total up to 35 per cent., and that mining would recover all but about from 5 to 15 per cent., depending on the process used. It is argued by those who oppose flooding and favour mining, that after a field is flooded it will be impossible to mine it, and that the risk is not worth the 10 to 20 per cent. additional oil recovered by flooding, when from 60 to 80 per cent. can be recovered by mining without the additional expense of drilling the new wells required in the flooding process, especially if mining is undertaken finally.

The oil in the Ontario fields under discussion occurs in the Onondaga limestone, which is a limestone of average hardness and more expensive to mine than the sandstone in the French and German mines, which are softer and yield to a pick. This limestone could not be mined without the use of explosives; and the history of the French mines prove that the gallery could not be driven in the rock from which oil or gas was flowing, as explosions and fires would undoubtedly result. Some method, such as recommended by Rich or Ranney, must be used in order to keep the gas from entering the galleries.

Ventilation might be made simpler by using as airways some of the thousands of wells, drilled in the Lambton county fields, scores of which were never plugged. These might be either a benefit or an obstacle. The locations of many of these abandoned wells are unknown, except in a very general way, and many of them have given the present operators much trouble through the water that they allow to enter the oil fields. However, they will in the course of time become plugged with silt or probably chemical precipitate; indeed, this may have taken place long ago. If these wells are flooding the fields, they will undoubtedly be a great source of annoyance in mining; but many of them would be encountered in driving the gallery and could be plugged or put to use as airways.

The Ontario oil fields that show most promise for mining operations are the Petrolia and Enniskillen, Oil Springs, and Bothwell. This is based on the production to date and on the records of the thickness of the oil-bearing rock. The Mosa township or Glencoe oil field is still giving good results by ordinary

[1] J. H. Fairbanks (ibid) states that wells half a mile distant are connected underground.

[2] The Mexican limestone fields, which are very cavernous and which produce oil at a constant rate until the oil is replaced by water, are estimated to have only 10 per cent. of their total production left underground when the wells cease to "flow oil."

methods of surface pumping; the production per acre to date is not nearly so great as the three fields mentioned, and the character of the oil-bearing rock is not well known. After experience has been gained in the more promising fields, it may then appear to be a profitable venture to mine this field.

The acreage and production from the date of discovery until 1925 and the number of operators follow:—

Field	Acres	Production		Number of operators
		Total to 1925, bbls.	Bbls. per acre	
Enniskillen and Petrolia	20,160	15,090,700	744	90 or more
Oil Springs	850	7,400,000	8,706	30
Bothwell	480	2,157,242	4,464	8

The records of the production in Ontario between the years 1870 and 1889 were never kept, and the total production for the Petrolia and Oil Springs fields is based on estimates made for these years, which are conservative. The great bulk of the oil was produced before 1889, if the number of refineries is any indication.[1]

If we consider that there has been a certain amount of indirect though unorganized flooding, then all the oil that can be economically obtained by present methods has now been recovered from the Petrolia and Oil Springs fields. An attempt will now be made to estimate the quantity remaining underground.

Many tests have been made by examining cores taken from different oil fields in order to approximate the percentage of total oil content that has been recovered and that is left underground when wells are closed down. A thorough investigation of this, made by a committee of the American Petroleum Institute,[2] in conjunction with the United States Bureau of Mines, shows that from 15 to 25 per cent. is recovered by natural flow and by pumping. The length of time that a field is pumped must naturally increase the percentage of oil recovered; but as each year's recovery at present is, in the case of the Petrolia and Oil Springs fields, less than half of one per cent. of the total produced to date, a matter of ten years' production is negligible. The Bothwell field has been producing for twenty years less time than the other two fields, and may be considered an average field. The annual production is about one per cent. of the total produced to date. Allowing a margin of safety, 30 per cent. of the total content of the field is a reasonable estimate of the total production to date, basing the estimate on the authorities mentioned. On the other hand, men of experience,[3] believe that this estimate is too low. In the Mexican limestone fields and in the fields along the Balcones fault line in Texas, the recovery by natural flow is supposed to be 90 per cent. The force expelling the oil is, in this case, hydraulic pressure. Our Ontario fields are in limestone, but the expelling force is gas and not water; the porosity may be much greater than in the sandstone fields of Pennsylvania, Kansas, and Oklahoma, but it is not nearly so great as in the Mexican fields, where initial flows of 120,000 barrels of oil a day are not uncommon, whereas the largest initial flow in Oil Springs

[1]Mineral Resources of Ontario, Rept. Roy. Com., 1890, pp. 157, 160, 162.
[2]American Petroleum—Supply and Demand, pp. 97-102; David White, op. cit.
[3]Prof. H. C. George, personal communication.

was 7,000 barrels. Giving due consideration to these facts, it seems possible that the maximum present production could be as much as 50 per cent., in these two fields. Using the same basis and considering the difference in the length of time that the Bothwell field has been pumped, these percentages can be reduced by ten, viz., minimum present production 20, maximum 40 per cent. of the total oil in the field.

Although tht patentees of methods of mining claim a very high recovery of the remaining oil, it is best to take a conservative view and estimate that 20 per cent. of the remainder, or 10 per cent. of the total, will not be recovered. Only by using a core drill and testing many samples of the rock can the porosity and residual oil be measured.

Based on the above, the probable recovery by mining will be as follows:—

Oil Obtainable by Mining in Petrolia, Oil Springs, and Bothwell

Field	Total barrels		Barrels per acre		Thickness of sand
	Maximum	Minimum	Maximum	Minimum	
					feet
Enniskillen and Petrolia	25,040,000	12,072,560	1,148.6	.....	6–13
Oil Springs	12,265,000	5,920,000	14,429.4	6,965	5–12
Bothwell	6,393,000	2,157,242	13,319.6	4,464	8

As the production from the Moore, Plympton, and Sarnia fields was in the early years of the field added to and reported with the Petrolia and Enniskillen field, these fields must necessarily be treated as a unit. The wells in these three townships, as well as those in the outlying portion of Enniskillen township, never were great producers of oil, and the formation is described by the drillers as "crevicy." This and the small and short-lived production of the wells would indicate a thin oil horizon and porosity only along the joints and bedding planes of the limestone. This is further borne out by the relative production per acre in these townships in the past few years.

Township or oil field	Total acres	1921		1922		1923		1924		1925	
		Production	Production per acre	Production	Production per acre	Production	Production per acre	Production	Production per acre	Production	Production per acre
		bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.
Present productive area, Petrolia and Enniskillen	8,400	68,484	8.15	64,934	7.72	64,159	7.37	60,916	7.25	53,166	6.33
Plympton	3,160	480	.15	695	.22	872	.27	525	.17	1,424	.45
Sarnia	3,600	4,069	1.13	3,223	.9	2,378	.66	2,068	.57	1,905	.53
Moore	5,000	7,536	1.51	7,274	1.46	479	.96	4,483	.9	8,196	1.64
Oil Springs	850	40,967	48.2	43,214	50.8	3,909	43.6	41,320	48.6	39,137	46.0
Bothwell	480	26,877	56.0	25,681	53.5	27,655	57.6	26,700	55.6	26,243	54.7

The thickness of the oil "sand" in the Petrolia and Enniskillen field is reported by the drillers to be 13 feet at the highest point in the field and 5 feet in these outlying townships. The central or highest portion of the field has been pumped since 1865 and produces the major portion of the oil in the field, while

the outlying portions in Moore, Sarnia, and Plympton, as the table shows, have a much smaller production. The quantity of oil under an acre of ground, per foot thickness of oil "sand" of 20 per cent. porosity totally saturated, is 1,551.6 barrels. If we take the productive horizon as 5 feet thick in this portion of the field, instead of 13 feet, and the area as 5,000 acres, it will give a total of 38,790,000 barrels, 50 per cent. more than the maximum estimate for the whole field. There is, therefore, every reason to believe that the portion of the Petrolia field lying east of a north and south line drawn a mile and three-quarters west of Copleston cross-roads, should contain as much oil per acre as the Oil Springs field, or even more.

Cost of Mining

It is difficult to find any one experienced in driving tunnels or galleries through limestone or cost data for sinking shafts in the materials that will be encountered in reaching the oil "sands" in these fields. Definite information cannot be had with regard to the timbering needed. It is presumed that the hard Erie clay in Petrolia and Oil Springs will not require close timbering, but in the Bothwell field there is the possibility of encountering quicksand and caving material. The writer has compared estimates with several men who have long experience in mining and finds that their estimates of the cost of sinking a shaft are from $40 to $50 per vertical foot, and of driving galleries from $10 to $15 per lineal foot. The cost of channelling or drilling mine wells will vary with the field in which the operation is conducted. It is not expected that much timber will be required underground, as the limestone at its outcrop shows heavy bedding. If timbering can be dispensed with, it will greatly eliminate the danger of gas pockets forming in the roof. It will be necessary to have two shafts in order to conform with the mining laws of Ontario, which require that where workings exceed 100 feet in depth and 200 feet in lateral dimensions, a second shaft shall be sunk to provide an alternate exit for workmen, should an accident happen underground, and also for ventilation. The distance that mining could be economically conducted from a shaft is another matter that demands consideration. On account of the small amount of material to be excavated, it would no doubt pay to haul it underground much farther than it would pay to haul large quantities of ore in a metal mine. The gallery need be only 4 feet 6 inches by 6 feet 6 inches. Suppose we use a square mile as a test case, this would be midway between the Bothwell and Oil Springs fields in size.

ESTIMATED COST OF EXTRACTING OIL BY MINING[1]

2 shafts, 500 ft. deep, at $50 per ft	$50,000
42,000 ft. of galleries, at $15 per ft[2]	$633,000
Channels or mine wells	$40,000
Compressors, pumps, piping, etc	$75,000
Overhead, omissions, engineering, working capital, etc	$100,000
	$898,000
Consider the smallest yield per acre as 4,000 bbls.; the cost of lifting 2,560,000 bbls. (4,000 × 640) at 10c. per bbl	$256,000
Total cost	$1,154,000
Cost per barrel ($1,154,000 divided by 2,560,000)	.45 cents per barrel

[1]The depth of the shaft and the prices used are well in excess of the largest estimate, while the barrels per acre have been taken below the lowest figure.

[2]Extra galleries may be considered to be equivalent to 108 pressure wells.

Cost of Pumping Oil from the Surface

	Without interest on investment	With interest on investment
Operating cost per well per year	$85	$158
Production per well per year	105 barrels	105 barrels
Lifting cost per barrel	81 cents	$1.50

It is possible that quicksand might be encountered in sinking a shaft in the Bothwell field; if so, it would be necessary to use a caisson, which would increase



Edge of bank at Rock Glen, Ausable river, near Arkona, showing shales of the Hamilton formation overlying Onondaga limestone.

the cost of the portion of the shaft that passes through the quicksand to about $200 per foot, under normal conditions. This is provided for in the above estimate by the 100 feet extra in the depth of the shaft. However, $20,000 added will not appreciably affect the result.

It is apparent that the cost of mining in the Bothwell field would be about one-third of the present cost of pumping oil from the surface. In the Petrolia and Oil Springs fields, the difference is very much greater.

The present price of crude oil is given on page 45, and it can be seen that there is a very substantial profit, even if the estimates given are 50 per cent. too low.

The logs of wells in these fields are given below, and all available information regarding water-bearing rock and the thickness of the oil-bearing formation.

The upper and middle lime, and the lower soap refer to the Hamilton formation; big lime is the driller's name for the Delaware and Onondaga.

PETROLIA FIELD
Lot 11, con. XI, Enniskillen tp.

Formation	Thickness, ft.
Surface	93
Top rock	56
Upper soap	118
Middle lime	15
Lower soap	45
Top of big lime	316

Oil at 465 feet.
Thickness of oil sand, 13 feet.
Some water in the top rock.

PETROLIA FIELD
Lot 8, con. X, Enniskillen tp.

Formation	Thickness, ft.
Surface	108
Top rock	53
Upper soap	120
Middle lime	15
Lower soap	45
Top of big lime	351

Oil at 450 and 464 feet.

PETROLIA FIELD
Lot 13, con. X, Enniskillen tp.
No. 4, Howlett

Formation	Thickness, ft.
Surface	60
Top rock	56
Upper soap	120
Middle lime	20
Lower soap	36
Top of big lime	292

Oil at 20 feet in the top rock.

The thickness of the oil "sand" in the Petrolia field as given by Inspector John Scott is as follows:—

Lot 19, con. X, Enniskillen tp.,
12 inches at 484 feet.
Lot 12, con. XI, Enniskillen tp.,
13 feet at 465 feet.
Lot 10, con. XII, Enniskillen tp.,
8 feet at 470 feet.
Lot 8, con. XII, Enniskillen tp.,
6 feet at—not stated.
Lot 3, con. I, Moore tp.,
6 feet at—not stated.
Lot 7, con. II, Moore tp.,
0 feet, oil in crevices.

OIL SPRINGS FIELD
Typical log on low-lying land
Lot 19, con. II, Enniskillen tp.

Formation	Thickness, ft.
Surface	47
Soapstone	210
Big lime	100

Oil at 317 feet.
Water at 200 feet.
215 feet of water in this well.

OIL SPRINGS FIELD
Typical log in high land
Lot 19, con. II, Enniskillen tp.

Formation	Thickness ft.
Surface	60
Soapstone	240
Big lime	80

Oil at 360 feet.
Water at 235 feet.
248 feet of casing in this well.

Thickness of the Oil Springs field is given by Inspector John Scott as follows:—

Lot 19, con. II, Enniskillen tp.,
10 feet at 360 feet.
12 feet at 380 feet.

This is probably the thickest section in the field; the remainder he reports as:—

5 feet thick at 365 feet.
5 feet thick at 375 feet.

BOTHWELL FIELD
Typical log
Lot 7, con. VIII, Zone tp.

Formation	Thickness, ft.
Surface (quick clay and gravel)	210
Soapstone	10–20
Top of big lime	230

Water vein at 232 feet.
Oil at 375 and 385 feet.
The oil sand is reported to be 8 feet thick.

Addenda

Since the description of the Rich method of mining for oil (page 55) was written, Rich has given out some further improvements on his patent.[1]

Instead of drilling the row of twenty-seven wells in the centre of each block, he proposes to cut cross channels every 660 feet between the galleries, by diamond-drilling from one gallery to the parallel gallery 1,320 feet distant; or if this distance is too great, to drive a gallery between them, making the distance to be drilled 660 feet. The channels would then surround a 660-foot square or a 660- by 1,320-foot block.

The proposed method of cutting these cross channels is as follows: Sink wells or sumps through the oil sand at each end of the proposed channel to a point far enough below the sand to insure a complete cut, and fix a pulley at the bottom of each well or sump; then pull a cable around one pulley, through the drill hole to the parallel gallery, around the pulley in the bottom of the well at the end of the drill hole and back through the nearest parallel drill hole, where the ends of the cable are joined. The cable is then pulled through these holes by means of an underground power plant and in this way cuts channels through the rock. Different abrasives may be used to assist in cutting; one is a carborundum pool fixed at intervals to the cable. The ends of these channels and the entrances to the wells are sealed with steel plates or concrete and all gas excluded from the galleries.

After the oil that will flow by natural drainage has been exhausted from these blocks, a flood of water is introduced into every second channel, and the oil and flood water removed through the channels that are not flooded. This water may be kept underground, heated and re-circulated. Chemicals best suited for washing the oil that adheres to the rock may be added at the pleasure of the operator.

These improvements appear to add greatly to the merits of this method of oil mining, especially where a considerable volume of water is encountered underground.

---

[1] Meeting of Am. Inst. Min. & Met. Engrs., New York, Feb., 1927.

INDEX, PART V

PAGE

A

Abino pt. . . . 12
Abray, Thos. . . . 24
Ackland, C. . . . 13
Adelaide tp. . . . 22, 46
Ajax Oil and Gas Co. . . . 24, 36, 45
Albion tp. . . . 41, 46
Aldborough tp. . . . 7
Allied Oil and Gas Co. . . . 24, 26
Alsace, France.
  Oil. *See* Pechlebroon.
Amabel tp. . . . 1, 23
Ancaster tp. . . . 8, 42, 46
Arkona. . . . 4
Askew gas well. . . . 11
Attercliffe Gas Co. . . . 26
Ausable r. *See* Rock Glen.
Austin, W. . . . 13
Axle grease imports. . . . 48
Azoff Gas Co. . . . 26, 30

B

Barton tp. . . . 8
Bartonville. . . . 5
Bayham tp. . . . 1, 7, 11, 22
Beattie, W. . . . 14
Belle River. . . . 5, 17, 19, 44
Belmont. . . . 5
Bennett, J. B. . . . 11, 26
Benzine production 47
Bermingham, T. F. . . . 23
Berry, J. . . . 14
Bertie tp. . . . 8, 12, 23
Bertie Natural Gas Co. . . . 26, 27
Big Lime formation.
  See Delaware formation.
    Onondaga formation.
Binbrook. . . . 5
Binbrook tp. . . . 8, 14, 23
Blackheath. . . . 14
Blain, E. B. . . . 24, 38, 45
Blenheim. . . . 3, 5, 19
Blunden gas well. . . . 10
Border Cities. . . . 6
  See also Windsor.
Bosanquet tp. . . . 38
  See also Arkona.
Bothwell tp. . . . 44, 59, 60, 63
Bothwell oil field. . . . 57
Boulter, P. . . . 11
Bounty on oil. . . . 43
Bowden, J. . . . 13
Bow Island gas field, Alta. . . . 14
Boyd gas well. . . . 11
Bradford oil field, U.S.A. . . . 52
Brant co. . . . 1, 7, 12, 28, 29
Brantford. . . . 5, 19
Brantford tp. . . . 7, 19
Brantford Gas Co. . . . 19, 27
Bridgeburg. . . . 5, 17
Brigden. . . . 5

PAGE

British American Oil Co. . . . 46
British Empire.
  Helium in natural gas. *See* Inglewood.
Brooke tp. . . . 44
Brown, J. B. . . . 11
Bruce co. . . . 1
Buffalo, U.S.A. . . . 17
Burch, W. . . . 13
Burford tp. . . . 7
Burn, B. D. . . . 3

C

Cainsville. . . . 5
Caistor tp. . . . 8, 14, 23, 38
Caledon W. tp. . . . 10, 12, 23
Caledonia. . . . 5
Calgary, Alta.
California, U.S.A.
  Oil. *See* Ventura co.
Camden tp. . . . 7, 36, 37
Canadian Dutch Oils, Ltd. . . . 28
Canadian Oil Companies, Ltd. . . . 46
Canboro Gas and Oil Co. . . . 21, 30
Canborough tp. . . . 8, 13, 23, 29
Candles, production. . . . 47, 48
Canfield. . . . 5
Canfield Natural Gas Co. . . . 30
Cassidy pt. . . . 41
Castle Oil and Gas Co. . . . 26
Cayuga. . . . 5
Cayuga N. tp. . . . 8, 13, 22, 29-31
Cayuga S. tp. . . . 8, 13, 22, 29-31
Central Development Co. . . . 24
Central Pipe Line Co. . . . 27
Charlotteville tp. . . . 7, 12, 22
Charlton gas well. . . . 11
Chatham. . . . 5, 19
Chatham tp. . . . 7, 20
Chatham Gas Co. . . . 15, 27
Chippawa. . . . 5
Chippewa Development Co. . . . 26, 27
Chippewa Oil and Gas Co. . . . 2, 26, 27
Clinton formation. . . . 11-14
Colchester Oil and Gas Co. . . . 4
Coleman, J. A. . . . 26, 27
Comber. . . . 5
Consumption of gas. . . . 5-8
Copper production. . . . 1
Corrosion of pipes. *See* Pipe (gas) corrosion.
Courtland. . . . 5, 18
Courtright. . . . 18
Craig gas well. . . . 10
Crowland tp. . . . 8, 12, 23
Crumlin gas field. . . . 1
Crystal Beach. . . . 5

D

Dawn tp. . . . 7, 10, 22, 44
Declout gas well. . . . 11
Delhi. . . . 5
Dicout, F. . . . 13

PAGE
Divining rod 5
Dixon gas well 11
Dochstader tract, Canborough tp 29
Dominion Alloy Steel Corpn 10
Dominion Natural Gas Co.
Improvement in service 18
Leakage 19
Licenses 24-27
Wells, helium in 11-14
logs 28-41
Dorchester 5
Dorchester N. tp 7, 22
Dover gas field 1, 17
Dover W. tp 7, 11, 20, 37, 44
Downsview 16
Dresden 5, 19
Dumfries S. tp 7
Dundas 5, 19
Dundas shale 14
Dunn tp 8, 13, 23, 30-32
Dunn Natural Gas Co 26, 27
Dunnville 5, 19
Dunwich tp 7
Durham, John H. C 4
Dutton 5

E

Eagle Oil and Gas Co 37, 45
Echo Place 5
Eden 5, 19
Edsel, W 13
Electricity *vs.* gas 15
Elgin co 1, 7, 11, 22
Elworthy, R. T 10
Emerson, A 13
Enniskillen tp.
Gas 7, 10, 20, 22
Oil 44, 59, 60
Erie Gas and Oil Syndicate 33-35
Essex 5, 19
Essex co 1, 7, 11, 22
Esthill co., Ky 54
Euphemia tp 7, 22, 44

F

Fairbanks, J. H.
Refs 57, 58
Well 10
Fairground 5
Fenwick 5, 19
Fingal 5, 19
Fisher, J 12
Fisherville 5, 26
Flooding of oil fields 52
Fonthill 5
Fonthill-Ridgeville Gas Co 27
Fort Erie 5, 17
France, oil mining. *See* Pechelbroon.

G

Gainsborough tp 8, 23, 38, 39
Galt 5, 19
Gas, natural.
Compared with electricity 15
Restoring pressure of 51
Statistics 1-3
Report by Harkness 1-42
Gasoline production 47
Glanford tp 8, 14, 23

PAGE
Glencoe oil field 45
Glenwood 17
George, H. C 51
Germany, oil mining 54
Gold production 1
Gosfield N. tp 7
Gosfield S. tp 11, 22
Graham, J 12
Grantham tp 8
Great Lakes Oil Co 46
Griffin gas well 10
Grimsby 8
Grimsby sandstone 11, 14
Grimsby tp 8
Guelph formation 11

H

Hagersville 6, 19
Haldimand co 1, 8, 13, 22, 29-36
Haliday gas wells 11
Hamilton 2, 6, 14
Hamilton formation 62
Hamilton Gas and Oil Co 26
Hamilton West 6, 18
Hanover, Germany 54
Harkness, R. B.
Report on Natural Gas 1-42
" Petroleum 44-64
Harwich tp 2, 7, 20, 22
Heal, John 38
Heath, W. O 24
Heitbohmer, Frederick 5, 24
Helium in gas wells 10-15
Henderson, R. I 24, 46
Henry, G 12
Hepworth 6
Highgate 6
Holloway, W 11
Hoover, A. E 25
Hoover and May 24, 35
Houghton tp 22
Howard tp 1, 7, 11, 22, 23
Humberstone 6
Humberstone tp 8, 12, 22
Logs of wells 41, 42
Hunter, H 12
Hussey, William 45

I

Illuminating oil, production 47
Imperial Oil Refineries, Ltd 46
Industrial Natural Gas Co 24-27
Ingersoll 6, 19
Ingersoll Gas Light Co 19, 27
Inglewood 10
Irwin, J. J 25

J

Jarvis 6
Jasperson, Bon 11, 26
Johnston, H 14
Jones, J. S 26

K

Kent co 1, 7, 11, 22
Logs of wells 36-38
Kentucky, oil mining 54

PAGE
Kerosene imports ... 48
Kervin and Dawson ... 25
Kingsville ... 1, 6, 19
Kiser and Kiser ... 25
Kramp, H. ... 13

L

Laidlaw gas well ... 13
Lake shore, Lambton co ... 38, 45
Lake Shore Natural Gas Co ... 27
Lambeth ... 6
Lambton co ... 1, 7, 10, 22, 57
  Logs of wells ... 38
Lauer, D. ... 25
Leakage of gas ... 18-20
Leamington ... 6, 19, 27
Licenses, gas ... 24-27
Lincoln co ... 1, 8, 14
  Logs of wells ... 38, 39
Lincoln Gas Co ... 38
Lincoln Oil and Gas Synd ... 38, 39
Livesay, J. ... 11
Logan tp ... 5
Logs of wells ... 28-42
Lorraine (Hudson River) formation. *See* Dundas shale.
Lubricating oil, production ... 47
Lymburner, W. C. ... 14
Lyndoch ... 6

M

Mabee ... 6
McColl Bros ... 46
McCutcheon, T. J. ... 25
McIntosh, Wm ... 57
McKechnie, S. ... 25
McLennan, J. C. ... 10
McLister, J. J. ... 25
McQuillen, M. W. ... 24
McWilliams, David B. ... 24
Maidstone ... 7, 22
Manufacturers' Gas Co ... 16, 27
Map, oil and gas fields ... *facing* 58
Maple Leaf Oil and Gas Co ... 13, 26
Medina-Cataract formation ... 14
Medina Natural Gas Co ... 11, 24, 26
  Logs of wells ... 40
Merlin ... 6
Mersea ... 7, 22
Meters, orifice ... 8
Metropolitan Development Co ... 24
Mexico, oil fields ... 58, 59
Michener, Senator E. L. ... 4, 5, 46
Middlesex co ... 1, 7, 22
Middleton tp ... 2, 7, 12, 16, 22
  See also Courtland.
  Logs of wells ... 39, 40
Midfield Natural Gas Co ... 26, 27
Mitchell, W. ... 11
Mitchell Oil Producing Co ... 5
Moore tp ... 7, 20, 44, 63
Mosa tp ... 44, 45
Moulton tp ... 8, 13, 23
  Logs of wells ... 32, 33
Muirkirk natural gas line ... 20

N

Nagel, G. ... 13
Naphtha production ... 47

PAGE
Nelles tract, Seneca tp ... 35
Nelles ... 6
Nelles Corners Gas Syndicate ... 30, 34
Newton, Roy ... 24
Niagara formation ... 10
Niagara Falls ... 6, 12, 17
Nickel production ... 1
Niece, Hosea, and Son ... 27
Norfolk co ... 1, 2, 7, 11, 12
  Logs of wells ... 39-41

O

Oakes, L. ... 12
Oakland tp ... 12, 22
Oil, rock. *See* Petroleum.
Oil Springs ... 6
Oil Springs oil field.
  Acreage ... 59
  Age ... 43
  Oil production ... 1, 43, 44
    per well ... 57
    recoverable by mining ... 60
    wells, logs ... 63
Oil Springs Oil and Gas Co ... 10, 26, 27
Oneida tp ... 8, 13, 33
Onondaga ... 12
Onondaga formation ... 10, 54, 62
Onondaga tp ... 1, 7, 23, 44
  Logs of wells ... 28, 29
Orford tp ... 7
Orifice meters ... 8
Oxford co ... 7
Oxford E. tp ... 7
Oxford W. tp ... 7

P

Paraffin wax, statistics ... 47, 48
Paris ... 6, 19
Patterson, W. G. ... 2, 26
  Logs of wells ... 29-34
Peat, J., and Son ... 23
Pechelbroon, France, oil mining ... 53, 54
Peel co ... 10, 12, 41
Pelham tp ... 8
Petroleum.
  Condition of Ont. fields ... 57-65
  France; Kentucky ... 53, 54
  Flooding of fields ... 52
  Formations holding. *Map facing* ... 58
  Mexico ... 58, 59
  Price ... 45
  Production ... 43, 44
  Recovery of ... 48-51
    by mining ... 53-57
  Report by Harkness ... 43-64
Petrolia ... 6, 19
  See also Canadian Oil Companies.
Petrolia oil field ... 60
  Logs of wells ... 63
  Production ... 44, 57
Petrolia Utilities, Ltd ... 19, 27
Petrol Oil and Gas Co ... 17, 26
Pilette ... 18
Pilkington Bros ... 24, 26
Pioneer oil field, Pa ... 53
Pipe (gas) corrosion ... 9, 10
Plympton tp ... 44, 45, 60
  Log of well ... 38
Port Alma ... 17

PAGE
Port Burwell....6, 19
Port Colborne.... 6
Port Colborne-Welland Natural Gas and Oil Co....24, 26, 27
Port Dover....6, 11
Port Rowan.... 6
Port Ryerse.... 11
Premier Development Co....24, 42, 46
Proctor, Elsom.... 38
Proctor, Reuben.... 38
Production, gas.... 1
oil.... 44
Progressive Gas and Oil Co.... 26
Provincial Natural Gas and Fuel Co., 12, 14, 17, 24-27
Log of well.... 41

Q

Quance, A.... 12

R

Rainham tp....8, 13, 22
Logs of wells....33-35
Raleigh tp....7, 11, 20, 22, 44
Ranney, Leo....56-58
Ravinna, Ky.... 54
Red Medina sandstone. *See* Grimsby sandstone.
Refineries, petroleum....46, 47
Rich, John L....55, 64
Richmond gas wells.... 11
Ridgetown....6, 19
Riley, A.... 13
Roberts gas well.... 12
Robinson, W.... 13
Rochester tp.... 7
Rock Glen.... 62
Rodgers, Alex.... 24
Rodney.... 6
Romney tp....7, 11, 44
Logs of wells.... 37
Rosehill.... 6
Rosehill Natural Gas Co.... 27
Ruthven.... 6

S

St. Ann.... 6
St. Catharines....6, 19
St. George....6, 19
St. Joachim.... 17
St. Williams.... 6
Salina formation.... 11
Saltfleet tp.... 8
Sandstone.
See Grimsby sandstone.
Whirlpool sandstone.
Sandwich tps....7, 20
Sarnia....6, 19, 46
Sarnia tp.
Natural gas....7, 10, 22, 38
Oil....44, 45, 60
Sarnia City Dairy.... 38
Sarnia Gas Co....16, 19, 27
Schweyer, O.... 24
Scott, John.... 43
Selkirk....6, 13
Seneca tp....8, 13, 23
Logs of wells.... 35

PAGE
Shedden....6, 19
Shepley Bros.... 25
Sherbrooke tp....8, 23
Shetland.... 6
Shetland Gas Co.... 27
Shoup gas well.... 13
Silver production, ref.... 1
Simcoe....6, 12, 19
Six Nations Indian reserve....4, 5, 46
Smith, Luke.... 45
Smithville.... 2, 6
Snively, F. L....24, 25
Snyder, J.... 12
Soap, lower. *See* Hamilton formation.
Sombra.... 6
Sombra tp....7, 20
Southern Ontario Gas Co....16, 17, 24-27
Leakage.... 19
Logs of wells.... 37
Southwold tp.... 7
Speck, F.... 13
Springvale Oil and Gas Co....26, 27
Stamford tp.... 8
Sterling Natural Gas Co....12, 26, 27
Logs of wells....41, 42
Stevensville.... 6
Stevensville Gas Co.... 26
Straffordville....6, 19
Sullivan, Patrick....24, 25, 41, 46
Sulphur mt., Cal.... 54
Sundy Gas Well Co.... 26

T

Tar production.... 47
Tecumseh....6, 17
Tecumseth tp.... 14
Teller, A.... 12
Texas, oil.... 59
Thamesville oil field.... 44
Thorold....6, 19
Thorold tp.... 8
Tidoute oil field, Pa.... 53
Tilbury....6, 19
Tilbury E. tp....7, 11, 20
Gas production....22, 44
wells, logs....37, 38
Tilbury N. tp.... 7
Tilbury W. tp.... 7
Tilbury gas field.... 1, 2
Tillsonburg....6, 19
Toronto, oil refineries.... 46
Townsend tp....7, 22, 40
Trenton formation....10-12
Tupperville.... 5
Tuscarora tp....4, 46

U

Union Natural Gas Co....24, 25
Gas, helium in....10, 11
leakage.... 19
wells, logs....37, 38
Oil in Trenton gas wells.... 17
Piping improved.... 17
Sarnia plant bought by.... 16
Travelling instruction equipment, photo.... 21
United Gas Companies....17, 19, 26, 27
Logs of wells....32, 33

PAGE

V

Vacuum Gas and Oil Co. 26
Van der Gracht, W. A. J. M. 53-55
Vaseline imports 48
Ventura co., Cal., oil 54
Vienna 6, 19
Vittoria 6

W

Wainfleet tp 8, 12, 22
Logs of wells 42
Wallaceburg 6, 19, 46
Wallaceburg Gas Co 16, 19, 27
Wallacetown 6
Walpole tp 8, 13, 22
Logs of wells 50-52
Walsingham N. tp 7, 11, 22
Walsingham S. tp 7, 11, 22
Logs of wells 41
Wedlake gas well 11
Weitz, Germany, oil 54
Welland 17
Welland co 1, 8, 12
Logs of wells 41, 42
Wellandport 6
Wells, logs of. *See* Logs of wells.
Wentworth co 1, 8, 42
Wesner, O. A 25
West Hamilton 6, 18

PAGE

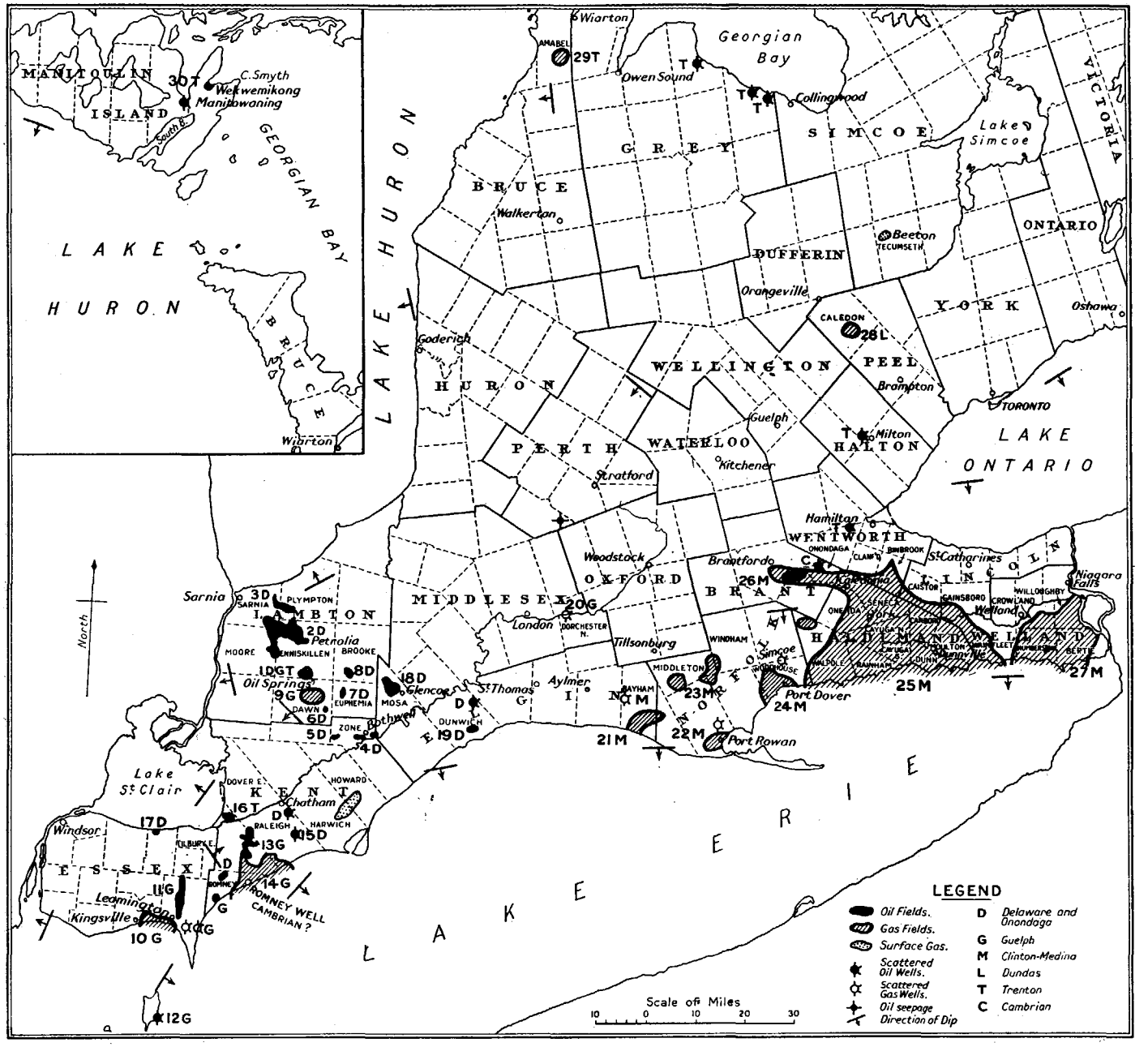
West Lorne 6
Westminster tp 7
Wheatley 6, 18
Whirlpool sandstone 10-14
Whitchurch tp 4
White, Dr. David 52
White Medina sandstone. *See* Whirlpool sandstone.
Williams, H 11
Willit, G. E 24, 25
Willoughby tp 8, 12, 23
Wills, W 12
Wilson, L 10
Windham tp 7, 11, 22
Windsor (Border Cities) 6, 19
Windsor Gas Co 19, 27
Woodhouse tp 7, 10, 11, 22
Logs of wells 41
Woodstock 6, 19
Woodstock Gas Light Co 19, 27
Wright, E. A 13

Y

Yager, J. J 26
Yomans gas well 12
York tp 46

Z

Zone tp 4, 45, 63

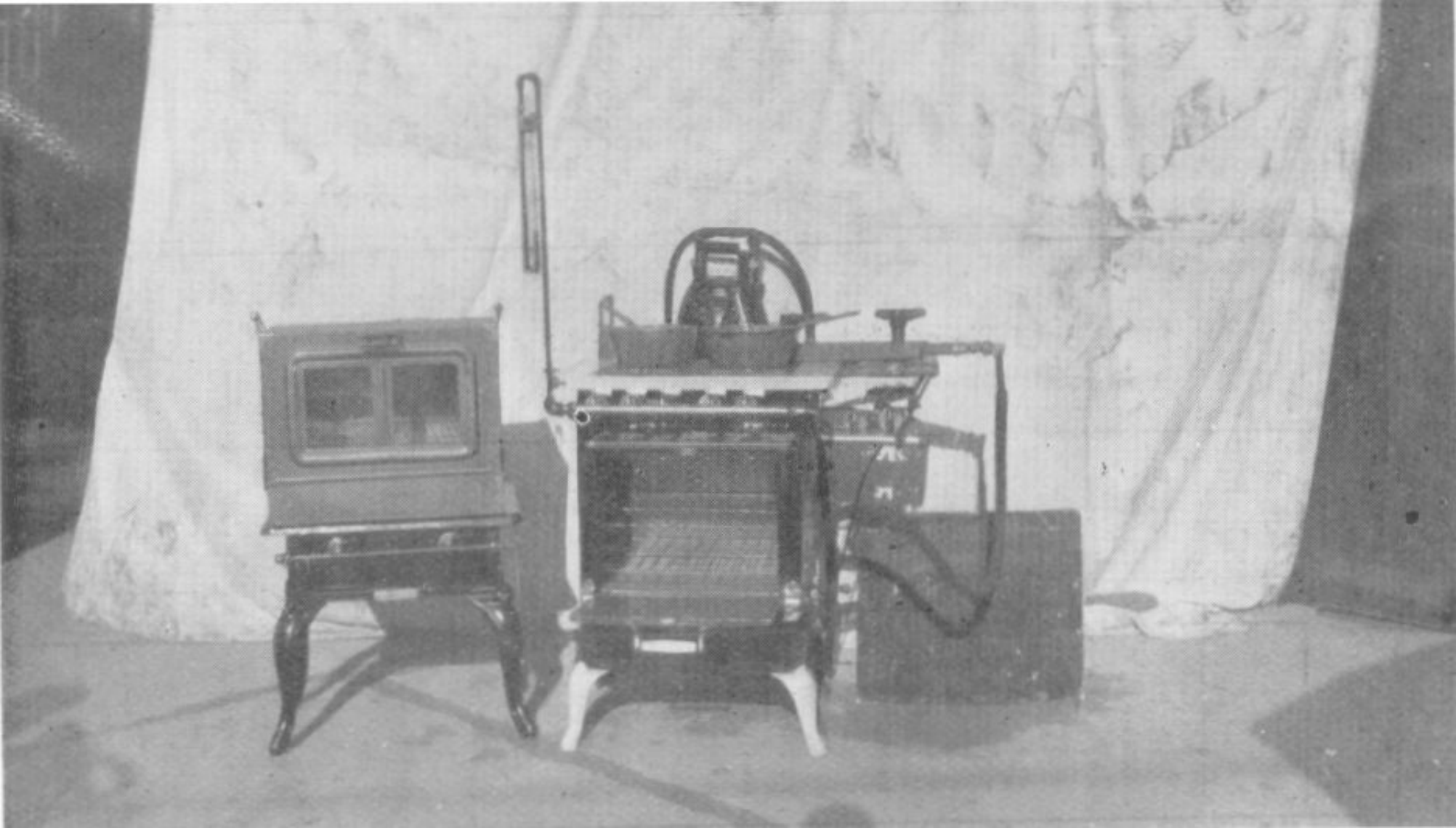


KEY TO OIL AND GAS FIELDS

1 Oil Springs (Oil and Gas)
2 Petrolia
3. Plympton
4. Bothwell
5. Thamesville
6. Florence
7. Shetland
8. Brooke
9. Dawn
10. Leamington (Gas)
11 Leamington (Oil)
12. Pelee Island
13. Tilbury (Oil)
14. Tilbury (Gas)
15. Gurd Gusher
16. Dover (Oil and Gas)
17. Belle River
18. Mosa or Glencoe
19. Dutton
20. Crumlin
21. Bayham
22, 23, 24. Norfolk.
25. Haldimand
26. Onondaga
27. Welland
28. Caledon
29. Amabel
30. Manitoulin Island

OIL AND GAS FIELDS OF SOUTHWESTERN ONTARIO

The letters D, G, etc., indicate the Formations where these Minerals are Found.











PROVINCE OF ONTARIO
DEPARTMENT OF MINES

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

THIRTY-FIFTH ANNUAL REPORT

OF THE

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BEING

VOL. XXXV, PART VI, 1926

Ogden, Bristol, and Carscallen Townships, by J. E. Hawley 1-36
McArthur, Bartlett, Douglas, and Geikie Townships, by E. L. Bruce 37-56
Grassy River Area, District of Sudbury, by T. L. Gledhill 57-76
Notes on the Southern Part of the Grassy River Area, by T. L. Gledhill 77-82
Wasapika Section, West Shiningtree Gold Area, by F. L. Finley 83-96

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CONTENTS, VOL. XXXV, PART VI

OGDEN, BRISTOL AND CARSCALLEN TOWNSHIPS. PAGE

Introduction 1
Acknowledgments 1
The Map 2
General Description of the Area 2
Means of Access 2
Topography 3
Drainage 4
Timber 4
Discoveries 4
Previous Work 5
General Geology 5
Table of Formations 6
Keewatin Volcanics 7
Keewatin Iron Formation 11
Intrusives into the Keewatin 11
Timiskaming 11
Haileyburian 12
Algoman 13
Matachewan 16
Keweenawan 16
Pleistocene and Recent 16
Structure 17
Gold Deposits 21
Veins 21
Placer Deposits 23
Claims and Mining Properties 23
Ogden Township 23
Bristol Township 29
Carscallen and Denton Townships 33

MCARTHUR, BARTLETT, DOUGLAS AND GEIKIE TOWNSHIPS.

Introduction 37
Acknowledgments 37
Position of Area and Means of Access 37
Previous Work 39
Summary 39
General Character of the Country 39
General Geology 39
Economic Geology 40
Topography and Drainage 40
Natural Resources 42
Soil 42
Timber 42
Fish and Game 43
Water Powers 43
Minerals 43
General Geology 43
Keewatin 43
Basic intrusives (Haileyburian) 45
Acidic intrusives (Algoman) 47
Granite 47
Feldspar and Quartz Porphyries 47
Late intrusives (Keweenawan) 49
Quaternary 49
Geological History 50
Economic Geology 51
History of prospecting 51
Gold claims 52
Other Localities 55
Other Deposits 56

GRASSY RIVER AREA.

Introduction 57
Location and Area 58
Access 58
Routes within the Area 59
Surveys and Prospecting 59
Summary 61
General Character of the Area 61
Relief 61
Drainage 63
Forests 66
Game and Fish 66
Resources 67
General Geology 67
Outline of Geological History 67
Table of Formations 69
Keewatin Series 69
Timiskaming Series 70
Acid Intrusives 70
Basic Dikes and Intrusives (Matachewan) 70
Cobalt Series 70
Pleistocene 71
Structural Features 71
Economic Geology 71
Beemer Township 71
English Township 72
Semple Township 72
Zavitz Township 74
Hutt Township 74
Halliday Township 75
Sothman Township 75
Nursey and Moher Townships 76
Geology of the Prospects on Beaver and Schist Lakes 76

SOUTH PART OF GRASSY RIVER AREA.

Introduction 77
Access 78
Topography 79
General Geology 79
Rocks 80
Structure 80
Economic Geology 80
Assays of Grab Samples from Cabot 82

WASAPIKA SECTION, WEST SHINGTREE GOLD AREA.

Introduction 83
Acknowledgments 83
Location and Access 83
History 83
Literature 85
Topography 85
General Geology 85
Keewatin 86
Structure of Keewatin 87
Algoman 87
Keweenawan 87
Economic Geology 89
Occurrence and General Character of the Veins 89
Minerals and Paragenesis 91
Description of Properties 92
Herrick 92
Wasapika 92
West Tree 93
White Rock 94
Atlas 94
McIntyre-McDonald 94
Bennett 95
Kingston 95
Other Properties 96
Silver 96

ILLUSTRATIONS

	PAGE
Brulé and swamp in central Bristol	3
Volcanic agglomerate in Keewatin, Bristol township	8
Quartz veinlets in rusty-weathering carbonate schist at the Hayden mine, Ogden township	10
Contact of Keewatin greenstone and quartz porphyry, Ogden township	13
Drag-folded quartz in Keewatin schist, Bristol township	17
Parallel quartz veins in rhyolite, north Bristol line	22
Quartz vein to the south of the Hayden shaft	24
Quartz veins on the side of the hill near Hayden shaft	25
Quartz vein carrying native gold in quartz porphyry	30
Quartz stringers following the schistosity of Keewatin greenstones	30
Mountjoy creek between Marceau and Triple lakes	38
Looking east from central Douglas to the ridge of Cobalt rocks in Fallon township	41
Volcanic fragmental rocks, Harrison claims	45
Vein on T. R. P. 11209, looking west across Triple lake	54
Fire Rangers' headquarters opposite the old Hudson's Bay Company post on Mattagami lake	58
View of skyline near Washagami lake, looking northwest from Sansawaju mountain	60
Pre-glacial fault scarp on the north face of a high ridge in Hutt township	62
Reading lake, one of the typical Kettle lakes in Sothman township	63
Looking north on the Grassy river in Halliday township	65
Moose on Washagami lake	67
Silicious sands in Cobalt conglomerate differentially eroded	68
Sand esker on the bank of the Grassy in the northwest part of Mond township	77
Sansawaju (Turkey) mountain as seen from Grassy river	78
Granite on the west shore of Sinclair lake	79
Group of camps of the Porcupine-Kirkland Gold Mines, Limited	81
Outcrop of quartz veins in Cabot township	81
View of West Tree mine, showing typical rocky surface of low relief	86
Photomicrograph showing corroded pyrite enclosing gold, etc	90
Photomicrograph showing auriferous pyrite in sphalerite	90
Photomicrograph showing grain of pyrite in sphalerite	91
View showing the Ribble vein and headframe over the Wasapika shaft	93
Gold bearing quartz lenses on the McIntyre-McDonald claim, MacMurchy township	95

DIAGRAMS AND SKETCH MAPS

Fig. 1—Diagram illustrating contact between folded sericite and chlorite schists	9
Fig. 2—Sketch map showing geology of the McKinley-Molesky claims, Bristol township	18
Fig. 3—Diagram showing structure of syncline in vicinity of the McKinley-Molesky claims	19
Fig. 4—Plan and section illustrating relation of cleavage to bedding in Timiskaming sediments, Bristol township	20
Fig. 5—Plan showing geology of claims in the vicinity of the McAuley-Brydge property	20
Fig. 6—Key map of Redstone River Area	36
Fig. 7—Key map of Grassy River Area	57
Fig. 8—Sketch map showing canoe route from Gogama station to Sinclair lake and Grassy River Area	59
Fig. 9—Geological sketch map showing part of the Grassy River Area	73
Fig. 10—Diagrams showing anticlinal and synclinal conditions	76
Fig. 11—Geological sketch map of Wasapika lake section, West Shiningtree gold area	84

COLOURED GEOLOGICAL MAPS

(In pocket at back of Report)

No. 35*g*.—Carscallen, Bristol and Ogden, scale ¾ mile to one inch.
No. 35*h*.—Redstone River Area, scale ¾ mile to one inch.
No 35*j*.—Grassy River Area, scale 1½ miles to one inch

Geology of Ogden, Bristol, and Carscallen Townships, Cochrane District

By J. E. Hawley

Introduction

Acting on instructions received from Thos. W. Gibson, Deputy Minister of Mines, a geological survey of the townships of Ogden, Bristol, and Carscallen, Porcupine mining division, was made in the summer of 1925. The townships lie immediately south of Niven's base line, latitude 48° 27′ 54″, the easternmost, Ogden, being southwest of Tisdale township, in which the famous Hollinger and McIntyre mines of the Porcupine camp are located.

Geologically, the area has long been considered rather favourable for the finding of gold deposits, as it lies directly along the strike of the formations exposed in the Porcupine fields and contains rocks of almost identical types and ages, in some of which auriferous veins have been found from time to time.

Prospecting has been done in the area at various periods since the discovery of the larger mines to the northeast in 1910 and 1911, and spasmodically since. Activities were renewed in 1924 and 1925, but always the prospectors have been hindered greatly by the heavy overburden of glacial and recent deposits which mask from 75 to 80 per cent. of the entire surface.

The most extensive mining operations have been in Ogden at the Hollinger Reserve property (later known as the McEnaney Mines) and the Hayden property, both of which, however, have been closed down. In Bristol, the earliest work was on the old McAuley-Brydge property, but more recently prospecting has been carried on intensively on properties held by McKinley, Molesky, Hubert, Wright, Toner, and a few others. In Carscallen, many old prospects were found dating back to the years 1911 and 1912, but the only active work now being done is on the Hazelton and the Beanland-Hurst claims.

In the latter part of the summer of 1925, interest was again aroused in placer deposits along the Redsucker river and Thunder creek in Bristol. Similar work was started the previous year on gravel and sand deposits on Paradis creek in Ogden.

Acknowledgements

In the field the writer was ably assisted by D. W. McKenzie and Herbert Parliment. To prospectors, including D. McRae, Thos. Wright, and Messrs. McKinley, Hubert, Toner, and Hazelton, the writer is especially indebted for information and help in finding isolated outcrops and trails, and for the use of cabins. To Alan Hubert thanks are due for aid in obtaining supplies and for information. Analyses of specimens were prepared by W. K. McNeill of the Provincial Assay Office. A report by E. T. Corkill on the McEnaney Go Mines, Limited, has kindly been placed at the writer's disposal by A. E. Osler & Company of Toronto. To A. G. Burrows the writer is also indebted for suggestions on the geology and mapping of the area.

The Map

A geological map, No. 35*g*, on a scale of ¾ mile to the inch, accompanies the report. It was compiled largely from compass-pace traverses spaced at suitable intervals and tied to surveyed claims or township lines. A compass-chain traverse of parts of the Whitesides road, which runs through Bristol to the west edge of Carscallen, was made and used as a central base line in these townships. Portions of the map include areas previously surveyed by Department of Mines officials. Parts of Ogden and Bristol were mapped by A. G. Burrows on map No. 21*a*, published in 1912.[1] Southern Carscallen was mapped by W. R. Rogers and E. L. Bruce in 1911.[2] Portions of these maps have been incorporated in the accompanying one, with new details.

General Description of the Area

Means of Access

Roads.—The area is readily accessible by roads from Timmins. In Ogden, a road used by motors leads south from Timmins along the eastern boundary line to the 2½-mile post. Branch roads lead off to the west at many points, including those to the McEnaney Mines, the Hayden, and the Owen Acme properties. The road to the McEnaney Mines, which follows the transmission line coming from Wawaitin falls, is in good condition as far as Mountjoy creek; southwest from there to the Grassy river it can only be used in winter on account of the many low swampy areas it traverses. There are numerous other winter roads in the southern and western portion of the township, but only a few of these have been mapped.

Bristol and Carscallen may be reached by the Whitesides road which runs from Timmins southwest through Mountjoy and Ogden, and thence west almost through the centre of the two townships to Trout lake in Whitesides township. During the summer of 1925 at the time of the Keefer placer rush, teams were driven through to Whitesides over this road, but experienced much difficulty in Carscallen. Since then, the writer has been informed, a right of way has been surveyed through Bristol to the Hazelton property which will greatly improve the road. Branch roads lead from this thoroughfare to the Toner-McCormick and McKinley-Daley claims, and south along the east Carscallen boundary to the Hazelton property in Denton township. An old winter road joins it with the long disused road leading from Bristol Landing on the Mattagami to the old McAuley-Brydge claims.

Trails.—Trails which have been used in the past and are now partly obliterated lead along Niven's base line from the 17-mile post to the northwest corner of Carscallen. From the 27-mile post on this line, a trail leads southwest through Carscallen to the old Blackburn properties. The old route from Denton township to Waterhen lake in Bristol, which has long appeared on maps, has almost totally disappeared, only small portions being now used by prospectors.

Rivers.—The Mattagami river flowing through western Ogden touches the east line of Bristol at the 2-mile post and at the southeast corner. Near the 4-mile post a road leads from Whitesides Landing to the Whitesides road; farther south another road runs from Bristol Landing to the McAuley claims. The river

[1]Ont. Bur. Mines, Vol. XXI, pt. 1, 1912.
[2]Ibid, Map No. 21*e*.

is travelled by motor boats from Mattagami Heights, but is not much used by those wishing to travel in these three townships. Since the water level has been raised, Pigeon rapids have ceased to exist.

In Ogden, Mountjoy creek is navigable by canoe throughout the township. No other creeks, however, are of much importance as transportation routes.

Topography

The area is on the whole one of low relief, elevations ranging from about 1,000 to 1,300 feet above sea-level. The highest ridges lie in western Carscallen where they rise above the general level 150 to 200 feet. Another prominent topographic feature is an elongated flat-topped boulder ridge paralleling the line between Bristol and Carscallen and extending between the 4- and the 2-mile posts. This ridge is well timbered with heavy spruce, poplar, and birch.

Major depressions occur in western Ogden, in the Mattagami river valley, and in central Carscallen where an old valley is now occupied by Big Marsh lake



Brulé and swamp in central Bristol.
The plane-like skyline is typical
of the area.

and its outlet. From both of these valleys the ascent to the higher areas of the townships is almost imperceptible. The Mattagami valley, however, is characterized by steep banks, 75 to 100 feet high, particularly in southern Ogden.

Eastern Ogden and Bristol constitute a monotonous, gently rolling plain, interrupted only by low rocky ridges, which in Ogden extend east and west near the centre of the township. Large sand-covered areas are interspersed with slightly lower swamp lands, and the southern sections consist of a succession of low, irregular sand ridges and swamps. In the sand plain of Bristol streams, including the Redsucker river, have eroded fairly deep and narrow gorges, most of which are in a youthful stage of development.

Throughout the greater part of Carscallen, irregular boulder ridges predominate. In many cases these have steep southern sides and an easterly trend. Their size and distribution suggest recessional moraines. Glacial outwash plains, however, are few.

Drainage

Practically all the waters of the three townships drain eventually into the Mattagami river, which winds a meandering course north through western Ogden. The larger tributaries of the Mattagami, the Redsucker, and the Grassy enter at the south. Only the latter is navigable by canoe for any distance, the Redsucker river in Bristol having numerous short rapids and a 7-foot chute. At the latter point, eight miles from the mouth, a small dam was being built for lumbering purposes in the fall of 1925.

Mountjoy creek, entering the Mattagami river immediately south of Mattagami Heights, drains the eastern part of Ogden and is navigable for its entire course. A bridge has been constructed over it at the transmission line.

Thunder creek in Bristol heads in a small lake in northeastern Carscallen and drains south into the Redsucker. The upper portion is narrow and obstructed by a few beaver dams; the lower part is narrow and rocky.

Big Marsh lake in central Carscallen is the source of the south branch of Kamiskotia creek. From this lake it flows north to near the north boundary, where it is joined by a small creek; from there it flows eastward and, turning north near the northeast corner, leaves the township and continues through Turnbull, Godfrey, and Jamieson townships to the Kamiskotia river.

Timber

The greater part of Ogden, Bristol, and Carscallen has been swept by several forest fires dating back to 1911. Burnt areas are outlined on the accompanying map. Most of the areas still forested are low and swampy, with stunted spruce and occasionally new tamarac growing in them. In southern Ogden and southeastern Bristol, higher sandy areas have growths of large jackpine. These have been largely cut over, and no appreciable stand of large timber now exists there. The long boulder ridge in western Bristol and eastern Carscallen is forested with larger spruce, poplar, and birch. It is duplicated to a smaller extent in northern Carscallen. The southern part of this township, where rocky, is now covered by an extremely dense growth of small jackpine, and where low, by spruce swamps.

Discoveries

Gold discoveries have been made in all three townships, but in only one of these have mines been in operation, and then only for short periods of time. No mining is now being carried on.

Many of the discoveries date back to the period of early development in the Porcupine area, 1909-12. Discoveries were made on the Grey claims, afterwards called the Hollinger Reserve mine, and later the McEnaney Mines. To the east, on the Hayden property, discoveries were also made which led to the formation of the Hayden Gold Mines, Limited, and the sinking of a shaft in 1915. Other discoveries were made on the Worthington claims, west of Mountjoy creek, but development work there has never been carried very far. Placer deposits have been reported from Paradis creek, an eastern tributary of Mountjoy creek.

In Bristol the earliest discoveries were made on the McAuley-Brydge properties in 1911, where small lenses of fairly good ore were found. More recently McKinley, Wright, Hubert, and Hendrickson have found native gold on claims held by them. This led to further intensive prospecting of the township in 1924 and 1925.

Southern Carscallen was the scene of active prospecting in 1911. In the adjoining part of Denton township, Terry Carlton made the first discovery on claims known as the Jowsey-Woods. At the same time Walter Kavannaugh and Stanley Ellis discovered what is now known as No. 1 vein of the Hazelton Porcupine Gold Mines, a vein extending just across the boundary into Carscallen. In 1918 James Hazelton made further discoveries, and in 1925 Sydney Beanland and Frank Hurst found gold in narrow veins not far from a contact of granite and greenstones. Since the writer visited the field, Beanland is reported to have found specimens of wire gold in this same vicinity.

Previous Work

Examination of the rocks and prospects in parts of the three townships had been made before 1925. During the development of the Porcupine camp, A. G. Burrows examined and reported on the northern part of Ogden and south Bristol; data on occurrences there may be found in his second report on the Porcupine area,[1] and in later publications on this area.

In 1911, W. R. Rogers and E. L. Bruce[2] made a survey of the grey granite area of southern Carscallen, and also mapped rock outcrops along the east and west township lines.

General Geology

The geologic formations of Ogden, Bristol, and Carscallen have both common and distinct features. The pre-Cambrian rocks range in age from Keewatin to Keweenawan, but those exposed cover approximately only 25 per cent. of the surface, the remainder being buried by varying thicknesses of glacial and recent deposits.

In general, all the formations are distinctly related and similar to those described in adjoining townships, and for this reason the following discussion will be brief.

Ogden township is characterized by the presence of Keewatin carbonate rocks with chromiferous micas, felsite and porphyry dikes, and Haileyburian serpentine, all of which are more or less duplicated in Deloro township. In Bristol, highly carbonated rocks are few, and serpentine is missing. An Algoman stock of red granite porphyry occurs in the south, and the remaining formations —volcanics, Timiskaming sediments, and small quartz porphyry intrusives— resemble the succession found in Tisdale township. Large beds of volcanic agglomerate appear in central Bristol and are followed on the north by highly schisted flows. In the northwest of the township, volcanic rocks of a more acidic nature predominate.

Carscallen embraces two petrographic provinces, a southern granitic one, probably Algoman in age, and a northern gabbroic one. In the latter, small dikes of porphyry rocks have been intruded in greenstones and gabbros. The geology of this region is more or less a replica of that in the southwestern part of Turnbull township.

The following table of formations shows the dominant features of the geology in each township.

[1]Ont. Bur. Mines, Vol. XXI, pt. 1, 1912.
[2]The Cripple Creek Gold Area, ibid.

Table of Formations

Period	Ogden	Bristol	Carscallen
QUATERNARY RECENT and PLEISTOCENE:	Stratified clays, boulder clay, boulders, and sand.	Boulder clay, sand. Boulders.	Boulders, boulder clay, and sand.
PRE-CAMBRIAN KEWEENAWAN:	Olivine diabase.		
	Intrusive Contact		
MATACHEWAN:	Quartz diabase.	Quartz diabase.	Quartz diabase.
	Intrusive Contact		
ALGOMAN:	Quartz porphyry, felsite dikes, grey granite.	Quartz porphyry, red granite, and granite porphyry.	Grey biotite granite, pink granite, quartz porphyry, rhyolite porphyry, and granophyre.
	Intrusive Contact		
HAILEYBURIAN(?):	Serpentine.	Gabbro.	Gabbro, diabase, hornblendite.
	Intrusive Contact		
TIMISKAMIAN:	Slates, quartzites, etc. (mapped on Mattagami R., now submerged).	Slates, quartzites, greywacké, conglomerate, and schistose phases.	
	Unconformity		
KEEWATIN:	Altered and schistose basic to acidic lava flows, ranging from basalt to rhyolite, generally carbonated. Pillow lava common, amygdaloidal lava, Fragmental rocks scarce. Rusty-weathering carbonated schists, some with chromiferous mica. Iron formation of chert and iron oxides.	Altered and schistose basic to acidic lava flows, basalts, andesites, dacites, and rhyolites. Good exposures of rhyolitic agglomerate and pillow lava.	Generally massive greenstones, highly altered to chlorite, with pyrite. Rhyolites and rhyolitic agglomerates occur in the northeast. Banded iron formation, chiefly chert and magnetite.

Keewatin Volcanics

The Keewatin rocks are the most prevalent of all exposures. They consist of two main types, volcanics and banded iron formations. The latter outcrop only in southern Ogden and in Carscallen.

Of the Keewatin volcanic rocks found, practically all the types have been well described by A. G. Burrows in his reports on the Porcupine area. In this area, they consist of flows ranging in composition from basalts to rhyolites, more properly called meta-basalts and meta-rhyolites[1] on account of their highly altered condition, volcanic agglomerates and fragmentals, spherulitic and rarely amygdaloidal lavas, and tuffs. Where schistose the lavas yield green, grey, and light-coloured schists, which have all gradations from finely laminated sericite schist to dark-green chlorite and occasionally hornblende schists.

Flows.—Volcanic flows are most evident in Ogden and Bristol. The more basic of these commonly have ellipsoidal pillow structures, which have been elongated by folding and shearing movements. Pillows have been noted in massive flows at irregular horizons and without any direct relation to the tops or bottoms. In southeastern Ogden along the Deloro line, the more schistose portions of the pillows, i.e. around their borders, were found to be replaced by reddish chert with iron oxides. Greyish-green, highly carbonated pillow lava occurs in the outcrops of the McEnaney Mines and on the rocky ridges to the south.

In Bristol, pillow lavas are common in the central portion where they are associated with agglomerate beds. In Carscallen, basic flows predominate in the west. These are highly altered and schistose, and most volcanic structures or textures in them have been obliterated. They fall into the broad class of greenstones, being highly altered to chloritic products. Somewhat similar massive greenstones occur in Bristol on the McAuley-Brydge claims, where they are partly surrounded by Timiskaming sediments. Many of these massive rocks suggest, by their structure and texture, intrusives rather than extrusives, but no definite data on this point were obtained.

In Bristol on claim P. 8,527, south of the Whitesides road, massive, less altered, and coarser grained rocks, with a diabase appearance and in which definite volcanic textures are also lacking, occur between finer grained flows. They are probably flows which cooled more slowly than usual and they contain amphiboles, altering to chlorite, titanite, secondary sericite, zoisite, and fine quartz, products of altered feldspars.

Determination of the tops and bottoms of flows by recognition of a gradation from massive to amygdaloidal lava and fragmental top, as in Porcupine,[2] was seldom possible as the upper portions of the flows are generally too severely schisted. The resulting schists show about equal gradations to more massive phases on both sides. For the same reason, amygdaloidal textures were also rarely found, as these initially more altered portions of the flows have yielded to flowage under stress more readily than the massive sections. Fragmental tops have been observed on flows in a few instances in Bristol and Ogden, but these, too, for the most part have been rendered so schistose that it is seldom possible to say on which side lies the top or base of the flow.

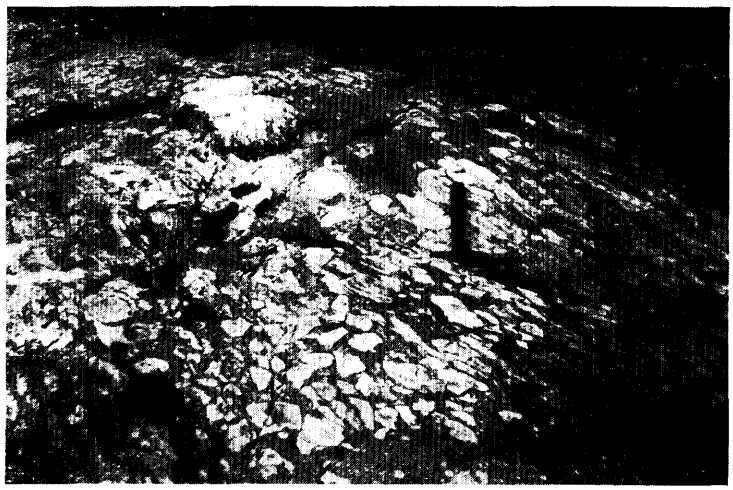
Massive to schistose spherulitic flows were found at two horizons in central Bristol, near and on claim P. 11,388. Whether these are identical beds was not determined. They are greyish green in colour and consist of abundant light-

[1]A. G. Burrows, Ont. Dept. Mines, Vol. XXXIII, pt. 2, 1924, p. 13.
[2]A. G. Burrows, op. cit., pp. 13-20.

coloured spherules, about an eighth of an inch in diameter, in a darker groundmass. Under the microscope, the lava is very fine grained and consists of quartz, sericite, chlorite, zoisite, and carbonate. The spherules are now largely made up of zoisite, carbonate, and some sericite, clearly alteration products, for the most part, of acidic minerals.

Volcanic agglomerates, composed of angular to subangular rhyolite fragments of irregular shapes and sizes, embedded in a dark-green chloritic groundmass, occur abundantly in central Bristol. A section north of the Whitesides road over claims P. 8,518 and P. 8,527 gives a total thickness of many agglomerate bands as 250 feet. These are separated by green schists of varying widths. Where schistose, these agglomerates may be distinguished by sericitic lenses in a chlorite matrix.

Amygdaloidal lava was observed on the Owen Acme claims in Ogden. The amygdules varied in shape from spherical to pipes, and were partly filled with calcite.



Volcanic agglomerate in Keewatin, central Bristol township.

Locally, vug-like masses of pink feldspars have been observed in basic flows in Bristol. These are doubtless segregations of the more acid constituents by processes of differentiation.

Tuffs.—For the most part tuff rocks are not easily distinguished among the Keewatin volcanic rocks of these townships. A band of light grey-weathering, highly foliated schists with a tuffaceous character were found on claim T.C. 603 and along the transmission line on claim P. 8,381 in Ogden. The latter show distinct bedding planes which are crossed by schistose cleavage.

Rhyolites.—Rhyolitic flows, often with a porphyritic texture, predominate in northwestern Bristol and northeastern Carscallen. These are light-grey weathering and generally highly schistose. In appearance some are exceedingly similar to Algoman quartz porphyry, especially where the latter have been rendered schistose, and as both rhyolites and porphyry yield sericite schists, distinction on a basis of composition alone is often impossible. Field relations, however, have in most cases enabled distinctions to be made.

Certain phases of the rhyolites are greenish-grey in colour and have phenocrysts of quartz and feldspar. These grade to more basic rocks with an increase in ferromagnesian constituents, which in most cases observed are now represented by chlorite. Where schistose, many of the rhyolitic flows take on a distinct yellow hue, a colour generally lacking in Algoman schists.

Thin sections of the rhyolite schists show that they are now composed dominantly of quartz and sericite, with minor amounts of chlorite and epidote. Rhombs of rusty-weathering carbonate and veinlets of carbonate and chalcedonic quartz cut across the schist.

On claim P. 8,483, Bristol, a schistose rhyolitic porphyry occurs, which has been taken for Algoman quartz porphyry. The rock is greenish grey in colour and contains abundant quartz phenocrysts which give an excellent augen texture to the schist. In general the texture is quite uniform and shows none of the definite features, such as amygdules and fragmental bands, characteristic of a flow. Under the microscope, it is found to contain phenocrysts of feldspar, orthoclase, and albite or oligoclase-albite. These with the phenocrysts of quartz lie in a fine schistose groundmass of feldspars, quartz, sericite, calcite, and chlorite. Chlorite is fairly common. In the field this rock was classed as a dacite porphyry, but the nature of the feldspars shows it to be more rhyolitic in composition. Petrographically it is very similar to the Algoman quartz porphyry intrusives, but the greater alteration and degree of schistosity have led to its being placed in the Keewatin. To the northeast almost identical schists appear infolded with the greenstones, though there they do not have feldspar phenocrysts.

Other dacitic quartz porphyry rocks in northern Bristol contain abundant quartz phenocrysts, highly altered plagioclase-feldspars, much chlorite, leucoxene, and secondary calcite.

In central Ogden, on the Pann Porcupine and Owen Acme properties, rhyolitic flows are also of common occurrence. There they are so interbedded with more basic flows that mapping of separate flows has not been feasible.

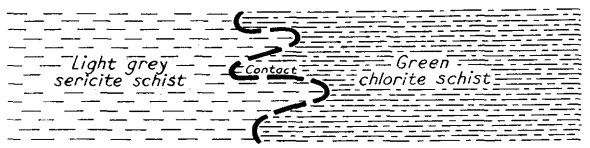


Fig. 1—Diagram illustrating contact between folded sericite and chlorite schists.

Foliated sections of rhyolitic, now sericitic, schists and chloritic schists, in which the contact lines cut back and forth across the schistosity, are of value in establishing a Keewatin age for the rhyolites.

On the north edge of outcrops on the Pann Porcupine claims, an interesting rhyolitic breccia-like rock appears with a few angular fragments of red jasper (iron formation). The greenish-grey rhyolite contains eyes of quartz and has lenticular and irregular blebs of a greyer and whiter rhyolite porphyry distributed throughout. The latter appears to be similar to injected quartz porphyry in rocks of the Porcupine area,[1] the phenomenon being known as *école* injection.

From a study of the regional structure in Bristol township, the conclusion has been reached that for the most part the more acidic flows of rhyolite and

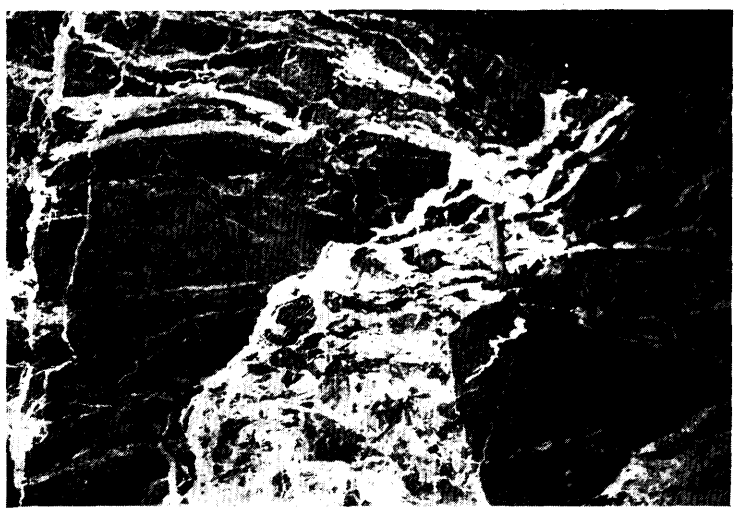
[1]A. G. Burrows, op. cit., p. 34.

dacite, where most abundant, lie at higher and younger horizons than the more basic flows. This conclusion is supported by two or more occurrences:—

1. South of the 21½-mile post on the north Bristol line, rhyolites are clearly folded with basalts, lie on top of them, and plunge westward at about 40 degrees. From the same locality westward, and therefore at higher horizons, rhyolites are the more dominant volcanic rocks.

2. On claims P. 8,404 and P. 8,405, central Bristol, structural evidence points to the fact that the outcrops there lie on the north limb of a syncline pitching west. Westward from this locality also, the volcanics become increasingly acidic.

This conclusion could not be verified in Ogden, where the rhyolites are not so common and the structure is less easily deciphered. It is possible that structural work in other areas will throw more light on the question, depending on the uniformity of vulcanism in Keewatin times. Horizons at which Timiskaming sediments overlie Keewatin are not of much help, as erosion may have removed parts of the younger Keewatin flows.



Quartz veinlets in rusty-weathering carbonate schist at the Hayden mine, Ogden township.

Carbonate Rocks.—Rusty-weathering carbonate schists with a massive medium-grained texture are rather common in central Ogden on the Owen Acme, Hayden, Pann Porcupine, Ostrosser, and Worthington (Langmuir) claims. At the McEnaney Mines, highly carbonated pillow lavas occur. The rusty-weathering schists correspond to rocks described by Burrows,[1] and are composed of calcium, magnesium and iron carbonates, chlorite, sericite, quartz, and other minor constituents.

On claim T.R.S. 1,164, Ogden, chromiferous mica (fuchsite) gives a brilliant green colour to the schist. Similar occurrences have been noted by Burrows in Deloro township.[2]

A genetic relation between these rusty carbonate rocks and intrusive dikes of quartz porphyry seems to obtain on the Hayden, Owen Acme, and

[1]Ibid, p. 38.
[2]Ibid, p. 39.

Pann Porcupine properties, where one is generally found with the other. The rocks are often penetrated by intricate stockworks of quartz and ankerite veins.

Keewatin Iron Formation

Banded iron formation, consisting dominantly of chert and iron oxides, similar to that in Deloro township[1] and elsewhere in Ontario, occurs in southern Ogden and in Carscallen.

In Ogden, the bands range from a few inches to 70 feet in thickness. Red iron oxides (hematite) give the red colour to the formation. They lie between basic lava flows and seem clearly related in origin to some process of vulcanism. Locally, drag folds appear in the chert bands, and brecciated iron formation outcrops on claim H.S. 840. Many of these bands are highly mineralized with pyrite which occurs either finely disseminated or in massive veinlets.

In Carscallen on claims of S. Beanland and F. Hurst, east of the contact of grey granite and greenstone, iron formation in 15-foot bands consists of white chert and dark cherty magnetite layers. Pillow lava and basalt lie on either side. Elsewhere in Carscallen, the iron oxides are present largely as magnetite.

That the iron formation appears largely in the southern part of Deloro township and not in the north, along with other data, has suggested to Burrows[2] an eastward-trending fault zone with a downthrow to the south. The same relation, as far as the iron formation is concerned, seems to continue into Ogden, a possible fault depression lying to the north of claims P. 7,307 and P. 7,369.

Intrusives into the Keewatin

The widespread intrusives in the Keewatin volcanics include the Haileyburian gabbros and serpentine, Algoman granitic rocks, Matachewan quartz diabase, and Keweenawan olivine diabase. These are described below.

Many small trap dikes of uncertain age also appear in the greenstones. Many of them have been faulted and partly folded, as illustrated by occurrences on claims P. 11,388 and P. 8,405, Bristol. These would probably best be correlated with the basic intrusives of Haileyburian age.

Still other small intrusives of questionable age are found in Bristol. These weather to a greenish-grey colour, are generally schistose and much altered. They occur on claims P. 11,388, P. 10,858, and P. 8,518. The largest is on a claim of Alan Hubert. In most cases these rocks were thought by prospectors to be Algoman quartz porphyry. Under the microscope, however, some of them are exceedingly fine grained and not porphyritic. Feldspars of two generations are present, an older, much altered andesine group, of which only remnants remain, and a younger much fresher group of albite, with sharp twinning lamellae. The latter are clearly secondary, as is much fine quartz, chlorite, sericite, and calcite. Fine needles of rutile are abundant. The rock was probably originally a dacite or andesite. Its age is not determinable, but the high degree of alteration suggests a pre-Algoman age.

Timiskaming

Greatly altered sedimentary rocks of Timiskaming age occur in southern Bristol. These have been previously noted by Burrows.[3] Their relation to

[1]A. G. Burrows, op. cit., p. 25.
[2]A. G. Burrows, op. cit., p. 22.
[3]A. G. Burrows, op. cit., p. 25.

the underlying Keewatin greenstones at this locality is obscure due to faulting, but it is known that elsewhere the formations are unconformable above the volcanics. The sediments here have been intruded by Algoman red granite and by later dikes of quartz diabase.

The rocks consist of partly schistose quartzites, greywacké, slate, and very minor conglomerates. They occur in fairly thin beds, one to two feet in thickness, and are all crossed by secondary fracture cleavage.

Large outcrops of the sediments occur on claims T.C. 613, P. 9,586, P. 9,587, and P. 7,374, and around the granite stock of southwest Bristol. Small outcrops also appear on claim P. 4,493 to the east, on claims H.R. 1,262 and H.R. 1,260, south of the Redsucker river, and on a small point near the junction of the Redsucker and Mattagami rivers.

The rocks have all been steeply folded and truncated. They are much disturbed and schistose in the vicinity of the Algoman granite. The outcrops appear to lie in a major east-west syncline in the Keewatin, the detailed structure of which will be dealt with in a separate section.

The contact between the sedimentary rocks and the Keewatin is a faulted one and highly schistose. It cuts the bedding of the sediments at a small angle, approximately 10 degrees. No conglomerates were observed along this contact, which runs at N. 50° E. through claims T.C. 613, P. 9,587, and P. 7,372. The sediments strikes N. 60° E., and dip steeply north. Near the McAuley-Brydge shafts they swing to an easterly strike and partly encompass massive Keewatin greenstones. The faulted contact at this point is covered. It is questionable if the fault continues to the northeast.

Haileyburian

Serpentine.—Small masses of serpentine occur in the central part of Ogden township. The larger outcrop intrudes Keewatin schists and occurs a few feet north of a mineralized quartz vein.

The contact of the serpentine and Keewatin has been slightly sheared, and along it fibrous plates of serpentine, with a length up to two feet, have been formed. The main mass of the intrusive has a gabbroid texture, though completely altered to serpentine. It weathers dark brown and has a greasy touch. Fine threads of asbestos occur irregularly throughout, but no deposits of commercial importance were found. Veins of fibrous serpentine, from one-half to one inch in width are present, radiating inwards. Under the microscope the rock consists essentially of ferriferous serpentine and iron oxides. The correlation of this with serpentine rocks in the Porcupine area is made solely on a basis of lithology and the fact that the intrusive is post-Keewatin in age.

Gabbro.—In northwestern Carscallen, several large masses of gabbro intrude Keewatin greenstones, and are in turn intruded by granitic rocks of Algoman age. Similar basic intrusives have been found in Turnbull township to the north and described recently by Finley,[1] who tentatively assigned to them a Haileyburian age. Since the age relations of the gabbro in Carscallen are identical with those in Turnbull, Finley's classification (after Miller and Knight) has been followed.

In Carscallen, the gabbros are medium to coarse grained. In a few places a diabasic texture is evident, and in small outcrops such rocks are distinguished with difficulty from later diabase dikes. Mineralogically, the gabbro contains altered labradorite, augite, titanite, hornblende, magnetite, and apatite. Locally,

[1]F. L. Finley, Ont. Dept. Mines, Vol. XXXIV, pt. 6, p. 50.

it grades to a very coarse grained amphibole-feldspar (hornblendite), with crystals over an inch in length. Identical phases of the gabbro have been described by Finley in Turnbull,[1] where they are regarded as pegmatitic phases of the gabbro intrusives. To the southwest of claim P. 2,122, Carscallen, a hornblendite rock is intruded by Algoman quartz porphyry. There the coarse crystallization of the gabbro rock seems closely related to contact action, though elsewhere similar intrusives have not thus affected the gabbro.

Algoman

In Ogden, Bristol, and Carscallen, granitic intrusions of Algoman age occur. These range in size from small dikes to batholiths, and in composition from soda-rich granite to quartz monzonite. Many of them are porphyritic, with phenocrysts of either quartz, feldspar, or bo h. In mapping these intrusives a distinction has been made between the finer grained quartz porphyry rocks and those with granitic textures.



Contact of Keewatin greenstone and quartz porphyry, Ogden township.

Quartz Porphyry.—Quartz porphyry intrusives, corresponding closely to Algoman intrusives of the Porcupine area, outcrop sparingly in each township. These vary somewhat in composition and mineral content. They occur as dikes or small stocks. All of them intrude Keewatin greenstones or Haileyburian gabbro, but none were found cutting Timiskaming sediments. Locally they are cut by later quartz diabase dikes.

In Ogden a small body of this rock outcrops on claim H.R. 1,220, west of the Hayden property. There the contact with the Keewatin green schists is well marked, the latter having been injected by the porphyry. The resulting contact rock is spotted and agglomeratic in appearance.

This intrusive is highly altered, the quartz phenocrysts remaining in a matrix of completely sericitized feldspars and fine quartz. No ferromagnesian minerals are now present, their alteration products having been largely disseminated or removed.

[1]Op. cit., p. 51.

Small dikes of quartz porphyry occur also on the Hayden, Owen Acme, and Pann Porcupine claims and on claim P. 7,142 near the Mattagami river. A dike of less altered porphyry from the Hayden property contains phenocrysts of albite, orthoclase, and quartz with secondary sericite, and cubes of pyrite.

In central Bristol, a small stock of quartz porphyry occurs on claim P. 8,537; and for five-eighths of a mile south, isolated outcrops protrude only a few feet above the heavy sand drift. In the southernmost outcrop is a large inclusion of green schist. The rock is medium to fine grained, and eyes of quartz are always present. Shearing has produced several schistose zones and most of the outcrops are much fractured.

Thin sections show that the porphyry contains phenocrysts of quartz and feldspar, orthoclase and albite, which are partly sericitized. These lie in a matrix of sericite, quartz, and some calcite. In places epidote and chlorite are fairly abundant. The chemical composition given below corresponds closely with quartz porphyry from the Clifton mine, Deloro township.

In Carscallen, small intrusives of quartz porphyry occur in the northeast along the township lines, and in the western part where they intrude gabbros. That in the east is similar to the grey porphyry of Bristol, and identical with porphyry described by Finley[1] in Turnbull. To the west the porphyry has a slight reddish tinge, contains considerable biotite, and is less porphyritic. Gradations from medium-grained to rhyolitic porphyry are common. In the northeast, a granophyric texture is present.

The rocks contain euhedral quartz crystals and feldspars, orthoclase, albite to oligoclase albite, and fine secondary minerals: sericite, zoisite, epidote, and chlorite. The granophyre is characterized by abundant graphic intergrowths of quartz and orthoclase.

Where intrusions of quartz porphyry occur in gabbro, in Carscallen, a contact breccia has been developed, consisting of fragments of gabbro scattered and embedded in porphyry. Similar rocks have been described by Finley[2] in Turnbull township. Where partly weathered and schistose these rocks are not easily recognized.

ANALYSES OF QUARTZ PORPHYRY ROCKS

	No. 1	No. 2	No. 3	No. 4
	per cent.	per cent.	per cent.	per cent.
Silica	65.5	71.04	65.22	69.64
Alumina	18.75	16.63	14.62	14.86
Ferrous oxide	1.14	1.73	1.14	.98
Ferric oxide	.75	.57	3.39	2.67
Lime	3.08	3.08	3.01	2.51
Magnesia	.61	trace	1.09	.67
Potash	1.15	1.9	1.45	2.44
Soda	5.72	3.64	5.66	2.5
TiO_2	.51	.54	.....	.....
Water	1.07	.76	1.07	1.43
Carbon dioxide	1.85	.21	2.61	2.24
Sulphur	.....	.....	.79	.15
Total	100.11	100.10	100.05	100.09

No. 1.—Quartz porphyry from central Bristol, claim P. 8,537.

No. 2.—Quartz porphyry from Carscallen, southwest of claim P. 2,122. It is somewhat pink and contains unaltered biotite.

No. 3.—From Clifton mine, Deloro township, after A. G. Burrows, The Porcupine Gold Area, Ont. Bur. Mines, Vol. XXXIII, pt. 2, p. 35.

No. 4.—Quartz porphyry from the 700-foot level, Dome mine, after Burrows, ibid.

Analyses by W. K. McNeill, Provincial Assayer.

[1]F. L. Finley, op. cit., p. 55.

[2]Ibid, p. 54.

Granites.—Granites of two types occur in the southern portion of the area. In Bristol, a small stock of red granite, rich in alkalies, intrudes Keewatin greenstones and Timiskaming sediments. In Ogden a small grey biotite granite intrudes greenstones, and in Carscallen a large intrusive of similar granite with batholithic dimensions appears to underlie the whole southwest portion of the township. The age of these two granites cannot be fixed with certainty. They are post-Keewatin and pre-quartz diabase in age. Their relative freshness and lack of gneissic textures make it probable that they are of Algoman age.

The red granite of Bristol has been previously described by Burrows.[1] The mineral constituents are orthoclase, microcline, albite, quartz, and small amounts of biotite, chlorite, and iron oxides. It is largely porphyritic, the phenocrysts of feldspar showing excellent zonal growths. The feldspars are partly sericitized and replaced by rusty-weathering rhombs of carbonate. Analysis of a dike of this rock from Thomson's claim is quoted below. Quartz stringers dissect the stock in a most intricate manner, and in these gold has been found. The stock is near the McAuley-Brydge property where auriferous veins with arsenical pyrite were worked in 1911. Near the northwest contact on claim P. 7,372, quartzose rocks have been impregnated by the granitic magma and contain small red patches and stringers of microcline, orthoclase, and quartz. The contact rock is highly carbonated and mineralized with pyrite.

The grey granite of Ogden is coarse grained and massive. It is cut by dikes of quartz diabase and olivine diabase. The mineral constituents are quartz, orthoclase, albite, biotite, and secondary sericite, chlorite, epidote, and zoisite. The feldspars for the most part are altered to sericite, and the biotite to chlorite

Grey biotite granite extends westward from Mahoney lake in southern Carscallen to Jowsey lake, and from the south township line north about two miles. The contact with the greenstones appears at only two points, on claims H.S. 1,031 and P. 2,117. On claim H.S. 1,031 the contact dips steeply under the granite. Petrographically the intrusive ranges from a biotite granite to a quartz monzonite, and contains quartz, orthoclase, albite, and in places oligoclase-albite to oligoclase-andesine, biotite, ilmenite or magnetite, and secondary sericite, chlorite, carbonate, and epidote. The freshest specimens obtained show considerable alteration, mostly of a hydrothermal type. At Jowsey lake the intrusive has a pinkish hue. Here the plagioclase feldspars are more basic, ranging to oligoclase-andesine. These predominate over the orthoclase. Mermyckite, graphic intergrowths of quartz and feldspar, are also present with fairly fresh flakes of biotite.

Shearing has locally rendered the granite schistose, but these zones are relatively narrow, of short lengths, and not widespread. In them, carbonates, auriferous pyrite, and blue quartz have been introduced. Further movements have left the blue quartz as augen eyes in the schist. In Denton township, just south of claim P. 11,357, a narrow lamprophyric dike occurs in a shear zone. It appears to be later than the shearing movement.

[1]A. G. Burrows, The Porcupine Gold Area, Ont. Dept. Mines, Vol. XXXIII, pt. 2, p. 37.

ANALYSES OF GRANITES

	No. 1	No. 2	No. 3
	per cent.	per cent.	per cent.
Silica	65.42	66.6	63.28
Alumina	15.8	18.1	20.01
Ferrous oxide	.91	1.18	3.22
Ferric oxide	2.75	.75	1.2
Lime	1.33	3.7	3.1
Magnesia	.53	1.42	trace
Potash	6.26	1.71	1.78
Soda	5.18	3.96	3.1
Titania	.....	.57	.98
Water	2.46	1.16	1.81
Carbon dioxide	.....	.68	1.78
Total	100.64	99.83	100.26

No. 1.—Granite porphyry dike, Thomson claim, Bristol township, after A. G. Burrows, op. cit., p. 38.
No. 2.—Grey granite, south central Ogden.
No. 3.—Grey biotite granite, vicinity of Mahoney lake, Carscallen.

Matachewan

Throughout the area, vertical dikes of quartz diabase ranging in width from one to 200 feet, almost invariably striking north, cut alike Keewatin schists, Timiskaming sediments, gabbros, granites, and quartz porphyries. These may be traced intermittently along the strike for lengths of two miles. The same strikes and dips prevail in the townships to the north and east. Their consistency should throw some light on the structural forces acting in the area prior to their intrusion.

The diabase contains altered labradorite, augite altering to chlorite, titanite, and interstitial quartz. Graphic intergrowths of quartz and orthoclase with a few fresher crystals of albite are present in a few places. These, while not usual in diabase, are not rare. Such constituents have been explained as the result of differentiation and later crystallization.

The diabase weathers to a typical dark-reddish brown. No mineral deposits are associated with these intrusives.

Keweenawan

At two localities in Ogden township, the youngest pre-Cambrian rocks of olivine diabase occur. These are in the form of dikes 100 to 150 feet wide, striking northwest and cutting Keewatin lavas near the Hayden shaft, and dissecting the grey granite to the southwest. Elsewhere the diabase is known to be younger than the quartz diabase.

The olivine diabase consists of augite (largely altered to chlorite), titaniferous magnetite, and leucoxene, almost completely sericitized plagioclase feldspars, and abundant altered olivine crystals. The latter now consist entirely of serpentine. Ophitic textures are quite evident.

Pleistocene and Recent

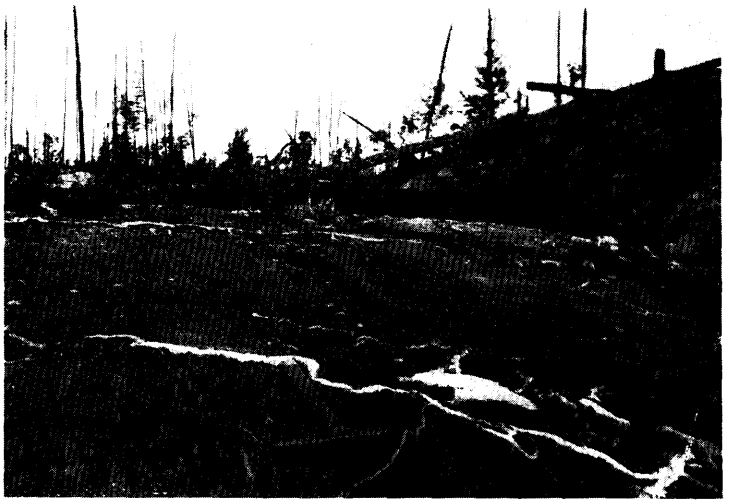
The area is covered largely by glacial deposits which range from sand and gravel to widespread boulder deposits. The latter are particularly abundant in Carscallen, while in Bristol and Ogden outwash deposits of sands, gravels, and clay have thicknesses of at least 100 feet. Where streams have worked

their way through these, small placer deposits of gold have been formed, as on Thunder creek and the Redsucker river in Bristol, and Paradis creek in Ogden.

Stratified clays, 10 to 15 feet thick, occur along the Mattagami river. These have been illustrated by Burrows in his second report on the Porcupine gold area.[1] They are not widespread, and are covered by sands.



Drag-folded quartz in Keewatin schists, claims P. 8,404 and P. 8,405, Bristol township. One vein is cut by a later trap dike.



Drag-folded quartz in Keewatin schists, claims P. 8,404 and P. 8,405, Bristol township.

Structure

The geologic structure of the area is one of closely folded lava flows and edimentary rocks. The major folding is of post-Timiskaming age. It has

[1]Ont. Bur. Mines, Vol. XXI, pt. 1, p. 207.

been followed by later shearing movements more or less along the same strike, which cause the foliation of previously formed schists and the drag-folding of some quartz veins. The later movements probably followed or accompanied the intrusions of Algoman age.

The general strike of the now truncated folds is slightly north of east. The dips are usually from 80 to 90 degrees. While it has not been possible to

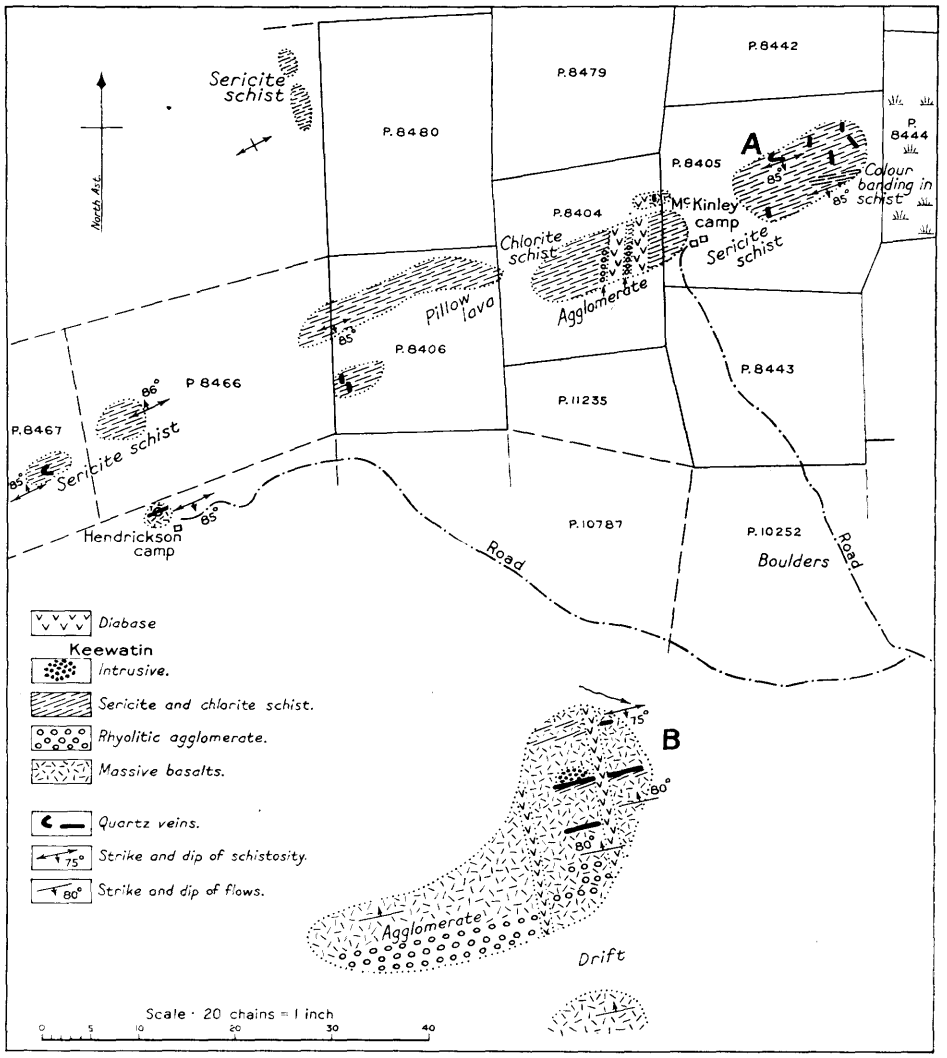


Fig. 2—Sketch map showing the geology of the McKinley-Molesky claims and the area to the south, Bristol township.

trace out the tops of flows and thus determine the location of anticlines and synclines, some broad conclusions have been reached by the use of certain structural principles, such as the relation of fracture and flow cleavage to bedding, the attitude of drag folds and their relation to major folds, principles developed by Van Hise and Leith.[1]

[1]C. K. Leith, Structural Geology, H. Holt & Co., New York, 1923.

It has been shown by Burrows in his reports on the Porcupine gold area that the major structures of the Keewatin and Timiskaming in Tisdale township pitch eastwards, and it has been suspected that along the strike of these formations in Bristol a reversal of pitch would be found. That the folds in the latter township do pitch for the most part to the west, at an angle of approximately 30 degrees, is shown by the following evidence:—

1. About half a mile south of the 21½-mile post of Niven's base line, interbedded rhyolites and basalt are closely folded. The rhyolites in part lie on the nose of a syncline and pitch west.

2. In the vicinity of the McKinley-Molesky claims, P. 8,404 and P. 8,405, Bristol, highly schistose outcrops of lavas occur. In these, numerous small quartz veins appear as drag folds, pitching west at approximately 30 degrees (see Figs. 2 and 3). Across the schist, bands of a dark-green colour, suggestive of original bedding (as the lavas behaved like sediments), cut the schistose cleavage at an angle of 17 degrees. The relations are fully shown in the diagram of Fig. 3. To the south, less schistose lavas dip steeply north. All of these

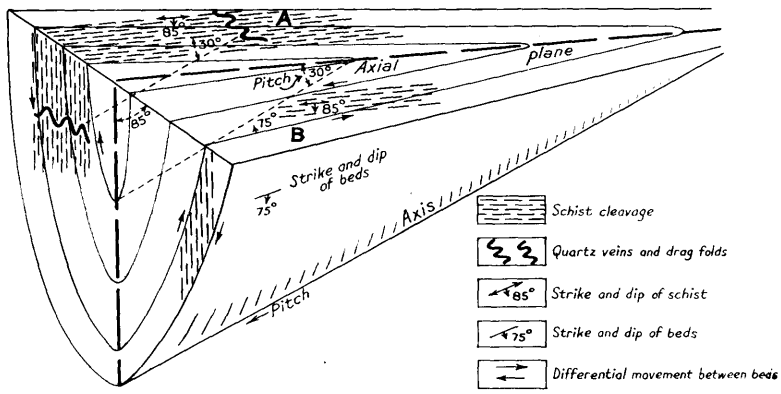


Fig. 3—Diagram showing structure of a westward-plunging syncline as indicated by the relation of cleavage and drag folds to lava beds in the vicinity of the McKinley-Molesky claims, Bristol township. The location of points A and B is shown in Fig. 2 (page 18).

facts point to a syncline pitching westward, the axis of which lies somewhere between the outcrops. The drag-fold nature of the veins might be questioned as not being characteristic of the major fold, on the basis that they are of later age than the folding. At some points these veins are brecciated, suggestive of folding. At others they are coarsely crystalline, but the folding movements would probably be sufficient to recrystallize for the most part any brecciated quartz. Even if the veins did replace previously existing drag folds, which is possible, the latter must certainly have been related to the major folding.

3. On claim P. 11,388, Bristol, large drag folds of quartz veins appear in green Keewatin schists and again pitch westwards. The veins are much thicker and wider at the crests and troughs of the folds than on the limbs.

4. In Timiskaming, sediments on claim P. 4,493, fracture cleavage crosses the bedding, striking N. 60° E. and dipping 40°-50° N. The sediments strike at E. 12° S. and dip at 75°-80° N. The relation of cleavage to bedding indicates

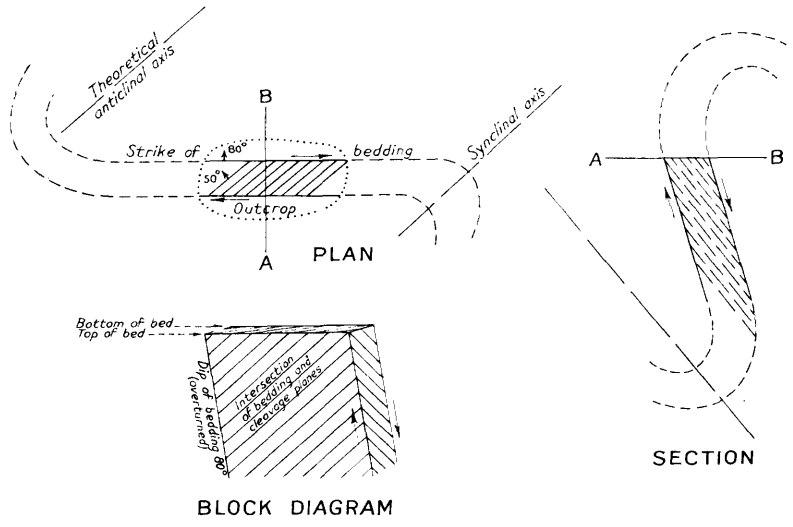


Fig. 4—Plan and section illustrating relation of cleavage to bedding in Timiskaming sediments on claim P. 4,493, Bristol township, and also the interpretation of the neighbouring structure. The strike of the beds is S. 78° E.

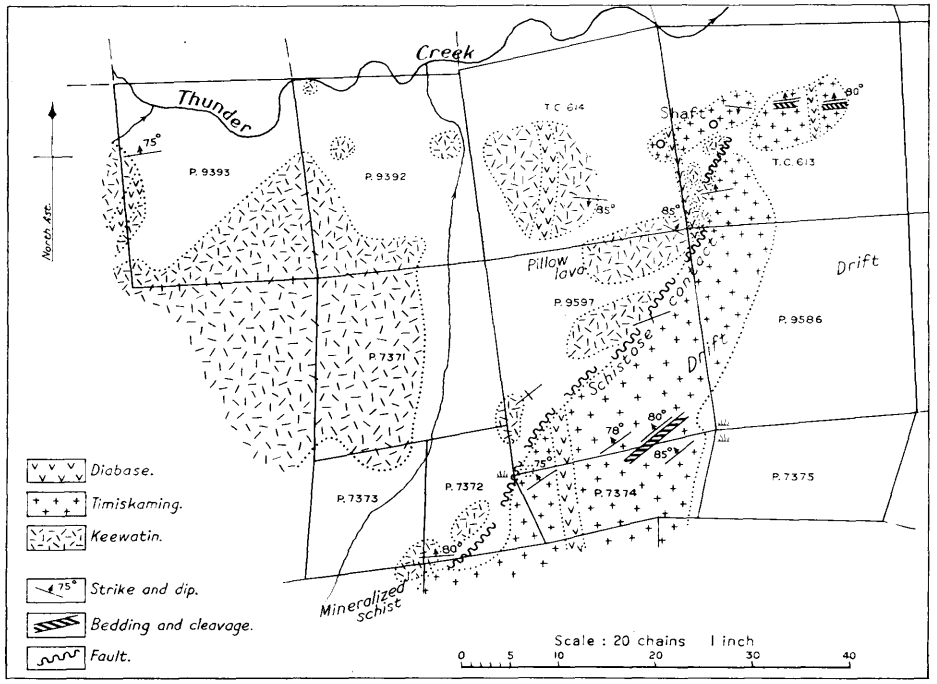


Fig. 5—Plan showing geology of claims in the vicinity of the McAuley-Brydge property, T. C. 613, Bristol township.

that the outcrop lies on the south limb of an overturned anticline pitching west, or the north limb of an asymmetrical syncline which may still exist to the south, where a heavy cover of glacial drift masks the structure (Fig. 4).

The structure of the large belt of Timiskaming sediments outcropping in the vicinity of the red granite stock is considerably disturbed and complicated by the intrusion and by faulting. The sediments for the most part strike N. 60°E. and dip 80°N. Reversals of dip and a change to an easterly strike occur at the northeast end of the outcrop, where cleavage and drag-folding suggest an anticline now pitching east. The beds are cut off on the west by a northeastward-trending fault zone along which Keewatin greenstones are brought up against the sediments. The highly schistose contact is not well defined as a fault. Lateral movement along the fault, however, is indicated by the schistosity, the west side having moved southwest. The schistose band of sediments on which the McAuley-Brydge shafts were sunk must be either faulted off to the west or folded back on itself, as Keewatin schists occur along the strike (Fig. 5).

The faulting in this area may possibly be related to the Algoman intrusive. Around this stock and to the east along the south township line, the sedimentary rocks are highly disturbed and no definite structure could be determined.

In Ogden, on claim P. 8,381, thin-bedded, slaty, tuff-like rocks are drag-folded and pitch steeply east, suggesting a similar pitch for the major structures. The location of synclines and anticlines in this township could not be determined on account of the schistose nature of the Keewatin.

Gold Deposits

Veins

In Ogden, Bristol, and Carscallen, gold has been found in mineralized veins in the vicinity of Algoman acidic intrusives. Promising values have been obtained at several places, but sufficient development work has not been done to prove the presence or absence of economic deposits. Where mining operations have been carried on, no large deposits of value have yet been discovered. At one of these localities (McEnaney), however, the most promising geologic conditions, as interpreted from surface geology alone, do not seem altogether fulfilled, and they should not be taken as a measure of the possible success to be attained in other localities.

The veins commonly occur in schistose zones in either Timiskaming sediments, Keewatin lavas, or the intrusives themselves. Some occur as replacement bodies, as instanced by several large quartz "blow-outs" in Bristol. Others are definitely fissure fillings, which are well exemplified in the red granite stock of Bristol. This was much shattered, probably in the later stages of cooling.

Veins situated far from any intrusive mass are not well mineralized, if at all. Those in rhyolitic flows likewise seem barren. Of two which occur in gabbro, one is heavily mineralized with sulphides, the other not. The former occurred in a brecciated zone and near a quartz porphyry intrusive. In Ogden, in rusty-weathering carbonate rocks, reticulated quartz veins are of common occurrence (see photograph on page 10).

The gold occurs in its native state or with pyrite. In the Bristol quartz porphyry stock, veins carry visible gold and a steel-grey metallic mineral, which is probably a telluride. Specimens of this mineral were too minute and disseminated for a determination, though assays are reported to have shown both gold and silver. Pyrite, chalcopyrite, and occasionally arsenopyrite

are present in the veins or wall rock. Chalcopyrite is common in veins near and in the grey granite of Carscallen. Arsenopyrite was found in Bristol in the veins of the McAuley-Brydge and Hubert properties. Galena and pyrite are sparingly present in calcite quartz veins of the Greenberg-Goldstein claim, P. 11,388, Bristol.

Minerals associated with the quartz veins are carbonates, calcite and ankerite, tourmaline, and locally a dull-green chlorite. Sericite may also be present where there has been some movement in the veins.

Favourable localities for more intensive prospecting are in the vicinity of the larger Algoman intrusives. Some work has already been done around the contacts of granite in Carscallen and Bristol, and has revealed veins carrying some gold. The contact of Timiskaming sediments and granite should be carefully examined, as elsewhere these rocks have had a marked influence on ore deposition.



Parallel quartz veins in rhyolite (Keewatin) near the 22-mile post, north Bristol line.

Where the contact of the intrusives with the country rock is not visible, as in central Bristol, a suitable and most economical method of locating it is by magnetic surveying. Sensitive dip needles will show a local attraction which is much greater over basic rocks than over acidic ones. The needles are effective, even though drift deposits of considerable thickness overlie the rocks, and have been used with some success by the Geological Survey of Wisconsin. The literature on this subject is not extensive, brief accounts being given by W. O. Hotchkiss[1] and H. R. Aldrich.[2]

In the intrusive granites and quartz porphyries, auriferous veins are not widespread, and the possibilities of finding economic deposits within these are not great. The gold as a rule is confined to veins in narrow schistose bands, which are of infrequent occurrence. The red Bristol granite is perhaps an exception to this, but most of the veinlets there are poorly mineralized.

[1]Wisc. Geol. Surv., Bull. No. 44.
[2]Econ. Geol., 1925; Trans. A.I.M.E., Aug., 1920.

Placer Deposits

Small placer deposits of gold have been found in Bristol at the mouth of Thunder creek and on the Redsucker river, and in Ogden on Paradis creek. These are situated in areas of heavy glacial drift, chiefly of sand with some clay, and in Ogden with some boulders. The placers have obviously been the result of local stream action. The rivers and streams of recent origin may have concentrated some of the widely scattered gold contained in the glacial sands and gravels through which they have made their channels.

Claims and Mining Properties

Ogden Township

McEnaney Gold Mines, Ltd. (P. 11,993, P. 11,994, P. 8,605, P. 8,606).— One outcrop of Keewatin rocks occurs in the centre of this property. It consists of greenish-grey altered Keewatin volcanics, parts of which are still massive ellipsoidal lava, the rest being schistose. The rocks strike approximately east and dip steeply north. The southern half of the outcrop is highly altered to carbonate schists. The nearest intrusive of Algoman quartz porphyry is on claim H.R. 1,219, half a mile to the southeast.

Quartz veins occur in the central and eastern portion of the outcrop. Near one of these a shaft has been sunk. Traced east from here, the vein cuts across the schistosity at a low angle. Sharp offsets, due apparently to pre- and post-vein faulting, occur at two places. The veins range from a few inches to 18 inches in width. At a pit on the northeast, a schistose zone is impregnated with quartz over a width of 25 feet. Of this, 16 feet are of quartz, the rest schist. The veins may be traced here for a length of 160 feet. The wall rock is well mineralized with pyrite. Carbonate and some tourmaline are associated with the quartz. Samples of the main vein found on the mine dump carry native gold in banded, greyish-blue quartz.

This property was first held by the Hollinger Reserve Mining Company, incorporated in 1911. In the second report by A. G. Burrows on the Porcupine gold area, carbonate rocks and dark-grey ankerite from the vein are described. In 1914 the property was worked for a portion of the year, and prior to 1922 the shaft had been sunk 300 feet and three levels opened up. In the fall of 1922 the mine was reopened. A winze was sunk to the 600-foot level by March, 1923, and 610 feet of drifting and crosscutting, and 3,400 feet of diamond-drilling was done.[1] Crosscuts were driven on the 200- and 600-foot levels, and diamond-drilling on the main vein explored 1,500 feet across the formation to a depth of 900 feet.

According to Corkill, the main vein on the 200-foot level occurs in a faulted zone 600 feet long. It is cut off at the west and east by faults. "Quartz in this vein ranges in width from three to four inches, averaging 15 inches for the entire length." Along the vein the rock is greatly schisted and mineralized with pyrite, which is practically barren. Blue quartz stringers, two to three inches in width, carry native gold.

[1]For this and the following information, the writer is indebted to A. E. Osler & Co., Toronto' who made available a report by E. T. Corkill.

On the 600-foot level no veins were encountered carrying 20 cents per ton in gold, except the vein at the bottom of the winze which carried $1.26 per ton in gold across a width of six feet at the 600-foot level, and 20 cents at the 850-foot level.

Diamond-drilling revealed many well-schisted bands mineralized with pyrite, but carrying only 20 cents in gold per ton. The only promising rocks were the blue quartz stringers, and these are too small to be mined profitably. Reports that the ore dump on the surface ran $8.00 per ton in gold were not verified, assays of $2.26 to less than $1.00 being obtained.

Hayden Gold Mines, Limited (H.R. 937-39).—The Hayden Gold Mines, Limited, was incorporated in 1912, and in 1915 sank a shaft near a 15-foot quartz vein in carbonated schists.



Quartz vein, to the south of the Hayden shaft, in which are many inclusions of quartz porphyry.

The outcrops consist of schistose and carbonated basic Keewatin lavas, into which small dikes and a stock of Algoman quartz porphyry have been intruded. Keweenawan olivine diabase cuts diagonally northwest across the schists. Immediately to the south of the shaft, a 15-foot massive quartz vein containing abundant, partly assimilated inclusions of quartz porphyry strikes east and dips about vertically. This vein may be traced intermittently approximately 10 chains to the east of the shaft and 20 chains to the west. At a point 15 chains west of the shaft, a second vein of similar dimensions appears, but is drift-covered to the west. North of this a small mass of quartz porphyry intrudes highly carbonated, rusty-weathering schists. On the surface these veins and the adjoining wall rock are only sparingly mineralized. Samples from the mine dump, however, show schists mineralized with pyrite in disseminated form and as large cubes. A large amount of quartz thoroughly impregnates the rusty carbonate rocks, in which the larger veins range from three inches to a foot in width. They are mineralized with sulphides and carry some calcite. Tourmaline, pyrite, and small amounts of chalcopyrite are present.

While no underground operations were in progress at the time of the writer's visit in 1925, it is learned from the reports of the mining inspectors' of the Department of Mines, that the property was under operation at different times, with periods during which it was closed down. By 1922, a two-compartment shaft had been sunk to the 500-foot level and lateral work done at the 100-, 200-, 300-, and 400-foot levels, and also some diamond-drilling.

St. Paul (H.R. 1,219, H.R. 1,220).—The largest quartz porphyry intrusive observed in Ogden outcrops on these claims. Only the northern contact with Keewatin greenstones is exposed, where the latter have been invaded irregularly by the intrusive. Post-intrusive movements are indicated by brecciation of some of these porphyry lenses and by the foliation of the greenstones (see photograph on page 13). The porphyry is highly altered to sericite and fine quartz, probably due to hydrothermal action.



Looking north to the Hayden shaft, Ogden township. Quartz veins impregnate rusty carbonate schist on the side of the hill.

Quartz veins, one and a half feet wide, occur in the porphyry away from the contact, but are poorly mineralized. Along the north contact small quartz stringers penetrate the greenstone, which is mineralized with pyrite. Two shallow pits have been sunk on the north edge. If any further work is contemplated, it should be done along the contact.

Claim P. 7,248.—On a small outcrop of carbonated, greyish pillow lava, several quartz veins, one and a half to three feet in width have been opened up by two pits. These are mineralized to a small extent with copper and iron pyrites.

Flynn (P. 6,984).—A small outcrop of foliated green schist on this claim is cut by 6-inch stringers of quartz. These are reported to have assayed $1.60 per ton.

Claim T.R.P. 590.—On this claim a 15-foot band of rusty-weathering carbonated schist, extending for 150 feet east and west, has been heavily mineralized with pyrite. The mineralization resembles greatly that in several

bands of iron formation farther south. A shaft, 30 to 40 feet deep, has been sunk on the vein.

Claims T.C. 604, T.C. 603.—On a small outcrop south of the No. 4 post of claim T.C. 603 are several irregular quartz veins in mineralized rusty carbonate schist. These are interbanded with finely crenulated, dark-grey schist. Lenses of mineralized carbonate schist attain a width of 15 feet. A 100-foot tunnel has been driven across the strike of the schists, passing through a small carbonate zone. This failed to encounter any large veins.

Porcupine Gold Quill (H.R. 1,271, H.R. 1,179).—A two-foot quartz vein occurs in rusty grey sericitic schist and greenstone, on claim No. 1,179. It extends for a length of 150 feet and dips steeply south. The wall rock has been mineralized with large cubes of pyrite. A shallow shaft has been sunk on the vein, and 200 feet of diamond-drilling have been reported as completed. The cores are said to have yielded fair assays, although no native gold was observed.

Owen Acme (T.R.S. 1,164, T.R.S. 1,169, T.R.S. 1,174, T.R.S. 1,175, H.S. 840).—Claims held by this company of which Harry Owen, South Porcupine, is in charge, cover a portion of the large rocky ridge a mile and a half southeast of the McEnaney Mines.

The rocks consist mainly of partly schistose Keewatin lavas. Acidic and basic lavas are present in about equal proportions. Associated with the latter are a few bands of iron formation which have in places been brecciated and mineralized with pyrite. Along the northern boundary are rusty-weathering carbonate schists containing abundant chromiferous mica. These are cut by narrow quartz veinlets with which are associated ankerite and other carbonates. Sulphides impregnate the green schist and quartzose bands.

Immediately to the south of the carbonate rock and at several other localities are narrow bands of sericite schist, whose association with the carbonate rocks and sulphides suggests an intrusive origin. They are probably dikes of Algoman age. On claim T.R.S. 1,175, a larger dike of porphyry, 60 to 75 feet wide in places, truncates green and grey Keewatin schists or follows along their strike. A short distance to the south of this is a reddish porphyry dike of aplitic character, consisting of orthoclase, albite, and quartz. This is cut by a stockwork of lenticular quartz veins in which small amounts of tourmaline occur.

Assays showing small values in gold have been obtained in many of the veins on this property. Galena is associated with pyrite and ankerite on claim T.R.S. 1,164. Narrow stringers in the green schist of claim T.R.S. 1,164 have been reported as giving good assays, but they are of irregular occurrence. Sufficient development work has not been done to prove any deposits of value. Six pits have been sunk on lensing veins ranging from one to three feet in width. Three shot drill-holes have been drilled in the northern carbonate band.

Claims P. 7,370, H.R. 871, and T.R.S. 1,114.—These three claims contain bands of well-mineralized iron formation varying in width from 20 to 80 feet. That in claim No. 7,370 is the largest. The iron formation consists of red and white cherts with iron oxides, hematite, and magnetite. The formations have been excessively brecciated, and many 3-inch quartz stringers of short and irregular lengths are present. The fragments and cementing material have been well mineralized with pyrite and some chalcopyrite, the former occurring often as coarse cubes. Assays across the band on claim P. 7,370 have been reported as yielding good assays.

On claims H.R. 871 and T.R.S. 1,114, the iron formation has been folded and curves from the northwest to the southeast. Where an old shaft has been sunk on the formation, solid pyrite, an inch or more in thickness, occurs along with more disseminated sulphides.

Pann Porcupine (P. 7,595, P. 7,600, P. 7,602, P. 7,615, P. 7,618, P. 7,620, P. 7,621, E.D. 256, E.D. 257, E.D. 260).—Little work has been done on these claims in the last few years, and a heavy growth of young jackpine over the rocky ridges made the mapping of outcrops and the finding of prospects difficult.

The geology is very similar to that found on the Owen Acme claims to the east. Eastward-striking Keewatin lavas predominate, and acidic, rhyolitic phases of these occur in many places. Bands of iron formation are associated with the volcanics. Several dikes of Algoman quartz porphyry intrude Keewatin schists on claims P. 7,621, P. 7,600, P. 7,602, and P. 7,595. These are generally schistose and seem to have altered the adjoining rocks to rusty carbonate schists. Reticulated quartz veinlets are associated with the latter, but for the most part are poorly mineralized.

On claims E.D. 256 and E.D. 257 a fairly large intrusive of Haileyburian serpentine cuts up through green Keewatin schists. Two chains to the south of the contact, in carbonated schist, a lensing quartz vein 400 feet long and one to two feet wide occurs, carrying sparse sulphides and some tourmaline. A 20-foot pit has been sunk on this vein. No outcrop of porphyry was observed in this vicinity. Whether contact action of the Haileyburian intrusive and that during its later alteration to serpentine might account for this vein is not known.

Ostrosser (P.P. 21, P. 10,964).—South of the transmission line on these claims, carbonated pillow lavas, fragmental rocks, and a slaty tuffaceous rock are followed on the south by rusty-weathering grey carbonate schist. Two quartz veins occur in the latter, cutting the schist at a low angle and varying in width from one to three feet. These have many grey inclusions which have been largely replaced by quartz. They suggest porphyry inclusions. Small fresher quartz veinlets cut across the larger veins. The schist carries some sulphides, but the major veins are only slightly mineralized.

Langmuir (H.S. 805, H.S. 956-64).—The Langmuir property includes a block of ten claims lying west of Mountjoy creek and the McEnaney Mines. Five small outcrops of Keewatin rocks occur on claim No. 421. This group of claims was formerly held by Worthington, who still retains an interest.

The geology of the area is fairly simple. The few outcrops consist of massive to schistose Keewatin lavas which have been highly altered. The central outcrop consists of typical rusty-weathering, greenish carbonate rock. In this, several quartz veins cut across the eastward-striking schists at N. 40° E. The more westerly of these is vertical at the surface, but at depth dips steeply east. Seventy feet to the east another vein dips at 75° W., and smaller veins between stand vertically. Numerous stringers of coarse and glassy quartz lead off from the hanging wall of each vein. The adjacent wall rock is fairly well mineralized with pyrite and chalcopyrite, and native gold has been reported. The veins seem to be a combination of fissure filling and replacement. Carbonates also occur with the quartz, but the carbonization of the wall rock seems to have preceded the injection of the quartz.

Near the eastern line of this claim, another mineralized vein occurs in massive, chloritic Keewatin basalt. The vein strikes N. 75° E., dips about

vertically, and is well mineralized with cubes of pyrite. Carbonates are intergrown with the quartz of the veins, and small quartz stringers cut across both carbonates and older quartz. Some sericite is present with the quartz.

In 1914-15, a shaft was sunk on the most westerly vein to a depth of 70 feet. Good values in gold have been reported from this vein. In 1922, the shaft was deepened 45 feet. On the most easterly vein a shaft was sunk to a depth of 60 feet in 1922. Free gold and galena have been reported in the quartz and carbonates, though no samples showing these could be found on the dump. Near the north line of claim H.S. 805, an old shaft was sunk on drift to an unknown depth. This is now completely filled in with mud.

Ogden Porcupine Gold Mines, Limited (T.R.P. 2,537, T.R.P. 2,524-26).—On these claims the only rock outcropping is a 50-foot quartz diabase dike striking north. It is exposed on the east line of claim T.R.P. 2,537, and extends for a length of three chains north of the No. 2 post. Evidence of trenching on this outcrop still exists, but no fragments of any other rocks or veins were found along the old workings.

Claims P. 3,786, P. 3,785.—These claims are crossed by the transmission line in the southwest part of Ogden. On claim P. 3,785, two 15-foot bands of green, rusty-weathering carbonate schist with a chromiferous mica occur in dark Keewatin greenstones. Through the carbonate rocks, lensing quartz carbonate veins occur. The adjacent schists are impregnated with disseminated pyrite, similar to the Owen Acme veins, which are almost along the strike. The veins have many large inclusions of schist which are also mineralized. Tourmaline was observed with the quartz, but no native gold. Two pits have been sunk and some trenching has been done on the property.

White (T.R.P. 2,014-16).—These claims are situated on the east bank of the Mattagami river in central Ogden. Outcropping in the centre of the claims are Keewatin green schists, partly carbonated. Cutting and in places paralleling the strike of the schists is a narrow dike of quartz porphyry of Algoman age, with a width ranging from 15 to 20 feet. This has been foliated and schisted but still contains occasional eyes of quartz. Near the east end of the outcrop, it swings sharply north for three chains and thence east to the edge of the outcrop. Red, banded iron formation occurs on the northwest.

A narrow 3- to 10-inch quartz vein follows along the south contact of the porphyry dike and penetrates irregularly into the dark Keewatin greenstones. On this vein a shaft 15 to 20 feet deep has been sunk. The greenstone on the south of the dike is quite schistose, carbonated, and rusty weathering. It is mineralized with pyrite in cubes and in disseminated form. Both carbonates and sulphides seem distinctly related to the intrusion of porphyry. Small stringers of quartz also cut the iron formation on the north and are mineralized with pyrite.

Near the point where the dike swings north, a small bleb of feldspar porphyry, with prominent feldspar laths, cuts up through and includes many fragments of greenstone. It is crossed by numerous small fractures filled with quartz, carbonates, chalcopyrite, and pyrite. The mineralization, however, is not extensive.

On the south of the outcrop, trenches and pits have disclosed a zone of quartzose Keewatin greenstone with quartz stringers carrying pyrite and chalcopyrite. Calcite rhombs form part of the vein material. Close to this, the Keewatin has been metamorphosed to a medium-grained rock containing hornblende, titanite, chlorite, and andesine.

Bristol Township

McAuley-Brydge (T.C. 612-14).—Gold was discovered on these claims in 1911. The occurrence is decribed by Burrows[1] as follows: "Here the gold occurs in a sheared zone of altered sedimentary rock, with included quartz stringers." "Arsenical pyrite occurs in quantity in the quartz veins . . . ."

The general geology of this area is shown in Fig. 5. The Timiskaming sedimentary schists in which the veins occur strike east and locally dip south. Along the strike to the east, where the sediments are less schistose, a northerly dip is apparent, and drag folds show an easterly plunge. Massive, dark-green, highly chloritized Keewatin rocks lie to the south of the schist, and around them on the east and south are more sediments dipping steeply north. The contact here between Keewatin and Timiskaming is schistose and probably faulted. At a little less than a mile south is an intrusive stock of red porphyry granite. The mineralization may be related to this intrusive.

Shafts have been sunk on mineralized veins on claims T.C. 613 and T.C. 614, near a 37-foot diabase dike which strikes north across the schist. The workings have long since been burned over and the pits filled with water, so little data are now available. About six chains west of the sedimentary schists, Keewatin volcanics occur along the strike, so it is apparent that the sediments must be either faulted off or folded back on themselves.

Claims in Vicinity of Red Porphyry Stock, Southwest Bristol.—To the north of the Algoman stock of red granite porphyry on claim P. 7,372 and to the southwest, a schistose band of greenstone near the contact with Timiskaming sediments is heavily mineralized with sulphides. They are reported to carry some gold. The greenstones here are intruded by small stringers of red felsite, containing orthoclase, microcline, and quartz. Quartz stringers are abundant. The same belt of schists outcrops near the No. 3 post of claim P. 9,587.

Within the granite stock, quartz stringers are very abundant and locally carry sulphides and often gold.

The geologic structure of this portion of the area is a favourable one for the deposition of ores, if these were available and abundant at the time of the granitic intrusion. The contact of the granite and sediments, and the sheared zone extending northeast between the greenstones and the Timiskaming, are areas worthy of careful prospecting.

Wright (P. 10,627-29).—To the east of Wright lake in the small stock of quartz porphyry are two partly schistose zones striking east. In these are quartz veins ranging up to 150 feet in length and from a few inches to two feet in width. The only other rocks in the vicinity are later dikes of quartz diabase. Native gold occurs in the quartz veins along with small pockets of pyrite and chalcopyrite, and a finely disseminated steel-grey mineral with one good cleavage. Grab samples are reported on assay to carry good values of gold and some silver.

Locally the quartz in the veins has been brecciated to a fine sugary type with sericite, which is cut by fresher quartz. The shear zones are not extensive, but too much of the porphyry is covered with drift to draw any definite conclusions. Trenching around the outcrop has not yet revealed the contact, to which further attention should be given.

Hubert (P. 8,518, P. 8,527, P. 8,786, P. 11,221).—On these claims several quartz veins occur in relatively narrow schistose bands between massive Keewatin lavas and agglomerates. They strike east and dip steeply north or south.

[1]A. G. Burrows, Ont. Bur. Mines, Vol. XXI, pt. 1, p. 205; Vol. XXIV, pt. 3, p. 36.



Quartz vein carrying native gold in quartz porphyry, east of Wright lake, Bristol township.



Quartz stringers following the schistosity of Keewatin greenstones, Hubert claim, central Bristol.

The main showing is on claim P. 8,527, where a pit has been sunk on two lensing quartz veins, 100 feet in length and 4 to 8 inches wide. The quartz is greyish blue and in places banded. It carries pyrite, chalcopyrite, arsenopyrite, and native gold. The veins cut across a black graphitic slate or schist which is well mineralized over a width of about three feet. The wall rock is in part silicified and slightly carbonated, and carries abundant pyrite and fine needles of arsenopyrite. Probable continuations of this vein are found to the west where it narrows and carries free gold.

North of the Whitesides road, pits have been sunk on similar veins occurring in schistose bands. Some of these have been drag-folded. Quartz and poorly mineralized schist attain in places a width of six feet. Some native gold is reported occurring with the quartz. The geology of the northern claims is shown on Fig. 2. Small andesitic or dacitic intrusives occurring near one vein are probably pre-Algoman in age. The only other intrusives are of quartz diabase.

The outcrops on this property are approximately a mile west of the quartz porphyry stock, and along the strike. The veins and minerals found are probably genetically related to this intrusive, the westward extent of which is not known.

McKinley-Molesky (*P. 8,404-6*).—Occurring in a highly schistose band of Keewatin rocks, the structure of which has been dealt with above, are many quartz veins varying greatly in width, but averaging 3 to 4 inches. Most of these are on claim P. 8,405, where they occur commonly in a grey sericitic schist which has been mineralized with sulphides. Nearly all of the veins have a drag-fold structure and are thicker at the crests and troughs than on the flanks. These small folds pitch westward at approximately 30 degrees. Hence trenches across the schist soon pass through the veins. Determination of their extent along the pitch to the west has not been made. Their projection in this direction will best be understood by reference to Figs. 2 and 3.

The drag-fold shape of the veins may be due to either folding of the veins or replacement of folds in the schist. Local brecciation of the quartz suggests the former, though this may easily have occurred after replacement by small later movements. Since Algoman porphyry is in places sheared and schistose, the veins may be of this age (Algoman). If so, the later shearing movement followed along the general strike of the pre-Algoman folding, probably accentuating the previous deformation.

Associated with the quartz in the veins are carbonates, tourmaline, and a dull-green, chloritic mineral. Pyrite, chalcopyrite, and native gold occur in the veins and mineralized wall rock. Assays have been made of channel samples across the mineralized schist, and show a wide range of values, going as high as $17 per ton per foot in gold. Further development work is planned for 1926; in any drilling campaign, the westerly pitch of the veins should be considered.

Hendrickson (*P. 8,466-68*).—On these claims, sericitic and chloritic schists, similar in every respect to those of the McKinley claims, contain several small quartz veins in which sulphides and some native gold occur. The veins are of drag-fold shape, but pitch more steeply westward than those to the east. A shaft was sunk on claim P. 8,468 in more massive Keewatin greenstone, in which a few narrow quartz stringers with sulphides are present.

Toner-McCormick (*P. 8,511, 8,508*).—In a greenish-grey, rusty-weathering schist, partly sericitic and partly chloritic in composition, there are several veins ranging in width from two to six inches, striking N. 68° E., and dipping

steeply north. These are often closely spaced. Associated with the quartz is tourmaline in fine radiating needles. The schist is mineralized with sulphides of iron and copper, but no native gold has yet been found. The belt lies on the strike of the McKinley schist zone, to which it appears to be closely related. No intrusive rocks of Algoman age occur near by.

Wright (P. 10,786, P. 8,483).—On the line dividing these claims is a small outcrop of schistose, quartz-feldspar porphyry which shows no certain evidence of volcanic origin, yet differs considerably from less schistose Algoman porphyry in its higher content of ferromagnesian constituents. It resembles greatly rhyolitic porphyries of Keewatin age which are infolded with greenstones to the north and east.

Quartz veins fill fractures in the rock and cut across the schist, irregularly replacing it. Both schist and quartz carry sulphides, and gold has been reported.

Claim P. 9,151.—Outcrops of Keewatin quartz porphyry rhyolite are here cut by quartz diabase dikes. At several places on the claim, pits have been sunk on small quartz stringers in the rhyolite, which is poorly mineralized, a feature common to this type of rock.

Greenberg-Goldstein (P. 11,388, P. 11,385, P. 11,397, P. 11,396).—On claim P. 11,388 in a belt of schistose Keewatin greenstones, several quartz-calcite veins occur as drag folds. Quartz and calcite also impregnate the schist in fine stringers. The veins carry pyrite and galena in small amounts. The larger veins, which are lenticular, are sometimes six inches in width. Near them is a small dacitic dike cutting the schist. It contains eyes of quartz, with plagioclase feldspars, oligoclase andesine, zoisite, epidote, and iron oxides, and is probably of pre-Algoman age. During the summer of 1925, the property was prospected by trenching.

Scobell (P. 9,649).—In the centre of this claim a large mass of quartz, 85 by 50 feet, occurs in Keewatin greenstones derived from fragmentals and ellipsoidal lavas. The quartz is largely glassy and contains some sericite. There has been little mineralization in the vein material. Reports were current in 1925 that this body of quartz was to be drilled, but no work had been done up to the autumn of that year.

Toner (P. 8,544, P. 8,545).—On these claims are small outcrops of rusty-grey sericite schist, almost identical with those on the McKinley and Hendrickson claims to the northeast. The schists occur in bands 10 to 20 feet wide and grade into dark greenstones and massive basaltic lavas. Small quartz stringers show drag-fold structures and pitch west at 35 to 40 degrees.

Cutting the schist is a 2-foot dike of a dark-grey, andesitic rock. Massive lenses in the schist consist largely of carbonate and sericite flakes with brown iron oxides. Quartz is present in chalcedonic form, but is largely secondary. None of the rocks correspond to Algoman intrusives. The schistose bands are somewhat mineralized with pyrite, but no gold assays of value have yet been obtained.

McDonell (P. 1,243, P. 1,410).—To the south of McDonell lake lies a large outcrop of schistose Keewatin rhyolite in which quartz eyes are abundant. Small quartz veins appear on claim P. 1,243 and are accompanied by a slight mineralization. A shaft was sunk on these some years ago, but has long since been abandoned.

Hubert (P. 8,504).—Along the creek draining Waterhen lake, small outcrops of partly schistose greenstones contain several small stringers of quartz. The schists locally contain coarse and fine cubes of pyrite, and are somewhat carbonated. They are reported to have yielded gold on assay, and small amounts of galena have been observed.

Carscallen and Denton Townships

Hazelton Porcupine Gold Mines, Ltd. (P. 8,751, P. 8,775, P. 11,153, P. 11,152, P. 11,936, P. 10,740, P. 10,739, P. 11,468-72, P. 11,678-80, P. 11,765-67, in Denton; and P. 10,998 in Carscallen).—Since 1911 gold has been known to occur in the vicinity of the grey granite intrusive which outcrops along the south line of Carscallen west of Mahoney lake. Discoveries have been made both in the granite and along the eastern contact with the Keewatin. In 1922 the Hazelton Porcupine Gold Mines Syndicate was formed by Jas. Hazelton. In 1925 the Hazelton Porcupine Gold Mines, Limited, took over the assets of the syndicate together with several additional claims. The property now held includes 20 claims containing over 800 acres in Denton.

Pits were dug on the various discoveries in the early days, and in 1918 and in the autumn of 1925 extensive diamond-drilling was done on this property.

The claims cover a portion of the contact between the large intrusive of grey biotite granite and Keewatin rocks. The contact curves to the southwest in Denton through claims P. 10,739, P. 10,740, and P. 11,153, but is exposed at the surface only to the north in Carscallen. Near vein No. 4, claim P. 11,152, the Keewatin rocks are highly schistose and contain small bands of light-grey, partly schistose granite, as well as some cherty iron formation which shows small folds cut at right angles by a northeasterward-trending cleavage. Diamond-drilling in this vicinity has penetrated granitic rocks, so it is apparent that the intrusive, or offshoots from it, extends farther east below the surface.

Within the granite a few shear zones occur, in which well-mineralized schist carrying gold is present.

Vein No. 1, situated six chains west of Mahoney lake on claim P. 8,751, strikes approximately N. 20° E. and dips steeply east. No definite quartz vein can be traced through this zone of schist, but small stringers of bluish quartz and rusty to reddish carbonate are abundant. Thin sections of specimens taken along a similar shear zone to the west show a complete gradation from altered massive biotite granite to sericite schist with eyes of blue quartz. The vein or shear zone has a length of about 150 feet, pinching out to the north and south and extending a short distance into Carscallen, on claim P. 10,998. Diamond-drilling under the outcrop of this vein, for a distance of 300 feet at an angle of 57 degrees, is reported to have cut mineralized sections with quartz and tourmaline which yielded some gold on assay. The width of the zone on the surface ranges from one to five feet.

Outcropping near the east shore of Mahoney lake in Denton is a slightly mineralized and schistose zone, which has been drilled from the west and cut at a vertical depth of 145 feet. It has a width of four to six feet.

Vein No. 2 outcrops on claim P. 10,739 near the southwest corner. It consists of an eastward-trending shear zone, eight feet in width and dipping steeply north. Massive altered granite occurs on either side. A shallow pit

and shaft on this vein exposed well-mineralized lenses carrying abundant chalcopyrite in which are a few cubes of pyrite. A diamond-drill hole started 125 feet due north of the shaft and drilled at 60 degrees south cut heavily mineralized schist and quartz. The core on assay gave average values of $1.28 in gold per ton over eight feet, 20 cents over five feet, and 64 cents over seven feet.

Veins Nos. 4 and 5 occur in a 15-foot band of Keewatin schist to the southeast, on claim No. 11,152. This band includes light-grey sericitic to dark and slaty schists. No definite vein system could be seen at the surface at the time of the writer's visit. Portions are well mineralized with sulphides, pyrite, chalcopyrite, and pyrrhotite. Three holes, totalling 905 feet in length, have been drilled across these veins. They are reported to have encountered several mineralized zones of schist, bands of feldspar porphyry (a phase of the granite), and a graphite seam or fault mineralized with pyrite, one of them ending in grey granite or granite porphyry. From the drill-core data, and assuming that the veins are approximately vertical, vein No. 4 varies from 6 to 20 feet in width, and No. 5 from 9 to 14 feet. One hole pierced a mineralized zone from 204 to 336 feet. This would give an approximate width of 56 feet, suggesting the merging of the two veins. Assays over this zone, however, show rather low values in gold. Other assays, particularly from the graphitic zone, are reported to have yielded excellent results.

The granitic portion of the area does not offer very great opportunities for the discovery of large ore bodies. The mineralized shear zones are relatively small and discontinuous, and the greater portion of the granite is massive. The results of drilling the contact so far have not shown any economic deposit, but further exploration is planned for the coming year.

Beanland-Hurst (P. 11,538, Carscallen).—To the east of the grey granite contact on this claim, a narrow vein of quartz and calcite cuts directly across a northward-trending band of white and black, banded iron formation, which consists largely of finely crystalline quartz and magnetite and simulates a quartz vein. It has a width of 17 feet and lies between massive, dark-green basalt and a bed of pillow lava, in which angular fragments of the iron formation are embedded. A small trap dike, two to three feet wide, cuts across the iron formation, and near by a small tongue of highly altered sericite schist with eyes of blue quartz intrudes the pillow lava. The latter is closely related in composition to the neighbouring granite.

Assays of the cherty iron formation along the fracture in which the narrow vein occurs are reported to give good assays over a length of seven feet. Since the writer visited the area, discoveries of wire gold by Sydney Beanland have been reported.

The mineralization of the fractures in the cherty iron formation is apparently directly related to the granitic intrusive. In further prospecting, care must be taken to distinguish the white-banded iron formation from quartz veins. Changes of strike in the iron formation may indicate either folding or faulting, and prospecting for breaks in this rock may yield some results.

Claims on Granite in South Carscallen.—On several claims situated on the granite intrusive in southern Carscallen, small shear zones have been mineralized with sulphides. On these, pits and shafts were sunk in the early days, but were later abandoned. They do not hold much promise for large deposits.

Claim P. 2,117.—In the vicinity of this claim in western Carscallen, the contact between massive to schistose greenstone and the grey biotite granite is exposed. The contact is fairly sharp, but in places offshoots of granite penetrate short distances into the Keewatin schists. On the west shore of a small lake on this claim, 15-foot bands of cherty iron formation accompanied by magnetite have been severely fractured and drag-folded. They are locally heavily mineralized with pyrite. The formation strikes northwest and is bordered by green schists. A pit was sunk on this many years ago, but was abandoned. No large quartz veins were uncovered.

Hendrickson (P. 10,957, P. 10,959, P. 10,960, Eastern Carscallen).—Three outcrops of grey sericite schist occur on claims P. 10,959 and P. 10,960, striking N. 55° E. and dipping from 80° N. to vertical. Portions of the rock are massive and appear to be highly carbonated and silicified. They carry small quartz stringers mineralized with pyrite. All the rocks are of Keewatin age, and as far as the writer is aware no assays of importance have been reported. Considerable trenching has been done across the schists, and pits have been blasted out in the massive bands. The severely schisted portion appears to be a continuation of that traced through central Bristol.

Hughes (P. 10,680, P. 10,681).—A large mass of quartz porphyry, with rhyolitic phases, intrudes Keewatin greenstones in the northeastern part of these claims. Near a smaller dike of porphyry on the south, a vein in the greenstones carries abundant sulphides and smoky quartz.

Claim P. 7,507.—Rhyolitic quartz porphyry intrudes Keewatin greenstones on this claim. Veins occur in the porphyry and greenstone and follow the contact. They are mineralized with sulphides, and native gold has been reported.

Fournier (P. 10,604).—Immediately to the south and east of the 25-mile post on Niven's base line, quartz porphyry dikes intrude Keewatin greenstones. Finley[1] mentions the occurrence of native gold in quartz stringers, "which cut these rocks in an irregular manner."

Aberdeen Syndicate (P. 2,123-26).—Massive to slightly schistose quartz porphyry outcrops in the centre of these claims, where considerable trenching has been done without revealing any quartz veins or mineralized zones. Along the east line of claims P. 2,123 and P. 2,125, the porphyry intrudes gabbro, and to the east similar occurrences are found. Little mineralization appears to have accompanied the acidic intrusions, though a few brecciated contact zones were found.

Blackburn (Southwest of P. 2,122).—A heavy mineralized zone follows along the contact of intrusive quartz porphyry and gabbro, striking N. 25° W. It has a width of about 20 feet and outcrops on the west face of a 30-foot cliff. A 20-foot tunnel, driven in at the base of the cliff eastward, passed almost immediately into massive and non-mineralized quartz porphyry. The vein contains glassy, bluish quartz, partly brecciated and much jointed. The sulphides are pyrite and pyrrhotite. The workings are old, and no data about assays obtained are available.

[1]Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, p. 61.

Claims P. 1,154, P. 1,155, P. 1,233.—This group of claims covers the northern portion of a large gabbro intrusive in which inclusions of greenstone were found. The only showing consists of a 3-foot quartz vein extending for 100 feet south of the No. 2 post of claims P. 1,155 and on claim P. 1,233. Massive, coarse-grained gabbro lies on the west, and schistose altered gabbro on the east side. No mineralization of any extent accompanies the vein.

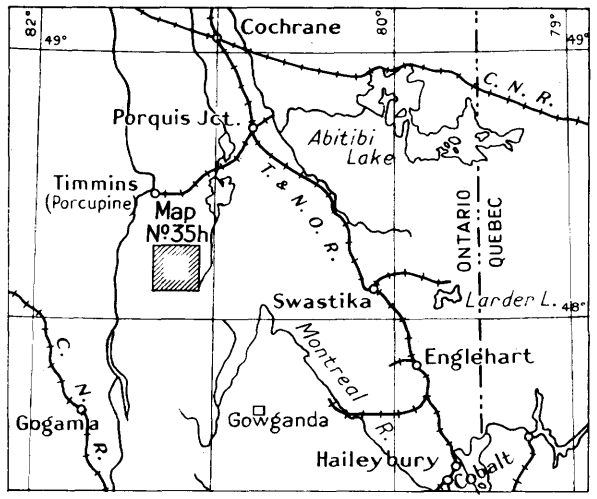


Fig. 6—Key map, scale 50 miles to the inch, showing position of the Redstone River Area.

Geology of McArthur, Bartlett, Douglas and Geikie Townships (Redstone River Area), District of Timiskaming

By E. L. Bruce

Introduction

An area of unmapped or only partially mapped country lies between the Porcupine and Matachewan map-sheets. The townships of McArthur, Bartlett, Douglas, and Geikie form one unit in this area, and the present report deals with the map covering them. Only the outlines of these townships have been surveyed, and in many places the severe forest fires of the last few years have completely obliterated the lines, excepting in the swamps. In Bartlett and McArthur townships, a number of mining claims have been surveyed. Compass and stadia traverses of the rivers, lakes, roads, and trails were made as a basis for geological mapping; the rock outcrops were located from them or by compass and pace traverses spaced at intervals of approximately a quarter of a mile. As far as possible, both ends of such traverses were tied to points which had been approximately located, and the paced distances were adjusted between the known points. The map is an attempt to show the consolidated rocks which actually outcrop, but some small exposures have no doubt been missed. In places where numerous small exposures occur close together, with evidently only shallow overburden separating them, all have been shown as a continuous outcrop. The field work on which the report and accompanying map (No. 35*h*—Redstone River Area) are based was done in the summer of 1925.

Acknowledgments

Able assistance in the field work was given by all members of the party. G. D. Furse, as senior assistant, is entirely responsible for the mapping of some parts of the area. W. E. Bawden and R. B. Walker also rendered very efficient and willing service.

The writer is indebted to W. A. Donaghue, mining recorder at South Porcupine for many courtesies and much assistance. Field work was facilitated by the interest and assistance of those prospecting or having claims in that area, and the writer's thanks are specially due to John Spence, Robert Johnson, and Martin Harkness, all of whom spent some time in showing members of the party where work had been done on some of the claims.

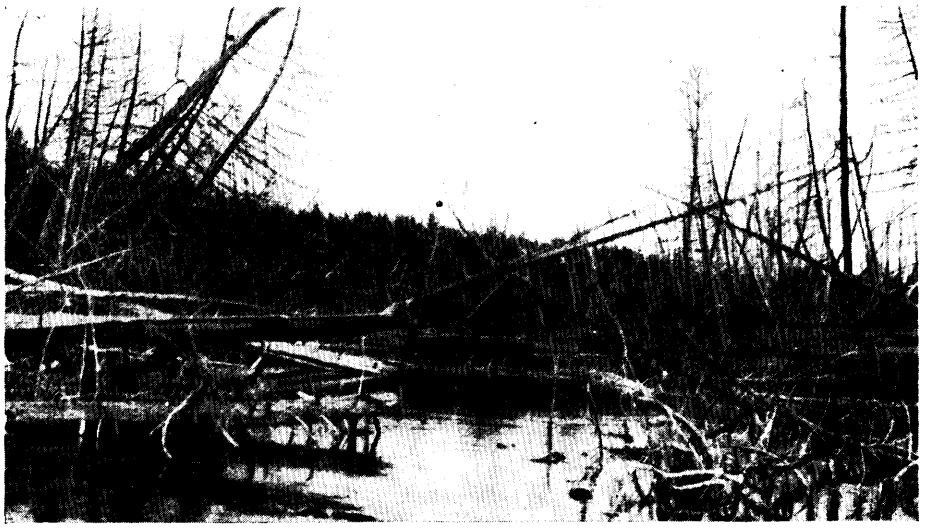
All assays quoted in this report were made at the Provincial Assay Office, Toronto.

Position of Area and Means of Access

The townships covered by this report lie directly south of the townships of Eldorado and Adams, which were included on the first maps of the Porcupine area. Although the distance from Porcupine is not great, most parts of the four townships are somewhat difficult to reach. Mountjoy creek, which flows through Bartlett and McArthur, is extremely crooked from McArthur to its junction with the Mattagami, and moreover is obstructed by many log jams.

The Redstone river which flows through Geikie and Douglas is of the same character. Two roads have been cut out, but neither has been graded and both are now growing up from lack of use. One of these leads south from Timmins to the Porcupine-Cameron claims in Bartlett township. A branch from it leads eastward to Papakomeka lake, an expansion of Mountjoy creek. This is at present the easiest route to McArthur and Bartlett townships, as the road can be used by wagons from Timmins to Papakomeka lake, and the part of Mountjoy creek in McArthur and Bartlett consists chiefly of lake expansions and is a good canoe route.

Another road leads south from South Porcupine to Clear lake, but cannot be used by wagons beyond a point about eight miles from the lake. From that point on, everything must be packed. In addition, those who wish to reach any other part of the four townships must pack over a trail about three miles in length, much of which is swampy, in order to reach the string of lakes on Mountjoy creek. An alternative route leaves the main road where the branch road turns eastward to the Miracle mine. A swampy portage of half a mile along this



Mountjoy creek between Marceau and Triple lakes.

winter road brings one to the Redstone river. This was the route followed by the writer. Redstone river, however, is a bad canoe route. It is swift in high water and is blocked by numerous log jams, which form again as soon as cut out. In addition, there are several rapids. Some of the portages are practically obliterated since the fires have swept the country; and at the long rapids, at the Douglas-Geikie boundary line, the old portage on the right bank could not be located at all, and a new one a mile and a half in length had to be cut on the left bank. The upper part of Redstone river is sluggish and forms a good canoe route. From a point just north of Muskrat lake, a portage 75 chains long leads westward to Scott lake, and thence, by a string of lakes, a canoe route leads northward through Bartlett township to join the lake expansions of Mountjoy creek.

Previous Work

As there are no large streams, this part of the district of Timiskaming was little known until after the discovery of gold at Porcupine. The boundary between the old districts of Algoma and Nipissing was run by Niven in 1896. His party included E. M. Burwash, who reported on the geology of the country through which the line passes.[1] This line forms the east boundary of Douglas and Geikie townships, which along with McArthur and Bartlett were blocked out during the summers of 1910 and 1911. During 1911, a trial line was projected for a branch of the Temiskaming and Northern Ontario Railway from Gowganda to Porcupine. J. G. McMillan was attached to the survey party as geologist and reported on the northern part of the area traversed by the line.[2]

Prospecting rapidly extended south from Porcupine, and McArthur township was a centre of much activity during 1911. P. E. Hopkins examined the claims staked in that year and prepared a somewhat detailed map, which, with a brief report, was published in the Twenty-First Annual Report of the Ontario Bureau of Mines.

Summary

General Character of the Country

The topography of the townships of Bartlett, Geikie, McArthur, and Douglas is one of low relief. From the summits of rock ridges to the bottoms of rock hollows is probably nowhere more than 300 feet. As the hollows are filled to a considerable depth with glacial material, the relative difference of elevation of the surface is considerably less than that. Here and there, isolated ridges and hills stand out above the level, soil-covered country, but elevations of only 100 or 200 feet form prominent landmarks.

Much of the area has been burned over several times by forest fires, and the remaining timber occurs in isolated patches. Some stands of pine of considerable size still remain in southern Geikie and Bartlett.

General Geology

The general geology of the area is very similar to the succession at Porcupine except that the Timiskaming sediments are not present. The following table summarizes the geological succession:—

QUATERNARY: Terminal moraine deposits of sand and gravel.
Outwash deposits of sand and clay.

Great unconformity

PRE-CAMBRIAN

KEWEENAWAN: Diabase dikes.

Intrusive contact

ALGOMAN: Feldspar and quartz porphyries.
Granite and granite porphyry.
Hybrid granite or diorite.

Intrusive contact

HAILEYBURIAN: Amphibolite.

Intrusive contact

KEEWATIN: Iron formation.
Rhyolites, trachytes, tuffs, agglomerates.
Serpentine and greenstone (andesites, basalts, etc.)

[1]Ont. Bur. Mines, Vol. VI, 1896, pp. 167-84.
[2]Report of the Geology of the Area along the T. & N. O. Railway, Trial Line between Gowganda and Porcupine, 1912.

Economic Geology

The only mineral of possible economic value is gold, which occurs in quartz veins associated with the porphyries which intrude the older rocks. There are a few gold-bearing veins that are not near exposures of porphyry, but as they are similar in character to those which are, all are believed to have similar relations to the igneous intrusions.

Topography and Drainage

The area is drained by three main streams: Mountjoy creek takes the run-off from the greater part of Bartlett and McArthur townships; Redstone river flows across the southeast corner of Bartlett and northward across the centre of Geikie and Douglas; and the west branch of the Night Hawk river crosses the southeast corner of Geikie and, after flowing through part of Cleaver and Fallon, meanders along the east boundary of Douglas.

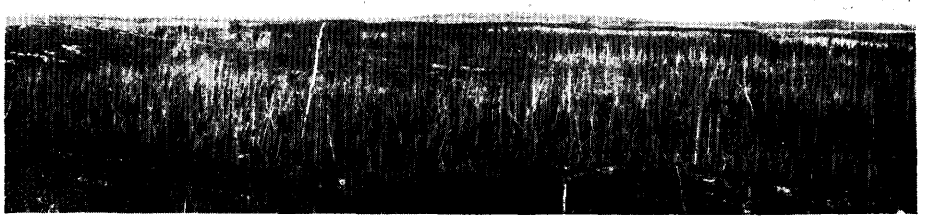
From Muskasenda lake, Mountjoy creek flows in a notably straight course northward to Marceau lake, Marceau and Triple lakes being merely expansions of the river; and between Triple lake and Papakomeka lake, the stream meanders between terraced banks of sand. Rock is exposed only at the two rapids, but isolated ridges rise inland. Below Papakomeka lake, the creek meanders through a drift-covered area. Clear lake is drained into Papakomeka lake by a meandering stream. Redstone river has an upper, sluggish part in Geikie; but below the long rapids on the boundary of Bartlett and Geikie, it is a fast-flowing, meandering stream broken by rapids at only two places.

The lake expansions along Mountjoy creek and the string of lakes from Scott lake, northwestward to Marceau lake all lie in shallow depressions in the glacial deposits. They are not rock basins. Clear lake, however, is a rock basin and is much more irregular in shape.

Between the watercourses, the country rises into ridges with a general northerly trend, but in most cases with no great length for individual ridges. That is, the elevated areas are in general elliptical in outline, sinking in all directions into drift-covered or swampy country. Many of these areas are quite isolated, as is the case at Serpentine mountain in the central part of McArthur township, the prominent hill which rises 120 feet above Redstone river in the central part of Douglas, and others. East of Redstone river, somewhat more massive elevated areas extend northward from the granite country of Geikie into Douglas, and another high and broad ridge lies west of Muskasenda lake. Diabase dikes produce long narrow ridges differing from the short elliptical ridges commonly developed in other rocks. On the whole, the maximum difference of relief is not great, as is shown by the fact that the hill mentioned above near the Redstone river in Douglas, rising only 120 feet above the river, forms a striking feature in the landscape.

The present topography is evidently the result of pre-glacial etching, with the ruggedness of the resulting surface in part masked by accumulations of glacial material, so that only the higher parts of the ridges of the pre-glacial topography are left exposed. In this way isolated rock hills are surrounded by relatively level areas of sand and gravel. In places, however, ridges and hills of some height have been formed by glacial deposits. The modern surface has been produced by erosion of various types prior to the glacial period, by the action of the ice during the glacial advance, by the aggradational effect of the retreating glacier, and finally by the recent incision of valleys in the glacial and post-glacial deposits.

Preceding the glacial period there were, no doubt, many alternations of deposition and erosion, the recognition of which is now impossible. The net result, however, was the formation of ridges on the harder rocks and valleys or hollows in those which were less resistant. Taking the region as a whole, the conglomeratic rocks of the Cobalt series were the most resistant, and they form prominent ridges. None of these are within the boundaries of the four townships covered by this report; but a prominent ridge lies just east in the townships of Fallon and Cleaver, and viewed from any of the hills in Douglas or Geikie (see photograph above), this ridge forms a striking feature in the landscape to the eastward. The southern extension of it is described by Cooke.[1] He concludes that the main valleys of the Matachewan area were superimposed upon the older rocks as the Cobalt series were removed; in this way he explains the northerly trend of the principal valleys and watercourses, even where rocks of the Cobalt series do not now occur. There seems no need, in the townships covered by this report, to assume any such process. It is true that the main watercourses have a general northerly direction, but there are other streams, such as that joining Mountjoy creek above Marceau lake, that flow in other directions. Furthermore, any general parallelism that may appear in the valleys can be explained as a



Looking east from central Douglas to the ridge of Cobalt rocks in Fallon Township.

partial adjustment to the masses of intrusive rock which have a general elongation north and south. Glacial deposits also have had some effect on the direction of valleys, and in many places it is evident the courses of streams have been determined by the direction they followed after the retreat of the ice-sheet. In many places, the glacial debris is still being eroded by these streams, and only a few have cut their valleys deep enough to expose consolidated rocks.

Ridges are formed on rocks of much variety. The granites form broad elevated areas, but their uniform character does not favour the production of marked hills or valleys. The porphyry bodies, however, being relatively small, stand above the greenstones which they intrude. Massive greenstone in many places forms prominent ridges in contrast to valleys carved in the same basic rocks that have undergone shearing or alteration. Thus the hill in Douglas, mentioned previously, is composed of ellipsoidal greenstone, and the rock of Serpentine mountain in McArthur is believed to be serpentinized greenstone. The basic intrusives form elevations, some of which may be seen along the McArthur-Bartlett boundary line, west of Mountjoy creek and along the west side of Marceau lake. This rock also forms the elevated region west of Muskasenda lake. The still later diabase intrusions are ridge-forming rocks, wherever the dikes are

[1]H. C. Cooke, Geol. Surv. Can., Mem. No. 115

of any size. A striking example of this is the prominent dike in Douglas township. It has a width of two to four chains and outcrops as a steep-sided ridge traceable almost across the township.

Previous to the glacial period, the net result of the geological processes was the production of ridges and valleys by erosion. During the glacial period and immediately following, certain topographic forms were produced by the deposition of material. Immediately at the ice front, debris was piled up without much sorting action, and an irregular hummocky country was the result. The southern part of Douglas township and the northern part of Geikie township along the Redstone river is of this character, with many irregular, oval hills and winding ridges as the chief features. Farther out from the ice front, the material was more thoroughly sorted and more evenly distributed, forming plains such as the sand plain, crossed by the portage from the Redstone river to Scott lake, and the level country of the central part of Geikie. In these plains are the occasional steep-sided depressions or kettle lakes, characteristic of outwash plains along glacier fronts. All the pre-glacial valleys were filled by deposits of this kind, and the deposition probably reached well up to the tops, if not above the highest ridges. This is shown by the heavy cover of glacial debris tailing out from even the highest rock ridges. The southern slope of hills, such as those mentioned above as being the chief elevations of the area, are completely drift-covered, so that no consolidated rocks are visible from the south. No forms that can be attributed to erosion by ice action were seen, although the ridges of consolidated rocks no doubt received some polishing during the glacial advance. During much of the period, however, material was being deposited. As soon as the country was freed from the glacial ice, streams were re-established and began at once to degrade the new surface. In most places these streams are still working on glacial deposits, and well-marked terraces have been cut in the unconsolidated sands and gravels. Cooke mentions terraces in the streams draining south, the Montreal river and Duncan creek, but comments on the fact that they are not marked on northward-flowing creeks in the Matachewan area.[1] Terraces, however, are well developed on Mountjoy creek and along the broad valley of Clear creek, where it flows through the heavy glacial deposits southeast of Serpentine mountain.

Natural Resources

Soil

Although a large part of the four townships is drift-covered, the areas of good soil are not very large and are isolated. Sand and gravel deposits are abundant, and even on the outwash plains the soil is light. The largest area that seems suitable for farming lies in the central part of Geikie where the exposures of consolidated rock are not numerous and the land is a fairly good sandy loam.

Timber

The northern part of McArthur and part of Douglas have been swept several times by forest fires, so that even in the swamps the trees have been killed. In Douglas, the burned area extends from the Geikie boundary to the north boundary of Douglas with the exception of the northwest corner of the township. East of the Redstone river, extensive cedar swamps have been burned over and the trees killed. Tongues of burned country extend from the two northern town-

[1]H. C. Cooke, op. cit., p. 39.

ships south along the uplands into Bartlett and Geikie, but the areas of recently burned country are not so extensive. The timber, therefore, is confined chiefly to the southern townships where there are several fairly large stands of red and white pine and some areas of good spruce. With the market offered by Porcupine, no doubt the timber will soon be utilized.

Fish and Game

Moose are fairly plentiful in the wooded country, and a deer is occasionally seen. The smaller animals are beginning to come back to the burned-over areas, as the new forest grows up.

Pickerel are abundant in Papakomeka and Clear lakes, but do not seem to live in the upper lakes of Mountjoy creek. Pike are to be found and are abundant in Muskasenda. Clear creek and Redstone river are well stocked with speckled trout of fair size.

Waterpower

None of the streams is of sufficient size to produce any power.

Minerals

Gold has been found in several parts of Bartlett and McArthur, but so far none of the deposits has been successfully worked. The widespread occurrence of the metal and the favourable geological relations seem to give promise of workable veins. Some search has been made for asbestos in the serpentinized rocks and small stringers have been found, but nothing that is of commercial importance.

General Geology

The consolidated rocks of the area are all pre-Cambrian in age and are practically all of igneous types. The oldest rocks are volcanics, such as are usually classed as Keewatin—basic and acidic lavas, and volcanic fragmental rocks with a small amount of sedimentary iron formation. The Keewatin rocks are intruded by dark-coloured, coarse-grained rocks, which are here called amphibolites but which may have been quartz diorites, diorites, or even gabbro. Considerably later are the granitic intrusions consisting of typical granite and granite porphyry and of feldspar and quartz porphyries. The youngest consolidated rock is diabase, which occurs in dikes up to 250 feet in width. A mantle of glacial deposits covers the greater part of the surface of the consolidated rock.

Keewatin

Greenstone.—Basic lavas now altered into greenstones, form a large part of the rocks classed as Keewatin. Many of these are ellipsoidal and similar in all respects to the ellipsoidal greenstones described in the report on the Porcupine area.[1] In some specimens, a few crystals of badly altered plagioclase-feldspar can be recognized, but in many others alteration has proceeded so far that only a felt of secondary minerals remains. Chlorite is common to practically all specimens. Calcite is usually abundant, and secondary quartz is present in many sections. In an outcrop, a mile and a quarter west of Marceau lake, rounded masses, an inch and a half in diameter, of ashy white material, were observed as bosses on the surface of the greenstone. These proved to be composed chiefly of epidote and are probably segregations in the lava.

[1]A. G. Burrows, The Porcupine Gold Area, Ont. Dept. Mines, Vol. XXXIII, pt. 2, 1924, p. 13 *et seq.*

Serpentine.—An area of rock consisting chiefly of serpentine extends southeastward from Serpentine mountain east of Mountjoy creek to Clear lake, and other outcrops were observed in Geikie and Bartlett west of Redstone river. The rock is dark in colour, fine grained and massive. Many outcrops have roughly rectangular patterns on the surface, with the minerals radiating from the edges of the blocks. The boundary lines of these areas, which vary from 2 to 6 inches in diameter, seem to have been formed through a greater degree of serpentinization. An outcrop along the trail northwest from Clear lake shows remarkable fibrous structures in the rock constituents. The fibres are radiate to stellate in arrangement, and many reach a length of 10 to 12 inches. Furthermore, the rock has a banded appearance: fibrous rock passes gradually into a massive rock of a lighter and greenish colour, and this is in sharp contact again with fibrous rock. The whole thus has the appearance of bands, one edge of each band being fibrous, the other massive. This character shows only on the weathered surface, and the fresh surfaces appear dense, homogeneous, and a uniform black in colour. A thin section of the rock shows that serpentine forms practically all of it and that the fibres consist of tiny foils of serpentine at the centre and larger ones along the margins. They are no doubt formed after some original fibrous mineral.

The massive serpentine rocks or those with the prismoidal patterns are well exposed on the cliffs of Serpentine mountain. A sample from the southeast side consists of a felt of fine needles of serpentine. The only indication of any larger crystals is the occurrence of magnetite in fern-like skeleton forms which may mark the boundaries of larger original crystals. A sample from the north side of the mountain is similar in character, but the texture is still finer.

In the absence of any conclusive proof of an intrusive relationship for the serpentine rocks, either field or microscopic, it seems wise to include them with the greenstones as part of the volcanic series. Practically, there seems no possibility of delineating the serpentine-bearing area without much detailed work, if at all.

Rhyolite.—Bands of typical rhyolites are interbedded with basic lavas. Some of these large enough to show on the map occur in the northeast corner of Bartlett. They are light-greyish weathering rocks that the microscope shows to be porphyries with fairly large phenocrysts of orthoclase and plagioclase in a very fine-grained groundmass. Calcite and sericite are the abundant alteration products, with the latter especially abundant in the groundmass. A little chlorite also is present.

Trachyte.—In the northeastern part of Douglas there are a few isolated outcrops of a hetereogenous series of volcanic rocks. Some of these are thin flows, which in the field have the appearance of trachytes and which the microscope shows as porphyries with large phenocrysts of plagioclase in a trachytic groundmass of feldspars and chlorite. Thin beds of ellipsoidal greenstone are interbedded with the trachyte.

Quartz—Sericite Rocks.—White-weathering rocks are associated with the trachytes just described. They are thin bedded, with the strata well marked by colour variations in shades of grey. In the field they were believed to be tuffaceous, although thin sections show them to be composed of a mosaic of quartz with a foliation marked by foils of sericite.

Volcanic Fragmental.—At several places, but notably on the boundary line between Bartlett and McArthur near the second mile-post, 10 chains north of the line in McArthur on claim T.R.P. 8,796 in Bartlett, there are exposures of a rock

made up of rounded, angular and subangular fragments set in a matrix like ordinary greenstone in appearance (see photograph below). The fragments are composed of lava and are all similar in character. There are no sediments associated with these occurrences, and it is believed that they represent autoclastic or perhaps volcanic fragmental rocks formed during the extrusion of the lavas.

Iron Formation.—Typical banded iron formation occurs in several places interbedded with the volcanics. Some of these bands seem to be continuous. South of Clear lake, two bands of considerable width and only a few hundred feet apart strike northwest. Between Clear lake and Triple lake, a high ridge consists of two bands of iron formation separated by 50 feet of chloritic rock.

Structure of the Keewatin.—Lack of continuous outcrops and the absence of ater sediments make the determination of the structure difficult. Fragmental



Volcanic fragmental rock, Harrison claims.

tops in the lava flows were observed east of the Redstone river in the central part of Douglas township; and from the limited exposures, it seems likely that the trachytes and tuffs to the northeast lie above the more basic lavas to the southwest.

At a point on the Porcupine-Cameron road, north of the Cameron claims, ellipsoidal greenstones are well exposed, with the ellipsoids flattened parallel to a plane dipping approximately 55° S.W. and striking northwest. If this is accepted as the bedding of the lava flows at this point, a major anticlinal structure extends northwest across McArthur township. There may, however, be many minor folds, and no doubt the numerous intrusions of igneous rocks have complicated this simple structure.

Basic Intrusives (Haileyburian)

Amphibolite.—Many small and one large area of a dark intrusive occur in the four townships. The character of the rocks is variable, ranging from a pepper and salt variety with granitic texture to a rock composed chiefly of greenish amphibole in bladed crystals.

In that part of Bartlett township west of Marceau lake and Mountjoy creek, there are several ridges of this rock. An outcrop on the creek below Marceau lake, just west of the end of the portage past the first rapids, is a greenish rock of granitic texture with dark green basic minerals and creamy to greenish feldspars. The microscope shows the constituents to be an amphibole, somewhat fibrous at the ends of the crystals, and a lesser amount of badly kaolinized feldspar, the variety of which cannot be determined. Quartz is a fairly abundant filling between the crystals of amphibole and feldspar. A high ridge west of the creek on the boundary line between McArthur and Bartlett is similar in mineral composition, excepting that quartz is practically lacking and the amphibole is more fibrous than in the preceding specimens. A mile directly west of Marceau lake is another outcrop in which the rock is porphyritic with green amphibole in large crystals; feldspar is subordinate in amount, and quartz practically lacking.

In McArthur township, several outcrops of the amphibolite occur northwest of Clear lake. In the second knoll on the trail northwest from Clear lake towards Triple lake, the coarsely crystalline rock consists of abundant green amphibole in frayed-out crystals, parts of which are nearly opaque by alteration. Feldspar is abundant but much altered, so that the crystals appear muddy and contain much sericite. Quartz is fairly abundant in this rock.

The largest area of amphibolite lies in Bartlett township west of Muskasenda lake. The rock is variable in appearance, the most abundant type being a granular, greyish-green rock with many patches and streaks of epidote. There are, however, pepper and salt varieties similar to those described above. The difference seems to be wholly in the proportions of amphibole and feldspar. In those rocks consisting chiefly of amphibole, the crystals are lath-shaped with frayed-out ends and are altered in some degree to chlorite. In all types of this rock, lath-shaped crystals of feldspars, turbid through alteration, are present. In some specimens, epidote is so abundant that it forms a sort of groundmass for the amphibole.

In spite of these variations in constituents, all of the rocks of this group are similar in the abundance of strongly pleochroic, greenish amphibole, usually with a decided fibrous structure. Feldspars are present in all, but so badly altered that the variety is undeterminable. The chief variation is in quartz, which may be present. The texture of the rocks is granitic, and it is possible that they were originally diorites and quartz diorites. However, as the amphibole in all types is fibrous, it is probably secondary, even though no other definite proof of this was observed. Hence all of these rocks will be referred to as amphibolites.

Wherever contacts with rocks of the Keewatin group occur, the amphibolite is intrusive. West of Marceau lake, this relation is plain; tongues of the amphibolite extend into the greenstone, and fragments of greenstone are included in the amphibolite. Along the margin of the large mass west of Muskasenda lake, pieces of ellipsoidal greenstone are included in the amphibolite. Along part of the margin, however, there is a fault contact. At many places in the township of Douglas, tongues of amphibolite, many of them too small to be shown on a map of the scale of that accompanying this report, cut greenstone, iron formation, and the acidic volcanics.

No contacts with granite were observed, but judging by the degree of metamorphism there seems no doubt that the granite is much younger than the amphibolite. The diabase dikes cut sharply across the amphibolite. These relationships are well shown in an outcrop a mile west of Clear lake, where amphibolite cuts across iron formation and both rocks are cut by an east-west diabase dike.

In the absence of sediments of Timiskaming age, the exact correlation of the amphibolite intrusions cannot be determined, but the relations to the Keewatin rocks and to the younger intrusives are such that it may be at least tentatively assigned to the Haileyburian group.

Acidic Intrusives (Algoman)

Acidic intrusives of somewhat different types, but all probably related, underlie a large part of the four townships of Bartlett, McArthur, Geikie, and Douglas. Granites are the most abundant, but even in these there are varieties ranging from greyish rocks that may be granodiorites to bright pink, practically binary granites. In places granite porphyries are well developed, but as they are similar to the granite in all respects excepting texture, they will not be described as a separate group. In addition, there are rocks high in hornblende and very similar in appearance to the amphibolites. These, however, are marginal rocks along the granite masses and are believed to be hybrid types formed by the assimilation of basic material.

Quartz porphyries and feldspar porphyries differing decidedly from the granite in appearance, distribution, and possible importance, have been separately indicated on the map, even though they seem to be facies of the same intrusion.

Granite.—A greyish granite occupies the northwestern part of Bartlett and the southwestern part of McArthur, and extends westward into the neighbouring townships. In appearance it is a typical granite, but some of the more basic portions may be more properly described as granodiorites.

Along the margins of this mass where it intrudes greenstones, a hybrid rock consisting chiefly of dark-coloured minerals was formed. Under the microscope this rock shows a few areas of quartz and a great deal of bright green amphibole, some of which has changed to chlorite. Epidote is also present. The amphibole contains a great many inclusions of quartz, which seem to be residual from some earlier crystallization, as along the margins needles of amphibole project into the irregular areas of quartz. From a study of the thin sections, it would seem as if a quartz-bearing rock, such as the granite, had solidified first and then been slowly attacked by a basic liquid facies, perhaps formed by the thorough assimilation of basic rock in granite magma. Such a hybrid mixture might have existed at temperatures lower than the consolidating point of granite and may gradually have attacked it, so that only the quartz remained.

Some areas and tongues of this hybrid rock are shown on the map in the western part of McArthur and Bartlett.

A great mass of equigranular pink granite extends northwestward across the township of Geikie, occupying the greater part of it and extending southward into the adjoining township. It is typical granite and requires no detailed description.

The northern part of McArthur township and a part of the township of Douglas is occupied by a great batholith of granite, which in parts is remarkably porphyritic with phenocrysts of feldspar up to an inch in length. The groundmass consists of equigranular granite, not differing in appearance from the non-porphyritic variety.

Feldspar and Quartz Porphyries.—In the southeast corner of McArthur township and northeastern part of Bartlett is an area of acidic rocks, most of which are porphyritic. The district is heavily covered with drift and trees, and

the outcrops are small and isolated. Immediately south of Clear lake, a ridge of feldspar porphyry extends almost to the south boundary of McArthur. A large ridge of acidic rock crosses the boundary between McArthur and Bartlett between the first and second mile-posts. It extends northward to Clear creek. Southward the ridge can be traced for a considerable distance, and isolated outcrops are found as far south as Scott lake in southern Bartlett.

The ridge south of Clear lake consists of strikingly porphyritic rock with abundant blocky phenocrysts of feldspar. The variety is predominantly orthoclase, but plagioclase is present. Sericite is abundant as an alteration product in the feldspars. The amount of groundmass is comparatively small; and calcite, probably secondary or introduced, is abundant.

The ridge of porphyry, extending north and south across the boundary line between McArthur and Bartlett, occupying T.R.P. 4,612, and swinging southwest across the southern part of T.R.P. 10,724, presents an interesting example of gradation from equigranular fine-grained granite to porphyries. In the central part of the ridge, a mile and a quarter south of the McArthur boundary, the rock is a fine-grained granite, varying from grey to pink in colour. A specimen from the south part of T.R.P. 10,724 is fine grained in texture, but has the mineral composition of granite with quartz, orthoclase, and plagioclase as the chief constituents, and calcite and sericite as alteration products. A grey specimen farther east is typical granite with orthoclase and plagioclase in blocky crystals. Quartz is abundant, and biotite was an original constituent but is now almost completely altered to bright green chlorite. In other specimens plagioclase is in excess of orthoclase, but essentially the rock is the same.

Towards the margins of this mass, the rock becomes decidedly porphyritic. The colour is ordinarily buff to pink, but also ranges from light to very dark grey. Rounded blebs of quartz are visible. Along the McArthur-Bartlett boundary, only this porphyritic type of rock was observed. In some specimens, the phenocrysts are both quartz and orthoclase, set in a fine-grained groundmass; in others, plagioclase of an undetermined variety forms the phenocrysts, but quartz is abundant in the groundmass. A specimen from an outcrop east of Scott lake has, in order of abundance, phenocrysts of quartz, orthoclase, and plagioclase. The orthoclase is fairly fresh, but the plagioclase shows much alteration to sericite. The quartz phenocrysts are broken, and the fragments have been separated by rock movements. The groundmass contains some calcite. The outcrop on the west side of Scott lake is composed of rock considerably altered, but still containing recognizable phenocrysts of orthoclase, plagioclase, and quartz in a sericitic groundmass.

From the descriptions given above and the distribution of the varieties exposed, it seems clear that there is a zonal arrangement of rock types in this boss —the central part being composed of fine-grained granite; the margins of porphyritic rocks, quartz porphyries, feldspar porphyries, and feldspar-quartz porphyries.

All of the rocks of the Algoman group are clearly intrusive into the rocks of the Keewatin. The porphyry mass described in detail above is in contact with greenstone just southeast of the Gibson cabin on Clear creek, and partially digested fragments of greenstone are included in the porphyry. The porphyries do not seem to have assimilated much foreign material, and so there is no contact zone of hybrid rocks. In place the granites have absorbed a good deal of the intruded rock and have become dark coloured. The porphyries have produced rather intense alteration effects in some places. Along the south shore of Clear lake, the greenstones lying along the strike of the porphyry masses have been

altered into rusty-weathering carbonate rocks, probably by the metamorphosing effect of porphyry tongues which may extend northward at no great depth below the present surface.

Late Intrusives (Keweenawan)

Diabase.—Diabase dikes are fairly abundant, but never of any great size. Occasionally a maximum width of 200 feet is attained. The large dike west of Redstone river in Douglas is the most continuous. It is apparently faulted near the south boundary of the township, but northward can be traced for several miles in a remarkably straight line. It forms a resistant band and stands out as a steep-sided ridge that can be followed by the eye for long distances where the country has been deforested. In places it is the only rock that rises above the swamps that occupy so much of the central part of Douglas township.

The rock of all the dikes is equigranular and very fresh, with a brownish weathering due to slight oxidation of the iron. So far as could be seen in the field, the dikes appeared similar in mineralogy, and few samples were taken. A thin section from a dike west of Muskasenda lake shows an ophitic texture. Plagioclase is abundant in well-formed, lath-shaped crystals, which belong to an early period of crystallization. The variety is a basic andesine. Magnetite formed at a later period, as it includes some of the feldspar crystals. Magnetite or ilmenite is included in augite, which is a pale violet colour, shows slight pleochroism, and probably is titaniferous. Plagioclase somewhat more acidic than the lath-shaped crystals, but still andesine, includes all other minerals and is the last mineral to crystallize from the magma. Olivine is present in some quantity and appears to be earlier than the lath-shaped feldspars, as they do not cut through the olivine and seem to be moulded around grains of it in some places. Along the cracks in the olivine, some serpentine has developed; but this and a small amount of leucoxene surrounding the magnetite or ilmenite are practically the only secondary minerals.

This particular dike has the same mineralogical composition as the olivine diabase dikes that Burrows found to be the latest pre-Cambrian formation in the Porcupine area.[1]

It is probable that the diabase dikes in the area covered by this report are not all of the same age. Some of them may belong to the earlier or Matachewan period of diabasic intrusion, and others to the later period of Keweenawan or post-Keweenawan activity. It is doubtful if even a microscopic examination of each dike would determine that age relationship in the absence of occurrences of sedimentary rocks of Cobalt age.

Quaternary

Pleistocene.—The outcrops of consolidated rocks form isolated areas lying in a great mantle of unconsolidated material left by the ice-sheet of the Pleistocene glaciation. During the main advance of the ice, weathered material was removed from the pre-Cambrian rocks, and their surfaces were scoured and polished. During the retreat of the ice, there were periods of stagnation during which debris was dumped in great quantities and many of the typical forms of glacial deposits were developed.

Redstone river in Douglas flows through a terminal moraine country with irregular hills of unassorted sand and gravel, undrained hollows, and winding, steep-sided ridges. Just north of Papakomeka lake, another similar area is crossed by the road to Timmins. In both places the removal of the forest by

[1]A. G. Burrows, The Porcupine Gold Area, Ont. Dept. Mines, Vol. XXXIII, pt, 2, p. 40.

fire has made possible extended views; no doubt the glacial topography of many other sections would be quite as striking were they not forest-covered. The rock ridges have served as buffers on the south sides of which glacial material has lodged. South of Serpentine mountain, a large area exhibits well-marked glacial phenomena, including irregular hummocky ridges and kettle lakes separated by narrow, steep-sided, winding ridges. Again in Douglas, the southern slope of the prominent hill mentioned previously is so thoroughly mantled that no consolidated rocks are exposed from base to summit.

Another prominent type of glacial or post-glacial deposit is the outwash plain formed of sand, usually grading along the margins into a mixture of sand and clay. The surface of the plains is fairly level, but not absolutely flat, as smooth knolls and hollows break the uniformity and in places there are steep-sided depressions, in some of which lie the kettle lakes with no visible outlet, so typical of glacial topography. These plains are thought to be formed of the material carried out from the glacier front by the water from the melting ice during periods of stagnation. That is, the plains are really the apron deposits from the terminal moraines just described. The grading from sand in the central part to clayey material at the margin is simply the natural gradation out from the source of supply.

Recent.—Deposits of recent date are confined to the peat, which forms wherever the country is undrained. Along the streams, there is erosion rather than deposition, and the banks of streams are being carved into terraces as mentioned in a previous part of this report.

Geological History

The geological history of this section of the country has been described in many previous reports dealing with areas on all sides of the four townships covered by this report. Here, however, the record is less complete than it is in the neighbouring areas, either north or south. At Porcupine the sediments of the Timiskaming group are evidence of a long period of which no trace is found immediately to the south. In the Matachewan area, rocks of the Cobalt series still remain as residuals on the early pre-Cambrian floor upon which they were deposited. But in the four townships of McArthur, Bartlett, Geikie, and Douglas, no outliers of these formations remain. Parts of the geological history, therefore, must be supplied from neighbouring districts.

The earliest rocks in all this part of Northern Ontario are the greenstones, which were originally lavas high in iron and magnesia. At times, during the long period of volcanic activity, more acidic rocks, such as rhyolites and trachytes, were extruded, and towards the end of the period the rocks were chiefly acidic lavas and explosive varieties such as tuffs. Some true sediments were formed when the volcanic vents were not in activity. Among the commonest of these were the beds of iron formation that occupy various horizons in the volcanic series and were evidently laid down in isolated basins at different times.

The sediments of the Timiskaming group were no doubt deposited in this area, since rocks of that age have been described in surrounding areas. They have apparently been completely eroded, as would be expected if the major structure is anticlinal, with the basic igneous rocks of the axis of the anticline occupying the greater part of the map-sheet and with the acidic lavas and tuffaceous rocks, which are believed to be later in age, appearing in quantity only in the northeastern part of Douglas township.

The absence of sediments makes it impossible satisfactorily to correlate the igneous intrusives. The oldest of these, the amphibolite, was perhaps originally a diorite or quartz diorite. It intrudes the Keewatin rocks and in character corresponds to those basic rocks which have been found in other areas intruding the Timiskaming sediments. That correlation may tentatively be applied here. Intruding this again are rocks which by their character can with some assurance be correlated with the granite and porphyry intrusions classed as Algoman in other areas. In the larger masses, this intrusive rock is granite or a coarse-grained granite porphyry. Where the masses are smaller, the central part of the boss may be fine-grained granite, and the margins a feldspar or quartz porphyry. Accompanying or closely following these intrusions came the veins which carry gold.

Again, there is an hiatus in the geological record, during which some of the diabase dikes may have been intruded; but in the absence of the Cobalt sediments, accurate correlation is again impossible. Cobalt rocks form the prominent ridge in Cleaver township only a short distance east of the border of this sheet, and it is perhaps a reasonable assumption that they once extended over much of the country west and north of this ridge. In any case, prior to their deposition there was an extremely long period of time during which the heterogeneous rocks of these previous epochs were worn down to a comparatively smooth surface upon which the normal sediments of the Cobalt group were later spread out. Following the consolidation of the conglomerates, slates, and quartzites of that group come the minor intrusions represented by the diabase dikes. This was accompanied by little disturbance, and the Cobalt sediments still lie at comparatively low angles.

No consolidated rocks of an age later than the diabase dikes occur either in this or in closely adjacent areas, and it must remain a matter of speculation whether or not there was deposition in this region, during Paleozoic, Mesozoic, and Tertiary times. If rocks were deposited, as it seems likely they were, erosion had completely removed them before the advance of the Pleistocene ice-sheet and weathering had no doubt attacked the resurrected pre-Cambrian surface. Whatever soil may have been developed in this way was swept away by the ice, and on the clean and polished surfaces were deposited the residual moraine and outwash plain deposits of the glacial period.

Stratified clays occur at Porcupine and to the northward. The absence of them here may mean that this area lies just along the southern shore of the great glacial lake in which the clays of the northern clay belt were deposited.

Since the retreat of the glacier and the draining of the post-glacial lakes, the present rivers have been cutting into the unconsolidated deposits and developing terraces along some of the streams. No important recent deposits are known.

Economic Geology

History of Prospecting

It was only natural that an area so poorly supplied with good waterways should not have attracted prospectors until some time after the discovery of the gold deposits at Porcupine.

In addition, the almost entire lack of any outcrop in the townships immediately south of the Porcupine area proper discouraged to some extent exploration to the southward; and even in much of this southern area, the small and scattered outcrops gave little encouragement to the prospector looking for new promising ground. However, in the two or three years following the discovery of gold at Porcupine in 1909, prospectors worked south into McArthur

township, and in 1910 and 1911 much of the promising area was staked and some discoveries of gold-bearing veins were made. No deposit of prime importance, however, was located; and although there have been spasmodic revivals of interest, comparatively little has been done in the last dozen years. The difficulties are further increased by the fact that these townships are part of the Timagami Forest Reserve, and there are certain restrictions on development work.

Gold Claims

Gold has been discovered at several places in McArthur and Bartlett townships. No doubt all of the occurrences are of similar origin, but there are differences in their associations. Gold is present in sheared zones in the porphyries, no doubt chiefly in the small quartz veins that reticulate through the zones. Gold-bearing quartz veins have been found cutting iron formation and in greenstone. In all of these types, the veins contain only a very small amount of sulphides and the gold occurs as the native metal, in places in rather large flakes and blebs in the quartz. It is probable that the veins are similar in origin to the Porcupine veins and are in some way connected with the igneous activity which produced the porphyries. If so, the veins certainly came as a last effect of the igneous activity, as the porphyries were not only solidified but sheared and altered either before or during the introduction of the veins. The localization of the highest values around the smaller granitic intrusions rather than along the margins of the main granite masses is striking and illustrates a relation that has been discussed in reports on many other gold occurrences. Exceptions to this rule are probably apparent rather than real. The main features in the gold occurrences will be plain from the following brief descriptions of some of the more important properties.

Claims South of Clear Lake.—A group of claims in southeastern McArthur and northeastern Bartlett were among the first worked in these townships. Several pits were sunk, and considerable stripping and trenching were done. There has been little recent work, but such old workings as could be found were examined. As much of the country has been burned over since most of the pits were sunk and old trails have thus been obliterated, there is no doubt that many of the former prospects have not been seen.

On claim T.R.P. 3,027, there are old pits on the north end of the porphyry ridge and considerable areas of the rock have been stripped. The porphyry is altered and pyritized, and quartz veins up to two feet in width traverse it. In the oxidized material from the porphyry, gold can be panned in abundance, but a sample of the solid pyritized rock assays only $2 per ton in gold.

On claim T.R.P. 8,633, at a point five chains south of No. 4 post, a pit has been sunk on a feldspar porphyry dike, seven feet in width, that cuts greenstone. Along the margins of the dike, the greenstone has been altered to a rusty-weathering carbonate rock. The dike itself contains stringers of quartz from half an inch to two inches in width. Pyrite occurs in the dike rock. In the quartz stringers, some gold is visible. Pits have been sunk along the east side of the porphyry ridge which occupies the eastern part of T.R.P. 2,984. Some of these are on the claims adjoining it to the east, T.R.P. 8,633 and 8,634. In one of the pits is exposed a vein seven feet wide striking northwest and dipping 55° N.E. It narrows to a crack 200 feet southeast. The vein lies along a small dark-coloured dike which forms the hanging wall. Decomposed material gives gold on panning, but a specimen of quartz just across the line on T.R.P. 2,984 gave no gold on assay.

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

Harrison Claims.—A group of claims extending east from Marceau lake for a distance of two miles, with a width of three claims on the north boundary of Bartlett, and several claims in McArthur extending westward to Triple lake, received a good deal of attention during the summer of 1924. The claims are rather heavily drift-covered, as may be seen on the map, especially those lying just east of Marceau and Triple lakes. On the other claims, the rock exposures are small. The greater part of the work has been done on the claims in McArthur. At the cabin, which is on the McArthur-Bartlett boundary, the rocks exposed (see photograph on page 45) are volcanic fragmentals with large rounded masses of white-weathering lavas enclosed in a dark-greenish ground mass. One claim north of the cabin, a knoll of rock shows a contact between this pyroclastic rock and dense greenstone. Much stripping has been done along this contact, which is exposed for several hundred feet. A few quartz stringers have been uncovered lying in the fragmental rock transverse to the contact with the dense greenstone and ending abruptly at the contact. There is nothing to indicate any possibility of an important vein or deposit, and as the contact is not an intrusive one it does not present any more favourable locality for mineral deposition than any other part of the volcanic group.

One claim farther north, a shaft about 50 feet in depth was sunk in a band of iron formation striking northwest. The iron formation outcrops in a narrow ridge, which has been stripped for 200 to 300 feet. On both sides it drops steeply into lower, drift-covered country. The rock is the typical banded variety, with white granular quartz and magnetite in bands up to half an inch in width. A few stringers of quartz, none over half an inch in width, cut across the bands, and in these a little galena was observed. High assays in gold were reported from some samples from this pit, but the appearance of the rock and of the material on the dump is not at all promising.

Spence Claim, T.R.P. 11,209.—This claim is on the east shore of the second expansion of Triple lake, immediately north of the narrows. The only rock exposure along the shore is on this claim, and there is no other exposure of consolidated material on the claim. When the discovery was made by John Spence, only a small outcrop of rock was visible. Noticing a piece of float quartz, he dug into the sandy bank and located the vein. Since then he has stripped the vein back as far from the shore as the glacial sand deposits, here some 20 to 25 feet thick, will permit and has sunk a pit six feet in depth into the vein. (See photograph on next page.)

The country rock is a dense massive greenstone. The vein is somewhat irregular and lenticular, varying from two to five feet in width in the distance stripped. It strikes N. 65° E. and dips 60° S. at the surface, but lower down

seems to be nearly vertical. The quartz is white and sugary. Metallic minerals are abundant, those observed being pyrite, chalcopyrite, pyrrhotite, and a little sphalerite. At the time of the last visit, gold was visible in half a dozen places on the surface of the vein. In addition to this impressive development of visible gold, samples from the dump, chosen because they contained no visible metal, have given favourable assay results.

Altogether this prospect seems to be the most promising seen in the area. The heavy overburden, however, will make further development somewhat difficult and will require drilling or underground work to determine the size and value of the vein along its strike.



Vein on T. R. P. 11,209, looking west across Triple Lake.

T.R.P. 7,716 and 7,717.—These claims, commonly called the Lohner claims from their original staker, are in McArthur immediately north of the boundary west of Mountjoy creek. Not much work has been done recently, but a vein is well exposed by old workings which include trenches and shallow test pits. The rock is a slightly schistose greenstone. The vein strikes N. 15° E. and dips 75° E. It varies from a series of offsetting lenses one to two inches wide in parallel zones, up to a width of three feet of solid quartz with parallel stringers in the foliated greenstone of the footwall for an additional six feet. The quartz is sugary and contains only a small proportion of sulphides. Some gold is still visible, but a sample of quartz with no gold showing gave only a low assay.

Campbell Claims.—Half a mile east of the portage at the north end of Scott lake, a knoll of iron formation has been stripped for a length of 200 feet by a width of 100 feet. It is similar in type to the iron formation described above, but the bands of magnetite are somewhat thicker, reaching a maximum width of two and a half inches. A shallow pit has been sunk in this material. There are no indications of gold, and the iron in the band is too low in grade to be considered as a possible ore of that metal.

Cameron-Porcupine Claims.—Claims of the Cameron-Porcupine Gold Mines, Limited, consist in part of the surveyed claims, T.R.P. 8,989 to 8,994, inclusive. They lie in the western part of Bartlett township, a mile and a half west of Marceau lake. From the claims a road was cut to Timmins, but the southern part of it was never used for wagons. A good trail leads from Marceau lake to the claims, and the creek that enters at the west side of Marceau lake can be used for canoes. Only two portages are necessary, but the stream is small and tortuous.

Work on the claims was concentrated on T.R.P. 8,992. A shaft 30 feet in depth shows considerable quartz, but the walls are so badly shattered that there is some doubt if the quartz seen is actually in place. On the surface just at the shaft, no consolidated rocks are to be seen, but 50 feet to the north an east-west trench shows a dioritic rock cut by a number of quartz veins. The strike of the veins is N. 20° W. The section exposed in the trench, beginning at the sand overburden at the west end is as follows: quartz 6 feet, diorite 4 feet, quartz 6 feet, diorite 8 feet, quartz 6 inches, diorite 3 feet, quartz 6 inches, diorite 4 feet to the end of the trench. The diorite is that described as a contact facies of the granite. The quartz is white and vitreous with a few yellow stains, but practically no sulphides are present. From the apparent strike of the veins, the eastern 6-inch stringer in the trench should appear in the northwest corner of the shaft. If the quartz showing in the shaft is this vein, it must increase remarkably in size in the 50 feet of covered ground between the trench and the shaft. Two samples were channeled from the two 6-foot quartz veins in the trench, but neither of these showed any gold on assay. This probably explains the abandonment of workings which exposed so large a quantity of quartz.[1]

Other Localities

Although the above details cover those properties where much work has been done, attention should be called to a large area of greenstone that has not been prospected to any extent. The central part of the township of Douglas is underlain largely by volcanic rock, and since the fire this is well exposed, as the map will show. It has been the general impression that this township, like Geikie to the south, is chiefly underlain by granite, as that is the rock along the boundary, on the road to South Porcupine, along Redstone river and on the portage in the southern part of Douglas. Away from the river, however, the greenstone forms large north-south ridges. No porphyry intrusions were noticed in this area, but it would seem that parts of the township merit some detailed examination, especially that part lying around the isolated or nearly isolated area of granite between Clear lake and Redstone river.

[1]For details of company, etc., *see* Ont. Dept. of Mines, Vol. XXXIII, pt. 7, p. 41.

Other Deposits

As serpentine-bearing rocks are common in parts of the Keewatin, asbestos might be expected to occur. Some small seams of good fibre were seen, but none of sufficient size to make it seem possible that any commercial quantity of that mineral will be found.

Grassy River Area, District of Sudbury

By T. L. Gledhill

Introduction

Following instructions from Thos. W. Gibson, Deputy Minister of Mines, the writer with three assistants commenced early in June and continued until the middle of September, 1925, the mapping of the topography and geology of the townships of Nursey, Moher, Beemer, Sothman, Semple, English, Halliday, Hutt, and Zavitz. Going northeast by canoe from Gogama, a village on the Canadian National railway 100 miles northwest of Sudbury, the party reached

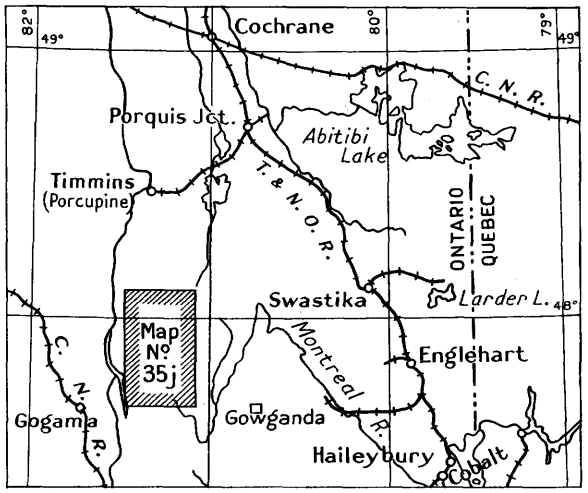


Fig. 7—Key map of Grassy River Area, scale 50 miles to the inch.

the field by means of Minisinakwa river, Mattagami lake, and a creek that leads to the portage into Sinclair lake. When supplies are carried, a day and a half or two days are needed for this trip.

Acknowledgment is due to W. T. Robson, chief assistant, and to A. G. Horning and C. B. Shipman, assistants, for their efficient help during the summer; also to A. L. Reading, Wm. Pigott, and the people of Gogama for many kindnesses. Mr. Reading kindly furnished some of the photographs used in this report. The writer appreciates the help of the Provincial Geologist and the Draughting Department for supplying township plans and other useful data.

The object of the work was to make a micrometer survey of the above townships, outlining the various rock masses and paying special attention to any rocks or minerals of economic importance.

The method followed in the field was to map the geology along the watercourses at the time they were being surveyed, to walk the township lines, and to make sections across country so that no appreciable part of the area would be

left unvisited. The water routes were surveyed with a Lugeol split-lens micrometer, the land traverses being run by the standard pacing and compass method. All the surveys were tied to township lines. A traverse had already been made of the Grassy river in Nursey, Moher, and Beemer townships. The map and report by J. G. McMillan,[1] published by the T. & N. O. Railway Commission in 1912, was of great assistance.

A short side trip was made to Beaver and Schist lakes, a day's paddle west of Gogama, in order to visit some prospects that were being developed.

Location and Area

The area covered in this report represents a block of nine townships, each of which contains 36 square miles, the group being three townships deep north and south and three wide east and west. This square lies within the Timagami Forest Reserve, with the Sudbury-Nipissing line forming the east boundary. The mines at Porcupine are thirty miles to the north, and the Matachewan gold



Fire Rangers' headquarters opposite the old Hudson's Bay Company post on Mattagami lake.

field lies a few miles to the east. The area lies between 81°30′ and 81° west longitude, and the 48th meridian of north latitude passes through the middle of the block. The township lines cut in 1911 and 1912 were easily followed. The magnetic variation of the compass, from bearings taken along the township lines, was found to be between 8° and 10° W.

Access

The best route to the area is by canoe from Gogama, on the Canadian National railway, where supplies may be purchased. The Minisinakwa river is followed northeastward and, after a lift over a dam and later a mile portage, Mattagami lake is reached. A short paddle to the northeast across the lake brings one to a creek which is followed, with one 25-chain portage, to the portage into Sinclair lake. This portage is about a mile and a half long over a good trail, which was once an old road.

[1]J. G. McMillan, Report of Geology of the Area along the T. & N. O. Railway Trial Line between Gowganda and Porcupine, 1912.

Other routes lead into the area. It is possible to enter the Grassy river at Grassy lake in Kemp township by taking a canoe route north from Shiningtree. Dumbbell lake in Halliday township can be reached by canoe from Gowganda by way of Lloyd lake. Prospectors in the early days entered Kitchiming lake, shown at the northeast corner of the map, by going up the Night Hawk river.

Muskasenda lake in the northwest of English township lies on a canoe route coming from the north through Bartlett township. It is also possible to reach the Grassy river in the north of the area by a portage leading east from the Mattagami river. Sinclair lake, which lies in the southwest corner of the area, can also be reached by coming south on the Mattagami river and lake from Porcupine; from here one can use the extensive course of the Grassy river.

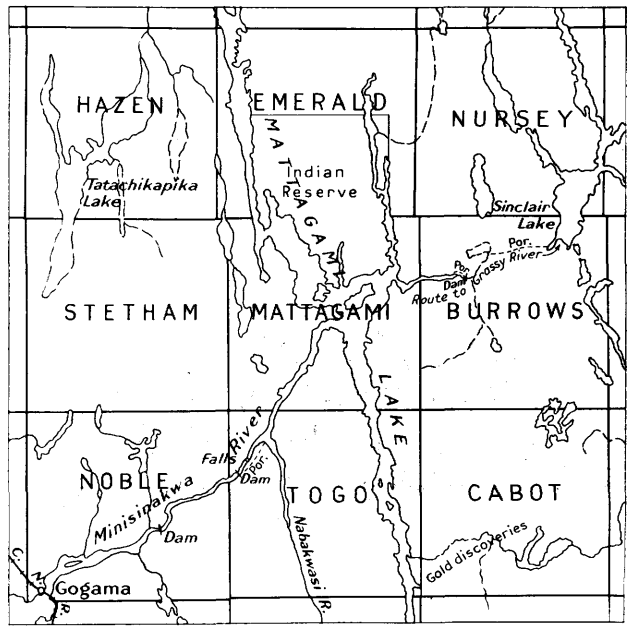


Fig. 8—Sketch map, scale 6 miles to the inch, showing the canoe route from Gogama station on the Canadian National Railway to Sinclair lake and Grassy River area.

Routes within the Area

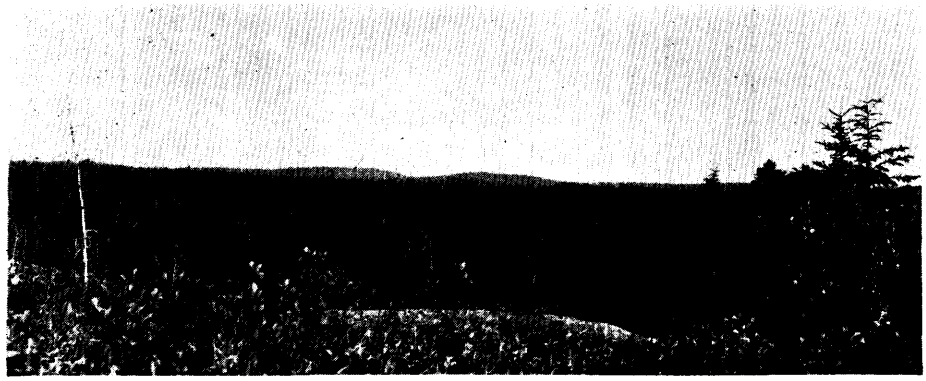
There are many rapids in the lower reaches of the Grassy but none in the upper waters. On account of the circuitous course of the river it is possible to travel by canoe into almost any part of the nine townships. Portage routes lead north to Muskasenda lake by way of the kettle lakes in Sothman, Semple, and English. Most of the creeks are navigable in early summer, and the portages are in good condition. Washagami, Dumbbell, Canoe Shed, Hutt, Montrose, Wellington, Horseshoe, and Kitchiming lakes can all be reached by canoe from the Grassy river.

Surveys and Prospecting

The population of these townships consists of a few Indian trappers with their families. Previous to 1867, this area was an unsurveyed Indian trapping-ground. In that year P. L. S. Sinclair ran a line, now practically obliterated,

from the forks on the Montreal river to Kenogamissee falls on the Mattagami river. Austen's Canadian Pacific trial line of 1880 crossed the area by way of Muskasenda and Kitchiming lakes to the great northern bend on the Montreal river. In 1896, the Nipissing-Algoma boundary line—now the Sudbury-Nipissing line—was run in this area by O.L.S. Niven; the report by the accompanying geologist, E. M. Burwash,[1] describes the rocks along the line. In 1900, Messrs. DeMorest and Sylvester, of Exploration Party No. 3, made a micrometer survey of the Mattagami river down to Niven's base line of 1899, and of the Grassy river from its mouth to Peter Long lake. They continued a canoe and log survey up the Grassy from Kapiskong to connect with the district line at Ferris lake; and from the portages at the divide, they made a canoe and compass survey down the Montreal river to Matachewan. The report of J. L. R. Parsons,[2] the geologist on this party, includes a description of the rocks along these streams.

The latest work prior to the present work of 1925 was by J. G. McMillan,[3] who described and mapped the geology along the T. & N. O. trial line in 1911.



View of skyline near Washagami lake, looking northwest from Sansawaju (Turkey) mountain, east of Grassy lake in Kemp township.

Early stakings were made in 1908 on the iron formation east of Muskasenda lake at the north end of English township. The discovery of gold at Porcupine in 1909 resulted in the staking of the quartz veins on Muskasenda and Kitchiming lakes. In 1912, tellurides of gold and silver were reported from Telluride and Muskasenda lakes. At this time, there was also considerable staking done in other areas, especially in the country north of Dumbbell lake and in Semple near Horseshoe lake.

During the summer of 1925, there was much prospecting along the Redstone in Semple and English, north and east of Canoe Shed lake, and north of Dumbbell lake in eastern Hutt and Halliday. Gold has been found in small quantities, especially near Horseshoe lake and east and north of Canoe Shed lake. This belt is several miles wide and is accompanied by feldspar porphyries and narrow quartz veins. The Keewatin greenstones in places have been heavily pyritized near the acid intrusives.

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[1]Ont. Bur. Mines, Vol. VI, 1896, pp. 167-84.
[2]Ont. Bur. Mines, Report of the Survey and Exploration of Northern Ontario in 1900, p. 107.
[3]Op. cit.

Summary

The area described is part of the Archean shield, and its present form is the result of long erosion. The flat peneplain surface is dotted here and there with a few resistant hills and ridges having elevations of 100 to 200 feet (see photo. on page 60). The basement consists of old Keewatin basic flows, slates, rhyolitic agglomerate and tuffs, all folded together, resting at high angles, and cut by later intrusives in the form of granite, feldspar porphyry, a few lamprophyre dikes, and northward-trending dikes of diabase. In the southern part of the area small patches of flat-lying Cobalt slates and conglomerate rest on the old Archean surface and dip gently to the east and southeast.

The diabase is chiefly in the form of narrow, northward-trending dikes that contain light-coloured spots of altered plagioclase crystals which have been called huronite. These dikes are commonest along the Grassy in Nursey, Moher, and Beemer. No dikes of this rock were seen to cut the Cobalt sediments.

The feldspar porphyries and lamprophyres are found chiefly in the country between Hutt and Muskasenda lakes. These porphyries have caused pyritization in the Keewatin greenstones, while they themselves are usually fresh, pink-coloured, and massive.

Small quartz veins are found in a number of places, especially near Telluride, Muskasenda, and Kitchiming lakes, along the Redstone in Semple and English townships, and from there in a southeast direction to Dumbbell lake. The veins on Telluride lake contain pyrite and pyrrhotite; those on Muskasenda are pegmatitic, having prismatic quartz crystals and pink feldspar, with few or no sulphides. The latter veins are spectacular in appearance, but have small possibilities as gold-carriers. Mineralized veins and wall rock appear on the Redstone near Horseshoe lake. A few quartz veins bordered by carbonatized and pyritized greenstone are found in the vicinity of Canoe Shed lake.

Quartz veins in sheared Keewatin rock appear in the eastern parts of Halliday and Hutt townships.

Among the samples of mineralized material, the best carried 40 cents per ton in gold and was found about ten chains north of the lake expansion of the Grassy situated on the north boundary of Hutt township. The next best carried 20 cents and came from an outcrop on the west boundary of Hutt just south of the porphyry outcrop marked on the map, west of the west arm of Canoe Shed lake.

Hutt, Halliday, and parts of Zavitz contain fairly good areas of clay soil that compare well with any in the clay belt of Northern Ontario. Black birch grows in a number of places in the above-mentioned townships; as a rule this tree indicates suitable farm land.

General Character of the Area

Relief

The group of nine townships examined lies within the area of the old peneplain that extends about Lake Superior. The low relief and immature drainage of this type of country is well known. On a large scale, it shows a monotonous flat skyline, but locally it presents sudden but small differences in elevation. There has been deep erosion in the old crystalline rocks, but where the flat-lying Huronian sediments (Cobalt series) or sills of Keweenawan diabase are encountered, hills and ridges formed of these rocks rise above the general level (see photograph on page 60). The glacial action has modified the present land forms as well as the drainage pattern.

Outcrops are fairly common, especially along the margins of lakes and rivers. A large part of this country is covered with vegetation and glacial material, not more than one-fifth of the total area having the bed rock exposed. The mantle of drift is usually thin, so that in places where fires have destroyed the protective growth, as in northern English and Zavitz, the loose covering has been washed from the higher ridges and hills.

The northern part of the area differs from that to the south in not having flat-lying Cobalt sediments resting on the planed-down surface of the Archean folds. It is a country of low rocky ridges and isolated hills, strewn with glacial drift. The land along Grassy river in Halliday, Hutt, and Zavitz generally lacks elevations exceeding 100 feet.



Pre-glacial fault scarp on the north face of a high ridge in the southeastern part of Hutt township.

A few miles east of the eastern boundaries of Zavitz, Hutt, and Halliday a prominent line of elevations appears, of which Mount Sinclair is the highest. These hills and ridges are composed of Cobalt sediments. Two prominent Cobalt hills rise in Mond township, forming landmarks on the southeastern horizon when viewed from Washagami lake in east central Sothman or from points in the south of Halliday. The Cobalt ridges to the east can be seen from the canoe route to Kitchiming lake through Austen lake, also from the route leading south from Montrose lake. The Cobalt rocks in the southern part of the nine townships do not form noticeable elevations and appear as low outcrops near water-level.

A thirty-foot cliff of Cobalt conglomerate can be seen along the Grassy about two miles north of Sinclair lake. Two rocky hills, which have a bench

of glacial gravel extending between them, appear in the southeastern part of Geikie township along the granite-greenstone contact. Similar glacial benches, at about the same elevation of seventy-five feet, were seen in the hills southeast of Dumbbell lake. A prominent ridge covered with birch and poplar runs north from the centre of Nursey township. The best example of a ridge formed at the granite-greenstone contact borders the east side of the Grassy in Beemer township, where the portage leaves the Grassy for Telluride lake. A rock ridge bordered by faulting, stretches southwestward from the north end of Hutt lake to the Grassy river. The faulting seen along the north flank of this ridge is shown in the photograph on page 62.

The majority of the land forms are rounded, but a few of the ridges show evidence of being bounded by fault or shear planes.

A noticeable change of relief is found in passing from the greenstone to the granite area, since the granite weathers differently from the greenstone on account of its greater uniformity of texture and difference in mineral composition. The



Reading lake, one of the typical kettle lakes in Sothman township.

Keewatin greenstone after being intruded by granite and diabase has been locally hardened by recrystallization; and as a result of erosion, these places stand up as hills and ridges, in contrast to the flatly eroded granite.

The regional north and south trend of the land forms and drainage has resulted from intrusive action, faulting, and glacial scouring. The glaciers have emphasized the pattern in the rocks by gouging out the softer ones, rounding off the ridges, and dumping loose rock material in a line parallel with its southerly movement.

Drainage

The lakes of the area are of two kinds: the one fills rock basins in the old rock surface or occupies valleys dammed by morainal material, while the other occupies kettle depressions encircled by glacial material (see photograph above). The lakes of the first type are usually linear and are part of a continuous drainage system, while those in the glacial drift are very irregular in outline, much smaller, shallower, and in places landlocked. Reading lake is a typical crystal-clear

lake of the kettle type, while Muskasenda lake is an example of the rock-basin variety. The kettle lakes in places are irregularly spaced, as in Sothman, or form a chain that serves as a canoe route connecting the lines of travel along the larger rivers. Such kettle-lake routes extend northward from Reading lake to Horseshoe and Muskasenda lakes, Parting lake being the point where the routes divide.

Most of the streams are free from long stretches of rapids, the northern part of the Redstone being the only exception. There are a few portages around rapids, but usually not more than one or two on each route. The damming of the Grassy has drowned two rapids on the route between Grassy and Sinclair lakes.

The Grassy starts from a swamp southeast of Kitchiming lake and has a number of large-sized tributaries in its course in Hutt and Halliday townships, the important ones coming from Wellington, Washagami, and Dumbbell lakes. The waters from Ferris lake join those from Dumbbell lake, about twenty chains east of the Grassy, and then flow into this river a few chains below the south boundary of Halliday. The Grassy river is also enlarged by the waters that flow into Grassy lake from the south.

Kitchiming lake sends its waters into the Night Hawk river by way of Austen lake. The river from Montrose lake has a tortuous course with one rapid before it enters Wellington lake. A fall is situated at the outlet of Wellington lake, but from here to the Grassy the stream is wide, with muddy banks and a slow current. The stream from Dumbbell lake has a few lake expansions and one small fall. Washagami lake receives most of its waters from the kettle lakes to the northeast and is one of the largest feeders of the Grassy.

The Grassy follows a circular course between the headwaters of the Redstone and the Mountjoy rivers. A study of the Grassy and its tributaries shows a possibility of its being a reversed river The tributaries in Hutt and Halliday flow in from the southeast and southwest, in keeping with the barbed pattern of a stream that once ran north, possibly into the Night Hawk The Night Hawk and the Grassy rivers both rise in the large swamp west of Kitchiming lake in Zavitz. Southward from Canoe Shed lake to the south boundary of Halliday, the valley of the Grassy is rock-walled, wide, and straight. It is possible that glacial damming in Zavitz and post-glacial tilting has deflected the Grassy waters southward.

At its source in Zavitz, the Grassy has a very small volume, although it is possible to canoe on it almost to the centre of the township. Just north of the south boundary of Zavitz, it widens into a large meadow expansion, then makes an elbow turn to the east, widens again to form a small lake, and runs south into Canoe Shed lake. Canoe Shed lake has low shores and an abundance of wild rice, the plant being so rank in its growth in the fall that it hides the inlet and outlet of the lake. Between Canoe Shed and Grassy lakes, the Grassy has intermittent ridges of Keewatin rocks along its banks. Meadow expansions of the river valley and a few large back-water lakes appear near the south of Halliday township.

The Grassy from the south of Halliday to Grassy lake has many meanders and flows through a drift-covered country having few rock outcrops. From Grassy lake to Sinclair lake, the river flows through glacial material into Loonwing lake and from there runs west, turning north where it touches Sinclair lake.

The drainage northward from Sinclair lake is through lake-like expansions, the largest of which is called Kapiskong lake and extends almost the length of

Moher township. Few tributaries join the Grassy in this part of its course, the largest being the creek out of Edith lake and a creek from the northwest of Beemer.

Nursey township contains three fairly large rocky lakes besides Sinclair lake. Blair lake at the south has shores of granite, except at the southeast corner where diabase and gabbro appear. Edith lake and the lake to the southeast of Edith have parts of their shores rockbound and are also encircled, like Blair lake, by some large stands of pine. It is possible to go from Sinclair lake to Edith lake and from there north to the Grassy or south into Blair lake. In Moher township, there is a long and shallow lake just north of Edith lake.

A creek, which rises in the large swamp at the north of Moher and south of Beemer, flows south along the west boundaries of Nursey and Moher. Another creek of good size comes into the Grassy from the northwest corner of Beemer.



Looking north on the Grassy river in Halliday township. This is a typical grassy expansion of this meandering river in the eastern part of the area.

The lower part of this stream near the Grassy is rocky and full of rapids; but above these, a large beaver dam raises the water and makes good canoeing to the west side of Beemer.

The route north from Reading lake via the kettle lakes is well cut out. From the northwest corner of Parting lake, there is a route to Semple and Muskasenda lakes, and from its northeast corner one to Horseshoe lake. McLeod's cabin and claims on a small lake are reached by following a mile down the creek flowing northeast from Ferrier lake. The trip from Muskasenda lake to Telluride lake is made by an alternation of creek and portage. These portages are not much used and are not in repair. A good portage leads west from Telluride lake to the Grassy.

The route to Kitchiming lake commences with a portage from the east end of the small lake on the Grassy on the north boundary of Hutt. This route is followed by means of portages and a series of lakes and creeks bordered by glacial material. Mary lake on the east boundary of Zavitz has outcrops of basic, massive Keewatin greenstone and is one of the prettiest lakes in the area, having

shores covered with large birch and pine. A creek leads from Mary to Austen lake. Kitchiming lake is reached by a creek emptying into the northwest corner of Austen lake.

A canoe route, by way of Wellington and Montrose lakes and then southward from Montrose lake, leads to Hutt lake. Massive Keewatin greenstone and rhyolite outcrops are fairly numerous on this route, but no mineralization was found. There is considerable faulting and shearing in the rocks on and west of Hutt lake.

Forests

The district is generally well forested except in the burned areas in Hutt, English, and Zavitz. The glacial soil which covers the greater part of the area produces a mixed woods composed of various conifers, together with birch and poplar. In parts of Sothman and Semple, jackpine, with diameters from eight to fourteen inches, are found in park-like stands. The low places along the watercourses are wooded, chiefly with spruce and cedar. A big ridge covered with birch and poplar extends along the west side of the Grassy in Nursey and Moher.

White and red pine of large size were seen in isolated patches on sandy soil about the rocky lakes in Nursey and the kettle lakes in Sothman and Semple. A splendid stand of white pine was found a mile southwest of Kitchiming lake in Zavitz.

Signs of old fires show in the areas of birch and poplar, and it appears that these trees have replaced former growths of red and white pine.

Spruce is scattered over the whole area but is especially abundant in the low places along the branches of the Grassy.

The chief burnt areas are about fifteen years old and are indicated on the map. The largest of these occupies a wide band from Telluride lake eastward to Kitchiming lake. Another large burnt area reaches from Montrose lake southwestward to the Grassy.

Much timber has been killed along the Grassy in Nursey, Moher, and Beemer by the damming of this river, and the south end of Sinclair lake is filled with dead timber. In places in this flooded area, it is difficult to land from a canoe on account of the dead and fallen trees.

A few ash trees grow on the muddy banks of the Grassy in Halliday, and a large, mature white elm was seen on the south boundary of Sothman.

The red squirrel is a great enemy of the red and white pine as this rodent lives on the seeds of the pines, thus preventing natural reforestration.

Game and Fish

Moose are fairly plentiful. The country is well suited to these animals on account of the large number of creeks and secluded small lakes. Red deer were seen in a few places; they are plentiful on the big birch and maple ridge in southeast Hutt. Black bear were met on a few occasions. Black duck are quite numerous along the rice-bordered parts of the Grassy in Zavitz, Hutt, and Halliday. Beaver are not numerous, as this ground has been trapped over thoroughly by Indians from Fort Mattagami.

Pike and pickerel are plentiful in nearly all the lakes and streams. Lake trout can be caught in Ferrier lake, which is one of the headwaters of the Redstone, and brook trout in the Redstone north of Steve lake in English township.

As a fact of historical importance, it may be noted here that there are signs of very old Indian encampments on Canoe Shed lake and at other points along

the Grassy. The passing of old Fort Mattagami on Mattagami lake and the removal of the Hudson's Bay Company to Gogama marks a new cycle in northern Ontario trading.

Resources

No water-power is found within the area, but the waters of the Grassy serve as a reservoir for the power development farther north on the lower reaches of this stream.

The large quantity of pulpwood and timber is the chief resource of this area. Spruce, poplar, and jackpine cover large tracts along the Grassy and its tributaries.

Certain areas, especially in Hutt and Halliday townships, have a clay soil suitable for mixed farming.

Prospecting up to the present has not shown any large masses of mineralized rock, although gold may possibly be found later in paying quantities. Gold has been found in several places, especially about Horseshoe and Canoe Shed lakes. The feldspar porphyries are coarse grained. No gold-bearing quartz porphyries of definite Algoman age were discovered during the summer.



Moose on Washagami lake, a familiar scene in fly season.

General Geology

Outline of Geological History

Examination of the rocks shows that they fall into five main groups.

The oldest group, the Keewatin, consists for the greater part of altered eruptive rocks, both extrusive and intrusive in origin. The colours are usually green or grey. Very few areas of intensely sheared rocks were found, and well-developed chlorite and hornblende schists are uncommon. Most of the Keewatin has a massive texture, which doubtless is the result of recrystallization by the intruding granite that probably lies at no great depth beneath it. A few bands of acid tuff were seen, the best example being northwest of Hutt lake.

Most of Halliday and the eastern part of Sothman is underlain by a rhyolitic agglomerate of Keewatin age. This rock resembles a conglomerate in places and has been mistaken for a Timiskaming sediment. (If its uniform composition is noted, this error is usually averted.) No areas of serpentine-periodite rocks were seen.

A band of Keewatin iron formation with lenses of magnetite and pyrite extends southward from the old Cropsey iron claims at the north central part of English to Redstone lake in Semple. Near Foisey's dam, in Semple, a mile below Horseshoe lake, iron formation is cut by feldspar porphry and granite porphry. In places it is pyritized and contains quartz veins with gold. This band of iron-formation sediments is standing on edge, showing that the enclosing greenstones, although now massive, were also highly folded. The iron formation is a remnant in an old synclinal area parelleling the major granite contact that lies to the west along the Grassy river.

The second group comprises fragmental rocks, possibly of Timiskaming age, which appear in the northeast of Halliday north of Dumbbell lake. These rocks are now highly altered, being schistose and carbonatized, and in places contain slaty bands. The structural evidence shows that they form the nose of a syncline that plunges eastward. These much altered rocks are surrounded by Keewatin agglomerate that also has slaty horizons, and it is most likely that the altered Timiskaming-like rocks represent a metamorphosed facies of the Keewatin agglomerate.



Siliceous bands in Cobalt conglomerate differentially eroded and resembling pink granite dikelets, Grassy river north of Sinclair lake.

The third division consists of granites and similar acid intrusives with a considerable variety of composition, colour, and texture. They are all intrusive into the Keewatin, which is altered to massive hornblendic rocks and in places is injected with acid bands of pegmatitic material and crosscutting dikes of porphyry, pegmatite, and lamprophyre.

The fourth series are north-trending dikes of diabase accompanied by bosses of gabbro. The dikes are usually narrow and in places contain altered phenocrysts of feldspar. Their altered appearance, their direction, and the fact that they were not seen to cut the Cobalt series but cut the granite, places their age as pre-Cobalt and post-Algoman. They are doubtless of the same age as similar dikes found to the east in the Matachewan area and described by Burrows.[1]

The fifth and youngest group consists of conglomerates and greywackés (see photograph above) similar to those of the Cobalt area. They are usually distinguished from the Timiskaming series by the abundance of granitic material

[1]Gowganda Silver Area, Ont. Dept. Mines, Vol. XXX, pt. 1, 1922, p. 89.

in their composition, by the fact that they are but little altered, and by their nearly horizontal attitude. In places the Cobalt conglomerate has a steep primary dip where it rests on the sloping Archean basement. Granite porphyry boulders found in the conglomerate match the rock in place a few chains away.

Table of Formations

The rocks of the nine townships are all pre-Cambrian and, starting with the youngest, may be classified as follows:—

COBALT SERIES (Upper Huronian): Conglomerate, greywackés, slates, and quartzites, generally dipping at low angles and nearly free from folding and shearing.

MATACHEWAN SERIES of basic dikes and gabbro intrusions.

ACID INTRUSIVES (probably Algoman): Granites, gneisses, porphyries, pegmatites and lamprophyres (basic), all older than the Cobalt series.

TIMISKAMING SERIES: There is a small possibility of this series being represented by much altered rocks in eastern Halliday.

KEEWATIN SERIES: This is the oldest series and has been much altered, being formerly composed of basalts, andesites, quartz porphyries, amygdaloidal greenstones, rhyolitic agglomerates, with a few bands of iron formation.

Keewatin Series

The Keewatin series is found in more than two-thirds of the area, underlying practically all of the townships of Sothman, Semple, English, Halliay, Hutt, and Zavitz. The greenstones and rhyolites comprise the two main groups of this series. The rhyolitic greenstones and rhyolitic agglomerate form the bed rock of most of Halliday and the eastern half of Sothman, while the remainder of the Keewatin embraces various facies of the more basic greenstones varying from basalts and andesites to dacites.

A sheared Keewatin rhyolite outcrops along the water on the southeast bay of Canoe Shed lake. On the southwest corner of Muskasenda lake, the greenstones correspond to a dacite or quartz andesite. The general direction of schistosity is from northeast to southwest, with nearly vertical dip.

The Keewatin on Sinclair lake consists of pillow lava and volcanic fragmentals now rich in carbonates. Northward on the Grassy from Sinclair, the greenstones have been altered to fissile hornblende and biotite schists. Profound metamorphism of this type is lacking in the Keewatin area to the east.

The Keewatin on Telluride lake is massive and shows little effects of shearing. On Muskasenda lake there are a few narrow bands of intensely sheared greenstones, but these zones lack mineralization or quartz veins.

A cliff of greenstone with quartz veins can be seen on the secluded bay at the south end of Ferrier lake in English township. On Kitchiming lake, the Keewatin rocks are massive and the quartz veins they contain are unmineralized.

The greatest amount of shearing seen in any of the greenstone areas is in Hutt township in the vicinity of Canoe Shed lake and in directions west, north, and east of this lake. In these places the Keewatin is much sheared and carbonatized. Just south of the crossing of the Grassy river and the north boundary of Halliday, a Keewatin agglomerate has been greatly sheared, together with some included slate bands.

The mass of rhyolitic greenstone and agglomerate in Halliday and Sothman apparently has been little affected by dynamic metamorphism. Quartz veins and acid dikes are practically absent in the rhyolites excepting in places near Dumbbell lake.

Timiskaming Series

No rocks of this age have been definitely located within the nine townships examined. The rocks near the east side of Halliday have been called Timiskaming, but they are probably sheared agglomeratic Keewatin volcanics.

Acid Intrusives

No granite appears in the country east of the course of the Grassy in Nursey, Moher, and Beemer, excepting a small amount just inside the north boundary of Zavitz. Within the Keewatin area, the acid intrusives have both fine and coarse texture, but there are no true rhyolites or quartz porphyries. Feldspar and granite porphyry are the commonest acid dike-rocks.

The main mass of hornblende granite and gneiss in Nursey, Moher, and Beemer is characterized by a content of pink potash feldspar. In a few places a biotite-rich granite appears, as on the small lake at the north boundary of Moher. Along the major granite-Keewatin contact, hornblende and biotite schist are included in the granite and represent a highly altered form of the basic Keewatin flows. They represent the highest degree of alteration that the Keewatin has undergone in the entire area.

In certain localities along the granite contact in Moher, the granite has developed phenocrysts of pink potash feldspar.

The acid dike intrusions are commonest between Muskasenda and Hutt lakes. Granite porphyry is found near Horseshoe lake, just north of Redstone lake, and again near the northeast corner of Canoe Shed lake on a claim staked by James Luke. Some of the dike rocks that are pyritized are lighter coloured than the usual porphyritic pink ones. This is due to alteration by solutions which have introduced pyrite and carbonates.

A few lamprophyre dikes were noted. One cuts the granite on the southwest shore of Sinclair lake; others were seen on claims north of Canoe Shed lake and near Horseshoe lake.

Basic Dikes and Intrusives (Matachewan)

The diabase intrusions are narrow, usually less than 100 feet wide. They trend north and south and have large altered plagioclase phenocrysts. They outcrop along the Grassy river in Nursey, Moher, and Beemer, and mark a line of faulting which parallels the major contact of the granite and greenstone. Similar dikes appear in Zavitz on the second lake west of the Grassy river on the route to Kitchiming lake. Near the east end of Semple lake, diabase grades into gabbro, which in turn changes to granophyre. Gabbroid rocks were seen on the southeast of Blair lake and on the Grassy river a few chains from the north boundary of Beemer. The diabase dikes resemble closely diabase dikes in the Matachewan area to the east, described by Burrows.[1]

Cobalt Series

Sediments of Cobalt age in this area are limited to several small outcrops. At the east end of Loonwing lake, a little-altered basal conglomerate rests on the old land surface, which here is a massive diabasic rock. This diabase has furnished the boulders for the conglomerate, a fact that shows the local origin of some of the material in the Cobalt sediments. Cobalt conglomerate boulders are seen in numbers on the shore at the north outlet of Sinclair lake on the route

[1]Op. cit.

to Loonwing lake. McMillan has Cobalt rocks marked here, and no doubt the outcrop would show if the Grassy waters were lowered 15 feet or so to their natural level. Again, about two miles north of Sinclair lake, the Cobalt rocks appear on a steep cliff, and other outcrops on the same shore extend for half a mile farther north. The cliff exposure is composed chiefly of conglomerate, which in places contains bands of felspathic quartz sand that have been recrystallized and now stand out in relief. These pink stringers resemble dikelets of granite. The outcrops north of the cliff are mostly greywacké resting in an almost horizontal position. The greywackés show ripple marks and fine depositional banding. The conglomerate boulders are in part composed of porphyritic granite which is found near by.

Pleistocene

The rock surface is hidden in most places by a covering of glacial clay, sand, and gravel. This material is spread over the country in such a manner as to iron out many of the small irregularities in the bed rock.

Extensive, flat, glacially covered areas are found in Zavitz at the headwaters of the Grassy river and in English, Semple, Nursey, Moher, and Beemer. Halliday, Hutt, and Zavitz have no large areas of glacial sand or gravel.

Semple and Sothman townships are largely covered with glacial sand and gravel and have many kettle lakes.

Structural Features

That this country is regionally faulted north and south is suggested by the course of the Grassy in the west of the area, by the continuous north and south diabase dikes in the same area, by the course of the Grassy river in Zavitz, Hutt, and Halliday, and finally by the high, faulted ridge of Cobalt sediments lying just east of the present map area.

A later set of adjustment faults are accompanied by some northeast-southwest shearing and are most noticeable on the north side of the high ridge west of Hutt lake. This line of faulting is reflected to a minor degree by the direction of the river courses in Hutt township. Good field evidence of a shear zone was found passing through Shear lake and another along the north side of the big ridge in southeast Hutt (see photograph on page 62).

Economic Geology

The area discussed in this report is situated 50 miles west of Kirkland Lake, on the strike of the Kirkland Lake gold belt. Some gold was found during the first rush in 1910, which followed the discovery of the Porcupine gold field situated about 25 miles to the north. The chief interest in the early days was centred on the country about Telluride, Muskasenda, Kitchiming, and Montrose lakes. The recent prospecting has been along the Redstone river near Horseshoe lake, about Canoe Shed lake, and north of Dumbbell lake. Traces only of gold have been found in these localities.

Beemer Township

Telluride Lake.—The old claims on Telluride lake show a few small sugary-textured quartz veins contained in massive greenstones. The veins, which are in places well mineralized with pyrite and pyrrhotite, can be seen in the old trenches near the portage landing at the east end of the lake. Promising-looking

quartz veins over a foot in width appear half way along the portage trail east from the lake. No other quartz veins or mineralized rock were found on the traverses made in the area surrounding the lake.

Tests made on the sulphides and mineralized quartz from the veins on Telluride lake gave no traces of tellurides or gold.

English Township

Muskasenda Lake.—The veins on Muskasenda lake that excited so much attention in 1910 are of a pegmatitic nature, containing pink potash feldspars and comb-structured quartz. Sulphides are present in very small amounts. The veins conform to the dips and strikes of the joint planes of the massive greenstones and are widespread about the shores and islands at the southern part of the lake. A small island near the southwest shore is composed largely of quartz. These veins have small possibilities as gold producers.

On the southwest shore where the eleven patented claims are located, the Keewatin greenstones are cut in three places by small intrusions of fine-grained pink aplite. Several shear zones were found in the greenstones, but they are narrow and unmineralized.

A prospect has been developed by J. McLeod at a dam about a mile down the creek flowing northeast from Ferrier lake. At this place coarse-grained, pink feldspar porphyry cuts Keewatin greenstone; both the greenstone and the pink feldspathic material are heavily impregnated with cubical pyrites. Several similar prospects are located along trails leading away from the dam. One pit about a mile to the northeast contains feldspar porphyry and banded siliceous iron formation. More extensive iron formation can be seen to the north on the old Cropsey claims.

The Cropsey iron claims are unpatented and lie at the north central part of the township. They were examined in 1911 by J. G. McMillan. As this examination was made while their development was in progress, McMillan's description is given here:—

> These [claims] are situated on the north boundary in the middle of the third mile, and the showings extend for half a mile south in the township. The formation consists of banded silica together with a little jasper, and iron ore occurring both as magnetite and as hematite, in bands mostly a fraction of an inch in width. Green rock material with a spotted appearance on a weathered surface forms a considerable part of the formation, which has here a width of 50 feet. Considerable pyrite occurs banded with silica on the east side, and as large cubes scattered through the rock. In an outcrop 16 chains south of the other, the strike has altered from the general north and south direction and is nearly northeast. At this point the iron ore and green rock material both occur as pockets in much contorted banded silica, the width being about the same. At a point 12 chains north of the first outcrop the iron ore occurs as a cement, binding brecciated portions of the banded silica, and at 16 chains north there is 100 feet in width of this breccia, composed of iron formation. Similar breccia outcrops 4 chains north of this point and 12 chains from the line where the iron formation is lost in a spruce flat.

Claims have been staked in southeast English north of the Fo'sey group, about Horseshoe lake, and north along the Redstone as far as Steve lake. The general type of mineralization, in the areas adjacent to feldspar porphyry dikes, is a pyritization of the greenstones accompanied by quartz veins. A large volume of pink feldspar porphyry appears on the west bank of the Redstone in the long stretch of rapids just north of Steve lake.

Semple Township

An area of Keewatin greenstones cut by feldspar and granite porphyries stretches from Redstone lake to Horseshoe lake in northeast Semple; the mineralization appears along a band of iron formation that strikes north and south, following closely the west bank of the Redstone (see sketch map on next page).

The largest and most representative group of claims were staked by Frank Foisey in an area extending north into English township from the dam on the Redstone a mile south of Horseshoe lake. Twenty-seven claims have been recorded in Semple and forty-six in English up to June, 1925.

Foisey made his original discovery about fifteen years ago, when he found a large lens of pyrite. Since then he has prospected and developed a group of some twenty claims. The mineralization on these claims can be described as a pyritiferous, cherty, banded Keewatin iron formation, strking north and south,

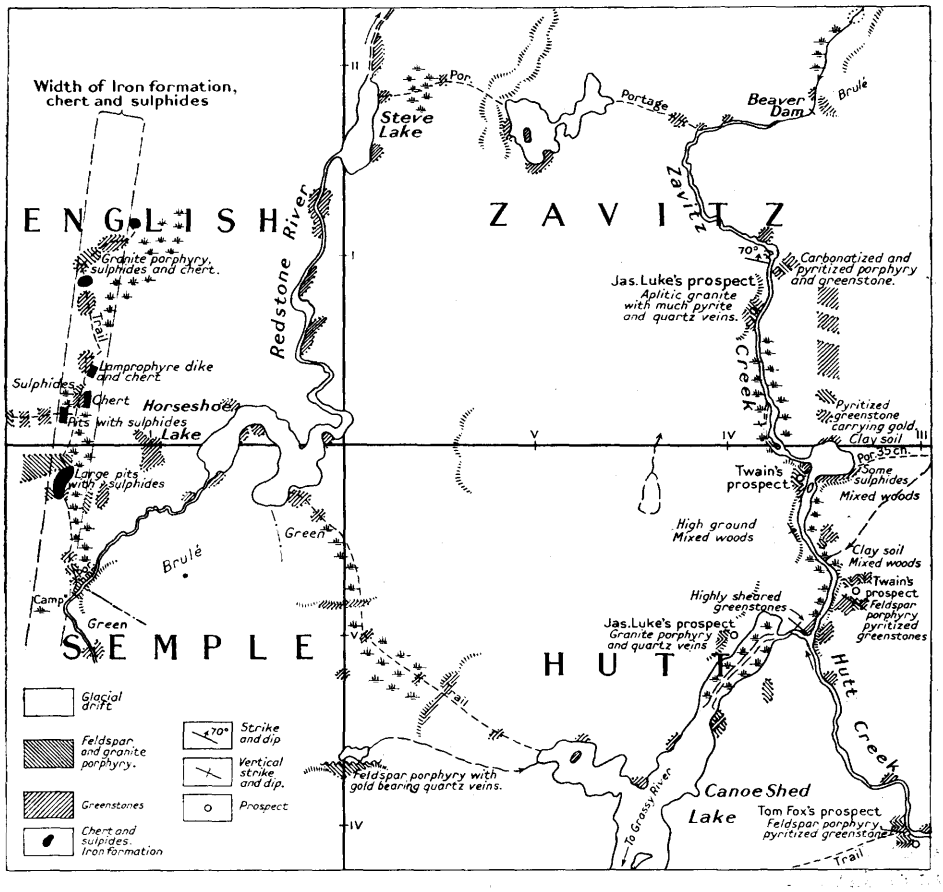


Fig. 9—Geological sketch map, scale one mile to one inch, showing part of the Grassy River area.

which is cut at intervals along its length by a set of east and west dikes of pink feldspar porphyry. Pyrite, quartz veins, and some gold were introduced with these intrusives.

The main trenches and development on the Foisey claims are situated 30 chains northwest from the crude dam on the Redstone, near Foisey's camp. Small pits were seen in a number of places, but the geology was much the same as that at the largest pits. Here pink and occasionally grey feldspar porphyry can be seen cutting Keewatin greenstone and cherty, banded iron formation. In many places the greenstone as well as the chert-like silica, has been heavily pyritized. The highly pyritized places have been deeply oxidized, the oxidation

extending to a depth of twelve feet in one locality. The rusty capping along the outcrop when panned sometimes shows finely divided gold. The chief minerals besides gold are pyrite, siderite, and a little chalcopyrite.

Northward in English township along the trails and claim lines, similar porphyry and mineralization were noted. In addition, in the area just north of the Foisey group, granite porphyry and dikes of lamprophyre were also observed.

The mineralization along this north and south belt of claims does not extend very far east and west and appears to be controlled by the pyrite-bearing iron formation (see sketch map on page 73). It is apparent after examining the vein matter on these claims that the pyrite most likely belongs to the Keewatin iron formation. Large lenses of pyrite have been seen in other areas having similar Keewatin rocks. The pyrite at some future time might be useful as a source of sulphuric acid.

Zavitz Township

Kitchiming Lake.—A burnt area extends over the north shore of this lake, exposing massive Keewatin rocks that have been altered to actinolite and epidote. These minerals give the rock a light colour, and at a distance it looks like a quartz porphyry. The joint planes are filled with vuggy quartz veins containing epidote. None of the veins exceeds 10 inches in width, and the only metallics are a few crystals of pyrite. These veins give little promise of gold.

Five claims have been recorded along the Redstone north of Steve lake and four others near the northwest corner of the township.

The more important claims in Zavitz are along the Grassy just north of the south boundary of the township. Three claims have been recorded on the west side of the river at a point where an aplitic dike cutting greenstones has has introduced pyrite and quartz veins. The old trial line of the T. & N. O. Railway passes through the claims close to the trenches. These claims were staked by James Luke, an Indian prospector. Samples from here carried no gold. Claims with similar geology are to be seen north and east of this group of three (see sketch map on page 73).

Ten chains north of the west end of the lake enlargement of the Grassy on the south line of Zavitz, the writer found an outcrop of pyritized greenstone, a sample of which assayed forty cents per ton in gold.

Hutt Township

Most of the prospecting in Hutt has been in the vicinity of Canoe Shed lake and along the Grassy north of the lake; at a point half way up the river between the Grassy and Wellington lake; in the country about Shear lake; and in the area of disturbed rock southwest and north of Hutt lake (see sketch map on page 73).

Feldspar porphyry outcrops on the west boundary of Hutt about 140 chains south of the northwest corner of the township. Here, just south of a small lake that touches the line, quartz veins were found that contain pyrite. A sample of this quartz carried twenty cents per ton in gold.

There are three prospects north of Canoe Shed lake. One is at the northwest corner of the lake where James Luke has found a granite porphyry accompanied by pyritized greenstones and small quartz veins. A sample from here carried no gold. Thirty chains north of the junction of the Grassy and the creek from Wellington lake, on the east bank, D. Twain, Sr., was developing a claim that showed sheared and pyritized Keewatin greenstone intruded by pink feldspar porphyry. A few chains in from the river, a break 16 chains long had

been picketed and showed greatly sheared greenstone with pyrite along its length. A band of highly carbonatized rock spotted with green was noticed on this claim. Quartz veins were lacking here, and a sample showed no gold on assaying.

The third place that showed mineralization was a few chains below the lake expansion on the north boundary of Hutt and on the west bank of the Grassy. Some work had been done here on an exposure of porphyry and greenstone that were pyritized and on the surface had a deep covering of kaolin and limonite. There were no quartz veins, and the deposit appeared to be small. Samples carried no gold.

Tom Fox found some mineralized greenstone bordering a feldspar porphyry on the south bank of a creek about half way up from the Grassy to Wellington lake.

Sheared greenstone containing some finely crystallized pyrite appears on the point running out from the west shore of Canoe Shed lake just south of the large island in the centre of the lake.

In general, the greenstones about Canoe Shed lake are sheared and pyritized, but quartz veins and other evidence of hydro-thermal action are lacking; up to the present, no mineralization of commercial interest has been found there.

Traverses north and south from Wellington lake failed to disclose any mineralized rocks or quartz veins, although shear zones were found in the greenstones. An outcrop of feldspar porphyry was found a few chains southeast of Shear lake.

Halliday Township

The most promising ground in this township lies north of Dumbbell lake and is contained between the Grassy and the east boundary of the township. On the line north from Dumbbell lake, the rocks were found to consist chiefly of sheared and carbonatized Keewatin rhyolites. No quartz veins were seen, but some are reported from the area about the small lake that can be reached by an old trail that leads north from the northwest corner of Dumbbell lake.

Rock Structure in Eastern Halliday.—In folded rocks with slaty cleavage, the cleavage planes are parallel to the axial planes of the folds, the slaty cleavage being more pronounced in synclinal areas. It is evident that the bedding and the slaty cleavage surfaces will intersect; the bedding planes, even in closed folds, are seldom as steep as the cleavage planes. This line of intersection of bedding and cleavage will show the pitch of the structure, i.e., it will pitch more steeply as either end of the fold is approached and be nearly horizontal along the central portion.

The pitch of folds is also shown by the pitch of smaller folds found on the larger ones. In places the folded rocks will show a pole-like form along the axial lines. This feature serves to indicate the pitch when the slaty cleavage is poorly shown.

On the east boundary of Halliday near mileage 83, bedding and cleavage are well shown. The relation of bedding and cleavage in this locality indicates the western nose of an east and west syncline. Synclinal areas, when they include porphyries or quartz veins, are favourable places in which to prospect, particularly along the line of their axial planes.

Sothman Township

Pyritized Keewatin rhyolite was found on the northeast bay of Sothman lake, but there were no quartz veins or other mineralization.

Nursey and Moher Townships

The remaining townships of Nursey and Moher are chiefly underlain by granite, and no signs of mineralization were found in them.

Geology of the Prospects on Beaver and Schist Lakes

In July, a visit was made to a group of claims on Beaver lake about twelve miles west of Gogama. The claims are situated on the east shore of the lake and about a mile north of the south boundary of Neville.

The Keewatin greenstones that form the country rock here are in contact with a pink massive granite 40 chains or so north of the claim with the showing of copper. The principal discovery is a few hundred yards back from the lake and southeast of the two cabins near the shore. The mineralization consists of chalcopyrite and quartz veins in an east and west vertical shear zone in the greenstone schists. Chalcopyrite, in honeycombed masses due to the oxidation of the admixed pyrite, forms the chief metallic content of the vein.

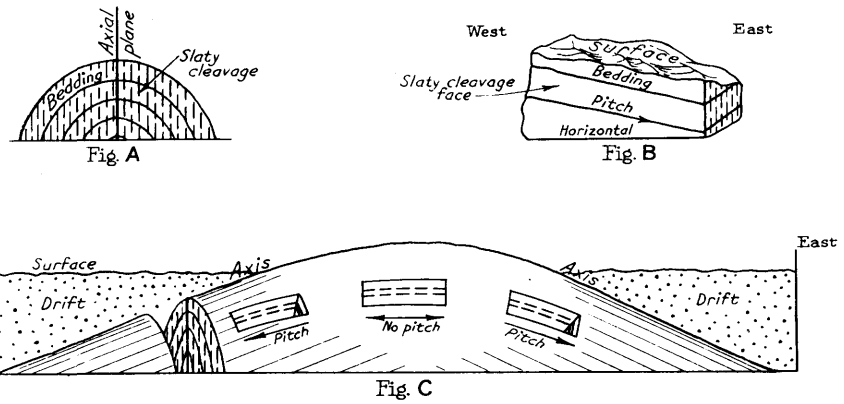


Fig. 10.—Diagrams showing anticlinal and synclinal conditions.

A.—Section through an idealized anticline to show relations of axial plane, bedding, and slaty cleavage.

B.—Conditions indicating proximity to nose of a syncline in eastern part of Halliday.

C.—An idealized anticline, explaining pitch. Conditions are reversed in a syncline.

A trench eight feet deep and six feet wide has been excavated along the vein system for over a hundred feet. The visible part of the vein carries too small a volume of metallics to be of commercial use. Prospecting along the strike of, or parallel to, the present break might uncover larger bodies of sulphide. From the railway this place is easily reached by canoe through Beaver lake.

Schist lake, lying in the southwest corner of Neville township, was reached from Beaver lake by following a canoe route that starts about half a mile northwest of the two cabins on the Beaver Lake copper claim.

The Keewatin rocks on Schist lake are lavas that are now highly schistose. The only prospect visited was situated about half a mile south of the central part of the south shore of the lake. An old road, now nearly hidden, leads to a 30-foot vertical shaft, which has been sunk on pyritized chlorite and sericite schist. A few small quartz stringers were seen, but the mineralization is on a small scale and could not be traced on the surface for any great distance. No gold was found in assays of the mineralized schist.

Notes on the South Part of the Grassy River Area

By T. L. Gledhill

Introduction

Owing to the death of F. L. Finley,[1] in April, 1926, his report on the townships of Burrows, Kemp, Mond, Cabot, Kelvin, and Natal did not come to hand, although he completed the geological map of these townships.



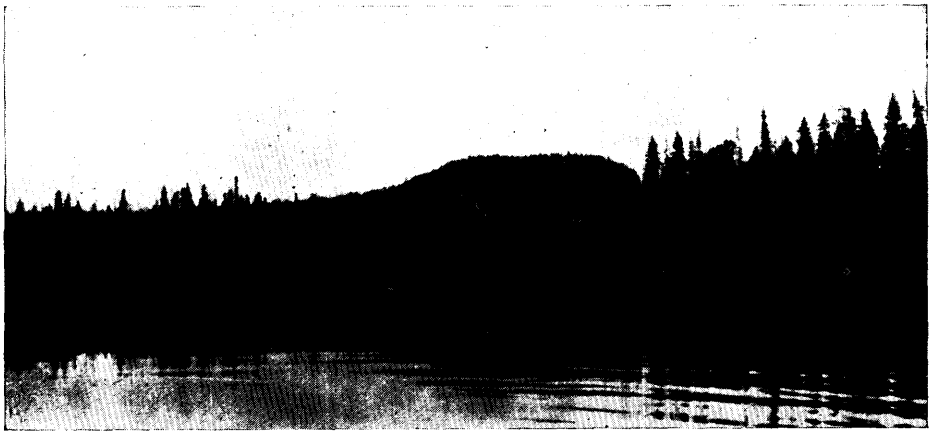
Sand esker, with Norway pine and flowering Saskatoon bush, on the bank of the Grassy in the northwest part of Mond township.

The writer has undertaken a brief summary of the geology, since he covered the area just north of Mr. Finley's, paddled through part of his territory, and

[1]F. L. Finley, under instructions from the Department of Mines, made a geological survey in 1925 of the townships of Cabot, Kelvin, Natal, Burrows, Kemp, and Mond. He finished his work in the field and returned to Princeton, where he was taking post-graduate work. He had completed the map of the area and also, as it is understood, his written report. Owing to his untimely death in April, 1926, the report has not been received. The map, however, is being printed on a single sheet, along with the area lying to the north, which was examined by T. L. Gledhill. Mr. Finley gave promise of unusual excellence, both as a man and as a geologist, and his early death is a loss to his profession.—T.W.G.

conversed with him in the field on the geology. Letters sent to A. G. Burrows, Provincial Geologist, from the field by Mr. Finley supplied additional facts. Through the kindness of Thos. Saville and the Porcupine-Kirkland Gold Mines, Limited, samples of rocks and vein material were received from the gold discoveries in Cabot. The following is an extract from a letter by Mr. Finley, dated July 9, 1925:—

I started working in Cabot township and have covered the south part of the township in some detail, for there are economic possibilities there. Passing through Claw lake, there is a stock of porphyry about one and a half miles long by half a mile wide. This body is pretty well differentiated into a basic granite or diorite along its southern margin and a reddish feldspar and quartz porphyry with associated lamprophyres on the north contact. A number of promising discoveries have been made along the north contact. In parts the quartz is shot through the porphyry, forming stockworks, but there are also some well-defined shears, giving more the Kirkland Lake type of deposit with quite abundant pyrite-molybdenite mineralization. Assays are reported from $1 to $6 to $14, but, as most of the stuff is still under moss, I have put off sampling till I go through there again in August on the way to Kelvin, Natal, and MacMurchy, and I expect that a little more work will have been done by then.



Sansawaju (Turkey) mountain as seen from Grassy river, looking east.

To the north and south of this body, the Keewatin is exceedingly tight, and all the north half of Cabot is sand plain. The west half of Burrows is granite and sand plain, but there is said to be some more favourable ground in the northeast corner of Burrows.

Mr. Finley's letter of October 28, 1925, to Mr. Burrows, says by way of summary:—

I have made a pretty careful examination of the six townships you assigned to me and found very little of economic interest, except in Cabot township, which has some possibilities. I also did the northeast corner of MacMurchy, where most of the staking belongs to the Gowganda boom days with very little activity since.

Access

Cabot and the adjoining townships are reached usually by canoe from Gogama station on the Canadian National railway by way of the Minisinakwa river and Mattagami lake, although an alternative canoe route is possible by going north from the West Shiningtree gold camp.

Topography

The northern tier of townships, i.e., Burrows, Kemp, and Mond, consists of sand plains, of glacial outwash, covered with small kettle lakes and pot-holes, with little bed rock showing, except near the watercourses.

The southern tier, i.e., Cabot, Kelvin, and Natal, shows higher ground and larger areas of exposed rock. The higher elevations here are composed of Keewatin rocks that form a height of land which passes in a northeast direction across Mond, Natal, and Kelvin.

Remnants of the Cobalt sediments, mainly conglomerate and quartzite, constitute the chief prominences, in the form of isolated hills and ridges, as in Mond and Natal. These hills dominate the landscape and are used as locations for lookout towers by the Ontario Forestry Branch. Two such towers were built, one in western Mond, used temporarily, and the other in western Natal, the latter being higher and better suited for observation purposes.



Granite on the west shore of Sinclair lake, looking northward.

The granite in Burrows and Cabot townships has been flatly eroded, in contrast to the remaining Keewatin and Cobalt areas that contain the high ridges and prominent hills.

The majority of the lakes and streams have their longer axis in a north and south direction, and this bearing is the line of crustal weakness.

General Geology

The rocks are similar to those encountered by the writer to the north, i.e., Keewatin volcanics of both acid and basic facies; pink Algoman-like granite and granite gneiss, with associated lamprophyres, porphyries, and gold-quartz veins that cut the Keewatin rocks; Cobalt sediments; and diabase dikes of Keweenawan age.

Rocks

The oldest portion of the Keewatin is the most basic and lies nearest the granite on the west of the area. As one proceeds eastward, the basic flows give place to tuffs and finer pyroclastic sediments. Farther east these are succeeded by trachyte breccia and thin flows. Since these varieties of acid and basic lavas are found in the same area, it is probable that the regional basic type of volcanic fissure eruption occurred in Keewatin time in this locality as well as the more acid, central or explosive type.

The granite is massive, pink in colour, and in places gneissoid. It also has a syenitic facies. The lamprophyre dikes are alkali-rich and appear chiefly near the mineralized breaks, as in Cabot.

The Cobalt series is composed of both fine-grained sediments, such as arkose, argillite, and quartzite, and a coarser conglomerate type. The conglomerate and quartzite grade imperceptibly into one another and are usually pinkish in colour, on account of their large amount of pink undecomposed feldspar from the local granite.

In Natal, Mr. Finley shows, on his map, diabase dikes cutting Cobalt sediments and in his map legend classes the diabase as Keweenawan in age.

Structure

The general grain of the rocks and the direction of crustal weakness appear to be north and south, as evidenced by the lake system, the direction of the diabase dikes, and faulting, although the gold-quartz veins in Cabot strike nearly east and west. This latter system is dependent on a local east-west ridgelike intrusion.

In Kemp and Kelvin Mr. Finley shows a large number of strikes and dips on bedded Keewatin volcanics. The average strike is north and south, and the dips are steep and variable in direction. The Keewatin in MacMurchy shows a swing in strike. Iron formation in the southeast part of Kelvin strikes northwest-southeast.

The Cobalt sediments, in Mond and Natal, are shown striking nearly north and south and dipping flatly, at angles of 20 to 30 degrees to the east.

Economic Geology

In south central Cabot, the discoveries of gold-bearing quartz veins have been made on the north side of an east-west ridge of a differentiated intrusive. Associated with these gold veins are pink feldspar and quartz porphyries. One type of mineralization is in a stockwork of vein quartz in porphyry, while another variety is formed in the sheared porphyry. This latter type has much pyrite and molybdenite as companion minerals to the gold. The gold assays are reported to run from $1 to $14 per ton. Some of the vein quartz has a greasy lustre and streaked appearance, not unlike that found at Kirkland lake.

Thos. Saville, Shiningtree P.O., was early in the Cabot field and staked a number of claims.

The Porcupine-Kirkland Gold Mines, Limited, has a group of fourteen claims in south central Cabot, and propose to do development work on some large quartz veins and build a road to connect with Westree station on the Canadian National railway.



Group of camps of the Porcupine-Kirkland Gold Mines, Limited, on claim No. 5,062 lying immediately north of surveyed claim No. 4,704, near Lucid lake, Cabot township.



Outcrop of quartz veins on claims of the Porcupine-Kirkland Gold Mines, Limited, in Cabot township.

According to a blue print furnished by the Mining Recorder for the Sudbury Division, 130 claims have been staked in southern Cabot in a belt stretching northeast from the southwest corner of the township.

The cuts for illustrations on page 81 were kindly loaned by the Porcupine-Kirkland Gold Mines, Limited.

Assays of Grab Samples from Cabot

Samples from the area showing molybdenite were assayed for gold. A greasy type of vein quartz with some fine, disseminated pyrite carried only a trace of gold; and a specimen with much molybdenite carried no gold.

Two hand specimens supplied by Thos. Saville from the Porcupine-Kirkland claims were assayed for gold. One sample with a pyrite and vein quartz combination assayed $15.40 per ton in gold; another specimen showing vein quartz, chalcopyrite, galena, pyrrhotite, and pyrite assayed $8.40 in gold per ton.

A discovery by Saville in Connaught township shows chalcopyrite and pyrite disseminated in a basic rock that has some quartz accompanying the mineralization. A small hand specimen from the above find, showing disseminated chalcopyrite, carried $4.80 per ton in gold.

Wasapika Section, West Shiningtree Gold Area, District of Sudbury

By F. L. Finley

Introduction

The gold-bearing quartz veins of the West Shiningtree area are mainly restricted to two localities, namely that around West Shiningtree lake and that known as the Wasapika section, five miles to the east. In the latter the principal properties show a marked alignment along Michiwakenda lake, and local mining men believe that some structural feature, such as a "main break," is responsible for this condition. The results obtained during an examination of one week in the fall of 1925 are compiled in the following report.

Acknowledgments

Acknowledgements are due to G. B. Sullivan, graduate student in mining of Toronto University, for his able assistance; and to the mining men and prospectors of the area for their hospitality. Particular thanks in this respect are due to Duncan McDonnell of the West Tree mine. The laboratory work was performed at Princeton University.

Location and Access

The Wasapika section lies about five miles northeast of West Shiningtree lake, the area examined including portions of MacMurchy and Churchill townships. It is most easily reached from Westree on the Canadian National railway, 8 miles northwest of Sudbury and 340 miles by rail from Toronto. A twenty-mile motor road connects Westree and West Shiningtree, and a fair wagon road extends from this point to Wasapika and the various properties. Progress is gradually being made towards linking the area to Gowganda by road. Alternative canoe routes may be used from Westree or from Ruel, but they necessitate portaging and a long day's travel.

History

Gold was first discovered in this area in August, 1911, in a small high-grade vein on the Jefferson claim, No. 2,504, now known as the Atlas. Other discoveries followed rapidly, such as that on the West Tree property where an uprooted tree exposed native gold, and within a few weeks this whole locality was solidly staked. The most recent discovery was made in 1919 on the Kingston property, No. 3,715, and it is probable that additional discoveries will be made from time to time in the future.

The camp has never developed beyond the prospecting stage and has been the scene of intermittent activity. Small mining plants have been erected on a number of the properties, but at the time of the writer's visit work was at a

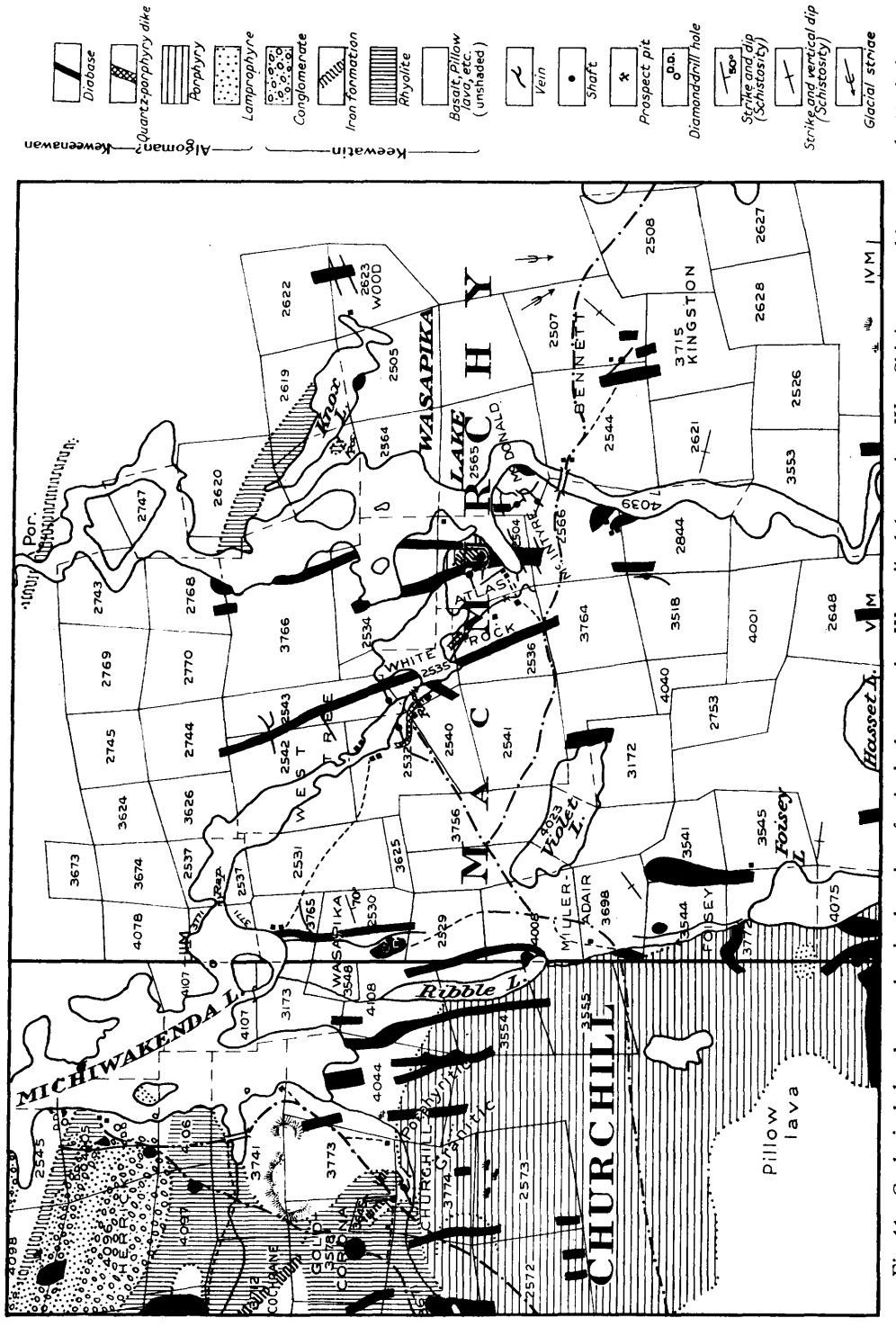


Fig. 11—Geological sketch map showing location of principal properties, Wasapika lake section, West Shiningtree gold area, scale 40 chains to the inch. Mine buildings are shown by solid squares.

standstill. The irregular gold distribution, the limited extent of some of the veins, extravagant development and financing, and a general loss of public confidence are responsible for this condition.

Notwithstanding the above features, the possibilities of the area can by no means be said to have been exhausted. In their general character, the veins are similar to those in the producing areas in Ontario and occur under similar geological conditions. It is to be expected that work will be resumed on several of the properties, and with careful development mines may result.

Literature

The earliest exploration of this area was made by A. P. Coleman,[1] who mentioned the water route followed by him from Mattagami lake to Shiningtree lake in 1900. In 1909, surveys were made of part of this route, including Michiwakenda lake, by W. R. Rogers[2]; and immediately following the discovery of gold in 1911, the deposits and the geology were examined by R. B. Stewart,[3] who continued his work during the following year. W. H. Collins,[4] who was also in the area at the time of discovery, in his report on the Onaping area, gives detailed petrographic descriptions and discusses the age relations of the rocks. In 1919, P. E. Hopkins[5] described most of the properties then under development and accompanied his report with an excellent geological map to which only very minor additions or changes have been made. In addition to these, several general articles have appeared in the mining journals by W. R. Hodge, R. E. Hore, and others.

Topography

In its physical character, the area is an irregular rocky plain at an elevation of about 1,400 feet. There are no hills rising more than 100 feet above the general level, and the depressions occupied by lakes are not very pronounced features. Michiwakenda and Wasapika lake occupy northward-trending valleys, which cross the structure of the bed rock at a high angle and are probably due to glacial gouging and damming. They are joined by the narrow southeast bay of Michiwakenda lake, and the sharp diversion of drainage has been interpreted by local mining men as evidence of a main fault zone. The bay, however, parallels the folded structures in the Keewatin rocks and more probably represents a valley eroded along a less resistant formation.

The height of land lies a few miles to the north, and the drainage eventually is carried south by the Montreal river.

General Geology

The bed rock is all of pre-Cambrian age, and except for the absence of the Timiskaming sediments the succession is similar to that at Porcupine. The oldest are highly altered and closely folded volcanics with subordinate bands of iron formation and small lenses of black slate. In the vicinity of the Herrick mine, volcanic tuffs grade into waterworn conglomerate, greywacké, and slate. These rocks are intruded by dikes of quartz porphyry and by a small stock of granite, granite porphyry, and quartz porphyry, and by sills or dikes of lamprophyre.

[1]Ont. Bur. Mines, Vol. X, 1901, p. 181 *et seq.*
[2]Ibid, Vol. XXI, 1912, Map No. 21*d*.
[3]Ibid, pt. 1, 1912, pp. 271-77; Vol. XXII, pt. 1, 1913, pp. 233-37.
[4]Geol. Surv., Can., Sum. Rept., 1911; Mem. No. 95.
[5]Ont. Bur. Mines, Vol. XXIX, pt. 3, 1920, pp. 28-52.

All the older formations are cut by an immense number of diabase dikes and larger sill remnants. Glacial deposits are thin, and as most of the area has been burnt over the bed rock is excellently exposed.

The succession and probable age of the rocks are given in the following table:—

Table of Formations

PLEISTOCENE		
	GLACIAL and RECENT:	Sand, gravel, and boulders.
PRE-CAMBRIAN		
	KEWEENAWAN:	Diabase.
		Intrusive contact
	ALGOMAN:	Lamprophyre.
		Granite, granite porphyry, quartz porphyry.
		Intrusive contact
	KEEWATIN:	Conglomerate, greywacké, slate, and tuff.
		Iron formation.
		Rhyolite, andesite, basalt, tuffs, carbonate-chlorite-sericite schist.



View of West Tree mine, showing typical rocky surface of low relief.

Keewatin

Basic Flows.—The greater part of the Keewatin consists of dark green volcanic rocks frequently showing pillow structure over considerable areas. Chlorite- and calcite-filled amygdules and occasional thin flow breccias at the tops of the flows are additional features indicating their surface origin. They probably varied in composition from basalt to andesite but are now so altered that a definite determination is impossible. When the rocks are examined under the microscope, the original constituents are shown to be almost entirely replaced, in some cases metasomatically and preserving the original texture, particularly the ophitic or diabase, but more frequently simply showing a very fine-grained confused aggregate of secondary minerals in which chlorite predominates, together with sericite, carbonates, epidote, zoisite, and secondary albite and quartz. Occasionally large white phenocrysts are present, which though originally feldspar are now completely altered to zoisite and calcite. This type would probably constitute a good horizon marker if the mapping of the structure of the volcanics in detail is ever undertaken. In the main these rocks are massive and preserve the original delicate volcanic structures, such as

the amygdules, but in narrow shear zones they have been converted to chloritic schists, often containing a high percentage of rusty-weathering carbonate. The greatest thickness of any of these flows, which could be definitely determined, was 450 feet, but over wide areas no definite characteristics of the tops or bottoms of the flows could be distinguished.

Acid Flows.—In strong contrast to the more basic types are light-coloured, less altered, and less schistose rhyolites. These are found in very subordinate quantities but are useful for determining the structural trend. Examined microscopically they show a few small, rounded or irregularly corroded phenocrysts of quartz and more abundant small laths of feldspar, predominantly albite. The groundmass is finely crystalline and consists of quartz, feldspar, and secondary products. Most of the rhyolite is very little altered, though in a fault zone on the Herrick claims it has been sheared and partly converted to a sericitic schist.

Sediments.—Lying between some of the flows are thin beds of black slate, which often contain much pyrite and weather to a rusty brown. In addition there are a few exposures of a lean iron formation consisting of finely granular quartz and disseminated grains of magnetite.

On the Herrick property tuffs grade into a waterworn conglomerate containing pebbles of rhyolite and quartz, and then into greywackés with some slate. These sediments are of pyroclastic derivation and have been described in considerable detail by W. H. Collins.[1] Their deposition probably involved only a short time in a prolonged period of volcanic activity and they are not considered to belong to the Timiskaming series. Farther to the north, however, P. E. Hopkins[2] noted slates which he considered might belong to the Timiskamian.

Structure of the Keewatin

Folding.—With the excellent exposures in this area, it is probable that the structure of the Keewatin could be determined as it has been at Porcupine.[3] This would necessitate, however, far more detailed work than could be done in the time available. Generally stated, the Keewatin lava flows and the associated sediments have been closely folded, and the axes of the folds strike about N. 60° W. The dips in most cases are vertical or nearly so. A series of four flows south of Foisey lake have a thickness of 1,200 feet, the thickest flow being 450 feet; all the flows face northeast and strike N. 70° W. Three flows on claim No. 2,621 show a similar strike and attitude, the dips in both cases being vertical. On the Atlas property, a black slate band strikes N. 50° W. and dips 70° S.W., while on the West Tree a similar bed, reported in the drill log as "black mineralization," underlies the southeast bay of Michiwakenda lake and strikes N. 50° to 60° W. The iron formation on the Cochrane claims strikes N. 45° W. and dips vertically. Near Knox lake and at the outlet of Wasapika lake, interstratified rhyolites show still more westerly strikes. It is possible that a synclinal structure is present, though no flow tops were noted facing the southwest. The sediments, which pinch out at the Herrick, have been determined farther west as a major downfold with complicated minor folds.

Faulting.—The compression to which the Keewatin has been subjected has developed numerous shear zones or faults of small displacement. As far as

[1]Geol. Surv. Can., Mem. No. 95.
[2]Ont. Bur. Mines, Vol. XXIX, pt. 3, 1920, pp. 28-52.
[3]A. G. Burrows, Ont. Bur. Mines, Vol. XXXIII, pt. 2, 1924.

could be determined these show no very regular system, though the majority have easterly strikes. Some of the most pronounced, such as that occupied by the Ribble vein, have almost northerly trends. On the West Tree two sets are apparent. One strong shear zone, on the extension of the Saville vein, passes beneath the southeast bay of Michiwakenda lake and strikes N. 50° W., while smaller ones are developed almost at right angles to this. The shear zones are important, for they have frequently afforded channels for the ore solutions and are now occupied by veins.

There is very little evidence to support the view that the southeast bay of Michiwakenda lake has been eroded along a major fault. The shearing extending on to the West Tree property from the White Rock claims does not cross the narrows north of the West Tree camps where rock is almost continuously exposed. There is some shearing, N. 60° W., on claim No. 2,531; and a mile to the north on the Herrick claims, the main vein terminates against a similarly striking fault. To the south of the White Rock, particularly on the Atlas and McIntyre-McDonald claims, there is no evidence of major faulting. It does not seem necessary to account for the valley of the southeast bay of Michiwakenda lake by postulating a fault, when it parallels the structure of the rocks and shows evidence of having been eroded along their strike.

Algoman

The following intrusives are provisionally classed as of Algoman age and include granite, granite porphyry, quartz porphyry, and lamprophyre.

In the southeast corner of Churchill township, there is a small stock-like mass of granite, granite porphyry, and quartz porphyry. The greater part of this mass is a granite composed of alkali feldspar, chloritized hornblende and biotite, and accessory magnetite and apatite. It has a fine even grain and a mauve rather than a pink colour. Around the north margin of the stock, it is porphyritic and shows feldspar phenocrysts with diameters up to a quarter of an inch. In the extreme southeast corner of Churchill township, the exposures consist of a white-coloured quartz porphyry, very similar to the Keewatin rhyolites but holding qute abundant inclusions of green schist. Gradations between these three types were not noted but are probably rapid. There is no evident contact metamorphism of the intruded rocks.

On the Atlas claims, a sericitic schist, still showing phenocrysts of quartz, intrudes the slates and holds inclusions of them; a similar schist occurs as a dike on the West Tree, where it ranges from one to twenty feet in width and has been traced, though not continuously, S. 60° E. for 60 chains on to the White Rock property.

A reddish-coloured lamprophyre occurs in the form of dikes or sills on the Herrick claims. It consists of chloritized mica phenocrysts in a groundmass of equigranular orthoclase and chlorite after mica, with a little accessory magnetite. The lamprophyre is a minette and is older than the Herrick vein.

The relation of the other veins to the intrusives is not known, but it is thought that the veins are somewhat younger, though both probably belong to the same magmatic period.

Keweenawan

An immense number of diabase dikes cut all the older rocks and the veins, and in addition to these there are a few sill remnants of gabbro or diabase. The widths of the dikes range from a few inches to 150 feet, and the strikes are generally north. The dikes present no petrographic peculiarities, though a small

one on the McIntyre-McDonald property has been irregularly fractured and the cracks filled with calcite, quartz, and epidote. Adjacent to these, the diabase has been partially replaced with the same minerals, giving a light-brownish, bleached effect, in sharp contrast to the dark-coloured, unaltered diabase.

One other point of interest arises relating to the manner of intrusion of these dikes. Hopkins noted that "most of the gold-bearing quartz veins have been cut by diabase, and usually without being displaced." If this were so, it would constitute a remarkable example of dike intrusion by stoping or some analogous process, whereas it is generally thought that a dike rises in a fracture, accompanied by a forcing apart of the walls and by shearing, resulting in a displacement of the formations traversed.

As far as observed by the writer, wherever the dikes cut slaty bands in the Keewatin there is a relative displacement of the slate beds on each side, which is proportional to the width of the dike. In the case of the veins the majority are cut at an angle so close to 90 degrees that the displacement does not show as an offset. In one case, however, on the McIntyre-McDonald claims, a 6-foot dike cuts a 2-foot vein without displacing it, the dike striking N. 30° W. and the vein due north. The contacts appear to be knife-edged, and there is no evidence of shearing or of fragments of quartz in the dike.

This evidence, however, is not conclusive, for the vein might have been faulted slightly into its present position, after or accompanying the intrusion of the dike. Moreover, the quartz veins in the vicinity are very irregular, and a vein may follow the schist and then terminate abruptly, joined to the next overlapping lens of quartz by only a minute stringer. A fracture cutting the stringer and subsequently occupied by a dike might thus bring two separate lenses into apparent alignment, though in reality they have been displaced. One or other of these possibilities is probably the true explanation, and it is highly improbable that the dike has cut a clean passage for itself by stoping or any other means.

Economic Geology

Occurrence and General Character of the Veins

The gold-bearing quartz veins occur in all the rocks which have been mentioned, except the granite and diabase. The great majority, however, have been found in shear zones in the basic volcanics. Of the total number of veins observed, not only the more important ones shown on the map, 60 per cent. strike east, 25 per cent. strike north, and 15 per cent. intermediate between these two directions. There does not seem to be any relation between the size of the veins and their strike, though some of the longest have northerly strikes. Nor is there any essential difference in the character of the mineralization in the different sets of veins.

The form of the veins may vary greatly. They may occur as irregular lenses, or as fairly well-defined fissure veins extending in stringers across the schist, or as lode deposits with interbanded schist and quartz; and one type may pass into another along the strike.

Many of the veins have been intensely crumpled and brecciated subsequent to their formation, and this is particularly noticeable in those of northerly strike, such as the Ribble vein on the Wasapika property. All the veins dip vertically or at high angles.

The quartz of the veins is white, though sometimes greyish and more glassy. It is coarsely crystalline and frequently contains minute gas inclusions. A

little albite was noted in veins on the West Tree, Bennett, and Kingston properties, and it shows apparently mutual crystallization relations with the quartz. Minute black tourmaline crystals occur in several of the veins. Pyrite is the principal sulphide mineral, but is not often abundant in the quartz, though



Photomicrograph showing corroded pyrite (Py) enclosing gold (Au) in sphalerite (Sp) veined by later galena (Ga), Kingston mine.

replacing the wall rock in greater amounts. Chalcopyrite, molybdenite, sphalerite, and galena occur sparingly; and pyrrhotite and arsenopyrite, as far as known, are confined to the Kingston vein. Specularite is another rare constituent.

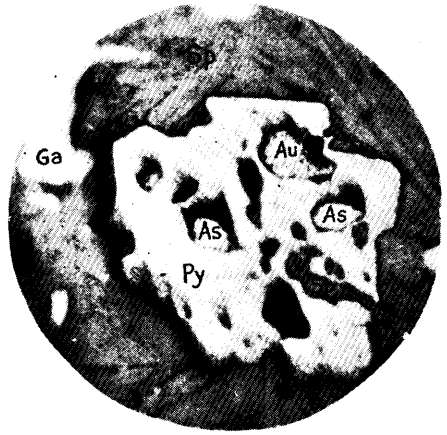


Photomicrograph showing auriferous pyrite in sphalerite, Kingston mine.

The native gold generally occupies small fractures in the quartz, together with such minerals as chlorite, sericite, talc, and carbonate, the latter often ferruginous. In some cases, however, it is found in unfractured quartz grains. The gold is not often found in contact with the sulphides, though in specimens from the Gold Corona, McIntyre-McDonald, and West Tree, it was found to form veins and replace the pyrite. In specimens from the Kingston mine, gold occurs in unfractured grains of pyrite. This is only the second case in Ontario

where this relation has been seen, the other being in Hollinger ore, noted by H. S. Robinson.[1] The corroded grains of visibly auriferous pyrite in sphalerite veined by galena, are clearly shown in the accompanying photomicrographs.

It is apparent from the facts stated above that the gold had a considerable range of deposition starting early in the period of vein formation and continuing to a very late stage. In particularly rich specimens, however, it appears to belong wholly to the late stage and is then found only in the crushed zones in the quartz.



Photomicrograph showing grain of pyrite in sphalerite, enclosing gold and arsenopyrite (As), Kingston mine.

Minerals and Paragenesis

The paragenesis or order of deposition of the vein minerals, as far as shown from the microscopic study of polished chips, follows:

Quartz
Albite
Arsenopyrite
Pyrite
Pyrrhotite
Gold
Sphalerite
Chalcopyrite
Galena
Calcite
Chlorite
Sericite
Talc

[1]Geology of the Pearl Lake Area, Econ. Geol., 1923.

The distribution of the gold, or at least of the visible gold, is erratic as far as could be determined from a casual inspection. Very rich specimens can be obtained in parts of an otherwise poorly mineralized or barren vein. Enrichments are apt to occur where a vein intersects a slaty pyritic bed or iron formation.

The veins are of the high temperature type formed in direct genetic connection with intrusive igneous rocks, and it is believed that the ore-bearing solutions rose from deep-seated granitic bodies of which the various acid stocks and dikes of the region are the upward extensions or apophyses. Similar veins elsewhere in the province have extended to great depths, and there is no reason why the gold found at the surfaces should not persist at lower levels.

Description of Properties

In the following paragraphs brief descriptions are given of the main properties, taken in order from north to south.

Herrick (Nos. 4,105-7; 4,096-98).—This property was last worked by the Tonopah Mining Company of Nevada, and when work was stopped in 1923 the shaft was 300 feet deep and over 1,000 feet of lateral work had been done, in addition to 3,000 feet of diamond-drilling. The ore body known as the "Kingsley" vein was discovered in 1918 by J. A. Knox. It occupies a well-defined vertical fault zone cutting conglomerate, slate, lamprophyre, and rhyolite on claim No. 4,105. At the north end the vein pinches out when it encounters another shear zone striking N. 60° W. in rhyolite, but it extends south from this point for over 1,000 feet. The width varies considerably along the strike, and while in places it may consist of several feet of solid quartz, in others, particularly where it crosses the lamprophyre and rhyolite, it splits up into a number of stringers across a width of eight or ten feet. The ore is considerably brecciated, and that in the red lamprophyre shows a strong resemblance to the Kirkland Lake type. The gangue is principally quartz accompanied by some calcite, and native gold can be seen at a number of points along the surface in dark seams of chlorite, sericite, and talc. Pyrite is rather sparse.

The earlier development is said to have been fairly encouraging, but the results of the last work done are not known to the writer.

Wasapika (Nos. 2,529, 2,530, 3,765, 3,771, 4,078, 4,108).—The most extensive development in the area has been done on this property since the discovery of gold in 1912. From 1916 to 1923, a considerable amount of surface and underground work has been performed, the last in 1923 carrying the shaft to 300 feet and adding 1,000 feet of drifting.

The deposit is known as the Ribble vein. It has a northerly strike and dips steeply to the west at an angle of about 60 degrees. It has been intensely crumpled and folded, some of the drag folds passing into small faults. This vein, which is one of the longest in the area, has been traced almost continuously for half a mile. What may be an extension of the same vein, or at least one formed in the same shear zone, is found three-quarters of a mile to the south on the Miller-Adair and Foisey claims. The average width is probably about four feet, though 23 feet of quartz and schist are reported at the 100-foot level. The wall rock is a chloritic schist, which to the east of the vein still preserves a pillow structure and is intruded by a large diabase dike.

Gold, sometimes pale white from the presence of silver, occurs mainly in the quartz with small amounts of pyrite and a very little chalcopyrite and sphalerite. The gold is said to be found chiefly in the quartz, though the adjacent schist is abundantly replaced by pyrite. Commercial values were reported at the surface and at the 100-foot level.

West Tree (No. 2,531, 2,532, 2,542, 2,543).—This property was formerly known as the Caswell and is now held by the Canadian Champion Reef Mining Company, with head offices in Toronto. It adjoins the Wasapika on the east and lies on each side of the narrow southeast bay of Michiwakenda lake, locally known as Caswell lake. Development work consists of two shafts, 92 and 75 feet deep, an open cut, 3,390 feet of diamond-drilling, and a considerable amount of surface work.



View showing the Ribble vein, outcropping in the distance, and the headframe over the Wasapika shaft.

The rocks are chiefly volcanics and include amygdaloidal and pillow lava, highly altered diabase, and dark slaty bands impregnated with pyrite. A massive greenish rock north of the office building shows a tendency towards fragmental structure and may be a highly altered andesite tuff. A quartz porphyry-schist intrudes the greenstone on the west side of the lake, and numerous small dikes of diabase and one large one cut the older rocks and the veins.

The shear zones on this property in the main trend a little north of east and vary from this up to N. 60° E., with vertical dips. In addition, a mineralized shear zone has been indicated beneath the southeast bay of Michiwakenda lake by means of three diamond-drill holes. The latter is in alignment with the Saville vein on the adjoining White Rock property to the south, but was not found to extend north of the boundary line between claims Nos. 2,532 and 2,542, although the rock is well exposed in the narrows at this point.

The veins are irregular and lenticular and, with the interbanded schist, form deposits of the lode type. In some places, several of these lying close together aggregate six to ten feet in width with lengths up to several hundred feet. In all, some 39 veins have been exposed, many of which are too small for mining. The most important are two parallel lodes, on which the shafts have been sunk, one near the centre of the east boundary of claim No. 2,542 and the other near the south boundary of the property.

Spectacular gold samples came from an open cut on the east side of the lake and from a shaft adjacent to this. As described by P. E. Hopkins,[1] "the samples apparently came from a vertical pipe-like deposit formed at the intersection of the shear zone, which is 15 feet wide at this point, and a slaty pyrite band. The slaty pyrite band. The slaty band, which is three feet wide, has been faulted, the south part being thrown approximately 15 feet toward the lake." The high grade is said to have continued to the bottom of the shaft, though the eastward extension of the vein is less promising. The shaft on the west side of the lake has been sunk on a similar zone and is probably on the same shear.

The presence of an ore body beneath the lake is reported by the management as an important recent development. This has been indicated by three diamond-drill holes of 150, 750, and 250 feet vertical depth which are said to have yielded values across a width of three to four feet. The core showing the ore intersections is not available, as it has been crushed for assaying. This zone, striking N. 60° W., might be expected to yield enrichments where it intersects east-west veins.

White Rock (*Nos. 2,535, 2,536*).—These claims were originally staked by T. Saville, and exploration has been carried out on a body known as the Saville vein. The rocks are amygdaloidal and pillow lavas, cut by a porphyry dike to the east of the vein and by diabase dikes. Underground work consists of a main shaft, 175 feet deep; another about 1,000 feet to the north, 40 feet deep; and over 1,000 feet of lateral work.

The vein varies from a stringer to a well-defined fissure vein over six feet wide and has in part been folded, particularly at the south end, though to a lesser degree than the Ribble vein. The vein strikes N. 60° W. and dips vertically, occupying a fairly well defined fracture or shear zone, which extends south from the adjoining West Tree for almost half a mile. Specimens from an open cut near the south end of the vein are among the richest observed in the area, but for considerable lengths the mineralization appears to be sparse.

Atlas (*No. 2,504.*—The first discovery in this section was made on the Atlas, which was formerly known as the Jefferson claim. Several small quartz veins trending eastward are well exposed, and on one a short tunnel has been driven at the base of a 60-foot bluff. There are very spectacular gold showings in the veins, which showed enrichments at their intersections with a slate band. The latter, known as the Evelyn vein, contains a little cobalt bloom, which has evidently been derived from the large diabase dike cutting the older greenstones, slate, and quartz porphyry-schist. Remarkably rich pockets of ore were taken from a 40-foot shaft on the Evelyn vein.

McIntyre-McDonald (*Nos. 2,565, 2,566*).—A number of veins are exposed on this property and frequently show much native gold. The longest is about 600 feet, ranging in width from a stringer to about six feet, and striking almost

[1]Ont. Dept. Mines, Vol. XXIX, pt. 3, 1920, p. 47.

due north. A shaft has been sunk on this vein to a depth of 55 feet; on another small branching vein, 350 feet to the north, there is a second small shaft 50 feet deep. There is abundant visible gold near this shaft, together with finely disseminated pyrite, which in part replaces the adjacent schist. Several hundred dollars in gold have been taken from this vein by hand methods. The rocks are greenish altered volcanics, highly and irregularly sheared and cut by numerous dikes of diabase.

Bennett (*Nos. 2,544, 2,507*).—These claims adjoin the McIntyre-McDonald to the southeast. The rocks are principally highly altered volcanics, with associated tuffs near the Montreal river, and a narrow slate band. A shear zone, striking N. 60° W. for 400 feet and dipping vertically, contains numerous lenticular quartz veins and stringers across a width of two to eight feet. The



Gold-bearing quartz lenses on the McIntyre-McDonald claim, No. 2,565, MacMurchy township.

quartz in the main follows the schistosity but in part crosscuts it, and the veinlets are partly displaced by small east-west slips. Abundant finely disseminated free gold can be seen in the vicinity of a 50-foot shaft.

Kingston (*Nos. 3,715, 2,508, 4,955*).—This is the only important discovery made since the area was examined by P. E. Hopkins in 1919. The property is held by English interests, though at present it is not being worked. Development consists of two small shafts, a considerable amount of surface work, and some diamond-drilling. The vein occurs in a vertically dipping shear zone in greenstone and strikes N. 60° W. It is said to have been traced for 1,200 feet, in part by diamond-drilling beneath drift, but only about half of this is exposed at the surface. At the surface the width ranges from one to six feet, of quartz or quartz and schist, and an average width in the main shaft is said to be about three feet. Native gold can be seen at a number of points at the surface, and locally there are quite notable quantities of sphalerite and galena and a fairly

uniform distribution of pyrite, with subordinate amounts of pyrrhotite. Several small faults displace the vein from one to fifteen feet, the strike of the faults varying from N. 20° to 40° E.

To the south of the Kingston, the continuous rock exposures pass under a sand plain in which there are only occasional outcrops.

Other Properties.—In addition to the above claims, hurried examinations were made of the Foisey, Miller-Adair, and Gold Corona properties, which as far as could be determined show little change since their examination by P. E. Hopkins. Some additional trenching and test-pitting have been done on the Foisey and some systematic channel-sampling on the Gold Corona.

To the east of the area shown on the accompanying sketch map, a vein is exposed on claim No. 4,428, MacMurchy township, discovery being made by H. B. Holbrook in 1924. Sand deposits cover most of the bed rock in this vicinity, but two pits 150 feet apart expose a 4-foot quartz vein, striking N. 70° W. and dipping 70° N.E. The wall rock is a greenstone schist, and near the No. 4 post of the claim and on claim No. 5,521 there are two small outcrops of reddish feldspar porphyry. Assay values up to several dollars in gold are reported from the vein, which besides quartz contains a considerable amount of rusty-weathering carbonate and pyrite.

Silver

A number of silver prospects in the vicinity of West Shiningtree lake, which lies four miles to the east of the map-sheet, have been described by R. B. Stewart[1] and W. H. Collins.[2] At present there is no work being done on these, but a more recent discovery near Sulphide creek, two miles to the west of West Shiningtree lake has been the scene of some activity, two veins having been exposed on the Smillie and McDonnell claims, Nos. 5,396 and 5,416, Fawcett township. On No. 5,396 a vein of calcite two feet wide occupies a fissure in a greenstone breccia or tuff, which has been strongly sheared N. 60° E. The vein is exposed for 150 feet, and near the south end it approaches a small outcrop of diabase, which may be a small sill remnant but is more probably a dike. The calcite is stained with cobalt bloom, but there are no visible sulphide or arsenide minerals other than a little pyrite and chalcopyrite.

About 15 chains N. 60° E., on claim No. 5,416, a pit ten feet deep has been sunk on a similar occurrence, the vein at this point consisting of interbanded schist and calcite and quartz stringers. Chalcopyrite is the only sulphide mineral observed at this point and occurs in the calcite as tarnished and iridescent coarsely crystalline aggregates.

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[1]Ont. Bur. Mines, Vol. XXII, pt. 1, 1913, pp. 233-37.
[2]Geol. Surv. Can., Sum. Rept., 1911.

INDEX, PART VI

A PAGE

Aberdeen Syndicate 35
Agglomerate.
  Bristol tp., in Keewatin, photo 8
  Redstone R. area. *See* Keewatin.
Agricultural land.
  Geikie tp 42
  Grassy R. area 61, 67
Aldrich 22
Algoman.
  Bristol, Carscallen and Ogden tps., analyses, notes and photo 5, 6, 13-16
  Churchill and MacMurchy tps., notes, 86, 88
  Redstone R. area, notes 39, 47-49
Amphibolite.
  Redstone R. area. *See* Haileyburian.
Analyses.
  Granite 16
  Quartz porphyry 14
Andesite. *See* Keewatin.
Anticline.
  Diagram of an ideal 76
Archean. *See* Pre-Cambrian.
Arsenopyrite.
  Bristol tp., quartz veins 22
Asbestos 44, 56
Atlas g. m. 87, 88, 94

B

Bartlett tp.
  See also Mountjoy ck.
  Forest fires 37
  Gold 43, 52-55
  Rocks 43-49
  Surveyed 39
  Topography 39-42
Basalt.
  Redstone R. area. *See* Keewatin.
Bawden, W. E. 37
Beanland, Sydney 5, 11
Bear 66
Beaver 4
Beaver l. 76
Beemer tp.
  See also Telluride l.
  Rocks 61, 63
Bennett g. m. 90, 95
Big Marsh l. 4
Biotite granite 16
Birch 4, 66
Blackburn g. claim 35
Bristol tp.
  Brûlé, photo 3
  Geology, report by Hawley 1-36
  Gold 1, 4, 17
    claims described 20-33
    See also McKinley-Molesky.
  Map, No. 35g ..... *In pocket*
  Quartz veins in rhyolite, photo 22
  Syncline, diagram 19

Bruce, E. L. PAGE
  Report by, on McArthur, Bartlett, Douglas and Geikie tps. 37-56
  Work (map), 1911 ..... 2, 5
Burrows, A. G. 1, 2
Burrows tp. 58, 78
Burwash, E. M. 39

C

Cabot tp.
  Area 58
  Economic possibilities 78
    gold 80-82
    molybdenite 82
  Granite 79
  Lamprophyre dikes 80
Cameron-Porcupine gold claims 55
Campbell g. claims 55
Canoe Shed l.
  Access to 59
  Gold near 60, 67, 71, 74
  Indian camps, ancient 66
  Pyrite in greenstone 75
  Rocks 61
Carbonate rocks.
  Bristol, Carscallen and Ogden tps., notes and photos 5, 10, 11
  Churchill and MacMurchy tps. *See* Keewatin.
Carscallen tp.
  Boulder ridges 3
  Geology, report by Hawley 1-36
  Gold 5, 33-36
  Map, No. 35g ..... *In pocket*
Carlton, Terry 5
Cedar 42
Chalcopyrite.
  Carscallen tp 22
  Connaught tp 82
  Fawcett tp 97
  Neville tp 76
  Semple tp 74
Chloritic schist 9
Chromiferous mica. *See* Fuchsite.
Churchill tp.
  Geology, sketch map of part 84
  Gold. *See* Gold Corona g. m.
  Rocks 88
Claw l. 78
Clay, stratified.
  Mattagami r. 17
Clear ck.
  Fish; porphyry; terraces 40, 43, 48
Clear lake, draining into Papakomeka l.
  Character 40
  Gold near 52-55
  Rocks 44, 45, 48
Clifton g. mine 14
Cobalt bloom 94
Cobalt series.
  Fallon tp., photo of ridge 41
  Grassy R. area 62

PAGE

Cochrane dist.
Report on Bristol, Carscallen and Ogden tps. 1-36
Cochrane g. claim 87
Coleman, A. P. 85
Collins, W. H. 85, 87
Conglomerate.
Churchill and MacMurchy tps. *See* Keewatin.
Connaught tp. 82
Copper. *See* Chalcopyrite.
Corkill, E. T. 1
Cropsey iron claims 72

D

Deer.
Grassy R. area 66
Redstone R. area 43
Deloro tp.
Fuchsite 10
Rocks 5, 11, 14
Denton tp.
See also Mahoney l.
Dike, lamprophyric 15
Gold 5, 33
Diabase. *See* Keweenawan.
Diorite.
Redstone R. area. *See* Algoman.
Dome g. mine.
Quartz porphyry, analysis 14
Donaghue, W. A. 37
Douglas tp.
See also Redstone r.
Forest fires 37, 42
Glaciation 42, 49, 50
Rocks 41-49, 55
Surveyed 39
Topography 39 42
Duck, black 66
Dumbbell l.
Access to 59
Gold, early stakings 60
prospecting 71
advisable 75
Duncan, ck 42

E

E. D. 256-7 gold locs., Ogden tp. *See* Pann Porcupine g. m.
Emerald tp. 58
English tp.
See also Muskasenda l.
Claims, notes on 72
Map, sketch 73
Mineralization; porphyry 74
Prospecting in 60
Erythrite. *See* Cobalt bloom.
Esker.
Mond tp., photo 77
Evelyn vein, Allen g. claim 94

F

Fallon tp. 41
Farm land. *See* Agricultural land.
Fawcett tp. 97
Feldspar porphyry.
Redstone R. area. *See* Algoman.
Ferrier l. 66

PAGE

Finley, F. L. 12, 13
Notes by, on southern Grassy R. area 78
Obituary notice 77
Report by, on Wasapika L. area 83-97
Fish 43, 66
Foisey, Frank. *See* Foisey iron claims.
Foisey gold claim 96
Foisey iron claims 73, 74
Forest. *See* Trees.
Forest fires.
Bartlett, McArthur, Douglas and Geikie tps. 37, 42
Bristol, Carscallen and Ogden tps. 4
Formational tables. *See* Table of formations.
Fox, Tom 75
Fuchsite 10
Furse, G. D. 37

G

Gabbro.
Carscallen and Turnbull tps. 12, 13
Game.
Grassy R. area.
Geikie tp.
See also Redstone r.
Farm land 42
Forest fires 37
Glaciation 42
Pine 39
Rocks 43-49, 63
Surveyed 39
Topography 39-42
Geology, economic.
Churchill and MacMurchy tps. 89-97
Grassy R. area 71-76
southern part 80-82
Redstone R. area 51-56
Geology, general.
Bristol, Carscallen and Ogden tps., report by Hawley 5-21
Churchill and MacMurchy tps. 85-89
Grassy R. area 67-71
Redstone R. area 39-50
Gibson, Thos. W. 1
Gibson cabin, Clear l. 48
Glacial deposits.
Bartlett, Carscallen and Ogden tps. 16, 17
Redstone R. area 40-42, 49, 50
Gledhill, T. L.
Report by, on Grassy R. area 57-82
Gogama, Noble tp.
Map showing route from, to Grassy r. 59
Gold.
Bristol, Carscallen and Ogden tps., 4, 5, 21-36
Grassy R. area 67, 71-74
Cabot tp. 80-82
Redstone R. area 40, 43, 52-55
McArthur tp., prospecting 51
Gold Corono g. mine 96
Granite.
Bristol, Carscallen and Ogden tps. 15, 16
Churchill and MacMurchy tps. *See* Algoman.
Redstone R. area. *See* Algoman.
Sinclair l., photo 79
Granite porphyry.
Bristol, Carscallen and Ogden tps., notes on claims near 29
See also Algoman.

PAGE
Grassy river.
Character....4, 59, 64
Esker, photo.... 77
Photos....65, 78
Pine, photo.... 77
Report on area, by Gledhill....57-82
Rocks.... 62
Greenberg-Goldstein g. claims.... 32
Greenstone.
Bristol, Carscallen and Ogden tps., contact with porphyry, photo.... 13
See also Keewatin.
Grey g. mine. *See* McEnaney g. m.
Greywacké.
Churchill and MacMurchy tps. *See* Keewatin.

H

Haileyburian series.
Bristol, Carscallen and Ogden tps., notes and distribution....6, 12, 13
Redstone R. area, notes and distribution....39, 45-47
Halliday tp.
Farm land....61, 66
Gold; prospecting.... 60
Notes, geological.... 75
Rocks.... 61
Syncline, diagram.... 76
Harkness, Martin.... 37
Harrison gold claims....45, 53
Hawley, J. E.
Report by, on geology of Ogden, Bristol and Carscallen tps.... 1-36
Hayden gold mine, Ogden tp.
Carbonate schist, photo.... 10
Diabase dike.... 16
Quartz porphyry.... 14
Veins, description and photo....24, 25
Work at (1915).... 4
Hazelton, James.... 5
Hazelton gold mine.... 5
Hazelton Porcupine Gold Mines, Ltd..33, 34
Hazen tp. area.... 58
Hendrickson g. claims, Bristol tp....4, 31
Hendrickson g. claim, Carscallen tp.... 35
Herrick g. claim....85-88, 92
Hints to prospectors.
Gold in Douglas tp.... 55
Hodge, W. R.... 85
Holbrook, H. B.... 96
Hollinger g. mine.
Gold in pyrite.... 91
Hollinger Reserve g. mine. *See* McEnaney g. m.
Hopkins, P. E....85, 87, 89
Field work (1911).... 39
Notes on Wasapika g. m.... 94
Horning, A. G.... 57
Horseshoe l.
Access to.... 59
Gold near....60, 67
prospecting....71, 72
Rocks.... 72
Hotchkiss, W. D.... 22
H. R. 871 gold loc., Ogden tp.
Rocks, minerals....26, 27
H. R. 1179 and 1271, gold locs., Ogden tp. *See* Porcupine Gold Quill.
H. R. 1219-20, gold locs., Ogden tp. *See* St. Paul g. claims.
H. R. 1260 and 1262, Bristol tp.... 12

PAGE
H. S. 805 gold loc., Ogden tp. *See* Langmuir g. claims.
H. S. 840 gold loc., Ogden tp.... 11
H. S. 956-64 gold locs., Ogden tp. *See* Langmuir g. claims.
H. S. 1031 gold loc., Carscallen tp.... 15
Hubert , Alan.
Gold mg., Bristol tp.... 1
See also Hubert g. claim.
Hubert gold claim, Bristol tp.
Arsenopyrite.... 22
Gold, native.... 4
Rocks....7, 8, 11, 29
photo.... 30
Hughes gold claim, Carscallen tp.
Rocks, sulphides.... 35
Huronian.
Grassy R. area. *See* Cobalt series.
Huronite.... 61
Hurst, Frank....5, 11
Hutt tp.
Fault scarp, photo.... 62
Farm land....61, 66
Gold, prospecting....60, 61
Map, sketch.... 73
Mineral claims; rocks....61, 74, 75

I

Indians.... 66

J

Jackpine.
Bristol and Ogden tps.... 4
Grassy R. area....66, 67
Jefferson g. claim. *See* Atlas g. m.
Johnson, Robert.... 37
Jowsey l.... 15

K

Kamiskotia ck.... 4
Kavannaugh, Walter.... 5
Keewatin formation.
Bristol, Carscallen and Ogden tps., notes and photos....5-15
Churchill and MacMurchy tps., notes.86-88
Grassy R. area....67-69
Redstone R. area, notes....39, 43-45
Kelvin tp., rocks....79, 80
Kemp tp., rocks.... 80
Keweenawan series.
Churchill and MacMurchy tps....86-89
Grassy R. area.... 61
southern part....79, 80
Ogden tp., notes.... 16
Redstone R. area, notes....39, 49
Kingston g. claim....90, 91, 95
Kitchiming l.
Access to.... 59
Mineral claims.... 74
Rocks....61, 74
Knox, J. A.... 92

L

Lamprophyre dikes.
See also Algoman.
Grassy R. area, S. portion.... 80
Langmuir (Worthington) gold claims.
Description....27, 28
Discovery.... 4
Rocks.... 10

Lava. *See* Keewatin.
Lohner g. claims 54
Lucid l.
  Gold near. *See* Porcupine Kirkland Gold Mines, Ltd.
Luke g. claims 73, 74

M

McArthur tp.
  See also Mountjoy ck.
  Anticlinal structure 45
  Forest fires 37, 42
  Gold 39, 43, 51-54
  Pine 39
  Rocks 41-49
  Surveyed 39
  Topography 39-42
McAuley-Brydge g. mine.
  Arsenopyrite 22
  Rocks 7, 12, 15, 21, 29
    sketch plan 20
McDonell g. claims 32
McDonell s. claim 96
McEnaney g. mine 1, 10, 23, 24
McIntyre-McDonald g. claim 89, 94, 95
McKenzie, D. W 1
McKinley, Mr.
  Gold mg., Bristol tp. 1
    See also McKinley-Molesky g. claims.
McKinley-Molesky gold claims.
  Geology, sketch map 18
  Gold, native 4
  Minerals; rocks 10, 11, 17, 31
McLeod, J 72
McMillan, J. G.
  Acknowledgments to 58
  Field work (1911) 39
  Notes by, on Cropsey iron claims 72
MacMurchy tp.
  See also Wasapika l.
  Gold claims, described 92-96
    map showing 84
McNeill, W. K 1
McRae, D 1
Mahoney l 15, 16
Maps.
  Bristol, Ogden, Carscallen tps. ..... *In pocket*
  notes on 2
  Grassy R. area ..... *In pocket*
  index 57
  sketch (pt.) 73
  McKinley-Molesky g. claims 18
  MacMurchy and Churchill tps., sketch 84
  Redstone R. area ..... *In pocket*
Marceau l.
  Gold. *See* Harrison g. claims.
  Rocks 41
Matachewan series.
  Bartlett, Carscallen and Ogden tps., notes 16
Mattagami l., photo 58
Mattagami river.
  Banks, height 3
  Clay, stratified 17
  Gold. *See* White g. claims.
Mattagami tp., area 58
M.E. 45 gold loc., Ogden tp. *See* McEnaney g. m.
Mica, chromiferous. *See* Fuchsite.
Michiwakenda l 88
Minisinakwa r 58
Mispickel. *See* Arsenopyrite.
Moher tp., Sud.
  Rocks 61, 76
  Timber 66
Molesky g. claims. *See* McKinley-Molesky g. claims.
Molybdenite 78, 82
Mond tp 77, 79
Montreal r., terraces 42
Montrose l 59
Moose 43, 66, 67
Mountjoy ck., Mattagami r.
  Character 4, 37, 40
  Photo 38
  Terraces 42
Muskasenda l., English tp.
  Early stakings; tellurides 60
  Mineral claims, notes 72
  Rocks 41, 46, 49, 61

N

Natal tp 79, 80
Neville tp 76
Night Hawk r 40
Niven, Alexander.
Noble tp. area 58
  See also Gogama.
Nursey tp.
  Area 58
  Rocks 61, 76
  Timber 66

O

Ogden tp.
  Fuchsite 10
  Geology, report by Hawley 1-36
  Gold, alluvial 17, 23
    mining 23-28
  Map (35 g.) ..... *In pocket*
  Porphyry-greenstone contact, photo 13
Ogden Porcupine gold mine 28
Olivine diabase 16
Osler, A. E., & Co 1, 23
Ostrosser g. mine 10
Owen, Harry. *See* Owen Acme g. claim.
Owen Acme gold claim (T.R.S. 1164)
  Fuchsite 10, 26
  Rocks 8-10, 14
    minerals; values 26

P

P. 1057-60 gold loc., Carscallen tp. *See* Hendrickson g. claim, Carscallen tp.
P. 1154-5 gold locs., Carscallen tp 36
P. 1233 gold loc., Carscallen tp 36
P. 1243 and 1410 gold locs., Bristol tp. *See* McDonell g. claims.
P. 2117 gold loc., Carscallen tp 15
P. 2122 gold loc., Carscallen tp 14
P. 2123-6 gold locs., Carscallen tp. *See* Aberdeen Synd.
P. 3785-6 gold locs., Ogden tp 28
P. 4493 gold loc., Bristol tp 12, 19, 20
P. 7248 gold loc., Ogden tp 25
P. 7370 gold loc., Ogden tp 26
P. 7372-4 gold locs., Bristol tp 12, 15, 20
P. 7507 gold loc., Carscallen tp 35
P. 7595, 7600 gold locs., Ogden tp. *See* Pann Porcupine g. claims.

PAGE
P. 7595, 7600 etc., gold locs., Ogden tp. *See* Pann Porcupine g. claims.
P. 8381 gold loc., Ogden tp. 8, 21
P. 8405-6 gold locs., Bristol tp. *See* McKinley-Molesky g. claims.
P. 8466-8 gold locs., Bristol tp. *See* Hendrickson g. claims
P. 8483 gold loc., Bristol tp. 9
P. 8504 gold loc., Bristol tp. *See* Hubert g. claim.
P. 8508, 8511 gold locs., Bristol tp. *See* Toner-McCormick g. claims.
P. 8605-6 gold locs., Ogden tp. *See* McEnaney g. claims.
P. 8511, 8508 gold locs., Bristol tp. *See* Toner-McCormick g. claims.
P. 8518-8527 and 8786 gold locs., Bristol tp. *See* Hubert g. claims.
P. 8537 gold loc., Bristol tp. 14
P. 8544-5 gold loc., Bristol tp. *See* Toner g. claim.
P. 8605-6 gold locs., Ogden tp. *See* McEnaney g. claims.
P. 9151 gold loc., Bristol tp. 32
P. 9292-3 gold locs., Bristol tp. 20
P. 9586-7 gold locs., Bristol tp. 12
P. 9597 gold loc., Bristol tp. 20
P. 9649 gold loc., Bristol tp. *See* Scobell g. claim.
P. 10604 gold loc., Carscallen tp. *See* Wright g. claim.
P. 10627-9 gold locs., Bristol tp. *See* Wright g. claims.
P. 10680-1 gold locs., Carscallen tp. *See* Hughes g. claim.
P. 10858 gold loc., Bristol tp. 11
P. 10964 gold loc., Ogden tp. *See* Ostrosser g. claim.
P. 11357 gold loc., Denton tp. 15
P. 11388 gold loc., Bristol tp. 7, 11, 19
P. 11396-7, 11385 and 11388 gold locs., Bristol tp. *See* Greenberg-Goldstein g. claims.
P. 11993-4 gold locs., Ogden tp. *See* McEnaney g. claims.
Pann Porcupine g. claim 9-11, 14, 27
Papakomeka l. 43, 49
Paradis ck., gold 17
Parliment, Herbert 1
Parsons, J. R. L. 60
Peat 50
Pickerel.
  Grassy R. area 66
  Redstone R. area 43
Pigeon rapids, Mattagami r. 3
Pigott, William 57
Pike.
  Grassy R. area 66
  Muskasenda l. 43
Pillow lava. *See* Keewatin.
Pine.
  Grassy R. area 65, 66
  Mond tp., photo 77
  Redstone R. area 43
Placer gold.
  Bristol and Ogden tps. 4, 17, 23
Pleistocene.
  See also Glacial deposits.
  Redstone R. area 49, 50
Poplar 4, 66, 67
Porcupine Gold Quill g. claims 26

PAGE
Porcupine-Kirkland Gold Mines, Ltd. 78, 80-82
Porphyry.
  Bristol tp., rhyolitic, notes 9
  See also Quartz porphyry.
P.P. 21 gold loc., Ogden tp. *See* Ostrosser g. claim.
Pre-Cambrian.
  Bristol, Carscallen and Ogden tps. 5-21
  Churchill and MacMurchy tps. 85-89
  Grassy R. area 69, 70
  Redstone R. area 39-49
Pulpwood 67
Pyrite 72-74

Q

Quartz diabase 16
Quartz porphyry.
  See also Algoman system.
  Bristol, Carscallen and Ogden tps., notes, photo and analyses 13, 14
Quaternary.
  Redstone R. area 39, 49, 50
Reading, A. L. 57
Reading l., Sothman tp., photo 63
Recent deposits 16, 17, 50
Redstone l., rocks 72
Redstone r.
  Character 38, 40
  Drainage area 40
  Fish 43
  Gold prospecting 71
  Pleistocene 42, 49
  Report on area, by Bruce 37-56
    key map 36
  Rocks 61
    iron formation, notes and sketch map 71, 72
Redsucker r. 3, 4, 23
Rhyolite.
  See also Keewatin.
  Bristol and Carscallen tps.
    notes 8
    quartz veins in, photo 22
Ribble vein, Wasapika g. mine 88, 89, 93
Robson, W. T. 57
Rogers, W. R. 2, 5, 85

S

St. Paul gold claims.
  Rocks; veins 13, 23, 25
Sansawaju (Turkey) mt. 60, 78
Saskatoon bush 77
Saville, Thomas 78, 80, 82, 94
Saville g. claim 88
Schist l., rocks 76
Scobell g. claim 32
Scott l.
Semple tp.
  Map, sketch 73
  Mineral claims 60, 73
  Timber 66
Sericite schist, Churchill tp. 88
Serpentine.
  Ogden tp., notes 12
  Redstone R. area 56
  See also Keewatin.
Serpentine mt. 40-44, 50
Shear l. 74, 75

PAGE
Shipman, C. B. 57
Siderite, Semple tp. 74
Silver.
West Shiningtree L. area. 96
Sinclair, Duncan.
Sinclair l. 59
Smillie s. claim. 96
Soil. *See* Agricultural land.
Sothman l. 75
Sothman tp. 66
Spence, John. 37
See also Spence g. claim.
Spence gold claim. 53, 54
Sphalerite. 90, 91
Spruce. 4, 66, 67
Squirrel, red. 66
Stetham tp., area. 59
Steve l. 72
Stewart, R. B. 85
Sudbury dist.
Reports on. *See* Grassy r.
Sullivan, G. B. 83
Sulphide ck. 97
Synclines.
Bristol tp., diagram. 19
Halliday tp., diagram. 76

T

Table of formations.
Bristol, Carscallen and Ogden tps. 6
Churchill and MacMurchy tps. 86
Grassy R. area. 69
Tamarac. 4
T.C. 603-4 gold locs., Ogden tp. 26
T.C. 613-4 gold locs., Bristol tp. *See* McAuley-Brydge g. m.
Telluride l. 60, 61, 71, 72
Tellurides. 60
Terraces. 42
Thomson g. claim. 15, 16
Thunder ck., Redsucker r. 4, 17
Timiskaming dist.
Report on part. 37-56
Timiskaming series. 11, 12, 50
Togo tp., area. 58
Tonopah Mining Co. 92
Toner g. claim. 1, 32
Toner-McCormick gold claims, Bristol tp.
Rocks; sulphides xxxv (6). 31, 32
Topography.
Bristol, Carscallen and Ogden tps. 3
Grassy R. area. 79
Redstone R. area. 39-42
Trachyte.
Redstone R. area. *See* Keewatin.
Trees.
Bartlett and Geikie tps. 39
Carscallen, Bristol and Ogden tps. 4
Grassy R. area. 66, 67
Redstone R. area. 42, 43
Triple l.
Gold. *See* Harrison g. claims.
Spence g. claim.
Iron formation near. 45
Photo. 54
Trout lake. 66
Trout, speckled. 43

PAGE
T.R.P. 590 gold loc., Ogden tp. 25, 26
T.R.P. 2 014-16 gold locs., Ogden tp. *See* White g. claim.
T.R.P. 2524-6 and 2537 gold locs. *See* Ogden Porcupine g. m.
T.R.P. 2984 gold loc. 52
T.R.P. 3027 gold loc., s. of Clear l. 52
T.R.P. 4612 gold loc., McArthur and Bartlett tps. 48
T.R.P. 6057 gold loc., Bartlett tp. 53
T.R.P. 7716-7 gold locs., McArthur tp. *See* Lohner g. claims.
T.R.P. 8633 gold loc., McArthur tp. 52
T.R.P. 8989-94 gold locs., Bartlett tp. *See* Cameron-Porcupine g. claims.
T.R.P. 10724 gold loc. 48
T.R.P. 11209 gold loc., Triple lake. *See* Spence g. claim.
T.R.S. 1114 gold loc., Ogden tp. 26, 27
T.R.S. 1164 gold loc., Ogden tp. *See* Owen Acme g. claim.
T.R.S. 1174-5 gold locs., Ogden tp. *See* Owen Acme g. claim.
Tuffs.
Churchill and MacMurchy tps. *See* Keewatin.
Ogden tp., notes. 8
Redstone R. area. *See* Keewatin.
Turkey mt., Kemp and Mona tps. *See* Sansawaju mt.
Turnbull tp., gabbro. 12-14
Twain, D., Sr. 73, 74

W

Walker, R. S. 37
Wasapiki g. mine.
See also Ribble vein.
Description. 92
Photo. 93
Wasapiki lake, MacMurchy tp.
Report on area. 83-96
Washagami l. 59, 67
Wellington l. 59, 74, 75
West Shiningtree g. area.
Report by Finley. 83-96
West Shiningtree l. 96
West Tree g. m.
Albite. 90
Description. 93, 94
Faults. 88
Photo. 86
Schist. 88
Slate band. 87
White g. mine. 28
White Rock g. mine. 88, 94
Worthington g. claim, Ogden tp. *See* Langmuir g. m.
Wright g. claim. 29, 30, 32
Wright l. 29

Z

Zavitz tp.
See also Kitchiming l.
Agricultural land. 61
Map, sketch. 73
Mineral claims, notes. 74
Trees. 66
Zinc. *See* Sphalerite.













































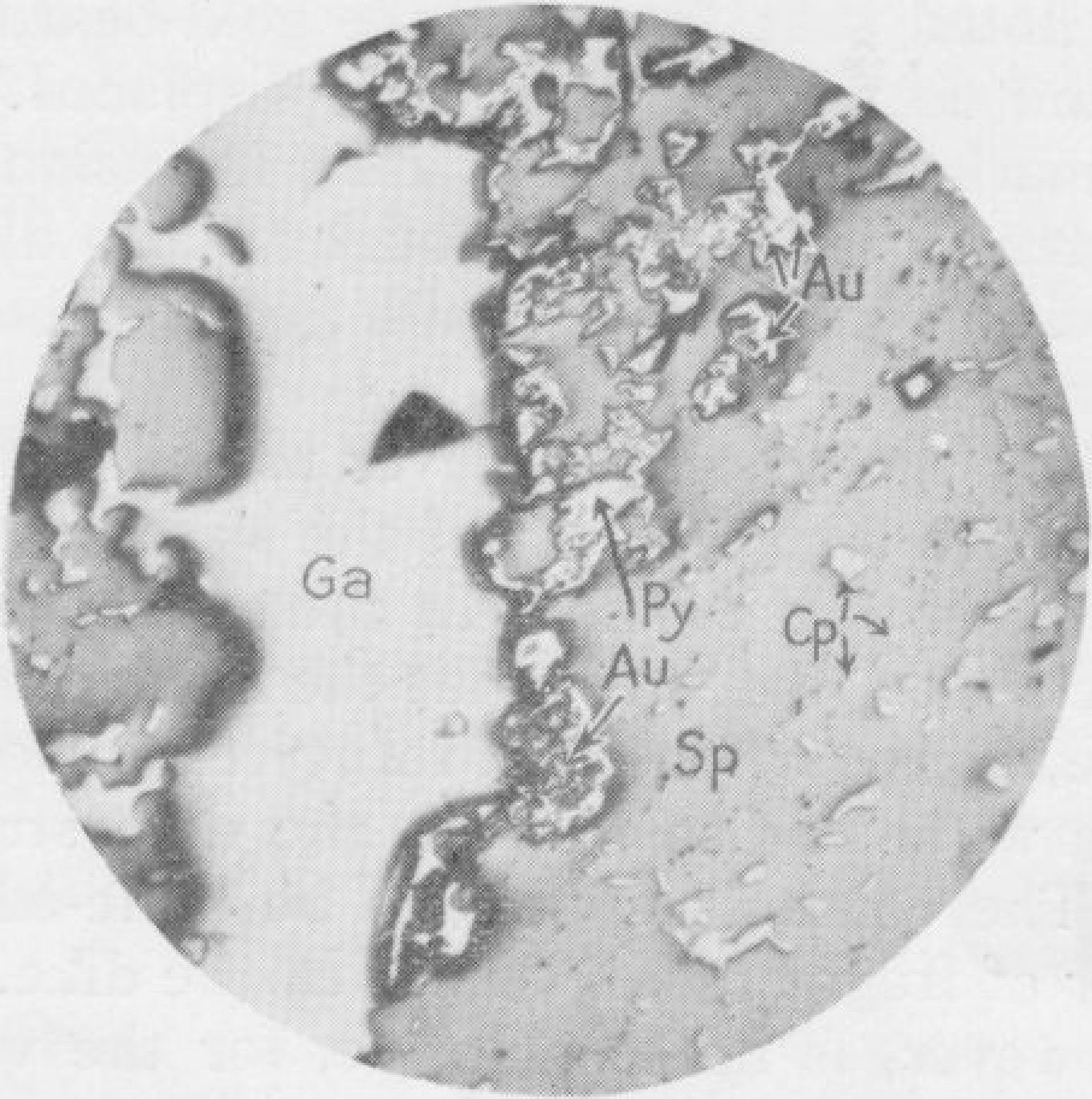


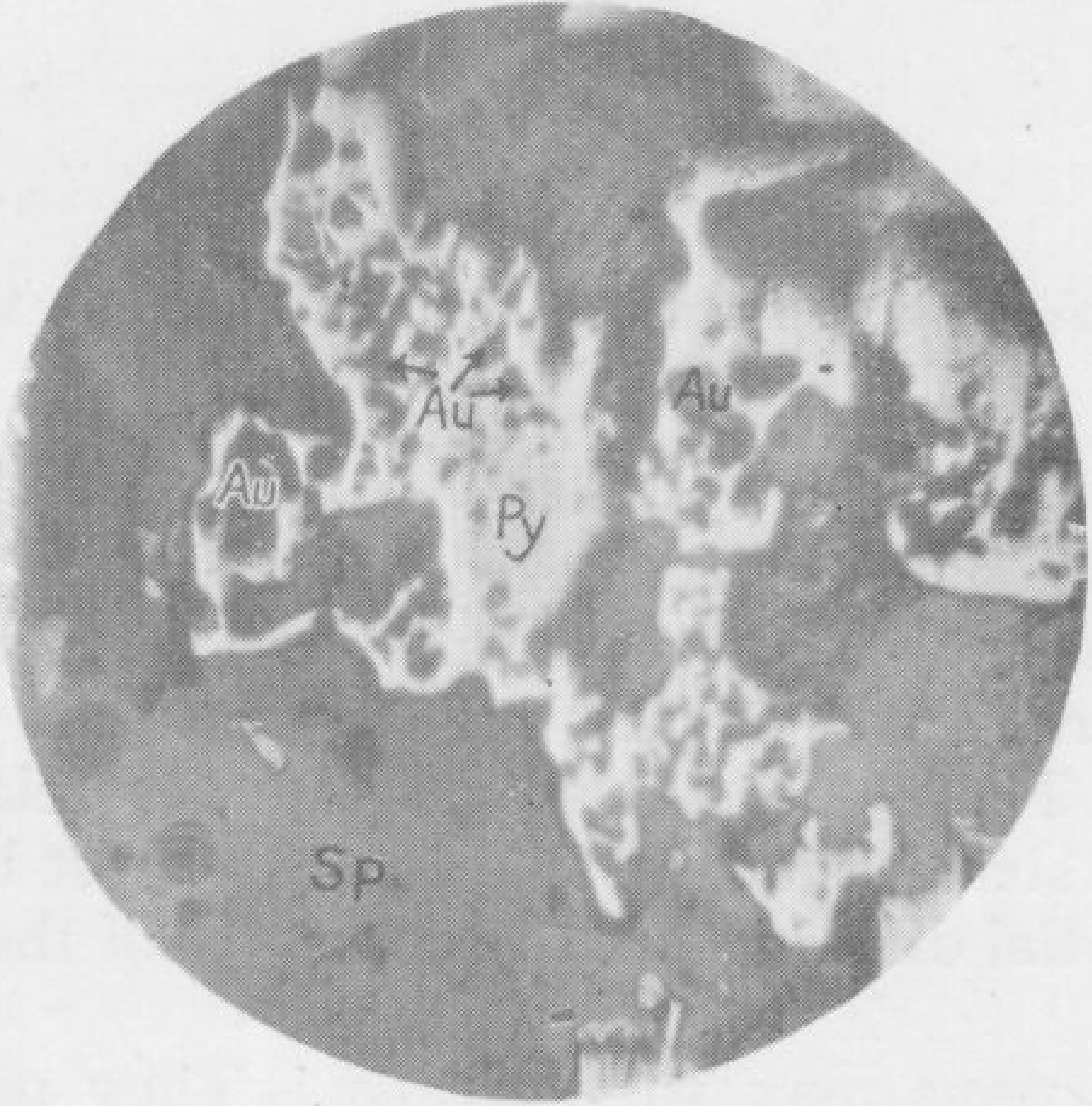


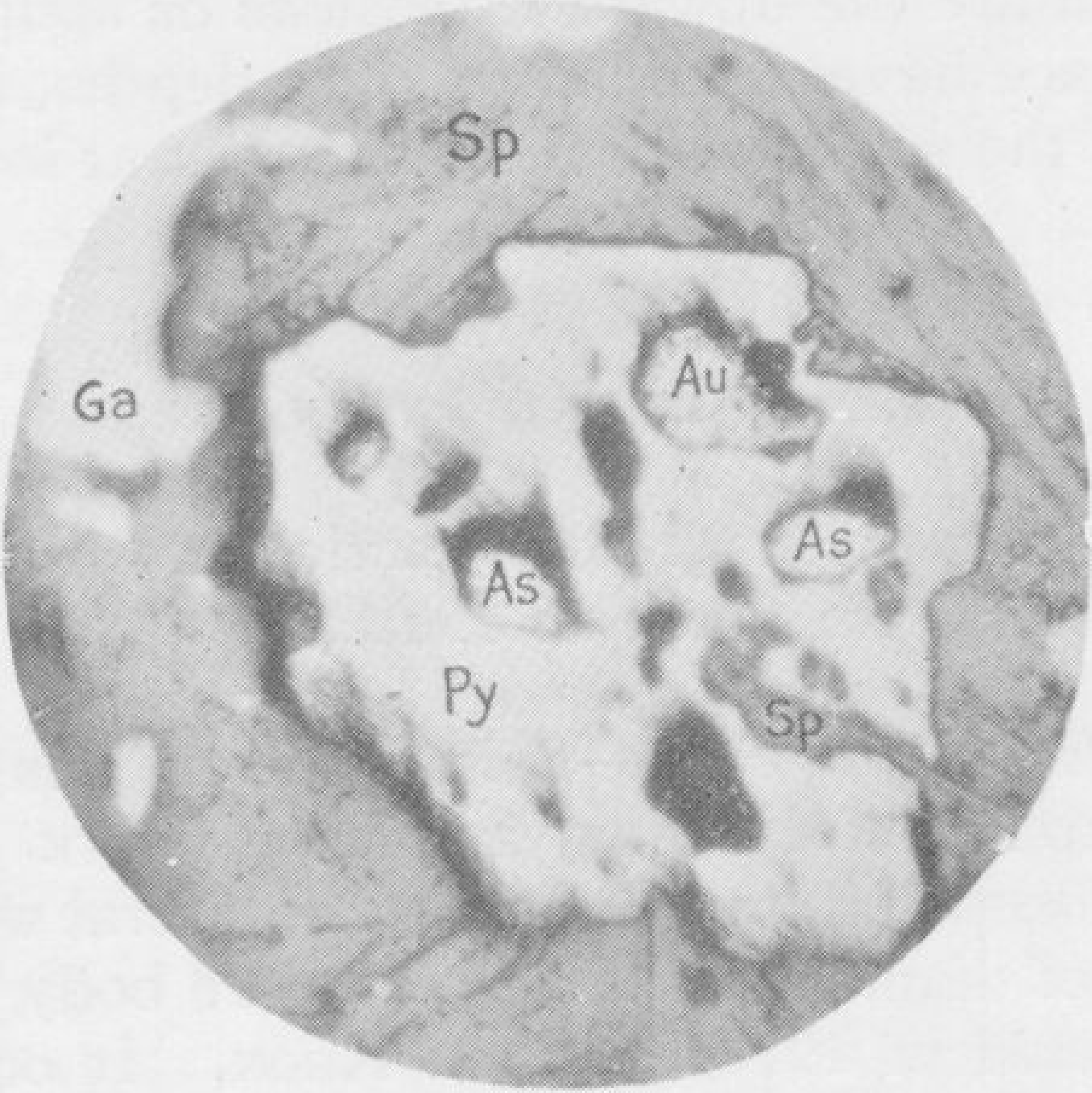







Au
Ga
Py
Cp
Au
Sp


Au
Au
Au
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Sp.


Sp
Ga
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