TWENTY-FIFTH ANNUAL REPORT

OF THE

ONTARIO BUREAU OF MINES, 1916

BEING

VOL. XXV., PART I.

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LETTER OF TRANSMISSION

To His Honour Sir John Strathearn Hendrie, C.V.O.,

Lieutenant-Governor of the Province of Ontario.

Sir,—I have the honour to transmit herewith, for presentation to the Legislative Assembly of the Province of Ontario, the Twenty-fifth Annual Report of the Bureau of Mines.

I have the honour to be, Sir,

Your obedient servant,

G. H. Ferguson,

Minister of Lands, Forests and Mines.

Department of Lands, Forests and Mines,
Toronto, 1916.

INTRODUCTORY LETTER

To The Honourable George Howard Ferguson, K.C.,

Minister of Lands, Forests and Mines.

Sir,—I have the honour to present to you herewith, to be transmitted to His Honour the Lieutenant-Governor in Council, the Twenty-fifth Annual Report of the Bureau of Mines consisting of three Parts, being for the calendar year 1915.

Part I comprises a Statistical Review of the Mining Industry of Ontario for 1915 by W. R. Rogers; a report on the Mining Accidents of the year by T. F. Sutherland, Chief Inspector of Mines, and Inspectors E. A. Collins and James Bartlett; an account of the operating mines in the Province by Mr. Sutherland and Inspectors Collins, McMillan and Bartlett; a description of the Iron Deposits of Hunter Island with notes on the Gunflint Lake Area, by A. L. Parsons of the University of Toronto; notes on Iron Pyrites Deposits in Southeastern Ontario, by P. E. Hopkins; a Study of Certain Minerals from Cobalt, Ontario, by H. V. Ellsworth, of the University of Toronto; reports on Boston Creek Gold Area and the Goodfish Lake Gold Area, by A. G. Burrows and P. E. Hopkins of the Geological staff of the Bureau; and a preliminary report on the Kowkash Gold Area, by P. E. Hopkins. The several illustrated reports of a geological nature are accompanied by appropriate maps and plans, both coloured and in black and white.

Part II, entitled Lead and Zinc Deposits in Ontario and in Eastern Canada, by W. L. Uglow, was prepared for the purpose of bringing together all the available information on the subject in view of the increased demand for these metals occasioned by the war. Dr. Uglow was particularly fitted for this task, having had experience in the investigation of deposits of these metals in the State of Wisconsin. He also made private examination of several properties in Ontario. The mines and prospects are described individually, and the report is accompanied by two geologically coloured maps.

Part III, a description of the Geology of Kingston and Vicinity, by Prof. M. B. Baker, of Queen's University, is accompanied by a contoured map, geologically coloured, of the southern part of Frontenac county. This part of eastern Ontario is well mineralized, mica and feldspar being mined extensively. The report is accompanied by two appendices by officers of the Geological Survey of Canada: Appendix I, the Ordovician Limestones of the Kingston area, by E. M. Kindle; Appendix II, a Synopsis of the Common Fossils of the Kingston area, by A. E. Wilson and K. F. Mather.

The statistical tables printed in Part I of the Report show the decline in value of the mineral output, which was occasioned in 1914 by the outbreak of war, to have continued in 1915 only so far as the non-metallic production is concerned. A great increase in the production of metals more than offsets this decline, so that the total value of the mineral production of the Province for 1915 exceeds that of the former record year, 1913, by over one million dollars. The greatest increase is in the value of nickel-copper matte which approached $21,000,000 as compared with a little over $7,000,000 in 1914. The advance in output and a higher valuation of the nickel and copper contents account for this unprecedented increase. Gold also showed an increase in output of nearly $3,000,000, which is credited largely to the Porcupine camp. The newer gold camps of Kirkland Lake, Munro, Boston Creek and Kowkash promise soon to add to the gold production of the Province. Molybdenite, used in tool steel manufacture, was produced for the first time in Ontario in appreciable quantities. Concentrators have been erected for treating this ore, and ferro-molybdenum is about to be manufactured in the Province.

I have the honour to be, Sir,

Your obedient servant,

THOS. W. GIBSON,

Deputy Minister of Mines.

BUREAU OF MINES,
DEPARTMENT OF LANDS, FORESTS AND MINES,
Toronto, 1916.

STATISTICAL REVIEW

of the

MINERAL INDUSTRY OF ONTARIO FOR 1915

By W. R. ROGERS

The Mining Act of Ontario (section 170) requires the owners or operators of all mines, quarries, metallurgical and mineral works in the Province to make returns to the Bureau of Mines, showing the quantity and value of the minerals produced during the year together with such particulars as to number of employees, wages paid, etc., as are necessary for statistical purposes. A penalty is provided for non-compliance with the provisions of the Act, and a further penalty for every day after written notice has been given that the offence continues. Owners and operators are reminded of the importance of supplying complete and accurate information promptly in order that the compilation of statistics for any particular industry may be presented at the earliest possible date in a careful and authoritative manner.

There are facts regarding the importance of several of the mineral products of the Province, perhaps not widely known in some instances, which are worthy of emphasis. The largest high-grade talc deposit on the continent is situated at Madoc; the greatest mica mine, the Lacey, near Sydenham; the largest high-grade feldspar mine near Verona; and the greatest graphite deposit known as the Black Donald mine, near Calabogie. All these non-metallic deposits are located in eastern Ontario in the counties of Hastings, Frontenac and Renfrew. Coming to the metals, Ontario possesses at Sudbury the most valuable nickel deposits in the world. Of these the Creighton ore body is undoubtedly the largest, the highest grade and most important. Cobalt is widely known as the richest silver camp in the world, the value of the output to date approaching that of gold from the Yukon. Ontario also possesses in Porcupine the most promising of the younger gold camps on the continent. During 1915 in the Province of Ontario there were 79 producing mines, 62 of which operated at a profit.

Production for 1915

Industrial depression which set in after the declaration of war in August, 1914, continued to some extent during the early part of 1915, but in the latter part of the year a revival in business was well under way. The mines were worked with feverish activity in order to supply the abnormal demand for metals, particularly nickel and copper. Prices, which are dependent on supply and demand, rapidly advanced.

The steady growth which marked the mineral production of Ontario for a decade prior to 1913, received a severe check in 1914, owing in part to business depression, but chiefly to the outbreak of war in the month of August, and to the resulting disturbances in industrial and financial conditions. In consequence, the 1914 production was 13 per cent. or $6,936,352 less than that of 1913. The year 1915, however, has shown a turn in the tide with a marked increase in production over 1914, amounting to 17 per cent. or $7,949,720. Gold has shown a large increase, offset to some extent by a decrease in silver production. Nickel and copper experienced what would be considered abnormal increases in times of peace. The great demand for these metals for munition purposes together with the impetus of increased prices stimulated production to the limit of capacity of the operating companies.

Among non-metallic substances, there has been a great falling off in the output of construction materials, brick, stone, lime, etc. A sufficient explanation of this decline is found in the fact that the energies of many of our people are turned from the building trades to the manufacture of munitions and to other industries more essential in the vigorous prosecution of the war.

Taking successive five-year periods, beginning with 1891, when the Ontario Bureau of Mines was established, the growth in the mineral production of the Province, expressed in value and by percentages for the several years and periods, has been as follows:—

Year.	Value. $	Growth per cent.
1891	4,705,673	
1896	5,235,003	11.2
1901	11,831,086	125.9
1906	22,388,383	89.2
1911	41,976,797	87.4
1915	54,245,679	29.2

In Table I a departure from the previous practice of the Bureau is made as regards pig iron and iron ore. Hitherto the total production of pig iron, from imported as well as domestic ore, has been given as that of Ontario. It is possible that this may give rise to erroneous impressions regarding the extent of the iron mining industry of the Province, and it has been thought best to confine the pig iron product of Ontario to the proportion of the output which, on the basis of the number of tons smelted of imported and Ontario ore, may be properly attributable to the latter. The iron ore reported is the quantity only that was exported, the remainder going to the blast furnaces of the Province to be smelted into pig iron. The total production of iron ore is shown under that heading.

Heretofore the low valuation placed on the nickel-copper matte by the producing companies has been accepted for statistical purposes. In 1914 these figures were 11.2 cents per pound for nickel and 7.2 cents for copper. Exact figures of value cannot be obtained, for the reason that nickel-copper matte is not a commodity bought and sold in the open market. The basis of valuation for 1915 has been fixed by the Bureau of Mines at 25 cents per pound for nickel and 10 cents for copper. These figures are conservative in view of the fact that the average price of refined copper in 1915 was about 17 cents, and that the nickel refined in Ontario in 1915 was sold at 40 cents per pound.

The quantities, valuation at the point of production, labour employed and wages paid in connection with the mineral industry of Ontario for the year 1915 are summarized in the following table:—

TABLE I.—MINERAL STATISTICS OF ONTARIO FOR 1915

Product.	Quantity.	Value.	Employees.	Wages.
METALLIC:		$		$
Gold ....ounces	411,588	8,501,391	2,419	2,206,179
Silver........ "	24,823,660	12,174,312	2,708	2,540,568
Copper ore ....tons	271	4,418	100	32,266
Copper in matte........ "	19,608	(a) 3,921,600	4,178	3,581,639
Nickel in matte........ "	34,039	(a)17,019,500		
Iron ore (exported)........ "	88,322	171,345	392	224,306
Pig iron .... "	(b)157,888	1,891,400	563	370,978
Cobalt ore........ "	177	21,464	(c)	(c)
Cobalt (metallic) .... lbs.	111,558	103,746	360	253,540
Cobalt oxide .... "	314,906	254,447		
Nickel " .... "	145,323	17,968		
Nickel (metallic) .... "	11,905	4,762		
Other Nickel and Cobalt compounds .... "	75,447	9,227		
Molybdenite ore........tons	192	12,859	95	22,061
Molybdenite concentrates .... lbs.	1,068	1,240		
Total metallic........	....	44,109,679	10,815	9,231,537
NON-METALLIC:				
Arsenic, (white, grey and other forms)........ lbs.	4,980,659	148,379	(d)	(d)
Brick (fancy, terra cotta, etc. M	3,758	158,515	344	160,483
" (pressed) .... "	24,836	217,350		
" (common .... "	91,967	763,591	1,627	445,726
Tile, drain .... "	17,837	321,253		
Cement (Portland) ....bbls	2,302,242	2,534,537	692	425,170
Corundum........tons	262	31,398	10	9,755
Feldspar........ "	12,649	47,031	66	22,265
Graphite (refined) .... "	2,534	115,274	78	37,929
Gypsum (crushed, ground and calcined) .... "	81,172	190,422	139	65,312
Iron pyrites........ "	145,315	353,498	213	177,627
Lime ....bush	1,340,394	244,953	158	90,808
Mica........tons	195	33,490	32	12,962
Natural gas........M cu. ft.	15,211,523	2,622,838	598	382,401
Petroleum (crude)........Imp. gals.	7,505,478	300,219	(e) 723	(e) 564,950
Pottery	....	49,387	26	15,280
Quartz ....tons	95,460	142,354	86	39,581
Salt .... "	116,648	585,022	242	183,558
Sand and gravel ....cu. yds.	670,510	178,288	292	87,264
Sewer pipe........	....	361,283	223	131,422
Stone (building, marble, trap, etc.)	....	651,593	726	290,945
Talc (crude) ....tons	1,720	5,160	40	23,790
" (ground)........ "	9,285	80,165		
Total non-metallic	....	10,136,000	6,375	3,167,228
Add metallic........	....	44,109,679	10,815	9,231,537
Grand Total	....	54,245,679	17,190	12,398,765

(a) Copper at 10 and nickel at 25 cents per pound in the matte.
(b) Production from Ontario iron ore only.
(c) Included in silver production.
(d) Included with cobalt and nickel compounds.
(e) Employees and wages for petroleum refineries.

In Table II comparative figures are given showing the value of the mineral production of the Province for a five-year period. A rapid development is noted despite a few decreases in individual products and the general set back recorded in 1914, the first year of the war. Among the metals, gold, copper and nickel show the greatest increases. The decrease in pig iron, as already explained, is due to reporting only the pig iron produced from domestic iron ore.

TABLE II.—MINERAL PRODUCTION, 1911 TO 1915

Product.	1911	1912	1913	1914	1915
METALLIC:	$	$	$	$	$
Gold	42,637	2,114,086	4,558,518	5,529,767	8,501,391
Silver	15,953,895	17,671,918	16,579,094	12,795,214	12,174,312
Cobalt	170,890	315,781	420,386	546,479	(a) 379,657
Copper	1,281,118	1,584,310	1,840,492	2,081,332	3,926,018
Nickel	3,664,474	4,736,460	5,250,803	5,136,804	(b)17,042,230
Other Nickel and Cobalt compounds	....	....	....	45,189	9,227
Iron ore	273,539	93,558	138,750	169,427	171,345
Pig iron	7,716,314	8,054,369	8,719,892	7,041,079	1,891,400
Lead	....	1,290	....	....	....
Molybdenite	....	....	....	....	14,099
Platinum	....	80,736	....	....	....
Palladium	....	147,235	....	....	....
Metallic production	29,102,867	34,799,743	37,507,935	33,345,291	44,109,679
NON-METALLIC:					
Arsenic	74,609	79,297	64,146	116,624	148,379
Brick, common	2,801,971	3,178,250	3,452,352	2,336,207	763,591
" paving, fancy, etc.	86,685	221,986	243,119	237,440	158,515
" pressed	564,630	634,169	919,741	656,944	217,350
Building and crushed stone	892,627	953,839	1,137,153	1,088,862	651,593
Calcium carbide	84,437	120,000	123,100	142,883	(c) ....
Cement, Portland	3,640,642	3,365,659	4,105,455	2,931,190	2,534,537
Corundum	147,158	233,212	137,036	65,730	31,398
Feldspar	51,610	28,916	67,142	55,686	47,031
Fluorspar	200	....	....	....	....
Graphite	36,492	65,076	93,054	87,167	115,274
Gypsum	32,535	50,246	92,627	221,175	(d) 190,422
Iron pyrites	118,457	71,043	171,687	264,722	353,498
Lime	402,340	381,672	390,600	333,407	244,953
Mica	43,058	57,384	55,264	40,402	33,490
Natural gas	2,186,762	2,268,022	2,362,021	2,346,687	2,622,838
Peat fuel	2,830	725	1,750	2,100	....
Petroleum (crude)	353,573	344,537	398,051	337,867	300,219
Phosphate of lime	240	....	....	3,150	....
Pottery	50,500	52,445	52,875	25,720	49,387
Quartz	64,405	179,576	130,860	82,544	142,354
Salt	430,835	450,251	474,372	498,383	585,022
Sand and gravel	....	....	233,567	151,909	178,288
Sewer pipe	410,064	464,627	600,297	571,756	361,283
Talc	47,725	61,358	125,340	(e) 74,583	(e) 85,325
Tile, drain	349,545	279,579	292,767	277,530	321,253
Non-metallic production	12,873,930	13,541,869	15,724,376	12,950,668	10,136,000
Add metallic production	29,102,867	34,799,743	37,507,935	33,345,291	44,109,679
Total production	41,976,797	48,341,612	53,232,311	46,295,959	54,245,679

(a) Cobalt ore, oxide and metallic Cobalt. (b) Nickel in matte, oxide and metallic Nickel.
(c) Raw materials not all produced in Ontario. (d) Crude Gypsum and Gypsum products.
(e) Crude and Ground Talc.

Although accurate figures of production for the early years of iron and copper mining in Ontario are not available, the amount is negligible as compared with the production since 1891, when statistics were first systematically collected. The total value of metals produced is shown in the following table:—

TABLE III.—TOTAL PRODUCTION OF METALS IN ONTARIO

Metal.	Value to end of 1914.	Value, 1915.	Total Value.
	$	$	$
Gold	14,822,998	8,501,391	23,324,389
Silver	126,550,597	12,174,312	138,724,908
Platinum and Palladium	290,755	....	290,755
Cobalt (a)	2,039,006	379,657	2,418,663
Nickel (b)	51,400,370	17,042,230	68,442,600
Other Cobalt and Nickel Compounds	45,189	9,227	54,416
Copper	21,161,355	3,926,018	25,087,373
Iron ore	7,679,836	171,345	7,851,181
Pig iron	73,007,072	1,891,400	74,898,472
Lead	117,290	....	117,290
Zinc	92,410	....	92,410
Molybdenum	1,675	14,099	15,774
Total	297,208,553	44,109,676	341,318,229

(a) Includes metallic contents of Cobalt Oxide.
(b) " " " Nickel Oxide.

Legislation.—The Workmen's Compensation Act covering mining as well as other industrial operations, came into effect on January 1st, 1915. It vests in a Government-appointed Board the adjustment of compensation for employees who may meet with injuries or be killed in the pursuit of their work. One result of the Act has been the speedy settlement of claims without expensive litigation. The rate paid by mine operators was 3 per cent. of the pay roll. This has been reduced to 2½ per cent. for 1916.

Water power is becoming an important factor in the operation of mines. Of late years there have been clashes between lumbering and water power interests, the former naturally wishing to take advantage of the spring run-off for floating logs, and the latter to store it for use during dry periods. Amendments made by the Rivers and Streams Act, 1915, place authority in the Minister of Lands, Forests and Mines to deal with conflicting interests as they may rise, and to exercise control over water levels.

Dividends:—During the year dividends paid by silver mines operating in the Cobalt area amounted to $4,441,948.08. The total return to shareholders up to the end of 1915 reached $59,670,912.70. Up to the end of 1914 two Porcupine gold mines, Hollinger and Porcupine-Crown, had paid dividends amounting to $2,850,000. During 1915 the Dome, Rea and Tough-Oakes were added to the list. The latter mine is in the Kirkland lake area. The total dividends paid by gold properties to December 31st, 1915, amount to $5,194,875.

TABLE IV—DIVIDENDS AND BONUSES BY SILVER AND GOLD MINING COMPANIES TO DECEMBER 31ST, 1915

Name of Company.	Date of Incorporation.	Authorized Capital.	Capital Stock issued.	Par value per share.	Amount of Dividends and Bonuses declared to end of 1914.	Amount of Dividends and Bonuses declared during 1915.	Total of Dividends and Bonuses declared to Dec. 31, 1915.	Last Dividend or Bonus. Date declared.
SILVER COMPANIES		$	$	$	$ c.	$ c.	$ c.	
Beaver Consolidated Mines, Limited	Feb. 25, 1907	2,000,000	2,000,000	1.00	470,000 00	120,000 00	590,000 00	Oct. 15, 1915
Buffalo Mines, Limited	April 27, 1906	1,000,000	1,000,000	1.00	2,787,000 00	....	2,787,000 00	May 28, 1914
Casey Cobalt Mining Company, Limited	Dec. 19, 1906	100,000	100,000	1.00	203,249 33	....	203,249 33	Apl. 22, 1914
†City of Cobalt Mining Company, Limited	Oct. 5, 1906 / Jan. 7, 1909	500,000 / 1,500,000	1,500,000	1.00	145,000 00	....	145,000 00	Apl. 15, 1909
†Cobalt Lake Mining Company, Limited	Dec. 22, 1906	3,000,000	3,000,000	1.00	465,000 00	....	465,000 00	May 29, 1914
†Cobalt Townsite Mining Company, Limited	May 8, 1906	100,000	45,011	1.00	1,042,259 61	....	1,042,259 61	Nov. 11, 1914
*Mining Corporation of Canada, Limited	Mar. 20, 1914	2,075,000	2,075,000	1.00	259,375 00	518,750 00	778,125 00	Sept. 30, 1915
Cobalt Central Mines Company, Limited	Dec. 13, 1906	5,000,000	5,000,000	1.00	192,845 00	....	192,845 00	Aug. 25, 1909
Cobalt Comet Mines, Limited, (Drummond)	April 16, 1913	1,000,000	1,000,000	1.00	103,000 00	27,000 00	130,000 00	Apl. 1 1915
Cobalt Silver Queen, Limited	April 1, 1906	1,500,000	1,500,000	1.00	315,000 00	....	315,000 00	Dec. 31, 1908
Coniagas Mines, Limited	Nov. 24, 1906	4,000,000	4,000,000	5.00	7,240,000 00	600,000 00	7,840,000 00	Aug. 1, 1915
Crown Reserve Mining Company, Limited	Jan. 16, 1907	2,000,000	1,999,957	1.00	5,996,279 46	106,128 84	6,102,408 30	July 15, 1915
Foster Cobalt Mining Company, Limited	Feb. 14, 1906	1,000,000	915,588	1.00	45,000 00	....	45,000 00	Jan. 1, 1907
Kerr Lake Mining Company, Limited	Aug. 9, 1905	40,000	40,000	100.00	5,834,000 00	674,000 00	6,508,000 00	Oct. 13, 1915
La Rose Mines, Limited	Feb. 21, 1907	6,000,000	6,000,000	5.00	5,374,546 84	328,000 00	5,702,546 84	Dec. 10, 1915
McKinley-Darragh-Savage Mines of Cobalt, Limited	April 17, 1906	2,500,000	2,247,692	1.00	4,404,484 38	269,723 04	4,674,207 42	Nov. 27, 1915
Nipissing Mining Company, Limited	Dec. 16, 1904	250,000	250,000	100.00	13,233,297 25	1,220,000 00	14,453,297 25	Dec. 13, 1915
Peterson Lake Silver-Cobalt Mining Co., Limited	April 11, 1906	3,000,000	2,401,820	1.00	126,095 55	168,127 40	294,222 95	Nov. 26, 1915
Right of Way Mining Company, Limited	July 13, 1906	500,000	500,000	1.00	324,643 93	....	324,643 93	....
The Right of Way Mines, Limited	Sept. 11, 1909	2,000,000	1,685,500	1.00	219,115 20		219,115 20	Nov. 16 1914
Seneca-Superior Silver Mines, Limited	Sept. 29, 1911	500,000	478,884	1.00	645,993 40	335,218 80	981,212 20	Dec. 5, 1915
Temiskaming and Hudson Bay Mining Co., Limited	July 29, 1903	25,000	7,761	1.00	1,940,250 00	....	1,940,250 00	Nov. 10, 1914
The Hudson Bay Mines, Limited	July 16, 1909	3,500,000	3,200,050	5.00	778,909 42	....	778,909 42	Aug. 31, 1913
Temiskaming Mining Company, Limited	Nov. 16, 1906 / Jan. 1, 1908	2,500,000	2,500,000	1.00	1,384,156 25	75,000 00	1,459,156 25	Dec. 31, 1915
Trethewey Silver-Cobalt Mine, Limited	May 30, 1906 / June 1, 1911	2,000,000	1,000,000	1.00	1,061,998 50	....	1,061,998 50	June 19, 1914
Wettlaufer-Lorrain Silver Mines, Limited	Nov. 30, 1908	1,500,000	1,416,590	1.00	637,465 50	....	637,465 50	Sept. 22, 1913
Total from Silver Companies	....	....	....	....	55,228,964 62	4,441,948 08	59,670,912 70	
GOLD COMPANIES								
Dome Mines, Limited	Mar. 23, 1910	5,000,000	4,000,000	10.00	....	400,000 00	400,000 00	Nov. 3, 1915
Hollinger Gold Mines, Limited	June 28, 1910	3,000,000	3,000,000	5.00	2,610,000 00	1,560,000 00	4,170,000 00	Dec. 31, 1915
Porcupine Crown Mines, Limited	May 26, 1913	2,000,000	2,000,000	1.00	240,000 00	240,000 00	480,000 00	Jan. 2, 1916
Tough Oakes Gold Mines, Limited	July 15, 1915	3,000,000	531,500	5.00	....	132,875 00	132,875 00	Nov. 15, 1915
Rea Consolidated Gold Mines, Limited	April 5, 1911	1,000,000	200,000	5.00	....	12,000 00	12,000 00	....
Total from Gold Companies	....	....	....	....	2,850,000 00	2,344,875 00	5,194,875 00	
Total Dividends in 1915	....	....	....	....	58,078,964 62	6,786,823 08	64,865,787 70	

† Now amalgamated and operated by the Mining Corporation of Canada, Limited.
* This Company operates the City of Cobalt, Cobalt Lake and Cobalt Townsite mines.

Gold

Ontario's gold production has increased steadily since the year 1911, until gold mining is now a well established industry in the Province. The leading position which Ontario assumed in gold production in 1914, among the Provinces of Canada, was firmly established in 1915, when the production was 411,588 ounces of gold worth $8,501,391, an increase of over 53 per cent. over 1914. As formerly, the large increase is credited mainly to the Porcupine camp. Other producers were the Tough-Oakes at Kirkland lake; Croesus in Munro township; Canadian Exploration Company at Long lake, near Sudbury; Cordova Mines in Belmont township, Peterborough county; and, in a small way, Olympia in northwestern Ontario. In addition, there was recovered from the bullion at the gold mines, 77,126 fine ounces of silver worth $38,496.

The employees numbered 2,419, of whom 1,286 worked underground and 1,133 on the surface. They were paid in wages $2,206,179.

Porcupine:—During 1915 there were milled in the Porcupine mills 964,334 tons of ore which yielded a value of $7,472,167 or $7.85 per ton. In addition, 9,693 tons of concentrates were shipped which yielded $97,829, making the total Porcupine production $7,536,275 or 89 per cent. of the whole.

The producing mines were twelve in number. In addition to the larger producers enumerated in the table below there were the Dome lake, Gold Reef, Schumacher, Porcupine Pet and Porphyry Hill.

The following table gives the tonnage milled and values recovered, etc., by some of the large producers for the year 1915:—

Mine.	Tons milled.	Gold produced, ounces.	Total gold value.	(5) Extraction per ton.	Dividends declared.
			$	$ c.	$
Hollinger (3)	334,750	152,673	3,154,992	9 47	1,560,000
Dome	317,740	73,726	1,524,051	4 80	400,000
Acme (4)	106,486	49,933	1,032,205	9 73	....
McIntyre	101,955	36,094	745,880	7 37	....
Porcupine Crown (6)	41,326	29,032	599,998	14 02	240 000
Vipond	35,899	11,871	245,372	6 85	....
Rea (Mines Leasing Co.)	....	....	....	....	12,000
Total	....	....	....	....	2,212,000

(3) The Hollinger received in addition $81,730 from 9,500 tons of concentrates.
(4) Ore was treated in the Hollinger mill.
(5) The extraction per ton is based on the total gold and silver recovery.
(6) The Porcupine-Crown milled in addition 5,093 tons of tailings from the first amalgamation mill.

The Northern Canada Power Company, Limited, supply the Porcupine camp with hydro-electric power from their two plants situated on the Mattagami river at Sandy and Wawaitin falls. Additional storage facilities are being provided at the head waters of the Grassy river, a tributary of the Mattagami, in order to provide an ample supply at low-water period, which usually extends from March until the spring break-up in April or May.

The prices of mine and mill supplies, which advanced considerably owing to war conditions, made the total costs higher than they otherwise would have been.

The total working costs at the Hollinger for the year, including depreciation, were $3.98 per ton, while at the Dome for the year ending 31st March, 1916, they were $2.56 per ton.

The Acme, which adjoins the Hollinger, was operated during 1915 by the Canadian Mining and Finance Company, Limited, the ore being treated in the Hollinger mill, but the returns kept separate. The McIntyre operated considerably from the Pearl Lake property which is under their control. The Schumacher carried on development work all year but did not begin to produce bullion until November. Favourable results were obtained in developing the North Thompson, but no mill has been erected as yet. The outlook at Porcupine for 1916 is undoubtedly good.

The production from the Province as a whole and from Procupine for the years 1910 to 1915 inclusive is shown in the following table:—

GOLD PRODUCTION, 1910-1915

Year.	Ontario.	Porcupine.
	$	$
1910....................	68,498	35,539
1911....................	42,637	15,437*
1912....................	2,114,086	1,730,628
1913....................	4,558,518	4,294,113
1914....................	5,529,767	5,190,794
1915....................	8,501,391	7,536,275

* The decrease in 1911 is due to the mills being burned in the great fire of that year.

Other Gold Areas:—Of the other gold mining areas, Kirkland lake is the most advanced, the Tough-Oakes being the largest producer outside of Porcupine. The new mill at the Tough-Oakes during 1915 treated 26,196 tons or ore yielding $551,069, or $21.04 per ton, out of which $132,875 was paid in dividends. The Lake Shore, Teck-Hughes, McKane and LaBelle Kirkland mines were engaged in development work in the same neighbourhood.

The Canadian Exploration Company at Long lake, near Sudbury, came next the Tough-Oakes in the value of gold produced.

The Dobie-Leyson claim in Munro township, now known as the Croesus mine, was one of the promising discoveries of the year. The quality of the ore from the shaft of this mine may be judged by the fact that from 800 pounds of quartz $40,000 in gold was recovered.

New Prospects:—Finds were also made at Boston creek. These are described by A. G. Burrows and P. E. Hopkins elsewhere in this report. At Kowkash, on the National Transcontinental railway, about 300 miles west of Cochrane, a spectacular showing was uncovered in the month of August by E. King Dodds. In the rush that followed, other veins were found in the vicinity, and also about 25 miles west, near Tashota. A preliminary report on the area by P. E. Hopkins accompanies this volume. Rich ore was also discovered south of Dryden near Contact bay, Wabigoon lake, on the Rognon claim.

The new finds will no doubt be developed in the near future. Meantime the year closed with an optimistic feeling in gold mining.

PRODUCING GOLD MINES, 1915.

Name of Company.	Name of Mine.	Locality.	P.O. Address of Manager, etc.
*Acme Gold Mines, Limited	Acme	Porcupine	Timmins.
Canadian Exploration Company, Limited	Long Lake	Long Lake	Naughton.
Cordova Mines, Limited	Cordova	Peterboro' county	Cordova.
Croesus Gold Mines, Limited	Croesus	Munro township..	Matheson.
Dome Mines, Limited	Dome	Porcupine	South Porcupine.
Dome Lake Mining & Milling Company, Limited	Dome Lake	Porcupine	South Porcupine.
Gold Reef Gold Mines, Limited	Gold Reef	Porcupine	South Porcupine.
Hollinger Gold Mines, Limited	Hollinger	Porcupine	Timmins.
McIntyre-Porcupine Mines, Limited.	McIntyre	Porcupine	Schumacher.
Mines Leasing & Development Company, Limited	Rea	Porcupine	Schumacher.
Olympia Gold Mining Company, Limited	Olympia	Shoal Lake, Kenora district.	92 Reamy Street, St. Paul, Minn.
Porcupine Crown Mines, Limited	Porcupine Crown	Porcupine	Timmins.
Porcupine Pet Mining Company	Porcupine Pet ..	Porcupine	South Porcupine.
Porcupine Porphyry Hill Mining Company	Porphyry Hill ..	Porcupine	South Porcupine.
Porcupine Vipond Mines	Vipond	Porcupine	Timmins.
Schumacher Gold Mines	Schumacher	Porcupine	Schumacher.
Tough-Oakes Gold Mines, Limited ..	Tough-Oakes ...	Kirkland Lake ..	Kirkland Lake.

* Ore treated in Hollinger mill.

Silver

Ontario's silver production in 1915 was 24,823,660 ounces, worth $12,174,312, or nearly 12 per cent. of the total world production. The full production for 1915 was not marketed, several of the mines holding considerable silver in concentrates and bullion at the end of the year with the hope of obtaining higher prices. By

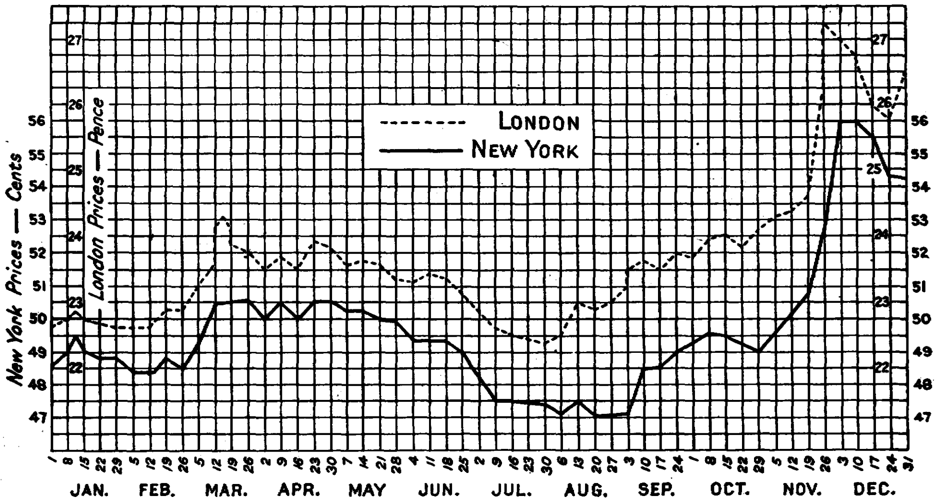


Diagram showing the weekly fluctuation of silver prices for 1915, as given by the Mining and Engineering World for New York and by Mocatta & Goldsmid for London. New York quotations are per fine ounce (Troy), while London prices are for bar silver, .925 fine.

reason of the continued low prices for the metal, the production, as compared with 1914, showed a decrease of 394,334 ounces. Development work was more expensive because of the increased cost of materials and labour as a result of the war.

In 1914 the average silver price was 54.81 cents, while in 1915 the average price fell to 49.684 cents per fine ounce. The lowest quotation for the year was 46¼ cents on September 1—the lowest known price for this metal. Toward the latter part of the year the demand for the metal for coinage purposes by belligerent countries caused a rise in price. There was also a considerable demand from India and China. The highest price for the year was 56¼ cents.

Apportioning the production to the several sources, we have the following:—

	Ounces.	Value. $
Cobalt	24,280,366	11,913,114
Casey township	223,939	105,846
Gowganda	242,229	116,856
Silver recovered from auriferous ores	77,126	38,496
Totals	24,823,660	12,174,312

Following the practice of former years, the mines shipping one-half million ounces or more of silver are given in the following list:—

Mine.	Ounces.
Nipissing	4,610,051
Mining Corporation of Canada (Townsite-City)	2,776,589
Kerr Lake	2,109,354
Seneca-Superior	1,996,257
Coniagas	1,916,616
Mining Corporation of Canada (Cobalt Lake)	1,566,206
Timiskaming	1,486,400
La Rose	1,071,694
McKinley-Darragh-Savage	1,061,827
O'Brien	991,084
Beaver Consolidated	970,168
Buffalo	839,010
Penn-Canadian	590,170
Crown Reserve	512,396
Cobalt Comet (Drummond)	507,367

Statistics of the yearly and total output of silver from the mines of Cobalt since their opening in 1904 are given in Table V, which follows:—

TABLE V.—SILVER PRODUCTION, COBALT MINES, 1904 TO 1915

Year.	Producing Mines.	Shipments and Silver Contents.					Av'ge Silver Contents per Ton.		Value of Silver Shipments.			Total.	
		Ore		Concentrates.		Bullion.	Ore.	Concentrates.	Ore.	Concentrates.	Bullion.	Ounces.	Value.
	No.	Tons	oz.	Tons.	oz.	oz.	oz.	oz.	$	$	$		$
1904	4	158	206,875	......	....	....	1,309	......	111,887	....	....	206,875	111,887
1905	16	2,144	2,451,356	......	....	....	1,143	......	1,360,503	....	....	2,451,356	1,360,503
1906	17	5,335	5,401,766	......	....	....	1,013	......	3,667,551	....	....	5,401,766	3,667,551
1907	28	14,788	10,023,311	......	....	....	677	......	6,155,391	....	....	10,023,311	6,155,391
1908	30	24,487	18,022,480	1,137	1,415,395	....	736	1,244	8,468,293	665,085	....	19,437,875	9,133,378
1909	31	27,729	22,436,355	2,948	3,461,470	....	809	1,174	10,809,872	1,651,704	....	25,897,825	12,461,576
1910	41	27,437	22,581,714	6,845	7,082,834	980,633	821	1,030	11,360,489	3,590,098	527,460	30,645,181	15,478,047
1911	34	17,278	20,318,626	9,375	8,056,189	3,132,976	1,176	858	10,250,991	4,017,241	1,686,615	31,507,791	15,953,847
1912	30	10,719	15,395,504	11,214	9,768,228	5,080,127	1,436	871	8,766,871	5,556,919	3,085,145	30,243,859	17,408,935
1913	35	9,861	13,668,079	11,016	8,489,321	7,524,575	1,386	770	7,444,995	4,554,797	4,554,189	29,681,975	16,553,981
1914	32	4,302	6,504,753	12,152	8,915,958	9,742,130	1,511	733	3,314,462	4,377,897	5,0[illegible],102	25,162,841	12,765,461
1915	24	2,865	6,758,286	11,996	10,001,548	7,986,700	2,359	834	3,422,627	4,673,624	4,039,565	24,746,534	12,135,816
Total ...		147,103	143,769,105	66,683	57,190,943	34,447,141	977	858	75,133,932	29,087,365	18,965,076	235,407,189	123,186,373

PRODUCING SILVER MINES, 1915

Name of Company or Owner.	Name of Mine.*	P.O. Address of Manager, etc.
Aladdin Cobalt Company, Limited	Chambers-Ferland	Cobalt.
Beaver Consolidated Mines, Limited	Beaver	Cobalt.
Buffalo Mines, Limited, The	Buffalo	Cobalt.
Casey Cobalt Silver Mining Company, Limited	Casey-Cobalt	New Liskeard.
Cobalt Comet Mines, Limited	Drummond	Giroux Lake.
Cobalt Silver Queen, Limited	Silver Queen	Cobalt.
Coniagas Mines, Limited, The	Coniagas	Cobalt.
Crown Reserve Mining Co., Limited	Crown Reserve	Cobalt.
Crown Reserve Mining Co., Limited	Drummond Fraction	Cobalt.
Crown Reserve Mining Co., Limited	Silver Leaf	Cobalt.
Kerr Lake Mining Company, Limited	Kerr Lake	Cobalt.
La Rose Mines, Limited	La Rose	Cobalt.
La Rose Mines, Limited	University	Cobalt.
McKinley-Darragh-Savage Mines of Cobalt, Limited	McKinley-Darragh-Savage	Cobalt.
Mining Corporation of Canada, Limited, The	Cobalt Lake	Cobalt.
	Townsite-City	Cobalt.
Nipissing Mining Company, Limited	Nipissing	Cobalt.
O'Brien, M. J.	O'Brien	Cobalt.
O'Brien, M. J.	Miller Lake-O'Brien	Gowganda.
Penn-Canadian Mines, Limited	Penn-Canadian	Cobalt.
Right of Way Mines, Limited, The	Right of Way	Cobalt.
Seneca-Superior Silver Mines, Limited	Seneca-Superior	Cobalt.
Temiskaming Mining Company, Limited	Temiskaming	Cobalt.
Trethewey Silver-Cobalt Mine, Limited	Trethewey	Cobalt.

Since the record year of 1911, when 31,507,791 ounces were produced there has been a steady decline in output. It is hoped that the flotation process of concentration will allow tailing dumps carrying only a few ounces of silver to the ton to be re-treated at a profit, thus prolonging the life and increasing the output of the Cobalt camp. Several of the producing companies are developing old prospects that have not received attention since the early days of Cobalt's history.

An interesting development is proceeding in the southeast section of the silver area, the expense of which is being borne jointly by the Timiskaming and Beaver mines. Diamond drilling has shown that the bottom of the diabase sill is about 1,700 feet below the surface. A shaft is being sunk to that depth in the hope that exploratory drifting near the lower contact will reveal productive veins similar to those found at or near the upper contact of the diabase and keewatin formations.

Other developments at Cobalt during the year included the complete dewatering of Kerr lake and the same undertaking initiated and completed at Cobalt lake, thus rendering accessible ore reserves assumed to exist between the beds of these lakes and the stope backs. In order to provide a new water supply for many of the mines and mills at Cobalt it was necessary to draw upon Brief, Short, Pickerel and Bass lakes in addition to the Montreal River. Pumping plants were erected at these points and a water supply service has been in continuous operation since April 29th, 1915. Up to the end of 1915 the total cost of dewatering Cobalt lake, including plant, was $10,704; and for the new water supply and lake drainage service the cost was $16,894. The work was undertaken and completed by the Mining Corporation of Canada.

*All the mines noted above are located at Cobalt, with the exception of the Casey Cobalt in Casey township and the Miller Lake-O'Brien at Gowganda.

Metallurgy.—In the metallurgical field doubtless the most important advance has been in the development of the flotation process and technical journals have given a great deal of attention to this subject throughout the year. As an auxiliary it would appear to fill a long felt want for the recovery of metals that slime-concentrating machines have attempted to gain heretofore. Some ores may be treated solely by flotation. It is particularly applicable to sulphide ores. The process will likely displace cyaniding to a large extent. There has been a great divergence of opinion as to the theory of the process but in practice the water, pulp and oil mixture is subjected to air agitation resulting in frothy oil rising to the surface and carrying with it metallic particles which are then skimmed. Unfortunately, litigation over patent rights has delayed the adoption of the process. In Ontario, an installation is proceeding at Massey for treating copper ore, and at Cobalt several of the mines, notably the McKinley-Darragh, Buffalo and Nipissing, are conducting experiments. It is contended that slimes carrying 5 or 6 ounces of silver can be profitably treated leaving only about one ounce unrecovered. If satisfactory results are obtained and the process generally adopted, it will mean considerable prolongation to the life of the Cobalt silver camp. Investigations are proceeding in the treatment of red pine stumps from Northern Ontario as a source of oil for use in the process.

Smelters and Refineries:—At Cobalt, silver bullion was produced by the Dominion Reduction Company, also by the Nipissing and Buffalo mines. The total bullion shipments for the year from Cobalt mines amounted to 7,986,700 ounces, valued at $4,039,565, or over 32 per cent. of the entire silver production of the Province.

Southern Ontario refineries operating in 1915 were the Coniagas Reduction Company at Thorold, the Metals Chemical Company at Welland, and the Deloro Mining and Reduction Company at Deloro. New items on the list of metallurgical products for 1915 from the silver-cobalt refineries are metallic nickel, cobalt and arsenic, also cobalt and nickel sulphates. The market for metallic cobalt has been somewhat limited although the suitability of the metal for electro-plating purposes has been amply demonstrated. There is, in addition, a certain field for its use in the manufacture of special steels. A suggested use of cobalt for coinage purposes, contained in Vol. XXIV, report of the Ontario Bureau of Mines, has met with favour in many quarters.

At the refineries there was produced and shipped metallic cobalt, cobalt oxide and cobalt sulphate. Metallic nickel was produced for the first time in addition to the regular output of arsenic nickel oxide and nickel sulphate. The total amount of silver-cobalt ore treated was 7,526 tons. Actual shipments from the refineries at Thorold, Welland and Deloro were as follows:—

——		Quantity.	Value.
Silver	ozs.	9,885,985	$4,942,993
Arsenic (white, grey and other forms)	lbs.	4,980,659	148,379
Cobalt (metallic)	"	111,558	103,746
Cobalt Oxide	"	314,906	254,447
Nickel Oxide	"	145,323	17,968
Nickel (metallic)	"	11,905	4,762
Nickel and Cobalt Sulphates, and Oxides not separated	"	75,447	9,227

Under the provisions of the Metal Refining Bounty Act (R.S.O. 1914, Chap. 33) a bounty of six cents per pound is paid on metallic cobalt and nickel and also on the metallic contents of cobalt and nickel oxides produced in the Province. It is stipulated in the Act that the maximum sum payable in any one year shall be $30,000 for cobalt and $60,000 for nickel. The bounty expires 10th April, 1917.

Bounties paid to the refiners of the Province on shipments for the year 1915 are shown in the following table:—

Company.	Cobalt Shipments.			Nickel Shipments.			Total Bounty.
	Pure Metal.	Cobalt oxide.	Bounty.	Pure Metal.	Nickel oxide.	Bounty.	
	lbs.	lbs.	$ c.	lbs.	lbs.	$ c.	$ c.
Coniagas Reduction Co., Limited	52,991	77,777	6,497 08	....	126,359	5,058 59	11,555 67
Deloro Mining and Reduction Co., Limited.	54,383	196,130	10,967 28	11,163	300	682 74	11,650 02
Metals Chemical, Limited	....	36,498	1,564 86	....	18,267	780 36	2,345 22
Totals........	107,374	310,405	19,029 22	11,163	144,926	6,521 69	25,550 91

The yearly and total production of silver, cobalt, nickel and arsenic from the ores of Cobalt since the mines were opened is as follows:—

TABLE VI.—TOTAL PRODUCTION, COBALT MINES, 1904 TO 1915

Year.	Nickel.		Cobalt.		Arsenic.		Silver.		Total 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....	(a) 90	28,978	(a) 351	590,406	2,030	116,624	25,162,841	12,765,461	13,501,469
1915....	(b) 35	28,353	(b) 206	383,261	2,490	148,379	24,746,534	12,135,816	12,695,809
Total.	3,825	99,518	8,213	2,445,196	34,037	715,983	235,407,189	123,186,373	126,447,070

(a) Metallic contents of nickel and cobalt oxides.
(b) Metals and metallic contents of all nickel and cobalt compounds.

Regarding the total production of cobalt, nickel and arsenic from the Cobalt camp, it is difficult to determine the actual quantities, because in the early days nearly all the ore was shipped abroad for treatment and the mine producers received little or no pay for these subsidiary constituents. The same still holds true for a small quantity of low grade ore shipped from the camp. Certain mines, however, sell at intervals cobalt residues which also contain nickel. A large proportion of the arsenic, cobalt and nickel contained in the ore is now recovered by the southern Ontario refineries. Since 1910 and prior to 1914 it was assumed that the ores and concentrates shipped from Cobalt contained on the average 3.20 per cent. cobalt, 1.47 per cent. nickel and 14.28 per cent. arsenic, as explained in Volume XX, Part I, page 18. As pointed out in Part I of the 1914 Report, page 15, this basis of calculation is no longer applicable, and the total production of arsenic, cobalt and nickel is now based on the residues paid for and the actual recovery from Ontario refineries.

Copper

The monthly average price of electrolytic copper for the year 1915 was 17.275 cents per pound, an increase of 27 per cent. over the 1914 price, which was 13.602 cents. In December the price rose to 22 cents. The higher prices prevailing and the great demand stimulated development of copper properties that had been lying idle for some years. Apart from the copper contained in the nickel-copper matte produced at Copper Cliff and Coniston smelters, 271 tons of copper ore worth $4,418 was marketed. This was produced by the Sable River Copper Company, now operating the Massey mine. Other copper properties in the vicinity of Mine Centre, Rainy River district, were developed and shipments to British Columbia smelters started early in 1916.

The copper content of the nickel-copper ores treated at Sudbury smelters was 19,608 tons as compared with 14,448 tons produced in 1914.

Nickel-copper producers in 1915 were as follows:—

NICKEL-COPPER PRODUCERS, 1915

Name of Company.	Name of Mine.	Location.	P.O. Address of Manager, etc.
Canadian Copper Company.....	Creighton, Crean Hill, No. 2, etc.	Sudbury........	Copper Cliff
Mond Nickel Company, Limited	Victoria, Garson, etc.........	"	Coniston
E. F. Pullen..................	Alexo	Dundonald tp ..	Porquis Junc.
Sudbury Leasing and Development Co..................	Mount Nickel	Sudbury........	Sudbury

A record of nickel-copper mining and smelting operations for the past five years is shown in the following table:—

TABLE No. VII.—NICKEL-COPPER MINING, 1910 TO 1915

Schedule.		1911	1912	1913	1914	1915
Ore raised	tons	612,511	737,656	784,697	1,000,364	1,339,322
Ore smelted......................	"	610,788	725,065	823,403	947,053	1,272,283
Bessemer matte produced.........	"	32,607	41,925	47,150	46,396	67,703
Nickel contents..................	"	17,049	22,421	24,838	22,759	34,039
Copper contents	"	8,966	11,116	12,938	14,448	19,608
Value of Nickel..................	$	3,664,474	4,722,040	5,237,477	5,108,997	17,019,500
Value of Copper	$	1,281,118	1,581,062	1,839,438	2,080,034	3,921,600
Wages paid	$	1,830,526	2,357,889	3,291,956	3,131,520	3,581,639
Men employed....................	No.	2,439	2,850	3,512	3,464	4,178

Nickel

The production of this metal in 1915 was much greater than in any previous year in the history of nickel mining in Ontario. Of nickel-copper matte the output from the Copper Cliff and Coniston smelters was 67,703 tons, as compared with 47,150 tons in 1913, and 46,396 tons in 1914. In 1913 and 1914 the nickel content of the matte produced was 24,838 and 22,159 tons respectively, while in 1915 the quantity was 34,039 tons, making the total production of nickel from the Sudbury region 237,204¼ tons up to the end of 1915. So unprecedented an increase in the production of nickel, owing to the higher prices prevailing and the unusual demand for nickel-steel for armament and munition purposes, is a direct outcome of the great war now raging.

In addition to the nickel from the Sudbury ores, there was produced within the Province, for the first time, metallic nickel obtained by the refining of cobalt-nickel arsenides from Cobalt, Ontario. This metallic nickel, amounting to 11,905 lbs., was produced by the Deloro Smelting and Refining Company at Deloro, Ontario.

During the year the quantity of nickel-copper ore raised was 1,339,322 tons, of which 11,923 tons came from the Alexo mine in Dundonald township, and 13,348 tons from the Mount Nickel mine operated by the Sudbury Leasing and Development Company. Ore smelted by the Canadian Copper Company at Copper Cliff and the Mond Nickel Company at Coniston amounted to 865,169 and 407,144 tons respectively. The production of the different mines is shown in the following table:—

TABLE VIII.—NICKEL-COPPER ORE RAISED IN 1915

Canadian Copper Co.		Mond Nickel Co.	
Mine.	Tons (2,000 lbs.)	Mine.	Tons (2,000 lbs.)
Creighton	778,976	Garson	193,562
Creen Hill	104,550	Kirkwood	38,448
No. 2	55,923	Victoria No. 1	58,248
Vermilion	889	Worthington	49,739
		Levack	31,755
Total	940,338	Bruce	1,961
			373,713
		*Alexo	11,923
		*Mount Nickel	13,348
		Total	398,984

*Ore purchased by the Mond Nickel Co., and treated at Coniston smelter.

Iron Ore

The production in 1915 came from the same three mines as in 1914. Of the 394,054 tons of iron ore shipped 88,322 tons went to the United States and 305,732 tons to Ontario blast furnaces. The total valuation was $764,515 or $1.94 per ton. In Table I—Mineral Statistics for 1915—the value of exported ore only is given as the remainder went to Ontario smelters for pig iron manufacture and its accrued value is given under that heading.

During the year 392 men were employed at the mines, and wages amounted to $224,306.

The following is a list of companies operating in 1915:—

IRON MINING COMPANIES, 1915

Name of Company.	Name of Mine.	Location.	P.O. Address of Manager, etc.
Algoma Steel Corporation, Limited......	Helen	Michipicoten ..	Helen Mine.
	Magpie........	Michipicoten ..	Magpie Mine.
Moose Mountain, Limited................	Moose Mountain	Sudbury dist..	Sellwood.

Pig Iron and Steel

During 1915 Ontario blast furnaces smelted 916,399 tons of iron ore, of which only 293,305 tons or 32 per cent. was of domestic production. The Canadian Furnace Company used imported ores entirely. The other iron and steel plants smelted some Ontario ore, the largest consumer being the Algoma Steel Corporation, which used domestic ore to the extent of 63 per cent. of the entire amount smelted. Scale and mill cinder produced amounted to 13,720 tons. Employees, in blast furnaces only, numbered 563.

The total pig iron product was 493,400 tons valued at $5,910,625. Crediting 32 per cent. to Ontario ores, the resulting figures are 157,888 tons worth $1,891,400. Heretofore the entire output of pig iron has been included in Table I showing the total valuation of the mineral production of the Province.

Early in the year the iron and steel industry recovered from the period of depression following the outbreak of war, and prices rose abnormally as a result of the great demand for iron and steel in the manufacture of munitions. Of the total pig iron production 329,974 tons were used in making steel.

The following figures summarize the details of the iron and steel-making industry for a five-year period:—

TABLE IX.—PRODUCTION IRON AND STEEL, 1911 TO 1915

Schedule.	1911	1912	1913	1914	1915
Ontario ore smelted..............tons	67,631	71,589	132,708	163,779	293,305
Foreign ore smelted.............. "	848,814	1,062,071	1,095,561	752,560	623,094
Limestone for flux................ "	275,628	305,509	351,741	252,258	215,686
Coke .... "	577,388	660,248	706,852	590,902	486,022
Charcoal ....bush	1,666,897	1,886,748	2,206,191	920,045	1,314,957
Pig iron ....tons	526,610	589,593	648,899	556,112	493,400
Value of pig iron................. $	7,716,314	8,054,369	8,719,892	7,041,079	5,910,625
Steel ....tons	361,581	457,817	648,948	479,320	471,059
Value of steel.................... $	9,505,013	8,071,339	11,230,109	7,786,303	7,618,272

The following companies were producers of pig iron in 1915:—

MAKERS OF PIG IRON, 1915

Name of Company.	No. of Furnaces.	Fuel used.	Location.
Algoma Steel Corporation	3	Coke	Sault Ste. Marie.
Canadian Furnace Co	1	"	Port Colborne.
Standard Iron Co	1	Charcoal	Deseronto.
Steel Company of Canada	2	Coke	Hamilton.

Molybdenite

Molybdenite (MoS_2), a sulphide containing 60 per cent. molybdenum, occurs in thin, bright, non-elastic, lead-coloured flakes, which are easily scratched by the finger nail and bend readily. It is more commonly found in irregular lumps, easily cleavable into thin leaves. When molybdenite contains no mica or other substance harmful to steel and difficult to separate, it is most valuable. In the last report, Vol. XXIV, Part I, pages 52-54, reference is made to the sources and uses of molybdenum. The only production of molybdenite in Ontario, prior to 1915, was confined to the years 1901 and 1902, when ore valued at $1,675 was marketed.

The great demand for molybdenum, incident to the war, is due to the difficulty in securing sufficient tungsten for the hardening of tool steel. Molybdenum serves the same purpose. The Imperial Munitions Board, Ottawa, is in charge of procuring supplies from Canada for the British Government.

Molybdenite in 1915 was shipped in the form of ore and concentrates, the latter containing 85 per cent. or more of MoS_2. Ore shipments amounted to 192 tons valued at $12,859. Concentrates amounted to 1,068 pounds, worth $1,240. Concentrating was done by the Orillia Molybdenum Company at Orillia, and by the Ore Dressing and Metallurgical Division of the Mines Branch, Ottawa. The following is a list of the producers of molybdenite:

MOLYBDENITE PRODUCERS, 1915

Name	Location of Deposit.	P. O. Address.
Chisholm, A. M.	Sheffield tp.	Enterprise.
Jamieson Syndicate (J. F. McKenzie, Manager)	Lyndoch tp.	Orillia.
McMahon, Frank	Cardiff tp.	Toronto.
O'Brien, M. J.	Mount St. Patrick	Renfrew.
Orr, F. O.	Cardiff tp.	Peterboro.
Paterson, M. J. and Pellatt, Henry	Bagot tp.	Toronto.
Spain, W. J.	Dacre	417 Fifth Ave., New York.
Russell, A. J. H. and Ponton, Douglas	Norland	Toronto.

Ontario molybdenite deposits are widely distributed, as will be seen from the investigations by A. L. Parsons, of the University of Toronto. His report, appended herewith, is preliminary to a fuller one which will appear in the Twenty-sixth Report:—

During the month of May and part of the month of June, 1916, the writer was engaged in an examination of the occurrences of molybdenite in eastern Ontario with a view to ascertaining not only the mode of occurrence but also the possibilities of production of this mineral which is in considerable demand at the present time for the manufacture of high-speed steel. In the present state of the industry it is difficult to accurately judge the possibilities of old prospects or even new ones upon which only a little work has been done, as most of the high-grade molybdenite has been removed from the older prospects and the remaining material has been oxidized and to a large extent washed away, while in the newer prospects it is seldom that fresh molybdenite shows on the surface, and it is necessary to estimate the quantity of rock that has been removed and then estimate the proportion of high-grade ore that has been laid to one side. In either case the results are likely to be fallacious, with the probability of minimizing the quantity of molybdenite present.

In view of the demand for molybdenite for munition work, this preliminary report is submitted before the completion of the work so that those interested in the development of the industry may have a list of the known occurrences to guide them in their search for properties and also that the prospector may have the common association well in mind.

With but few apparent exceptions to the rule, the molybdenite of eastern Ontario is intimately associated with pegmatite dikes in the gneisses and crystalline limestone, probably of Grenville age. In case limestone is present it is usual to find that the pegmatite is not directly in contact with the limestone but is separated from it by a band of pyroxenite which is presumably due to a chemical reaction between the pegmatite and the limestone. Where this pyroxenite is present it usually carries the greater part of the molybdenite and with it considerable quantities of pyrite and pyrrhotite. In certain instances brown and black mica replace part of the pyroxene. When limestone is absent and the pegmatite has intruded gneissic rocks the pyroxenite band is seldom present and the molybdenite is in the normal pegmatite, but in only one case did the writer find an outcrop where no trace of pyroxene was to be seen. In the more normal pegmatite deposits tourmaline is frequently associated with the molybdenite, and in certain instances the pegmatite becomes more siliceous until it appears to be an ordinary quartz vein. The deposits at Net Lake, near Timagami, district of Nipissing, appear to be an exception to the pegmatitic origin of the deposits. At this place the molybdenite is present in a series of gash veins of quartz, which contain in addition small quantities of gold and copper, the latter being in the form of chalcopyrite. Whether these veins are pegmatitic in origin is not definitely known, though such an origin has been suggested for some of the gold veins at Porcupine.* In case the pegmatitic origin for this deposit can be shown, the deposits of eastern Ontario may all be grouped together as being associated with pegmatite.

A list of localities where molybdenite has been found in Ontario is given below and brief comments are made concerning the development of some of them.

ADDINGTON COUNTY

Sheffield township.—Lot 5, con. XIV. Chisholm mine. About a dozen men were working in clearing the pits and in regular mining work. The old stock piles were being cobbed and the high-grade ore shipped. The mine is being operated by the International Molybdenum Company, Limited.

Lot .., con. ... On the farm of Timothy Dwyer is a pit about 8 x 10 feet and 10 feet deep, at which some molybdenite was seen. Not working.

Lot 8, con. XV. On the farm of Matthew Spratt a pit about 10 x 20 feet and more than 10 feet deep was sunk in pegmatite by L. L. Cailloux. The bottom of the pit was filled with water.

Lot 12, con. XII. On the farm of A. Kellar five open cuts have been opened up by O'Briens-Greenfield, of Superior, Wisconsin, and about 160 pounds of pure flake have been taken out in the prospecting. Five men were working at the time of the writer's visit.

Lot 15, con. XVI. Owner, Wm. Wager. Property not visited.

VICTORIA COUNTY

Laxton township.—Lot 5, con. XI. Two mines are being developed at this place, one on the farm of Wm. Adair by T. Horscroft; the other a few feet away in Mud Turtle lake by Douglas Ponton and A. J. H. Russell. At the time of the writer's visit, Mr. Horscroft was just installing a pump and had done very little work, but the writer was later informed that he had taken out ore which was being shipped to the Mines Branch, Ottawa. Little could be seen of the association, but a small pegmatite dike shows up and a few flakes of molybdenite were found in pyroxenite above water level in the pit which had been opened. The other property, under the management of Captain Russell, was not working on account of the high water which had flooded the shaft. This shaft is about 50 feet deep, and encounters a micaceous pyroxenite containing considerable molybdenite. Several tons of concentrating ore were in a stock pile.

*Report Ont. Bur. Mines, Vol. XXIV, Part 3, pp. 28-30.

Lutterworth township.—Lot 7, con. X. On property belonging to A. Y. Hopkins, of Kinmount, a small opening has been made in a small quartz vein in gneiss. Some molybdenite has been found, but probably this vein is not economic. There is, however, a larger mass of pegmatite a few rods to the west which might pay for further prospecting.

RENFREW COUNTY

Bagot township.—Lot 15, con. X. Owner, Samuel Hunter, Calabogie. No work has been done for some years and the deposit does not appear to be economic.

Lot 28, con. XII. On the farm of John Culhane, Ashdod, development work has been done by R. R. Gamey. The molybdenite occurs in a pyroxenite mass adjoining pegmatite. Mr. Culhane informed the writer that about 200 pounds of pure flake had been taken out. There is about a half ton of concentrating ore on the dump. The pit is about 40 feet long by 8 feet wide and averages 4 feet in depth.

Lot 27, con. IV. On the farm of Wm. Warren development work has been done by Mark J. Paterson and Sir Henry Pellatt. The pits were filled with water and the molybdenite-bearing rock was not seen in places. Several tons of low grade ore were seen on the dump.

Lot 25, con. IV. On the farm of Mr. Morin of Springtown. Property not examined.

Brougham township.—Lots 35 and 36, con. XIV. An open cut about 10 x 70 feet has been excavated by Legree Bros., Dacre, in a micaceous pyroxenite. About 8 tons of ore running possibly 3 per cent. MoS_2, together with possibly 400 pounds of pure flake, had been taken out and laid aside for shipment. The property merits further prospecting, and the ore should be shipped to prevent loss by oxidation.

Lots 16 and 17, con. XI, and lot 17, con. X. Owners of mineral rights, International Molybdenum Company, Limited. Development work is being carried on under the superintendence of J. C. Murray. From 20 to 30 men are employed. The molybdenite is in a series of parallel pegmatite-pyroxenite dikes, and at the time of the writer's visit the work had all been by stripping and open cuts. More than 200 tons of concentrating ore have been shipped from this property. The writer was informed that a shaft was started after his visit.

Lots 7, 8 and 9, con. XI, and lot 8, con. XII. The Renfrew Molybdenum Mines, Limited, under the superintendence of Charles Spearman, are working on a low-grade pyroxenite which lies between Grenville limestone and pegmatite. Several carloads of concentrating ore have been shipped from the property. A drift about 60 feet long and a cross cut about 90 feet in length have been driven into this deposit and two holes have been put in with a core drill. The deposit as exposed is about 600 feet long and 40 feet wide, and apparently offers a large tonnage of concentrating ore. Preparations were in progress for the erection of a mill, and two boilers were being installed. It is proposed to use the Elmore (flotation) concentrator in the mill. Preparations were being made for the sinking of a shaft.

Lot 15, con. XI, known as the Connelly-Chown property. Two pits have been sunk on a couple of narrow pegmatite dikes of apparently the same character as those on the adjoining claims, which are worked by Mr. Murray.

Bromley township.—Lot 24, con. V. Lessee, J. E. Cole, Renfrew. Development work is being done on a large mass of pyroxenite and about a ton and a half of concentrating ore has been shipped.

Blithfield township.—Lot 29, con. I. Some development is reported on the farm of Thomas Quilty, but the property was not seen by the writer. He was informed, however, that further development work will be done during the summer.

Griffith township.—Lots 31 and 32, con. V, and lot 31, con. IV. Owner, W. J. Spain, New York city. Manager, George R. Gray, Dacre. The molybdenite is in two dikes of pegmatite and pyroxenite in gneiss and crystalline limestone separated by about 10 feet of gneiss. The two dikes together give a width of about 25 feet of working ore. The molybdenite occurs in extremely large flakes, some of them being more than a foot across. Masses of nearly pure molybdenite weighing as much as 50 pounds have been taken out. A mill has been erected and was nearly ready for work. As much of the flake molybdenite as possible will be picked out on picking belts, and the remainder, after passing through rolls, will go to a Hooper Pneumatic Concentrator.

Lyndoch township.—Lots 5 and 6, con. VII. Jamieson mine, operated by the International Molybdenum Company, Limited. Idle at the time of the writer's visit and workings filled with water. There were 57 sacks of low-grade ore ready for shipment and a few small piles of ore to be cobbed. This is looked upon as one of the promising properties.

Matawatchan township.—Lot 3, con. VI. On the farm of James Wilson one shot has been put in a pyroxenite mass. Mr. Wilson's son told the writer that 2½ pounds of pure molybdenite had been taken out. The rock that had been blasted out appeared to have run about ⅓ to ½ per cent., and showed flakes of molybdenite scattered through it. The pyroxenite is on the margin of a large pegmatite mass and is from 40 to 50 feet wide. Nothing definite can be said as to values at present, but there is a possibility of a large tonnage of low-grade material. Further prospecting is desirable.

Miller township.—Lot 3, con. —. On the farm of Thomas Armstrong a pegmatite dike has been opened up by C. G. Shannon, of Kingston. Some molybdenite was seen, but the property does not appear to be high grade.

Lot 3, con. 8. Property not visited.

Lot 5, Northeast Range. Not visited.

Raglan township.—Lot 27, con. IX, and lot 27, con. X. Three pits have been sunk on these properties and molybdenite is on two of the dumps. The best pit is on or near the line between the two properties. The dike is about 4 feet wide, and 30 to 40 tons of rock have been removed, and possibly a ton of 3 per cent. ore lies on the dump. The other two pits are on concession IX. John Windle owns the lot in concession X and H. Liedke the lot on concession IX.

Ross township.—Lot 22, con. II. Owner, John Rose, Haley. An open cut has been made in a pegmatite dike from 2 to 4 feet wide. The cut is about 50 feet long and from 2 to 8 feet wide. The part showing molybdenite was under water. A ton or so of concentrating ore was on the dump.

Lot 7, con. IX. Property not visited, but the writer was informed that no work had been done for several years.

Sebastopol township.—Lot 18, con. VII. On the farm of Edward Ziebarth are two small dikes in gneiss and crystalline limestone. Some molybdenite has been found, but further development is necessary to show a sufficient quantity for commercial purposes.

HALIBURTON COUNTY

Cardiff township.—Lot 12, con. XI. Owners of mineral rights, Matthews and McMahon. An opening from which possibly 50 tons of rock has been taken has been made in pegmatite. Some large flake has been taken from this place and a small amount of concentrating ore is on the dump. No estimate could be made as to values.

Lot 11, con. X. On the farm of Alex. Evans a shaft has been sunk and an open cut has been made, but the property has not been worked for some time and the workings are filled with water. A small concentrating plant was erected containing a Wettlaufer crusher, 12-inch rolls and a screen. Several tons of finely pulverized ore containing small flakes of molybdenite were stored in a bin.

Lot 18, con. IX. On the farm of John Mooney is a mass of pegmatite, in which scales of molybdenite are visible. No work has been done on the outcrop.

Lot 6, con. IX. Owner, Walter R. Kidd, Paudash. An open cut has been made upon two parallel pegmatite dikes, each about a foot wide, in gneiss.

Lot 11, con. V. Owner, Walter R. Kidd, Paudash. Two open cuts or pits have been made upon a deposit similar to the last mentioned.

Harcourt township.—Lot 3, con. I and II. This is the property formerly worked by S. Dillon Mills and described by him.* In the main workings little molybdenite was to be seen, but at one of the workings further south a considerable quantity of rich ore had been laid to one side. This ore is a concentrating ore, but the writer would judge that there is from one to two tons of 15 per cent. ore at this place.

GENERAL.

Other localities which have been mentioned in various reports are noted below, but in most instances the deposits are probably not of economic importance.

Anstruther township, lots 24 and 25, con. XIV.

Beatty township, lot 4, con. I.

Belmont township, not far from Cordova mines.

Big Duck lake, north of Schreiber.

Black river, Lake Superior region. (Probably the same as Terrace Cove.)

Carlow township.

Craigmont, Raglan township.

Digby township, lot 16, con. VII.

Dungannon township, lot 25, cons. XIII and XIV. Visited, but no molybdenite was found.

* Report Ont. Bur. Mines, Vol. XI, p. 45.

Foley township, lots 32 and 33, con. V.

Graham township.

Gull lake, northeast from Dryden. Not visited. The writer was shown good flakes of molybdenite from this locality several years ago.

Kirkland lake, district of Timiskaming.

Lake of the Woods region. Several occurrences are known and have been visited by the writer, but with possibly one exception they are not economic.

March township, lot 6, con. II. Not visited.

Molybdenite lake near Michipicoten Harbour.

Monteagle township, lots 26 and 27, con. VI. Visited, but no molybdenite found. It is also reported from lot 6, con. I.

North Crosby township, lot 14, con. V.

Bear's Passage, Rainy lake.

Smooth Rock lake, Manitou region. Not economic.

Somerville township, lot 3, con. A. Visited. No molybdenite was found. This was the second locality at which molybdenite was discovered in Canada.

Swastika, district of Timiskaming.

Talon Chute, about 25 miles east of North Bay. Dr. T. L. Walker reports that he fonud graphite but not molybdenite.

Terrace Cove, Lake Superior. This was the first locality at which molybdenite was discovered in Canada.

Worthington mine, Sudbury district. Not economic for molybdenite.

CONSTRUCTION MATERIALS

Nowhere was the depression in business resulting from the war more keenly felt in 1915 than by the producers of materials used in the building trades. The production for 1914 was not greatly affected, but during 1915 building operations were almost at a standstill. This condition is reflected in brick and tile production which fell to about one-third that of 1914. Lime, stone and cement production fell off, but by lesser quantities. In the city of Toronto building permits which had advanced rapidly between 1909 and 1913 from $18,139,247 to $27,401,761, decreased in 1914 to $20,694,288, and to $6,659,383 in 1915. The end of the year, however, saw a general revival in business and 1916 opened with optimism.

Brick, Tile, Sewer Pipe and Pottery

Of the brick and tile works in Ontario about 30 per cent. were idle in 1915, while, in most cases, the output of the others was materially reduced. The average valuation of common brick was $7.96 and of pressed brick $8.75 per thousand, as compared with $7.99 and $10.66 in 1914.

The following table shows the comparative value in dollars of the 1914 and 1915 production:—

Year.	Brick.			Pottery.	Drain tile.	Sewer pipe.	Total.
	Common. $	Pressed. $	Fancy, Terra Cotta, etc. $	$	$	$	$
1914..	2,336,207	656,944	237,440	25,720	277,530	571,756	4,105,597
1915..	763,591	217,350	158,515	49,387	321,253	361,283	1,871,379

As regards the raw material used in common brick manufacture the following table shows the kinds employed:—

	Clay.	Shale.	Sand-Lime.	Cement.	Total.
No. of Brick—M...........	85,976	2,450	3,360	181	91,967
Value $....................	686,832	51,026	22,840	2,893	763,591

LABOUR AND FUEL COSTS.

Year.	Workmen employed.		Wood.	Coal and Coke.	Natural Gas.	Fuel Value.
	No.	Wages. $	Cords.	Tons.	M. cu. ft.	$
1914..........	2,523	978,498	65,079	67,226	140,835	576,334
1915..........	1,627	445,726	31,994	34,656	297,288	265,007

The above table applies only to common brick and tile works. Cheap fuel is vital to economical production. Wood alone was used in 61 plants, coal or coke in 14, and natural gas in 21. Some 43 operators used coal or coke in addition to wood.

Although some of the larger brickyards operate practically the year round, the season for the small plants is a short one. The average run in 1915 was 109 days.

Following is a list of the brick and tile manufacturers reporting to the Bureau:—

BRICK AND TILE-MAKING PLANTS.

Name.	Address.	Product.
Allen, Solomon	Brantford	Brick.
*Alsip, George	Fort William	Brick and Tile.
Alvinston Brick & Tile Co., Limited	Alvinston	Brick and Tile.
Armstrong Bros.	Fletcher	Tile.
*Armstrong, Geo. H.	Brigden	Hollow Blocks and Tile.
Arnold, Willard	Virginia	Brick.
Arnott, Thos. H.	Bracebridge	Brick.
*Ashbridge Brick Co.	Toronto	Brick.
*Baeckler, William	Chesley	Brick.
Baird & Son, H. C.	Parkhill	Brick and Tile.
Baker, Geo. E.	Arnprior	Brick and Tile.
*Baker Bros.	Casselman	Brick and Tile.
Bartonville Pressed Brick Co., Ltd.	Bartonville	Pressed Brick.
Beckett, E. C.	Orwell	Brick and Tile.
Bell Bros.	Paisley	Brick and Tile.
Bell Bros. & Co.	Toronto	Brick.
Bemrose, Thos.	Beeton	Brick.
*Blake, Elias D.	Lucan, R.R. No. 2	Brick and Tile.
Bogart Bros.	Southwold	Brick and Tile.
Bond & Bird	Woodstock	Brick.
Boone, Geo. H.	Thornbury	Brick.
Bowler, C. W.	Markdale	Brick.
Brampton Pressed Brick Co., Ltd.	Brampton	Pressed Brick.
Brandon Pressed Brick & Tile Co., Limited	Milton	Pressed Brick.
*Brantford Brick Co., Limited	Brantford	Brick.
Broadwell, Benj.	Kingsville	Brick and Tile.
Brown, J. W.	Vienna	Brick and Tile.
*Brown Bros. Brick Co.	West Toronto	Brick.
Brownscombe & Sons, H.	Cargill	Brick and Tile.
Brownscombe, E. N.	Paisley, R.R. No. 2	Brick and Tile.
Buchanan Bros. & Co.	Thessalon	Brick.
Buck, J. L.	Port Rowan	Brick and Tile.
*Bushell, Wm.	Toronto	Brick.
Butwell Brick Co.	Toronto	Brick.
Cabana, Jr., Oliver	Zurich	Brick and Tile.
Campbell, Neil F.	West Lorne	Brick and Tile.
Card, N. B.	Harrisburg	Brick and Tile.
Canadian Pressed Brick Co., Limited	Hamilton	Pressed Brick.
Clemens, Moses	Thamesville	Brick and Tile.
Consolidated Brick and Tile Co.	West Toronto	Brick and Tile.
Cooper, W. H.	Hamilton	Brick.
Cornhill Sons, Ltd.	Chatham	Brick.
*Crawford Bros.	Hamilton	Brick.
*Credit Forks Tile & Brick Co., Ltd.	Toronto	Brick and Tile.
*Crowhurst, W. J.	Port Hope	Brick.
Cumberland, J. M.	Listowel	Tile.
Curtis Bros.	Peterboro'	Brick and Tile.

*Not working in 1915.

Name.	Address.	Product.
*Davenport, B. F.	Orwell	Brick and Tile.
Deller & Sons, Geo.	Norwich	Brick and Tile.
*Deller, Wm. H.	Thorndale	Tile.
*Dominion Brick & Tile Co., Ltd.	Breslau	Brick.
Dominion Sewer Pipe Co., Limited	Waterdown	Brick.
Donaldson Bros.	Harriston, R.R. No. 4	Brick.
Don Valley Brick Works	Todmorden	Common, Pressed and Fancy Brick, Porous Hollow Blocks, etc.
Dublin Brick & Tile Works	Dublin	Brick and Tile.
Elliott, William	Glenannan	Brick and Tile.
*Emard, Trefflé	Embrun	Brick.
Forman, Stephen	St. Marys	Tile.
*Fort William Brick & Tile Co.	Fort William	Brick and Tile.
Fox, G. J.	Dresden	Brick.
Frank, E. D.	Strathroy	Brick.
Fraser, Chas.	Blyth	Brick and Tile.
Freek, William	Barrie	Brick.
Frid Brick Co., Ltd., Geo.	Hamilton	Brick.
Frid Bros.	Hamilton	Brick.
Frost, Geo. H.	Toronto	Brick.
Fuller, Geo.	Belwood, R.R. No. 2	Brick and Tile.
Gardiner, William	Blenheim	Brick and Tile.
George & Sons, Mrs. E. D.	Mossley, R.R. No. 2	Brick and Tile.
Govenlock, J. M.	Seaforth, R.R. No. 1	Brick and Tile.
*Gowanlock, J.	West Fort William	Brick.
Hall Estate, Ellen	Cobourg	Brick and Tile.
Hallatt, H.	Comber	Brick and Tile.
*Hallman, J. B.	Hanover	Brick.
Hamilton Pressed Brick Co., Limited	Hamilton	Pressed Brick.
Hamley, R. H.	Bowmanville	Brick and Tile.
Hancock, William	Hamilton	Brick.
*Harbour Brick Co., Limited	Toronto	Sand-Lime Brick.
Hepworth Silica Pressed Brick Co., Ltd.	Hepworth	Pressed Brick.
Hill, Will J. & James S.	Madoc	Brick and Tile.
Hill Bros.	Essex	Brick and Tile.
Hill Bros.	Coatsworth, R.R. No. 1	Brick and Tile.
*Hill, Sanford	Parkhill	Tile.
Hinde Bros.	West Toronto	Brick.
Hiscock & Sons	Cobourg	Brick.
Hitch, Mrs. Susan	Ridgetown	Brick and Tile.
Hitch, Thos.	St. Thomas	Brick and Tile.
Hohl, Geo.	Lisbon	Brick and Tile.
Holton, Fred. E.	Clifford, R.R. No. 3	Brick.
Holton, R. J.	Clifford, R.R. No. 3	Tile.
Howlett, Fred.	Petrolia	Brick and Tile.
Interprovincial Brick Co. of Canada, Limited	Cheltenham	Pressed and Fancy Brick.
Jamieson, J. A.	Renfrew	Brick and Tile.
Janes, D. A.	Delaware	Brick and Tile.
Jasperson, B.	Kingsville	Brick, Tile, Cement Blocks.
Jervis & Son, John	Dorchester Station	Brick and Tile.
Johnson, James	Pembroke, R.R. No. 3	Brick.
Jordan, D.	Chatham	Brick and Tile.
Kaar, John	Brownsville	Brick and Tile.
Kingston Brick & Tile Co., Limited	Kingston	Brick and Tile.
Koebel, Joseph Z.	St. Clements	Brick and Tile.
Kruse Bros.	Egmondville	Brick and Tile.
Kuhn, Henry J.	Crediton East	Tile.

*Not working in 1915.

Name.	Address.	Product.
*Lang Bros.	Merrickville	Brick.
*Launders, Thos.	Fruitland	Brick.
Leamington Brick & Tile Co., Ltd.	Leamington	Brick and Tile.
Leatherdale, R. W.	Dresden	Tile.
Lethbridge Brick Co., Limited	Steelton	Brick.
Light, William	Aylmer	Brick and Tile.
Lindsay, Stephen	Wallaceburg, R.R. No. 2	Tile.
Lingham, W. T.	Belleville	Brick.
Logan, John	Toronto	Brick.
Lowes, Gordon	Kent Centre	Brick and Tile.
MacKay Bros.	Dutton	Brick and Tile.
McCormick Bros.	Kingscourt	Brick and Tile.
McCredie & Reid	Lyons	Brick and Tile.
McGibbon, Dugald	Shedden	Tile.
McLoughlin, John	London	Brick.
Maloney, John	Humber Bay	Brick.
Mann Brick Co., Limited, John	Brantford	Sand-Lime Brick.
Marshall, W. W.	Woodstock	Brick and Tile.
Martin, David	Thamesville	Tile.
Martyn, W. A.	North Bay	Brick.
Mason, Charles	Toronto	Brick.
Meaford Brick Co., Limited	Meaford	Brick.
*Merkley Bros., Limited	Casselman	Brick.
Mills, Geo. E.	Hamilton	Brick.
Milton Pressed Brick Co., Limited	Milton	Pressed and Fancy Brick.
Miner, J. T.	Kingsville	Brick and Tile.
*Morley, Walker	Toronto	Brick.
*Morley & Ashbridge	Toronto	Brick.
Munro, D. W.	Carp	Brick and Tile.
Napanee Brick & Tile Co., Limited (A. F. Clark, lessee)	Napanee	Brick.
National Fire Proofing Co. of Canada, Limited	Aldershot	Terra Cotta, Hollow Blocks.
Nayler & Sons, J. W.	Trenton	Brick.
New, Edward	Hamilton	Brick.
Norton, Alsey	Bolton	Brick and Tile.
Norton, David	Woodbridge	Cement Tile.
Norton, T. W.	West Toronto	Brick.
*Oakville Pressed Brick Co.	Oakville	Brick and Tile.
Odell & Sons, Wm.	Ingersoll	Brick and Tile.
*Ollmann Bros.	Hamilton	Brick.
*Ontario National Brick Co., Limited	Cooksville	Brick.
*Ontario Paving Brick Co., Limited	West Toronto	Paving Brick and Blocks.
O'Reilly, T. E.	Ottawa	Brick.
Ott Brick & Tile Mfg. Co., Limited	Kitchener	Brick.
Ottawa Brick Mfg. Co., Limited	Ottawa	Brick.
Owen Sound Brick Co., Limited	Owen Sound	Brick.
Parks, H. W.	Dresden	Tile.
Paxton & Bray	St. Catharines	Brick.
Pears & Son, James	Toronto	Brick.
Pears, William	West Toronto	Brick.
Peerless Brick & Tile Co., Limited	Ottawa	Brick.
Pembroke Brick Co., The	Pembroke	Brick.
Petty, Chas.	Cherrywood	Brick and Tile.
Phillips, Thos.	St. Helens	Tile.
Phinn, Geo. E.	Lucan	Brick and Tile.
*Pilon, A.	Casselman	Brick.
Ponsford, A. E.	St. Thomas	Brick and Tile.
*Port Arthur Sand-Lime Brick Co., Ltd.	Port Arthur	Sand-Lime Brick.
Port Credit Brick Co., Limited	Port Credit	Common and Pressed Brick.
Port Dover Brick & Tile Co., Limited	Port Dover	Brick and Tile.
Price, John	Toronto	Brick.
Prices, Limited	Toronto	Brick.

* Not working in 1915.

Name.	Address.	Product.
Reed, Mrs. A.	Foxboro	Tile.
Rice, Geo. A.	Dresden	Brick.
Richardson & Son, James	Kerrwood	Brick and Tile.
Ries, John	Carlsruhe	Tile.
Rilett, David	Oil Springs, R.R. No. 3.	Tile.
Rowntree, Josiah	Mount Dennis	Brick.
*Russell, Joseph	Toronto	Brick.
*Russell Brick & Tile Co., Limited	Russell	Brick and Tile.
Schaefer Brick Co., Limited	New Hamburg	Brick and Tile.
Schultz Bros. Co., Limited	Brantford	Sand-Lime Brick.
*Scott, James M.	Meaford	Brick and Tile.
Silicate Brick Co. of Ottawa, Ltd.	Ottawa	Sand-Lime Brick.
Sinden, L. H.	Tillsonburg	Brick and Tile.
Sipprell, J. H.	Wilkesport	Brick and Tile.
Smith, Allan G. C.	Acton	Cement Blocks and Tile.
Smith & Son, Alex.	Dutton	Brick and Tile.
*Smith, W. W.	Shallow Lake	Brick and Tile.
Smith Bros.	Port Elgin	Brick.
Snelgrove & Teer	Beaverton	Brick and Tile.
Sproat, Wm. M.	Seaforth	Tile.
Standard Brick Co., Limited	Toronto	Brick.
Steele, Edwin	Vankleek Hill	Brick.
*Stickwood, Chas.	Newmarket	Brick.
*Sudbury Brick Co., Limited	Sudbury	Brick.
Sun Brick Co., Limited	Toronto	Brick and Hollow Blocks.
*Superior Brick Co., Limited	Fort William	Brick.
Taylor Bros.	Kemptville	Brick and Tile.
Taylor & Hall	Peterboro'	Cement Blocks and Pipe.
*Terra Cotta Pressed Brick Co., Limited.	Terra Cotta	Pressed Brick.
Thornton, John	Perth	Brick.
Toronto Brick Co., Limited	Toronto	Sand-Lime Brick.
Toronto Pressed Brick & Terra Cotta Co. of Milton, Limited	Milton	Pressed Brick.
Voakes, Ed. R.	Wheatley	Brick and Tile.
Wagstaff, A. H.	Toronto	Brick.
Waide Bros.	London	Brick.
Waite, J. E.	Foresters Falls	Brick and Tile.
*Wallace & Son, R.	North Bay	Brick.
Wallaceburg Brick Co.	Wallaceburg	Brick.
Wardle, John	Blenheim	Brick and Tile.
Watson Brick Co.	Bracebridge	Tile.
Wehlann, Alfred	Cairo	Brick and Tile.
Wehlann & Son	Rodney	Brick and Tile.
Weppler. Henry	Hanover	Brick and Tile.
Wood, W. H.	Brockville	Brick.
*Willcox Lake Brick Co., Limited	Toronto	Sand-Lime Brick.
Wright & Sons, Geo.	Comber	Tile.
Yaeck, Louis	Walkerton	Brick and Tile.
York Sandstone Brick Co., Limited	Toronto	Sand-Lime Brick.

POTTERY PLANTS

Name	Address.
*Belleville Pottery Company	Belleville.
Cranston & Son, John	Hamilton.
Davis & Son, John	Toronto.
Foster Pottery Co.	Hamilton.
Humberstone, Thos. A.	Newtonbrook.
Taylor, Geo. N.	Port Hope.

*Not operating in 1915.

Sewer Pipe

The three plants for the manufacture of sewer pipe produced $391,837 worth of pipe last year, and sold $361,283 worth. This is a considerable falling off from 1914, when the sales amounted to $571,756.

The names and addresses of the companies are as follows:—

SEWER PIPE MANUFACTURERS

Name.	Address.
The Dominion Sewer Pipe Co., Limited	Swansea.
The Hamilton & Toronto Sewer Pipe Co., Limited	Hamilton.
The Ontario Sewer Pipe Company, Limited	Mimico.

Lime

The production for 1915 was 1,340,394 bushels valued at $244,953 as compared with 2,075,228 bushels worth $333,407 for 1914.

Works in operation numbered 29. It will be seen from the list of producers that a number were idle during the year. Small producers are gradually going out of business, the demand for lime being met by larger and better equipped plants.

For firing the kilns, wood, coal and natural gas are used as fuel, the total value of which amounted to $60,705 in 1915. Employees engaged in lime manufacture numbered 158 and received $90,808 in wages.

Below are given the names of producers and the location of plants in Ontario:

LIME PRODUCERS

Name of Owner or Company.	Location.
Annis, Geo.	South Orillia.
*Baker, Edwin B.	Winchester.
Beachville White Lime Co., Limited	Beachville.
Beauchamp, F. X.	Dalhousie Mills.
Bergin, Patrick	Napanee.
Brown, E. A.	Owen Sound.
*Callan & Bros., John	Innerkip.
Cameron, W. M.	Carleton Place.
Canada Lime Company, Limited	Coboconk.
Chalmers, Mrs. Margaret	Owen Sound.
Chestnut, W. D.	Duntroon.
Delta Lime Co., Limited	Delta.
*Duckett, J. H.	Eugenia.
Flieler, E. & F.	Fernleigh.
*Frey, David S.	Elmira.
Harvey Limited, E.	Rockwood.
Higginson & Stevens	Hawkesbury.
Jamieson Lime Co.	Renfrew.
Lavoie, Alfred	St. Felix.
Leslie, A. E.	Puslinch.
*Lime Agencies, Limited	Port Colborne.
*Lumsden, G. D.	Holstein.
MacTernan, John	Dirleton.
McGilvray, Jas.	Priceville.

* Idle in 1915.

LIME PRODUCERS—Continued

Name of Owner or Company.	Location.
McKenzie Bros.	Lucknow.
McMillan, Fred.	Havelock.
Marshall Lime and Cement Works, Jas.	Hamilton.
Milton, Peter	Campbellford.
*Moore, Jos.	Foxmead.
*Oneida Lime Co., Limited	Hamilton.
*Ontario Limestone & Clay Co., Limited	Belleville.
*Parks & Sons, R. B.	Troy.
*Poirier, Emerie	Apple Hill.
*Poole, T. A.	Perth.
Robertson Co., Limited, D.	Milton.
Robillard & Son, H.	Ottawa.
Smith, John S.	Inverhuron.
Standard Chemical, Iron & Lumber Co., Limited	Eganville.
Standard White Lime Co., Limited	Beachville, Guelph, and St. Marys.
Toronto Lime Company, Limited	Limehouse and Dolly Varden.
*Walker, Jay	Uhthoff.
Wellman, Albert	Bellview.

* Idle in 1915.

Portland Cement

Compared with other construction materials the decrease in production of Portland cement in 1915 was not great. There were 2,302,242 barrels marketed worth $2,534,537. For 1914 the figures were 2,665,650 barrels valued at $2,931,190. The average price per barrel was practically the same as for 1914, or $1.10 nearly. Cement on hand at the end of the year amounted to 755,799 barrels.

The following cement plants operated in 1915:—

PORTLAND CEMENT PLANTS

Name of Company.	Location of Plant.	P.O. Address of Manager, etc.
Canada Cement Company, Limited, Plant No. 4.	near Belleville	Herald Bldg., Montreal, Que.
do do do No. 5.	near Belleville	do do
do do do No. 8.	near Port Colborne	do do
The Hanover Portland Cement Co., Limited	Hanover	Hanover.
National Portland Cement Co., Limited	Durham	Durham.
The Ontario Portland Cement Co., Limited	Blue Lake	Brantford.
St. Marys Portland Cement Co., Limited	St. Marys	St. Marys.

Sand and Gravel

Deposits of sand and gravel are widely distributed throughout the Province, both on land and in the beds of the great lakes and connecting rivers. Regulations governing the leasing of lands containing sand and gravel situated under the waters of the great lakes, etc., were approved by Order-in-Council dated April 30th, 1912. Since that date licenses authorizing the removal of such sand and gravel have been issued. In addition to the annual fee of $100 licensees pay a royalty or charge per cubic yard on sand or gravel removed, depending in amount on the location of the deposit, distance from market and other circumstances. At the conclusion of the section of this Report dealing with the Mines of Ontario is appended a list of sand and gravel operators whose excavations were inspected during the year.

The following, chiefly individuals or companies operating under license, have made returns to the Bureau of Mines:—

SAND AND GRAVEL OPERATORS, 1915

Name.	Material.	Address.
Armstrong Supply Co., Limited	Sand and Gravel	Hamilton.
Barnes, Wm.	Sand	Hamilton.
Cadwell Dredging Co., Limited	Gravel	Windsor.
Canadian Sand & Gravel Co., Limited.	Gravel	Thorold.
Cooper, W. H.	Sand and Gravel	Hamilton.
Empire Limestone Co.	Sand	Buffalo, N.Y.
Goodale, Emerson	Sand and Gravel	Hamilton.
Gould, Francis E.	Sand and Gravel	Cleveland, O.
Hagerman, Anson V.	Sand	Odessa.
Hansen, H. C.	Sand and Gravel	Cleveland, O.
Kingston Sand and Gravel Co.	Sand	Kingston.
Niagara Sand Corporation	Gravel	Welland.
Ollman Bros.	Gravel	Hamilton.
Oneida Lime Co., Limited	Sand	Buffalo, N.Y.
Smith, G. R.	Gravel	Dunnville.
Soo Dredging and Construction Co., Ltd.	Gravel	Sault Ste. Marie.
Superior Sand and Gravel Co.	Gravel	Detroit, Mich.
Superior Sand and Towing Co.	Sand	Port Arthur.
United Fuel and Supply Co.	Sand and Gravel	Detroit, Mich.
Windsor Sand and Gravel Co., Limited.	Sand and Gravel	Walkerville.
York Sand and Gravel Co., Limited	Gravel	Toronto.

Stone

Classified according to variety rather than to uses, the quarry products of the Province for 1915 were approximately as follows:—

——	Limestone.	Sandstone.	Trap.	Granite.	Marble.	Quartz.
Value $	587,000	5,500	32,100	15,500	10,600	142,400

Limestone is by far the most important, both as to variety of uses and value of production. The above valuation does not include limestone quarried for lime manufacture. Sandstone is not much used, for the reason that good quarrying beds are not found extensively in older Ontario. Trap is a hard, tough, volcanic rock admirably suited for road metal when crushed. It is used extensively also for concrete road construction, although cheaper varieties of crushed stone serve for most concrete work. Long freight hauls increase the price of trap to so high a figure that its use in certain parts of the Province will never become general. Granite is quarried chiefly for paving blocks. The ornamental marble in Ontario comes from Hastings and Lanark counties, while white marble is quarried in

Hastings and Renfrew. Quartz production shows a considerable increase in production. By far the greater part of the output is used by the Canadian Copper Co. as a smelter flux in the production of nickel-copper matte. In the Coniston smelter the Mond Company use quartz obtained from Bruce Mines. This quartz carries copper which is recovered in the nickel-copper matte.

Below are given lists of firms or companies operating quarries:—

GRANITE, MARBLE AND TRAP QUARRIES

Name of Owner, Firm or Company.	Location.	Kind of Stone.
Bannerman & Horne	Ignace and Butler	Granite Blocks.
*Canadian Marble Co., Limited	Bancroft	....
Canadian Towing & Wrecking Co., Limited	Port Arthur	Trap.
*Central Ontario Granite and Marble Co., Limited	Bancroft	....
Gordon & Bruce	Lyndhurst	Granite.
Granite, Crushed and Dimension, Limited	Washago	Granite.
*Hastings Quarries	Tweed	Marble.
Intercities Quarries Co., Limited	Port Arthur	Trap.
*Martin International Trap Rock Co., Limited	Bruce Mines	Trap.
*North Lanark Marble and Granite Quarries	Marble Bluff	....
Ontario Marble Quarries, Limited	Bancroft	Marble.
Ontario Rock Co., Limited	Preneveau	Trap.
Superior Sand and Towing Co., Limited	Port Arthur	Trap.
Thunder Bay Contracting Co., Limited	Port Arthur	Trap.
White Marble Co. of Canada, Limited	Haley Station	Marble.

QUARTZ QUARRIES

Name of Owner, Firm or Company.	Location of Mines.	P.O. Address of Manager, etc.
The Canadian Copper Company, Limited	Dill	42 Exchange Place, New York.
Kingston Feldspar & Mining Co., Limited	Desert Lake and Reynolds mines	Kingston.
The McPhail & Wright Construction Co., Ltd.	Mile 19, A. C. Ry.	Sault Ste. Marie.
Willmott & Company	Killarney	404 Lumsden Bldg., Toronto.

LIMESTONE AND SANDSTONE QUARRIES

Name of Owner, Firm or Company.	Location.	Kind of Stone.
*Battle, Joseph	Thorold	Limestone.
Beachville White Lime Co., Limited	Beachville	do
Bergin, Patrick	Napanee	Rubble, etc.
Britnell & Co., Limited	Burnt River	Limestone.
*Callan & Bros., John	Innerkip	do
Canada Crushed Stone Corporation, Limited	Dundas	do
*Canada Iron Corporation, Limited	Longford Mills	do
*Canadian Quarries & Construction Co., Limited	Ottawa	Sandstone.
*Canadian Quarries, Limited	Hamilton	Limestone.
Cartmell, Wm. R.	Thorold	do
Coast & Lakes Contracting Corporation	Windmill Point	do
Cook, J. S.	Wiarton	do

*Idle in 1915.

LIMESTONE AND SANDSTONE QUARRIES—Continued

Name of Owner, Firm or Company.	Location.	Kind of Stone.
*Coughlin, D.	Smiths Falls	Limestone.
Empire Limestone Co., Limited	Sherkston	do
Farr, L. G.	Haileybury	do
*Fleming, J. H.	Glenwilliams	Sandstone.
Fretz, Jacob M.	Vineland	Limestone.
Gallagher Lime & Stone Company, Limited	Hamilton	do
*Gosselin, Chas.	Quarries	do
Hagersville Contracting Co., Limited	Hagersville	do
Hagersville Crushed Stone Co., Limited	Hagersville	do
Hamilton Works Department	Hamilton	do, crushed.
Hastings Quarries, Limited	Actinolite	do
*Harrison & Beatty	Owen Sound	do
*Howey, George	Nanticoke	Blue Limestone.
Kennedy, R. C.	Guelph	Limestone.
Kingston Penitentiary	Portsmouth	do
*Lally Estate	Smithville	do
*Logan, Hugh	Georgetown	Sandstone.
Longford Quarry Co., Limited	Longford Mills	Limestone.
Maloney, John	Puslinch	do
Marshall, James	Hamilton	do
*Michigan Central Railway	Hagersville	do
Murphy, J. S.	Tweed	do
Oliver-Rogers Stone Co., Limited	Owen Sound	do
*Ontario Limestone & Clay Co. Limited	Belleville	do
Perkins, Geo. A.	Owen Sound	do
Point Anne Quarries, Limited	Point Anne	do
Queenston Quarry Co., Limited	St. Davids	do
Quinlan & Robertson, Limited	Crookston	do
Reid, Fenton	Odessa	Rubble.
Robertson, D., & Company, Limited	Milton	Sandstone.
Robillard, H., & Son	Ottawa	Limestone.
Roddy & Monk	Kingston	do
Rogers, F., & Company	Terra Cotta	Sandstone.
*Rubel Bros.	Jordan	Limestone.
St. Marys Horse Shoe Quarry, Limited	St. Marys	do
Standard Crushed Stone Company, Limited	Niagara Falls	do
Standard White Lime Co., Limited	Beachville, Guelph, and St. Marys	do
*T. Sidney Kirby Co., Limited	Ottawa	Sandstone and Limestone.
Thames Quarry Company, Limited	St. Marys	Limestone.
*Thebault, A.	Ottawa South	do
Tietz, Wm. A.	Waterford	do
Walker Bros.	Thorold	do
*Webber, John, Sr.	Dunnville	do
Webster, James S.	Galt	do
*Welk, Herman	Eganville	do
Welland County Lime Works Co., Limited	Port Colborne	do
Wentworth Quarry Co., Limited	Vinemount	do
William Markus, Limited	Pembroke	do
Wilson, G. S.	Manion	Sandstone.

*Idle in 1915.

Arsenic

Since the commencement of mining operations at Cobalt, white arsenic or arsenious acid has been produced from cobalt-nickel arsenides. The ore for the most part has been treated at southern Ontario silver refineries. Grey arsenic, which is an impure form of white arsenic, and metallic arsenic, are also produced to a limited extent. At the present time these arsenide ores are treated by the Deloro Smelting and Refining Company and the Coniagas Reduction Company at the refineries situated, respectively, at Deloro and Thorold, also at the Welland plant of Metals Chemical, Limited.

For the past five years the shipments of arsenic in its various forms have been as follows:—

Year.	lbs.	Value. $
1911	4,234,000	74,609
1912	3,927,347	79,297
1913	2,450,758	64,146
1914	4,059,868	116,624
1915	4,980,659	148,379

Calcium Carbide

There are two plants producing calcium carbide in the Province, those of the Canada Carbide Company at Merritton and of the Union Carbide Company at Welland. The capacity of the first mentioned is small compared with that of the same company's plant in the Province of Quebec which utilizes electric power from Shawinigan falls. Cheap electric energy is essential for the economic production of carbide, and power from Niagara is used at the Welland and Merritton plants.

Calcium carbide is a product of the electric furnace, lime and some form of carbon being the raw materials. Acetylene gas, resulting from the contact of water with carbide, is used to some extent in mine lamps, and for lighting buoys as aids to navigation. It is used also for lighting buildings where electricity or illuminating gas are not available. Another use for carbide is in the cyanamid process for the fixation of atmospheric nitrogen, which was described on pages 51 and 52 of the last annual report.

As coke and limestone, the raw materials used in the manufacture of calcium carbide, are largely imported from the United States, it has been deemed advisable to discontinue the inclusion of this product in the tables showing the mineral output of the Province.

Corundum

The market for corundum continues depressed. Carborundum, an electric furnace product, has interfered with the use of the natural abrasive. Shipments of refined corundum have fallen from 1,177 tons in 1913 to 548 in 1914 and to 262 tons in 1915, the value of the 1915 product marketed being $31,398.34.

At present, the only mines in operation are those of the Manufacturers' Corundum Company situated near Craigmont in the townships of Raglan and Carlow.

Feldspar

Feldspar production for 1915 shows a decline, there being 12,649 tons shipped as against 18,062 tons for 1914. Most of the product goes to the potteries of New Jersey and Ohio. There were only two shippers in 1915—the Kingston

Feldspar and Mining Co. from Desert lake and Reynolds mines, and the Canada Feldspar Corporation, Limited, from Verona. The first mentioned and largest producer ships to a grinding mill at Genesee Dock near Charlotte, N.Y. Some of this ground feldspar comes back to Ontario and is utilized by the Frontenac Floor and Wall Tile Co. of Kingston, which operated continuously during 1915. The Dominion Feldspar Company operate a grinding mill near Parham station, but little work was done in 1915. Feldspar, high in potash, is in good demand for the manufacture of chemicals.

Towards the close of the year a feldspar deposit, known as the Victoria quarry, was opened in Frontenac county about 3 miles west of Crow Lake station on the C. P. railway. More detailed reference to this property appears in the Mining Inspector's report, page 132.

Investigations were continued by Prof. Drury of Queen's University, Kingston, in the use of "Drury Slag," which is a blast furnace product, finely ground. It is a mixture of limestone, iron ore and feldspar. Experiments with this fertilizer were conducted at the Ontario Agricultural College farm, Guelph, by Prof. Harcourt, of the Chemistry Department, who reports as follows:

The results of the experiments in 1915 were not conclusive. We did get some good results and some negative. Of course, such may be true with almost any experiment. On the whole, I may say that our experiments lead us to think that we shall get good results from the use of this material.

The potash fertilizer is not on the market as yet.

Graphite

Only two graphite mines shipped in 1915, namely the Black Donald Graphite Company, Limited, near Calabogie, and the National Graphite, Limited, at Maynooth. Both companies mill and refine the mine product. The 1914 production showed an appreciable decrease from 1913, when 1,788 tons of refined graphite were shipped. The 1915 figures, 2,533½ tons valued at $115,274, show a decided increase in output. This is due to other sources of supply being shut off as a result of the Mexican revolution, and also to the curtailment of foreign shipments from Ceylon and Korea.

Regulations by the Dominion Government, respecting the exportation of flake graphite suitable for the manufacture of crucible steel, have been in force since the fall of 1914. Export is allowed to countries allied with Britain, and also to the United States under conditions satisfactory to the Minister of Customs.

Graphite mines in Ontario, situated in the counties of Renfrew and Hastings respectively and producing in 1915, were as follows:—

GRAPHITE MINES

Owner or Company.	Location of Mine or Works.	P.O. Address of Manager, etc.
Black Donald Graphite Co., Limited	Whitefish lake	Calabogie.
National Graphite, Limited	Maynooth and Harcourt.	Maynooth.

Gypsum

From the deposits situated in the valley of the Grand river, Haldimand county, 85,414 tons of crude gypsum were mined in 1915. Two companies are operating, neither of which makes shipments in the crude or lump form. Of the total tonnage, 46,026 were crushed, 1,942 ground and 25,404 tons ground and calcined before shipment. Crushed gypsum is used as a "retarder" in Portland cement and ground gypsum as land plaster for fertilizing. The ground and calcined variety is used in the manufacture of wall plaster, alabastine, and other gypsum products.

The following firms employ 139 men and paid wages amounting to $65,312 in 1915.

GYPSUM MINES

Company or Firm.	Location of Mines.	P.O. Address.
The Alabastine Co. of Paris, Limited	Caledonia	Paris.
Crown Gypsum Company, Limited	Lythmore	Lythmore.

Iron Pyrites

An upward trend in pyrite shipments, beginning in 1913, has continued steadily to date. The 1915 production was more than double that for 1913. The increase can be attributed to the war, the production for 1915 being 145,315 tons, valued at $353,498, as compared with 107,258 tons in 1914, worth $264,722. From the mine of the Northern Pyrites Company at Northpines, near Superior Junction on the National Transcontinental railway, a tonnage was shipped nearly equal in amount to the total shipments from all the mines of the Province for 1914.

Prohibitive ocean freight rates from Europe to the United States have restricted imports to the latter company of both pyrites and sulphur, and in consequence there has been a brisk demand for iron pyrites from Ontario. In addition to the United States markets, the Nichols Chemical Company and the Grasselli Chemical Company are purchasers of Ontario pyrite for treatment in their acid plants at Sulphide and Hamilton respectively.

Pyrites containing 31 per cent. or more of sulphur can be used profitably in the manufacture of sulphuric acid, which with salt and coal form the foundation of the chemical industry.

In addition to the list of 1915 shippers given below, the Goudreau mine on the Algoma Central railway, operated by the Madoc Mining Company, will be ready to ship pyrite in considerable amounts in 1916.

IRON PYRITE SHIPPERS, 1915

Name of Owner, Firm or Company.	Location or Name of Mine.	P.O. Address of Manager, etc.
Algoma Steel Corporation, Limited	Helen	Sault Ste. Marie.
Canadian Sulphur Ore Company, Limited	Queensboro	404 Lumsden Building, Toronto.
Nichols Chemical Company, Limited	Sulphide	Sulphide.
Northern Pyrites Company, Limited	Vermilion lake ...	Northpines.

Mica

Mica production in 1915 amounted to 195 tons of rough-cobbed and thumb-trimmed, valued at $33,490. The price was considerably higher than in 1914, although the tonnage showed a marked decrease, owing to restricted demand from the largest users. As in former years, the chief producer is the Loughborough Mining Company, near Sydenham, Frontenac county. This company operates the Lacey, which is the largest mica mine in the world, the product being used largely in the manufacture of electrical apparatus.

Several properties were operated during part of the year but the only individuals or companies reporting shipments in 1915 were as follows:—

Name of Owner or Company.	Name of Mine.	P.O. Address of Manager, etc.
Kent Bros. & J. M. Stoness	Taggart mine	Kingston.
Loughborough Mining Co., Ltd.	Lacey mine	Sydenham.

Natural Gas

The output for 1915 of natural gas is returned as 15,211,523 thousand cubic feet as compared with 14,062,800 for the preceding year. The average value at the place of production was 17.28 cents per M. cu. ft. The increase in output is due in part to the precautions taken by the oil and gas well inspectors. Three inspectors are kept in the field for the purpose of enforcing the statutory regulations regarding the wasting of natural gas and the plugging of abandoned wells. Attention has also been given to pipe lines for the prevention of leakage. John Scott of Petrolia, Jos. W. Beno of Tilbury, and A. E. Near of Gas Line are inspectors respectively for the Lambton, Essex and Kent, and Niagara peninsula oil and gas fields.

During the year 1,734 wells were producing, including 109 new wells drilled during the year. Only 13 new holes proved to be dry. The industry employs 598 men, and wages amounted to $382,401. Some 1,931 miles of gas mains are reported. This mileage would be greatly increased if the distributing pipes in the towns and cities were included.

The total production of natural gas is difficult to obtain with absolute certainty for the reason that the proportional meters used for measuring the gas at high pressure, i.e., pipe line pressure, are quite inaccurate. Low pressure meters on the other hand, according to the Meter Inspection Act, are supposed to be correct to within 3 per cent. A pressure of about 6 ozs. is maintained for domestic service and 2 lbs. for industrial purposes.

The deepest well on record in Ontario was drilled in 1915 on Con. VI, township of Enniskillen. A depth of about 4,000 feet was reached, penetrating to the pre-Cambrian basement, without striking either gas or oil. Heretofore, the deepest hole was 3,777 feet in depth, located at Petrolia and recorded on page 10, Vol. XXIV, Part 2, Report of the Ontario Bureau of Mines, 1915.

J. W. Beno, inspector of the Essex and Kent gas field, reports that seven companies or individuals are operating 216 producing gas wells. Some 387 miles of pipe line ranging in size from 3 in. to 12 in. are used for distributing the gas. Two large pumping plants in the Tilbury East field at Glenwood and Port Alma are operated respectively by the Southern Ontario and Union natural gas companies.

A. E. Near, inspector for the Welland gas field, reports as follows:—

Considerable drilling has been done during the year 1915, which has resulted in securing an additional amount of gas. Among the gas companies in operation the two largest producers are the Dominion Natural Gas Company of Hamilton, and the Provincial Natural Gas and Fuel Company of Niagara Falls, Ontario.

The Dominion Natural Gas Company drilled, during the year 1915, five wells, of which three were producing. They also purchased one well, and abandoned six wells, leaving them at the close of the year with a total number of 347 producing wells. The total open flow production from their own wells was 20,455 M cu. feet per day. This, together with 1,037,980 M cu. feet purchased, supplied upwards of 31,350 customers during the year. This company also receives a considerable quantity of gas from the Southern Ontario Gas Co., Limited, the product from the Tilbury gas field, which contains sulphur. This gas, however, is being supplied to Hamilton manufacturers only, and not for domestic use in that city. Gas from the Tilbury field is also being supplied to Brantford, Paris, Galt, and other places along the line.

The Provincial Natural Gas and Fuel Company during the past year drilled 19 wells in Welland County gas field, of which 13 were producing wells, making a total of 225 producing wells owned by this company. The total product of gas from these wells was 660,577 M cu. feet, which enabled them to give a very satisfactory supply to their 5,879 customers in the city of Niagara Falls, the towns of Welland and Bridgeburg, and the villages of Fort Erie, Stevensville and Crystal Beach.

During the year 1915 a new company was organized under the name of Relief Gas Company, Limited, of St. Catharines. This company drilled in the townships of Gainsboro, Wainfleet and Pelham, 25 producing wells having an aggregate open flow of about 3,328,800 cu. feet of gas, and have also recently laid a pipe line from this field into the city of St. Catharines. In this line are three miles of 10-inch pipe, twelve miles of 8-inch, five miles of 6-inch, and five miles of 4-inch, a total of about twenty-five miles.

The list of natural gas producers for 1915 was as follows:—

NATURAL GAS PRODUCERS

Name of Person or Company.	Township.	P.O. Address of Manager, etc.
Aldrich Gas & Oil Company, Limited, The	Rainham	Hamilton.
Aikens & Beck	S. Cayuga	Dunnville.
Barnard, Argue, Roth & Stearns Oil & Gas Co.		401 Iroquois Bldg., Buffalo, N.Y.
*Beaver Oil & Gas Co., Limited, The	Romney	Buffalo, N.Y.
Berry, R. N.	Glanford, Binbrook, and Seneca	Caledonia.
Bertie Natural Gas Company, Limited	Bertie	Ridgeway.
Buffalo & Dunnville Oil & Gas Co., Ltd.	Moulton	Buffalo, N.Y.
Canadian Gas Company, Limited	Romney, Tilbury E. and Raleigh	1426 Dime Bank Bldg., Detroit, Mich.
Canfield Natural Gas Company, Limited	North Cayuga	Canfield.
Chippawa Development Co., Ltd.	Willoughby	Chippawa.
Chippawa Oil & Gas Co., Ltd.	Caistor, Canboro, and Cayuga	Kitchener.
Coleman, J. A.	Wainfleet	Wellandport.
Commonwealth Oil and Gas Co., Limited	Onondaga	240 King St. East, Hamilton.
Crystal City Oil and Gas Co., Limited, The	Onondaga	Paris.
Danskin, D.	Brantford	Cainsville.
Deagle, John	Onondaga	Middleport.

* This company is controlled from the head office of the Dominion Natural Gas Company, Limited, 842 Marine Bank Building, Buffalo, N.Y.

NATURAL GAS PRODUCERS—Continued

Name of Person or Company.	Township.	P.O. Address of Manager, etc.
Dominion Natural Gas Co., Limited, The	Lincoln, Wentworth, Elgin, Norfolk and Haldimand (counties)	842 Marine Bank Bldg., Buffalo, N.Y.
Douglas, W. A.		Caledonia.
Dunn Natural Gas Company, Limited, The	Dunn	Dunnville.
Duxbury, Wellington	Walpole	Hagersville.
Eastside Gas Co., Limited	Sherbrooke	Lowbanks.
Emerson, Troughton & Laidlaw	Canboro	Attercliffe Station.
Empire Limestone Company, Limited	Humberstone	Buffalo, N.Y.
*Enterprise Gas Company, Limited	Norfolk (county)	Buffalo, N.Y.
Fairbank Estate, J. H.	Enniskillen	Petrolia.
Fisherville Gas Co. No. 1	Fisherville (village)	Fisherville.
*Glenwood Natural Gas Co., Limited	Raleigh, Romney and Tilbury East	Buffalo, N.Y.
Hager, Ham	Onondaga	Middleport.
Hamilton, Alex. M.	Onondaga	Cainsville.
Hart & Harrington	Canboro	Attercliffe Station.
Hendee Natural Gas Co.	South Cayuga	Cayuga.
Holmes Gas Company, Limited	Rainham and Walpole	Selkirk.
Hoover, D. E.	Rainham	Selkirk.
Hoover, D. E., A. E., and Menno	Rainham	Selkirk.
Hoover, James E.	Walpole	Selkirk.
Hyde, F. W.	Sherbrooke	Dunnville.
Hyde & Snively	South Cayuga	Dunnville.
Industrial Natural Gas Company, Limited	Crowland and Humberstone	Dunnville.
Jasperson, B.	Kingsville (town)	Kingsville.
Jones, James S.	Port Maitland (village)	Port Maitland.
Jones, Nelson	Haldimand (county)	Attercliffe Station.
Kindy Gas Co., Limited	Rainham	Cayuga.
Kindy & Sons, D.	Rainham	Selkirk.
Kohler and Aikens	Canboro	Dunnville.
Lalor, F. R.	Moulton	Dunnville.
Lalor & Vokes	Nanticoke (village)	Dunnville.
Lamb, Alfred	Walpole	Selkirk.
Lamb, Walter B.	Walpole	Nanticoke.
Liesinger-Lembke Co.	Humberstone	Buffalo, N.Y.
Maple City Oil & Gas Co., Limited	Raleigh, Romney, Tilbury East	Buffalo, N.Y.
Marshall James	Haldimand (county)	Hamilton.
Martin, Edward	Port Maitland	Dunnville.
Medina Natural Gas Company, Limited, The	Elgin (county)	Vienna.
Midfield Natural Gas Company, Limited	North Cayuga	32 Stinson Street, Hamilton.
Mickle, Geo. T., & McKechnie, S.	Canboro	Ridgetown.
Moote, Melick and Lymburner	Canboro	Canboro.
Nanticoke Natural Gas Co., Limited, The	Walpole	Nanticoke.
National Gas Company, Limited	Rainham, Seneca	503 Bank of Hamilton Bldg., Hamilton.
Niagara Natural Gas and Fuel Co., Limited	Humberstone	Sherkston.
*Norfolk Gas Company, Limited	Norfolk (county)	Buffalo, N.Y.
North Shore Gas Company, Limited	Rainham	Hamilton.
Northwestern Gas Company, Limited	Brant (county)	13 Scott Block, Erie, Pa.
Oil Springs Oil & Gas Co., Ltd.	Enniskillen	Oil Springs.
Onondaga Oil and Gas Co., Limited	Onondaga	Brantford.

* These companies are controlled from the head office of the Dominion Natural Gas Company, Limited, 842 Marine Bank Building, Buffalo, N.Y.

NATURAL GAS PRODUCERS—Continued

Name of Person or Company.	Township.	P.O. Address of Manager, etc.
Port Colborne-Welland Natural Gas and Oil Company, Limited	Seneca, Oneida, Onondaga	Port Colborne.
*Port Rowan Natural Gas Company, Limited	Norfolk (county)	Buffalo, N.Y.
*Producers Natural Gas Company, Limited	Haldimand (county)	Buffalo, N.Y.
Provincial Natural Gas and Fuel Company of Ontario, Limited	Welland (county)	Niagara Falls.
Relief Gas Co., Limited	Gainsboro, Wainfleet and Pelham	St. Catharines.
Robinson Road Gas Co.	Canboro and Moulton	Dunnville.
Rolston, James	Canboro	Dunnville.
Rose & Patterson	Seneca	Blackheath.
Snively, F. L.	Rainham and South Cayuga	Dunnville.
Sparham, Andrew	....	Blackheath.
Springvale Oil & Gas Co., Ltd.	Walpole	Hagersville.
Standard Natural Gas Company, Limited	Onondaga	Dunnville.
*Standard Oil Company of Canada, Limited	Kent (county)	Buffalo, N.Y.
Sterling Gas Company, Limited	Humberstone, Wainfleet and Moulton	Port Colborne.
Stevensville Natural Gas & Fuel Co.	Bertie	Stevensville.
Sundy Gas Well Company	Canboro	Dunnville.
Telephone City Oil and Gas Co., Limited	Onondaga	Hamilton.
Union Natural Gas Co. of Canada, Limited	Kent and Lambton (counties)	Niagara Falls.
United Gas Companies, Limited	Wainfleet and Moulton	St. Catharines.
Vansickle, A. W.	Onondaga	Cainsville.
*Waines & Root Gas Co., Limited	Canboro, S. Cayuga, Dunn, Rainham and Walpole	Buffalo, N.Y.
Welland County Lime Works Co., Limited	Wainfleet	Port Colborne.
Wedrick, M.	Walpole	Nanticoke.

* These companies are controlled from the head office of the Dominion Natural Gas Company, Limited, 842 Marine Bank Building, Buffalo, N.Y.

PIPE LINE COMPANIES OR DISTRIBUTORS ONLY OF NATURAL GAS

Brantford Gas Company, Limited.
Central Pipe Line Company, Limited.
Chatham Gas Co., Ltd.
Independent Natural Gas Co., Dunnville.
Ingersoll Gas Light Company, Limited.
Lake Shore Natural Gas Company.
Manufacturers' Natural Gas Company, Buffalo, N.Y.
Nelles Corners Gas Company.
Northern Pipe Line Co., Limited.
Petrolia Utilities Co., Ltd.
Port Colborne-Welland Natural Gas Company.
Regah Natural Gas Co.
Rose Hill Natural Gas Co.
Sarnia Gas & Electric Light Co., Ltd.
Southern Ontario Gas Co., Ltd., St. Thomas.
Thorold Gas Company, St. Catharines.
Tilbury Town Gas Company.
Town of Leamington.
United Gas & Fuel Co. of Hamilton, Ltd.
Wellandport Natural Gas Co., Wellandport.
Windsor Gas Co., Ltd.
Woodstock Gas Light Company, Limited.

The following information regarding the natural gas industry in 1915 has been supplied by G. R. Mickle, Mine Assessor:—

There was no important development in the natural gas production during this year. The increase of output over the previous year amounted to about 8 per cent., and the yield was distributed amongst the following different fields:—

	Million cubic feet.	
(1) Welland-Haldimand, etc.	3,592.9	or 23.6 per cent.
(2) Kent	10,819.1	or 71.1 " "
(3) Elgin	399.1	or 2.6 " "
(4) Lambton	401.2	or 2.7 " "
Total	15,212.3*	or 100.0 per cent.

The percentages derived from the first two fields are almost the same as for the previous year, while Elgin shows a decrease and Lambton an increase.

(1) The first field mentioned comprises productive areas scattered through the counties of Welland, Haldimand, Norfolk, Brant, and Wentworth, and is nearing exhaustion in some parts. There are over sixty producing companies or individuals; most of these are quite unimportant, as five companies are responsible for about two-thirds of this production. The total yield from this field up to the end of 1915 cannot be given with any degree of accuracy, as no records were kept in the earlier years of the productive life of the field. From 1906 to 1915, both inclusive, the production has been 36,906 million cu. ft. Estimating, however, from information given in the Reports of the Bureau of Mines, and checking this with the records of the Provincial Natural Gas and Fuel Company, which was the pioneer, and much the most important producer in the early life of this field, the following approximation is arrived at. Starting about 1892 there were approximately 16,000 million cu. ft. produced prior to 1906, making in all nearly 54 thousand million cu. ft. from Welland-Haldimand, etc.

(2) The Kent gas field appeared for the first time as a producer in 1907, and up to the end of 1915 has yielded 52,049 million cu. ft., or nearly as much as from the Welland-Haldimand field with a vastly greater area of productive rock.

(3) The production from the Elgin field, which was developed in 1911, now amounts to 1,913.7 million cu. ft. This field is small in area, the gas in composition being identical with the normal gas from Kent except that it contains no hydrogen sulphide.

(4) The Lambton field at Oil Springs has now produced 570.8 million cu. ft. Unfortunately it does not seem likely to last much longer.

It is interesting to note that the old abandoned Essex gas field, although very small in area, probably not exceedng 3 square miles, was, like the Kent field, very productive, possibly per unit of area equalling or even exceeding the latter. Calculating from the records available in the same way as explained above in connection with the Welland-Haldimand area, about 22.5 thousand million cu. ft. were utilized from the Essex field. In addition there was an enormous waste for some time after the gas was discovered. No reliable estimate can be made of this waste, but it certainly must have constituted a very substantial addition to the amount of gas of which we have a record. If we assume a value of 10c. per thousand for the gas in the field, the value per square mile of area must have exceeded one million dollars easily. A gas field need not be large to be very valuable, and consequently might easily escape discovery for some time.

Petroleum

For the first time in several years an increase is recorded in the production of crude petroleum, namely, 214,442 barrels or 7,505,478 imperial gallons in 1915 as against 7,437,356 gallons in 1914. The value, however, fell off from $337,867 in 1914 to $300,219 in 1915, the average price for 1914 exclusive of bounty being $1.59 per barrel (35 gals.) and $1.40 for 1915. The lowest and highest prices paid in 1915 were $1.28 and $1.68 respectively. A bounty of 1½ cents per Imperial gallon is payable by the Dominion Government on all crude oil produced in Canada. A great and increasing demand for gasolene, and the expanding use of heavier peroleums for fuel purposes, are the chief factors causing the rise in price which took place in the latter part of the year.

* This total includes 800 thousand cu. ft. of gas, being an estimate of the production from a number of private gas wells whose owners make no returns to the Bureau.

The credit for the increased production is due in large measure to the work of inspectors in plugging abandoned and non-paying wells, some of which leak water in addition to wasting gas, thereby reducing the rock pressure. Inspector J. Scott reports the following figures in regard to oil wells:—

Pumped.	Baled.	Not operated.	Abandoned.	Total.
4,890	436	1,400	543	7,269

The Supervisor of crude oil bounties, J. C. Waddell of Petrolia, kindly supplies the following figures showing the production in imperial gallons from the several fields:—

Lambton.	Bothwell.	Dutton.	Tilbury.	Onondaga.	Belle River.	Total.
5,647,894	1,168,829	189,046	445,957	52,160	1,592	7,505,478

Domestic crude petroleum forms only a small part of the raw material required in the manufacture of petroleum products, the bulk of the crude oil used by Canadian refineries being imported from the United States.

The following table shows the operations for the year of the two refineries, the Canadian Oil Co. Limited, Petrolia, and the Imperial Oil Co. Limited, Sarnia, and also gives comparative figures for a five-year period:—

PETROLEUM AND PETROLEUM PRODUCTS, 1911 to 1915

Schedule.	1911	1912	1913	1914	1915
Crude produced....Imp. gal.	10,102,081	8,432,730	7,915,761	7,437,356	7,505,478
Value crude produced $....	353,573	344,537	381,159	337,867	300,219
Crude distilled.... Imp. gal.	38,632,504	46,270,701	53,821,592	73,239,403	84,355,760
Value distilled products. $	2,294,396	3,592,230	3,068,312	3,360,913	3,193,222
Illuminating oil. Imp. gal.	20,240,523	23,090,280	21,415,010	28,817,830	26,261,575
Lubricating oil.. "	4,729,257	5,932,166	6,144,193	6,228,394	7,271,200
Benzine and naphtha "	4,179,575	4,955,022	7,349,015	13,542,383	19,118,334
Gas and fuel oils and tar....... "	4,847,124	6,028,983	10,157,948	10,747,838	23,478,236
Paraffin wax and candles ... ... lb.	5,267,485	8,086,841	10,153,806	11,053,058	9,826,635
Workmen employed. No.	511	699	781	925	723
Wages paid....... $	314,851	436,852	559,556	683,247	564,950

Salt

Salt production in 1915 shows an increase over 1914 figures of 11 per cent. Of the 116,648 tons marketed, valued at $585,022, there were 84,103 tons of fine, table and dairy grades, 31,553 tons of coarse and 992 tons of land salt. The source of supply is from the brine wells of southwestern Ontario. The industry affords employment to 242 men, whose wages amounted to $183,558 in 1915.

It may be pointed out that salt is one of the three basic materials in the chemical industry, the others being coal and sulphur. The chemical plant of the Canadian Salt Company at Sandwich is quite distinct from that for salt manufacture, and promises in a few years' time to be one of the largest in the British Empire.

The following salt producers reported to the Bureau of Mines:—

SALT COMPANIES

Name of Owner, Firm or Company.	Location of Wells or Works.	P.O. Address of Manager, etc.
The Canadian Salt Company, Limited	Windsor Sandwich	Windsor.
The Dominion Salt Company, Limited	Sarnia	Sarnia.
The Earlton Salt Works Company, Limited	South of Egremont Road	Hyde Park.
Exeter Salt Works Company, Limited	Exeter	Exeter.
North American Chemical Co., Limited	Goderich	P.O. Box 29, Clinton.
John Ransford	Stapleton	Clinton.
Western Canada Flour Mills Co., Limited	Goderich	Goderich.
The Western Salt Company, Limited	Mooretown and Courtright	Courtright.

Talc

Shipments of talc for 1915 exceeded those of 1914, the figures being 1,720 tons of crude and 9,285 tons of ground, with a valuation of $5,760 and $80,165, respectively, as compared with 1,694 tons crude and 8,866 tons ground in 1914. The total valuation of marketed product in 1915 was $85,325. For 1914 the amount was $74,663. Grinding mills are located at Madoc and Eldorado. The entire output of talc came from Hastings county.

Talc operators, the first mentioned company making trial shipments only, are as follows:—

Firm or Company.	Location of Mine or Works.	Address of Manager, etc.
Anglo-American Talc Corporation, Ltd.	Huntington Tp. (Connolly mine)	Madoc.
Cross and Wellington	Huntington Tp. (Henderson mine)	Madoc.
Eldorite, Limited	Eldorado	Eldorado.
Gillespie, G. H., & Co.	Madoc	Madoc.

Mining Companies

The number of companies incorporated in 1915 under the laws of Ontario to carry on mining business in any or all of its branches was much smaller than for the previous year. Companies incorporated were 59 in number and the aggregate capital authorized was $42,005,000. In 1914 the number was 80 with a nominal capitalization of $39,030,000. Only two companies of foreign or federal incorporation were licensed to do business in the Province as compared with thirteen for 1914.

The lists are as follows:—

MINING COMPANIES INCORPORATED IN 1915

Name of Company.	Address.	Date of Incorporation.	Capital.
Adanac Silver Mines, Limited	Toronto	May 15	$2,500,000
Algoma Nickel Mining Company, Limited	Toronto	Oct. 25	10,000
Casey Harris Mining Company, Limited	Toronto	Oct. 23	100,000
Croesus Gold Mines, Limited	Cobalt	Sept. 21	200,000
Dome Consolidated Mines, Limited	Toronto	Oct. 2	2,500,000
Elora White Lime Company, Limited	Elora	Sept. 22	100,000
Empire Sand and Gravel Company, Limited	Toronto	Dec. 16	40,000
Genesee Mining Company, Limited	Cobalt	July 30	1,000,000
George Frid Brick Company, Limited	Hamilton	July 15	40,000
Gould Allied Mines, Limited	Ottawa	Sept. 14	2,000,000
Gowganda Enterprise Mining Company, Limited	Fort Erie	Sept. 24	40,000
Haileybury Kirkland Lake Mining Company, Limited	Toronto	Jan. 26	1,000,000
Harris Development & Exploration Syndicate, Limited	Toronto	Oct. 25	650,000
Hastings County Marble Company, Limited	Toronto	May 14	100,000
Imperial Reserve Mines, Limited	Toronto	Sept. 24	1,500,000
James Gow Lime Kiln, Limited	Fergus	Jan. 5	60,000
Kirkland Lake Gold Mining Company, Limited	Toronto	Nov. 19	2,000,000
Knoxwell Mining Company, Limited	Toronto	June 29	500,000
La Belle Kirkland Mines, Limited	Fort Erie	Sept. 2	2,000,000
Lady Maud Lake Gold Mines, Limited	New Liskeard	Jan. 18	500,000
Letson Gold Mines, Limited	Toronto	April 7	1,000,000
McIntyre Extension Mines, Limited	Toronto	July 15	2,500,000
McIntyre-Jupiter Mines, Limited	Toronto	Nov. 3	2,000,000
Mercer Silver Mines, Limited	Toronto	July 12	1,000,000
Michigan-Ontario Mines, Limited	Windsor	April 19	100,000
Miller Independence Mines, Limited	Boston Creek	Nov. 17	500,000
Mount St. Patrick Molybdenite Mines, Limited	Ottawa	June 18	300,000
Munro Consolidated Gold Mines, Limited	Toronto	Sept. 15	1,000,000
National Graphite, Limited	Toronto	May 17	60,000
Newray Mines, Limited	Toronto	Feb. 11	1,000,000
Northampton Mining Company, Limited	Toronto	Nov. 17	50,000
Orillia Molybdenum Company, Limited	Orillia	Sept. 13	200,000
Porcupine Excelsior Mining Company, Limited	Porcupine	Aug. 7	100,000
Provincial Stone & Supply Company, Limited	Toronto	Nov. 22	40,000
Relief Gas Company, Limited	St. Catharines	April 15	40,000
Sable River Copper Company, Limited	Toronto	Dec. 30	100,000
Shamrock Consolidated Mines, Limited	Toronto	June 25	1,000,000
Swastika Gold Mines, Limited	Toronto	Dec. 13	2,000,000
The Belmont Oil and Gas Company, Limited	Belmont	Sept. 29	40,000
The Bowmanville Gravel Company, Limited	Bowmanville	April 27	40,000
The Casey-Seneca Silver Mines, Limited	Toronto	April 10	1,000,000
The Darlington Gravel Company, Limited	Bowmanville	Sept. 14	40,000
The Darragh-Downey Mining Company, Limited	Ottawa	Feb. 10	100,000
The Dominion Lime Company, Limited	Madoc	June 8	100,000
The Elk-Horn Lime Company, Limited	Madoc	Aug. 30	250,000
The Faced Brick and Machinery Company, Limited	Toronto	May 17	100,000
The Globe Graphite Mining and Refining Company, Limited	Port Elmsley	Jan. 7	500,000
The Gold Anchor Mining Company, Limited	Cobalt	April 13	1,000,000
The Hungerford Talc Company, Limited	Toronto	Feb. 1	50,000
*The Morse Porcupine Syndicate, Limited	Toronto	Sept. 11	35,000
The Shanedarr Mining Company, Limited	Ottawa	April 27	40,000
The Sudbury Leasing & Development Company, Limited	Sudbury	Feb. 23	40,000
The Sydenham Mica and Phosphate Mining Company, Limited	Kingston	Dec. 24	50,000
The Vacuum Gas and Oil Company, Limited	Toronto	April 17	1,000,000

* Name changed to Porcupine Bonanza Mines, Limited, on October 9th, 1915.

MINING COMPANIES INCORPORATED IN 1915—Continued

Name of Company.	Address.	Date of Incorporation.	Capital.
Toronto Gas and Oil Company, Limited	Toronto	July 8	$40,000
Triumph Mines, Limited	Toronto	Nov. 22	3,000,000
West Dome Consolidated Mines, Limited	Toronto	Sept. 23	3,000,000
Whitby Brick and Clay Products Company, Limited	Whitby	May 10	250,000
Yellow Jacket Gold Mine, Limited	Toronto	Nov. 10	1,500,000
			$42,005,000

MINING COMPANIES LICENSED IN 1915

Name of Company.	Head Office for Ontario.	Date of License.	Capital for Use in Ontario.
Mond Nickel Company, Limited	Toronto	Jan. 30	$10,000,000
The North-Thompson (Associated) Gold Mine, Limited	Almonte	Jan. 29	200,000
			$10,200,000

Mining Divisions

The following is a list of the Mining Divisions of Ontario, names and addresses of the Recorders, and receipts from each Division for the fiscal year ending Oct. 31st, 1915:—

Mining Division.	Name and P.O. Address of Recorder.	Receipts. Purchase price.	Permit.	Miners' Licenses.	Recording Fees.	Total Receipts.
		$ c.	$ c.	$ c.	$ c.	$ c.
Sault Ste. Marie	S. T. Bowker, Sault Ste. Marie	1,465 00	....	427 10	64 87	1,956 97
	W. N. Miller, Sault Ste. Marie	554 75	....	322 00	496 75	1,373 50
Sudbury	C. A. Campbell, Sudbury	4,213 90	130 00	2,757 15	2,205 25	9,306 30
Porcupine	G. H. Gauthier, Porcupine	11,720 66	130 00	3,116 40	2,928 75	17,895 81
Larder Lake	J. A. Hough, Matheson	10,607 96	....	2,570 00	10,106 50	23,284 46
Port Arthur	J. W. Morgan, Port Arthur	9,979 63	40 00	1,862 00	4,605 65	16,487 28
Parry Sound	H. F. McQuire, Parry Sound	161 60	....	149 00	244 00	554 60
Gowganda	H. E. Sheppard, Gowganda	366 19	60 00	344 00	208 65	978 84
Montreal River	A. Skill, Elk Lake	858 65	10 00	370 00	62 25	1,300 90
Timiskaming (including Coleman)	G. T. Smith, Haileybury	615 25	20 00	5,008 00	743 00	6,386 25
	N. J. McAulay, Haileybury	2,625 67	....	1,838 00	883 75	5,347 42
Kenora	W. L. Spry, Kenora	792 50	....	293 23	260 75	1,346 48
	Total	43,961 76	390 00	19,056 88	22,810 17	86,218 81

The Eastern Ontario and Fort Frances Mining Divisions have no resident Recorders, and all business originating there in connection with recording of claims, etc., is handled by the Bureau of Mines at Toronto. Revenue not derived from the Recording Officers is collected by the Department.

A brief record, as reported by the Recorders, of the activities of the year, in several of the Mining Divisions, follows herewith:—

Sudbury.—There were no new fields of any importance opened up during this last year, but it might be worthy to note that Harry Shepherd of North Bay staked a claim for molybdenite in lot 10, con. III, Garrow township, and John Mataris also staked claims for the same material in the township of Roberts. During the latter part of the year quite a lot of interest was taken in the nickel region and a number of claims staked.

Porcupine.—There has been an increase in the business transacted in the Recording Office as compared with 1914. Recently prospecting and staking have been active in Deloro and some other portions of the camp, and everything points to considerable activity during the spring and summer of 1916. More real substantial development work is being done on prospects as the camp proves up. In many cases the results obtained have been most encouraging. It is evident that Porcupine's gold production will eventually be much greater than it is at present. During the past year all of the producing mines have increased their output considerably, and three mines have been added to the list of producers, namely, Dome Lake, Schumacher and Acme. The ore from the latter is being treated at the Hollinger mill. There promises to be other producing mines developed during the coming year. The gold production of Porcupine will likely amount to between ten and eleven million dollars in 1916.

Larder Lake.—There was much activity in all parts of this Mining Division during the year 1915. One of the chief features of the year was the finding of high-grade gold ore in Munro township. Remembering that 1915 was supposed to be a year of stringency owing to the war, it is interesting to note that the revenue of this office was greater for the year 1915 than for any previous year.

Port Arthur.—Notwithstanding the depressing effects of the European war, the business in this office is very much in excess of that of 1914; the increased activity being largely due to the discovery of gold in what is now known as "The Kowkash Gold Fields," which lie northeast of the Nipigon Forest Reserve. The Tashota Gold Field, which is said to be very good, is simply a continuation to the west of the Kowkash deposits. A new discovery of gold has also been made quite recently in the northwest part of this Mining Division.

Parry Sound.—There were seventeen claims taken up in Lount township for iron ore by Bay City interests, but little or no work filed during this season. I am informed it is the intention to vigorously prospect these claims during the summer of 1916. In McConkey township there were five claims taken up for mica. Parties are now at work taking out some mica with the view to seeing if it is a commercial success. In Cowper township there were two claims taken up for feldspar, but it was not the intention to make any shipments until the summer of 1916. In Burton township there was also one claim staked for mica.

Mining Revenue

The revenue of the Department for the fiscal year ending Oct. 31st, 1915, was $342,986.44, a decrease of $160,682.11 from the previous year.

Miner's licenses and other fees connected with the recording of mining claims afford a criterion of the activity in prospecting and speculation in mining lands. When a new camp of any importance is discovered the reflection in mining revenue comes in the form of increased receipts.

The following itemized list shows the sources of revenue, also the corresponding receipts for the year ending Oct. 31st, 1914.

	1913-14.	1914-15.
Sales of mining land	$41,027 50	$46,584 88
Rental, leases, etc.	16,469 76	13,841 58
Miners' licenses, permits, fees	64,195 26	52,308 70
Royalties	74,685 11	52,860 60
Mining Tax Act	306,861 40	177,101 53
Provincial Assay Office, etc.	429 52	289 15
	$503,668 55	$342,986 44

The following schedule shows the transactions in mining lands for the fiscal year. It will be noted that the figures do not quite correspond with those given in the summary, since they cover sales, leases, etc., completed during the year, while the summary takes in all moneys collected.

MINING LANDS SOLD AND LEASED

District.	Sales.			Leases.			Total.		
	No.	Acres.	Amount.	No.	Acres.	Amount.	No.	Acres.	Amount.
Timiskaming....	273	9,765.86	26,898 34	41	1,407.89	1,407 89	314	11,173.75	28,306 23
Thunder Bay....	114	4,553.29	10,665 01	....	....	....	114	4,553.29	10,665 01
Algoma.........	35	1,282.50	3,245 50	....	....	....	35	1,282.50	3,245 50
Sudbury.........	26	1,017.60	2,972 25	10	457.20	457 20	36	1,474.80	3,429 45
Nipissing........	1	40.00	120 00	6	226.95	226 95	7	266.95	346 95
Kenora..........	8	388.00	990 00	....	....	....	8	388.00	990 00
Rainy River.....	1	11.00	11 00	....	....	....	1	11.00	11 00
Parry Sound.....	3	150.00	450 00	....	....	....	3	150.00	450 00
Elsewhere.......	2	69.60	87 00	....	....	....	2	69.60	87 00
Total........	463	17,277.85	45,439 10	57	2,092.04	2,092 04	520	19,369.89	47,531 14

Royalties.—Cobalt mines paying royalty to the Crown are now only three in number, namely, the O'Brien and Hudson Bay mines under special agreement, and the Crown Reserve under the terms of the original grant. Details as to rates, etc., were outlined in Volumes XX and XXII of the Bureau's Reports on pages 47 and 51 respectively. The payments for the fiscal year ending October 31st, 1915, were as follows:—

Crown Reserve	$22,062 14
O'Brien	23,734 76
Hudson Bay	7,063 70
Total	$52,860 60

Some of the mines paying royalty have ceased operation. In the case of others there has been a decline in production. As a result, revenue in the future from this source will undoubtedly show a decrease.

The total royalties paid by the mines subject to these arrangements, up to the end of the fiscal year, are shown in the following statement:—

Crown Reserve	$793,945 58
O'Brien	724,700 83
Hudson Bay	333,870 05
Chambers-Ferland	26,259 64
Cobalt Provincial	6,735 14
Hargrave	1,200 00
Waldman	777 48
Wyandoh	1,421 72
Total	$1,888,910 44

Certain mining companies at Cobalt, holding lands from the Timiskaming and Northern Ontario Railway Commission, pay a royalty on their output directly to the Commission. The leases, which originally specified a royalty of 25 per cent. at the collar of the shaft, have been reduced gradually to 5 per cent. on the net profits, which rate became effective on Sept. 1st, 1915. For the year ending Oct. 31, 1915, the Commission received from the Mining Corporation of Canada and the Right of Way Mines $31,341.25 as royalty. Total receipts by the Commission from this source are as follows:—

City of Cobalt	$100,791 13
Cobalt Townsite	279,482 72
Mining Corporation of Canada	39,703 83
Nancy Helen	6,126 60
Right of Way	272,152 19
Total	$698,256 47

Mining Tax Act.—The revenue received under the Mining Tax Act (chapter 26, R.S.O. 1914), for the fiscal year ending Oct. 31st, 1915, together with comparative amounts for the preceding year, was as follows:—

	1913-14.	1914-15.
Acreage Tax	$10,046 41	$10,716 24
Profit Tax	272,610 89	139,978 62
Natural Gas Tax	24,204 40	26,406 53
Totals	$306,861 40	$177,101 53

The 3 per cent. tax on profits of mining companies has yielded in all since the Act came into force, the sum of $1,200,600.07, the amounts by calendar years being as follows:—

1907	$66,741 68
1908	65,922 48
1909	78,327 58
1910	111,546 17
1911	131,577 75
1912	$200,275 25
1913	206,212 77
1914	201,940 20
1915	138,056 19
Total	$1,200,600 07

The mines which have paid the tax, and the total amounts paid by each, are as follows:—

Silver Mines.	$ c
Beaver	9,785 85
Buffalo	36,340 70
Casey-Cobalt	4,836 41
Coniagas	114,825 96
Cobalt Silver Queen	4,657 15
Cobalt Comet	1,942 02
Cobalt Lake (Mining Corp'n of Canada)	12,750 60
Drummond	11,788 84
Foster	577 87
Kerr Lake	120,276 30
La Rose	135,519 92
McKinley-Darragh-Savage	77,458 85
Miller-Lake-O'Brien	9,043 96
Nipissing	229,907 56
Penn-Canadian	383 82
Timiskaming	34,052 27
Trethewey	15,153 18
Seneca-Superior	14,429 22
Standard	1,447 00
Watts	258 69
Wettlaufer-Lorrain	19,054 45
Total	$854,490 62

Nickel-Copper Mines.	$ c
Alexo	309 93
Canadian Copper Co.	245,000 00
Mond Nickel Co.	18,226 94
Total	$263,536 87
Gold Mines.	
Dome	9,068 06
Hollinger	62,077 38
McIntyre-Porcupine	1,543 64
Porcupine-Crown	7,983 78
Total	$80,672 86
Miscellaneous.	
Lake Superior Corp'n (iron)	1,683 51
Loughborough Mining Co. (mica)	216 21
Total	$1,899 72
Summary.	
Silver Mines	854,490 62
Nickel-Copper Mines	263,536 87
Gold Mines	80,672 86
Miscellaneous	1,899 72
	$1,200,600 07

The total revenue paid into the treasury of the Province by the Cobalt silver mines, without including the amounts paid to local municipalities under the provisions of the Mining Tax Act, are set forth in detail as follows:—

Royalties paid direct to the Crown	$1,888,910 44
Royalties paid T. & N. O. Railway Commission	698,256 47
Three per cent. Profit Tax	854,490 62
	$3,441,657 53

The Mine Assessor, G. R. Mickle, who has charge of the collection of revenue derived from the Mining Tax Act, furnishes the following notes regarding the operation of the Act for the calendar year 1915:—

Three different taxes are levied under the Act, viz.: (1) the Profit Tax, being three per cent. of the profits in excess of $10,000, computed as explained in the Act; from this is deducted the income tax paid municipalities; (2) Natural Gas Tax, being equivalent to $2.00 per million cu. ft.; and (3) Acreage Tax of two cents per acre on mining lands in districts with no municipal organization. The amounts realized from these various taxes for the calendar year 1915 were as follows:

Profit Tax	$138,056 19
Natural Gas Tax	27,952 61
Acreage Tax (Apr. 15th, 1915, to Apr. 15th, 1916)	12,020 83
Total	$178,029 63

This is a decrease of over $58,000 from the amount received in 1914, the corresponding figure for that year being $236,700.06. The loss is in the profit tax, due to the substantial decrease in the production of silver. This decrease amounted to about 4½ million ounces. Moreover, the average price obtained per ounce was about three cents lower than in the year before, and the working expenses somewhat greater per unit recovered. As the tax is always based on the operations of the preceding year, this decrease in production refers to the year 1914 as against 1913. Moreover, the amounts given above are for the calendar year in which they are payable, and consequently will not agree with the Public Accounts Statement, which deals with the fiscal year for the Province ending on 31st October. As these taxes are not due till October 1st, it has never been possible to collect them all before the end of the fiscal year, consequently it seemed preferable for the purposes of comparing the results from year to year to give them in this way.

With regard to the immediate future there will be a small increase in the profit tax, due to increased production of gold. Natural gas will also yield a small amount more revenue, while the acreage tax remains about the same from year to year, only showing an increase when a list of lands is advertised for forfeiture.

Provincial Assay Office

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

During the year 1915 the Provincial Assay Office, located at Belleville between 1898 and 1911, now at No. 5 Queen's Park, Toronto, Ontario, carried on its work along the usual lines. This work includes:—

(*a*) Examination and assaying of samples from mining engineers, prospectors, geologists and the public generally. This covers a wide range of work.

(*b*) Work for the Ontario Bureau of Mines consisting of analyses of rocks, assaying of different ores and identification of minerals for the various geologists in the employ of the Bureau of Mines.

(*c*) Testing samples submitted by the public for radium. This work is done free of charge.

(*d*) Sampling car lots of cobalt-silver ore shipped from the mines upon which the Government collects a royalty. This necessitates having a sampler at Deloro for a large portion of the time.

(*e*) Assaying and valuation of these car lots.

(*f*) Analyzing and valuating shipments of cobalt and nickel oxides shipped by the various smelters, and on which a bounty is paid.

The following list will show the work done by the Laboratory:—

Gold.—Three hundred and seventy-eight samples were assayed for gold and reports issued. One hundred and twenty-seven of these were done for the Bureau and two hundred and fifty-one for the public.

Silver.—Seventy-one samples of silver were assayed for the public and forty-nine for the Bureau: one hundred and twenty in all. This does not accurately represent the work as a car lot is represented here by one sample.

Platinum.—Fifty-five samples—forty-eight for the Bureau and seven for the public. The method for assaying is given elsewhere in this Report.

Copper.—Forty-five samples—twelve for the Bureau and thirty-three for the public.

Iron Ores.—Eight samples were analyzed for iron. During the latter part of December a large number were analyzed for iron, phosphorus, sulphur, silica. ferrous iron, etc. These will appear in next year's report.

General.—Twenty-eight rock samples were submitted by the geologist of the Bureau for exhaustive analysis. One hundred and sixty-six other samples were received, including samples of feldspar, molybdenite, graphite, lead, zinc, etc. In carrying out this practical work only one assistant, T. E. Rothwell, was employed.

In addition to the work designated in this report the writer had charge of the mineral exhibit of the Ontario Bureau of Mines at the Canadian National Exhibition, Toronto. This entailed a large amount of work, and he desires to thank the mine owners and managers who so kindly loaned samples and in other ways contributed to the success of this exhibit.

Platinum Method.—During the year a decided increase in the platinum assays shows a continued interest by the public in this precious metal, which has increased enormously in value in recent years.

The method used in the chemical determination of platinum and allied metals is that outlined by A. M. Smoot, chief chemist of Ledoux & Company, New York, in the *Engineering and Mining Journal,* Vol. 99, pp. 700-701, April 17th, 1915, and reprinted by the United States Geological Survey.*

For the prospector and those with slight chemical equipment the identification of platinum and allied metals is not always certain. The following tests are believed to be most easily applied, and, if the material is carefully handled, they will give fairly reliable results.

Platinum has a colour ranging from silvery white to steel-gray, its shade depending on the quantity of impurities present. In some placer deposits the grains of platinum are coated with a dark film and somewhat resemble grains of ilmenite or magnetite, from which, however, they are separated by careful washing, as platinum has a specific gravity equal to or greater than gold, and so stays in the pan with the gold.

Platinum will not amalgamate with quicksilver alone, but will amalgamate if sodium is added. In ordinary quicksilver amalgamation the flakes of platinum float on the surface and can be removed. If sodium is used, the platinum may be separated from gold by agitating the amalgam with water until all the sodium is used up to form sodium hydroxide,

*Quotation from " The Production of Platinum and Allied Metals in 1914," by James M. Hill, U. S. Geological Survey.

when the platinum will come out on the surface of the amalgam, provided, of course, that it is sufficiently liquid.

Platinum has a hardness of 4 to 5, and can be scratched with a knife. It is so malleable that it can be pounded without heating into very thin sheets. It is infusable, cannot be run together as gold can, and is insoluble in all acids except aqua regia, a mixture of two parts hydrochloric (muriatic) acid and one part nitric acid. This solution (platinum chloride?) is yellow, but its colour is changed to deep red by the addition of metallic tin. From an aqua regia solution, potassium platinic chloride (K_2PtCl_6), a yellow crystalline precipitate is formed when potassium chloride (KCl) is added; or ammonium platinic chloride (NH_42PtCl_6) also yellow when ammonium chloride (NH_4Cl) is added. Both these precipitates are insoluble in alcohol, but are soluble in water, and may be reduced by heating, so that sponge platinum is left.

Radium.—Of the number of samples tested for radium only three showed signs of radio-activity. These were as follows:

1. Sample of euxenite submitted by Jas. A. Morrow, Maberley, Ontario.
2. Sample of euxenite from E. H. Wilson, Perth, Ont. This sample was obtained from near Maberley.

Euxenite is a dark mineral with a conchoidal fracture and brownish streak, containing niobium and tantalum, along with rare metals; yttrium and cerium in combination with iron and titanium, and it also contains some uranium.

3. Corundum concentrates submitted by the Provincial Geologist.

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

Crushed samples representing large quantities or samples less than five pounds weight may be sent by mail as third-class matter. Write your name and address plainly on each parcel. Send instructions, with money in payment of fees in a separate letter. Samples may be sent by express, charges prepaid. Sample bags addressed to this Laboratory for sending ore pulp by mail may be obtained free on application; also canvas bags for shipping.

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

Address samples as follows:

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

TARIFF OF FEES FOR ANALYSES AND ASSAYS

1. *Assays:*

Gold	$1 00
Silver	1 00
Gold and silver in one sample	1 50
Platinum	4 00
Gold and platinum in one sample	5 00
Gold by amalgamation	2 00

For the amalgamation assay for gold at least five pounds of ore must be sent.

2. *Iron Ores:*

Iron (metallic)	$1 00
Silica	1 50
Iron and insoluble residue	1 50
Ferrous oxide	2 00
Phosphorus	2 00
Sulphur	2 00
Iron, sulphur, phosphorus and insoluble	5 00
Manganese	2 00
Titanium	2 00
Complete analysis:—Ferrous oxide, ferric oxide, total metallic iron, silica, alumina, lime, magnesia, manganese, phosphorus, sulphur and titanium	15 00

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

Determination of:

Insolubles	$1 00
Silica	1 50
Ferric iron	2 00
Ferrous iron	2 00
Alumina	2 00
Lime	1 50
Magnesia	1 50
Alkalies (combined)	5 00
Potash	4 00
Water (combined)	1 00
Moisture	0 50
Organic matter	1 00
Carbon dioxide	1 50
Sulphur	2 00
Phosphorus anhydride	2 00

4. *Examination of Clay, Shale, or Cement Rock for cement manufacture:*

Determination of silica, iron oxide, alumina, lime, magnesia, sulphuric anhydride and volatile matter	$10 00

5. *Coal, Coke, Peat, etc.*

Determination of:

Moisture	$0 50
Volatile combustible	1 00
Fixed carbon	1 00
Ash	1 00
Sulphur	2 00
Phosphorus	2 00
Calorific value	5 00
Ultimate analysis	Price on application

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

7. *Ores and Minerals:*

Determination of:

Alumina	$2 00
Antimony	3 00
Arsenic	3 00
Bismuth	3 00
Cadmium	3 00
Chromium	3 00
Cobalt	3 00
Copper	2 00
Gold	1 00
Ferrous oxide	2 00
Ferric oxide	2 00
Lead	2 00
Lime	1 50
Magnesia	1 50
Molybdenum	2 00
Manganese	2 00
Nickel	3 00
Silica	1 50
Water	1 00
Zinc	2 00

8. *Rocks, Complete Analysis* ....Prices on application

9. *Slags, Sand, etc.* ....Prices on application

10. *Identification of Minerals and Rocks not requiring Chemical Analysis* ....Free

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

The pulp of each sample is retained for future reference.

MINING ACCIDENTS IN ONTARIO IN 1915

By

Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, E. A. Collins, Kingston; James Bartlett, Cobalt

General

During the year 1915 at the mines, metallurgical works, quarries, clay and gravel pits regulated by the Mining Act of Ontario there were 22 fatal accidents, causing the death of 22 men, as compared with 58 deaths in 1914 and 64 in 1913. Of these 17 occurred underground, a decrease of 12 as compared with the preceding year. The fatal accidents took place in mines operated by 11 different companies. Only one fatality occurred at metallurgical works, as compared with 5 in 1914 and 11 in 1913.

There were no fatalities in quarries, clay pits and gravel pits governed by the Ontario Mining Act. Four farmers in different parts of the province were killed by falls of sand and gravel. These accidents were duly investigated, and it was found that in three cases gravel was being hauled by the farmers in performance of their annual statute labour on the roads; in the fourth case the gravel was to be used in building a concrete silo. As this Department has no jurisdiction over such works or such labour, the accidents are not included in these statistics; but they emphasize the danger even in small gravel pits, a danger as a rule totally unrecognized by the man not familiar with such operations.

The decrease, compared with the preceding year, in accidents at quarries, clay and gravel pits is no doubt largely due to the fact that excavating operations were greatly curtailed during 1915.

The tables of accidents at the metallurgical works and quarries are separated in this report from accidents at mines. For this tabulation the clay and gravel pits are grouped under the heading, Quarries.

The total number of serious accidents in and about the mines of Ontario reported to the Bureau of Mines in 1915 was 424, resulting in 21 deaths and injuries to 415 persons. In the non-fatal accidents, 305 men were injured underground and 110 above. At metallurgical works there were 71 accidents, resulting in one death and injuries to 70 persons. Eleven non-fatal accidents were reported from quarries.

In accordance with the Mining Act inquests were held on all fatal accidents and attended by one of the Inspectors.

Table of Accidents

	1914		1915	
—	Killed.	Injured.	Killed.	Injured.
MINES:—				
No. killed underground	29	....	17	....
No. " surface	9	....	4	....
No. injured underground	....	251	....	305
No. " surface	....	77	....	110
METALLURGICAL WORKS:—				
No. killed	5	....	1	....
No. injured	....	101	....	70
QUARRIES:—				
No. killed	15	....	....	....
No. injured	....	16	....	11
Totals	58	445	22	496

The fatal accidents occurring in the mines were divided amongst the several districts as follows:—

	1914.	1915.
Gold mines of Porcupine and Kirkland lake	12	3
Silver mines of Cobalt and adjacent districts	11	6
Nickel-copper mines of Sudbury	9	11
Iron mines of Michipicoten	4	0
Iron pyrites mine, western Ontario	1	0
Eastern Ontario	1	1
	38	21

By months the mining fatalities occurred as follows:—

Month.	1914.	1915.
January	6	0
February	5	3
March	7	0
April	7	3
May	5	0
June	8	1
July	4	2
August	5	3
September	2	3
October	3	3
November	4	1
December	2	2
	58	21

Analysis of Fatalities at Mines

Cause.	1914	1915
	Per cent.	Per cent.
Falls of ground	7.9	4.8
Shaft accidents	26.3	23.8
Explosives	26.3	33.3
Miscellaneous (underground)	15.8	23.8
Surface	23.7	14.3

Table of Fatal Accidents in Mines, Metallurgical Works and Quarries, 1901 to 1915

—	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	1.80
1905........	9	4,415	500	4,915	1.83
1906........	11	5,017	750	5,767	1.90
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	1.50
Totals ..	459	125,493	18,940	144,433	3.18

As will be seen from the above table the fatal accidents per 1,000 employed in 1915 is the lowest of which there is any record in Ontario mines.

Cause and Place of Fatalities in Mines

The following schedule shows the cause and place of the fatalities in 1915 compared with 1914:—

BELOW GROUND

	1914.		1915.	
Falls of ground	3		1	
		3		1
Shaft accidents:—				
Struck by cage	0		1	
Staging in shaft breaking	1		0	
Falling down shaft	2		1	
Objects falling down shaft	2		0	
Falling from bucket or skip	2		1	
Attempting to get on and off skip or cage in motion	1		0	
Run over by skip	1		1	
Killed in cage while gassed	1		0	
Runaway car	0		1	
		10		5

	1914.	1915.
Explosive accidents:—		
Premature explosion while loading or lighting holes	5	0
Drilling into bottom of old or missed holes	1	2
Asphyxiation from gases from explosives and falling	2	1
Picking or putting bar into old hole containing explosive	1	1
Delayed explosion while sandblasting	1	0
Explosion in blacksmith shop (above ground)	0	1
Explosion in magazine	0	1
Walked into blast	0	1
	—10	—7
Miscellaneous accidents:—		
Falling down winze	2	1
Falling down stope	1	3
Struck or buried by ore	2	0
Crushed between cars	0	1
Scaling	1	0
	—6	—5
ABOVE GROUND.		
Slide of surface material	0	1
Struck by falling objects	1	0
Electrocuted	0	1
Killed by fall	3	0
Caught by machinery	1	1
Team running away	1	0
Drowned	2	0
Boiler explosion	1	0
	—9	—3
Totals	38	21

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

Occupation.	English-speaking.	Finn.	Italian.	Austrian.	Roumanian.	Bulgarian.	Total.
Drill runner	1	1	1	1	......	......	4
Drill helper	1	1	......	1	1	......	4
Trammer	......	......	1	1	......	1	3
Chute blaster	......	......	......	1	......	......	1
Foreman	1	......	......	......	......	......	1
Mule driver	1	......	......	......	......	......	1
Timberman	1	......	......	......	......	......	1
Electrician	1	......	......	......	......	......	1
Blockholer	1	......	......	1	......	......	2
Surveyor	1	......	......	......	......	......	1
Pumpman	1	......	......	......	......	......	1
Blacksmith	1	......	......	......	......	......	1
Totals	10	2	2	5	1	1	21

The ages of the men killed in the mines were as follows:—

17–20	21–25	26–30	31–35	36–40	41–45	46–50	56–60	Total.
3	5	4	3	1	1	3	1	21

Cause and Place of Non-Fatal Accidents at Mines

The following schedule shows the cause and place of the non-fatal accidents in 1915 at the mines and the number injured:—

UNDER GROUND

Falls of ground	9	
		9
Shaft accidents:—		
Cage accidents	8	
Falling part way down shaft	7	
Objects falling down shaft	9	
Miscellaneous	0	
		24
Explosives:—		
Drilling into old or missed holes	7	
Picking into explosives	3	
Premature explosion	9	
		19

MISCELLANEOUS ACCIDENTS

Falling down stopes, raises, winzes, chutes or man-ways	11	
Jammed by cars, skips, buckets or pieces of rock or ore	48	
Scaling	14	
Foreign material in eyes	21	
Injured at chutes	69	
Flying rock	3	
Rock rolling down pile	12	
Caught by drill	28	
Falling objects	8	
Falling from staging	13	
Miscellaneous	26	
		253

SURFACE

Falling from elevated places	14		
Caught by machinery	33		
Burned by electric wire	1		
Falling objects	14		
Burned	7		
Foreign material in eyes	4		
Slipped on ice	6		
Miscellaneous	31		
		110	
			415

The occupation and nationality of the men injured in or about the mines follows herewith:—

Occupation.	English-speaking.	Italian.	Austrian.	Finn.	Russian.	Pole.	Swede.	Roumanian.	Bulgarian.	Spaniard.	German.	Serbian.	
Trammer	13	40	22	11	26	5	2	5	6	2	1	1	134
Drill runner	30	18	16	19	3	4	4	1	....	....	....	....	95
Labourer	11	20	6	....	5	1	....	....	....	....	....	....	43
Drill helper	14	7	2	3	2	....	1	1	....	....	....	....	30
Timberman	5	....	....	8	....	....	....	....	....	....	....	....	13
Machinist	8	3	....	....	....	....	....	....	....	....	....	....	11
Carpenter	9	1	....	....	....	....	1	....	....	....	....	....	11
Millman	9	1	1	....	....	....	....	....	....	....	....	....	11
Blacksmith	7	1	....	....	....	....	....	....	....	....	....	....	8
Cage tender	5	1	1	1	....	....	....	....	....	....	....	....	8
Ore sorter	4	2	1	....	1	....	....	....	....	....	....	....	8
Foreman	7	....	....	....	....	....	....	....	....	....	....	....	7
Blaster	....	4	1	....	....	....	1	....	1	....	....	....	7
Scaler	1	....	....	3	....	1	....	....	....	....	....	....	5
Teamster	5	....	....	....	....	....	....	....	....	....	....	....	5
Blockholer	1	1	1	....	....	....	1	....	....	....	....	....	4
Electrician	3	....	....	....	....	....	....	....	....	....	....	....	3
Crusherman	1	....	....	....	1	....	....	....	....	....	....	....	2
Surveyor	2	....	....	....	....	....	....	....	....	....	....	....	2
Nipper	....	....	1	....	....	....	1	....	....	....	....	....	2
Deckman	1	....	....	....	....	....	....	....	....	....	....	....	1
Assayer	1	....	....	....	....	....	....	....	....	....	....	....	1
Pumpman	1	....	....	....	....	....	....	....	....	....	....	....	1
Hoistman	1	....	....	....	....	....	....	....	....	....	....	....	1
Sculler	....	....	....	....	1	....	....	....	....	....	....	....	1
Trackman	1	....	....	....	....	....	....	....	....	....	....	....	1
Totals	140	99	52	45	39	11	11	7	7	2	1	1	415

Falls of Ground

Only one man was killed from this cause during 1915, and in this case the deceased, an Austrian, had been warned by the man working on the opposite shift at the same part of the stope to keep away from the particular spot where the accident occurred. The shift boss, making his rounds, found the deceased, who was a blockholer, working under this bad ground and ordered him to stop drilling and to scale, but before he could remove his drill and hose the ground fell.

Shaft Accidents

Five men were killed in shaft accidents as compared with 10 in 1914. In the case of the Acme accident on April 9th the deceased, an Austrian, was leaning over the guard rail looking for the cage when he was struck. All guard rails at shaft openings on the Acme, Hollinger and Millerton properties are now set out from the shaft a distance of about 18 inches.

The accident at No. 20 winze in the O'Brien mine on February 23rd, when a timberman named Lennox was killed, was due to riding a bucket against orders and to an unsuitable hoist. The hoist was equipped with a foot brake. When Lennox got in the bucket the friction loosened and, before the hoistman could get to the hoist, the bucket dropped to the bottom of the winze.

A Roumanian drill helper, while riding the skip in an incline shaft at the Levack mine on July 15th, was caught by the station timbers and swept off the skip. Four men were on the skip, and the skiptender gave the signal to hoist while the shift boss was on the station. It appears therefore that the shift boss was not very strict regarding infringements of this provision of the Mining Act.

A Finn who was getting a bucket of water from the sump in the Mount Nickel shaft was struck by the descending skip and killed.

A mule driver on the level from the bottom of the incline shaft to the Dome mill was killed when a loaded car broke away at the top of the incline and, keeping the track, ran out on the level and struck the car being hauled away. The last was the only one of the shaft accidents not due to carelessness or an infringement of the Mining Act.

Accidents from Explosives

As in other years the percentage of fatal accidents due to explosives is higher than from any other cause, being 33.3 per cent. in 1915, 26.3 per cent. in 1914 and 31.1 per cent. in 1913. Seven men were killed in explosive accidents and 19 injured.

Two of the fatal accidents were directly due to infringements of the Mining Act. At the Craigmont mine on February 18th dynamite was being thawed beside the boiler in a building used as a blacksmith shop and boiler house when an explosion occurred, resulting in the death of the blacksmith's helper. The cause of the explosion of four boxes of dynamite in a temporary magazine at the Creighton mine is unknown, but the chute blaster in charge of this powder was known to be in the magazine with an open carbide lamp when the accident occurred.

In the Kerr Lake accident Eldridge, the mine surveyor, was piloting a visitor, Foote, through the mine when they walked into a blast. Both men were instantly killed.

Sauve, who was killed at the Nipissing, fell while going up into a raise shortly after blasting. He was probably overcome by gas, as he was on his way up to learn why the air was not blowing.

Three fatalities were due to unexploded powder in the bottom of holes; in two of these cases, the Worthington and Cobalt Comet, No. 6 detonators had been used. To ensure complete detonation No. 8 caps should be used, and it is unfortunate that any of the No. 6 are on the market.

Miscellaneous Accidents Underground

Five men were killed in accidents that come under this heading. These accidents occurred in the nickel mines of the Sudbury district, and all were in connection with the mining and handling of large tonnages; one through falling down an ore pass, one by being crushed between two ore cars and three by falling off benches. In connection with the accident at the Garson mine, the deceased had not a life line on as required by the rules of the company. His helper's life was saved by the observance of this precaution.

Surface Accidents

Four men were killed in surface accidents, including the fatality at Craigmont while thawing powder in the blacksmith shop which is included under the heading of explosive accidents. The practice of storing electrical supplies in the transformer house resulted in the death of an electrician at the Acme mine, and an exposed set screw in the pump house at the Temiskaming mine resulted in a fatal accident.

Prosecutions

Before Thos. M. Wilson, J.P., at South Porcupine on June 25th L. Mazzutto, an Italian foreman at the Dome mines, was fined $100 and costs for violating rule 98, sec. 164, of the Mining Act. Mazzutto's offence was that on June 15th he sent some men up in the skip without waiting for the skip tender to give the necessary signal.

Rules of Canadian Copper Company

At the mines of the Canadian Copper Company the following methods, as explained by Superintendent J. C. Nicholls, are required to be followed in dealing with winding ropes:—A daily examination of the winding ropes and attachments thereof, to the drums and to the cages, skips and other means of conveyance, the brakes and depth indicators, the cages, skips or other means of conveyance, and any safety catches attached thereto, and the pulley wheels and all and every external part of the winding arrangements, upon the ropes or working on which the safety of persons depend.

A monthly examination at least of the structure of the winding rope, with a view of ascertaining the amount of deterioration thereof. For the purpose of this examination the rope must be cleansed at places selected by the mechanical engineer, who notes any reduction in the circumference of and the proportion of wear in the ropes.

At least once in six months the winding rope is recapped, a portion thereof, not less than seven (7) feet in length, being at the same time cut off at the lower end.

The portion of the rope so cut off shall have ends adequately fastened with binding wire to prevent disturbance of the strands and shall be sent to a reputable testing laboratory and a certificate showing the result shall be furnished to the owner.

At the periodical recapping of the winding rope, the connection between the rope and the cage, skips, or other means of conveyance is annealed.

All new ropes purchased must be accompanied by a certificate from the manufacturer showing the amount of breaking load, as ascertained by actual test.

A winding rope newly put on and the connecting attachments between the rope and the cage, skips or other means of conveyance must be carefully examined by mechanical engineer, and must not be used for the ordinary transport of persons in any shaft or winze until after two complete trips up and down the working portion of such shaft or winze, the cage, skip or other means of conveyance attached thereto bearing its authorized load. The result of the above examination must be immediately recorded in a book.

In case of an overwind or skip or cage derailed, the ropes and all attachments are examined, and must not be used for raising or lowering persons until conveyance has been run at least two (2) complete trips up and down the working portion of the shaft.

No winding rope for raising and lowering persons shall be used when the breaking load at any point therein has become reduced to less than six times the maximum working load. The maximum working load shall include the weight of the rope in the shaft when the cage, skip or other means of conveyance is at the correct working point and the weight of such conveyance with its contained load.

During hard frost it has been found necessary to instal scraper, to prevent ice building up in groove of pulley wheels on headgear.

Signal System of Canadian Copper Co.

The aim in laying out a signal system for the mines was to get something which should combine safety and efficiency.

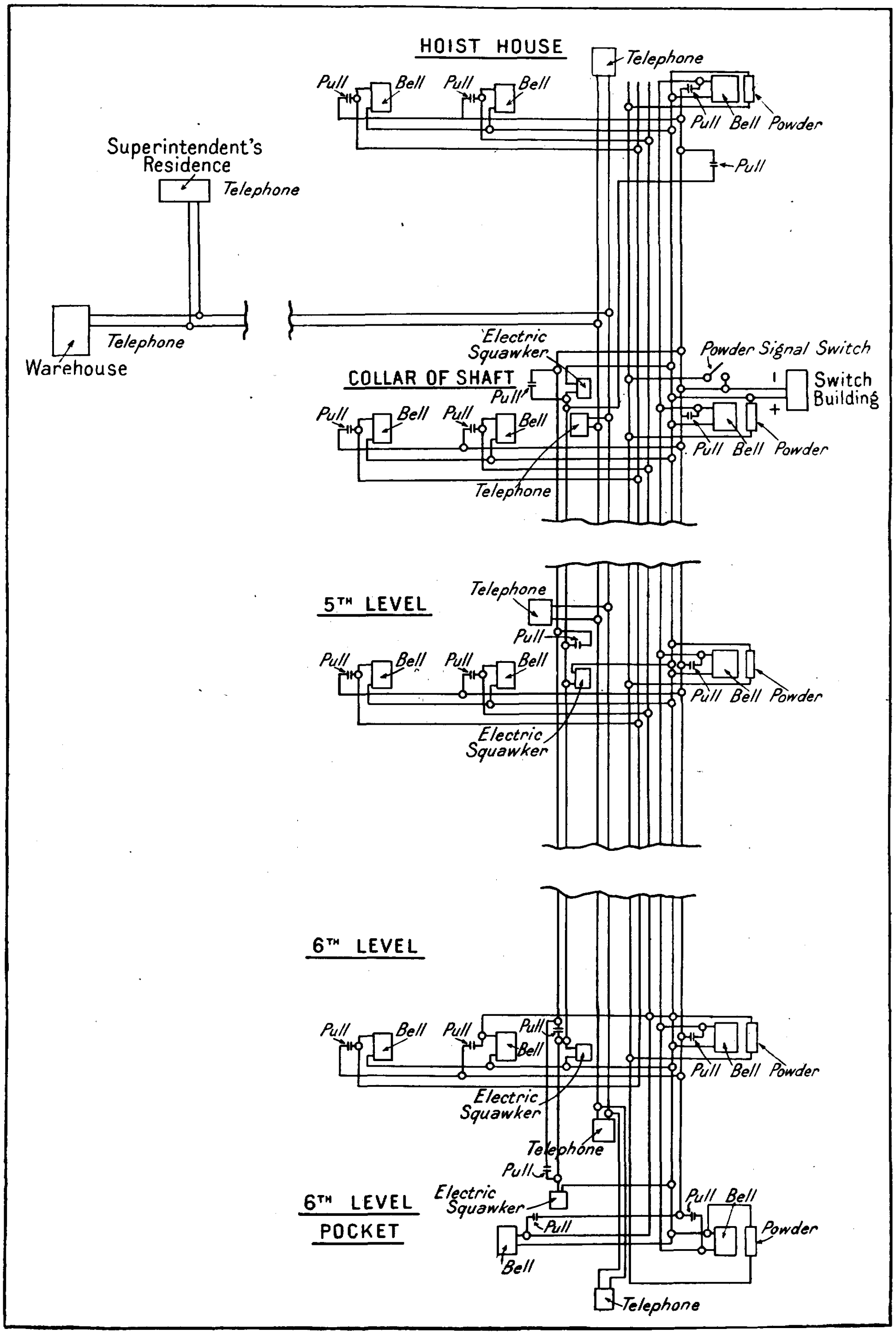
The code of signals adopted was started with the signals prescribed by the Mining Act, with the addition of other signals to meet our needs. In all auxiliary signals the one, two, or three bells were not used—these being kept solely for the use given in the Mining Act. Cases have been known where a repetition of the one, two, or three bell signals in level, or other auxiliary signals, has led to serious hoisting accidents.

The hoistman, after receiving signals to move men, waits for ten seconds before moving the cage. In case he is not able to move the hoist within one minute after receiving the signal he awaits a fresh signal.

The system is the return bell electric system. When a signal is given at any point, this rings signal bells for that compartment at the hoist, collar, and all stations. The bells for each compartment have different tones, so that it is easy to distinguish in which compartment signals are being given. When the hoistman receives a signal, he immediately repeats it, so that the man giving the original signal knows if his signal is received correctly, and he has then time to give a correcting signal if not correctly answered. In hoisting men three distinct signals are given: First, the three bells, indicating men to be moved; second, the signal for the level to which the cage is to be moved; and third, the one or two bell signal, signifying that the cage is to be moved. The hoistman repeats each of these three sets of signals, so that there is no chance of a misunderstanding. It would appear that the code of signals means a large number of bells being rung and might be confusing, but this is not a fact, as the men soon get used to it. Also as a quick ringing bell is part of the system, the time consumed is not noticeable.

When explosives are being sent into the mine, the powderman closes the powder signal switch, which throws on a red light at the hoist in the engine room, shaft collar and all levels.

In addition to the bells there is a buzzer at each level and the collar of the shaft. This does not signal the hoistman but is used as a call for the cage. This signal



Signal System, No. 2 Shaft, Creighton Mine.

when heard at any level indicates to the cage tender, the level at which the cage is wanted. This buzzer having a distinct tone is not confused with the bell signals.

Also there is a telephone system connecting all levels, the hoist house, the collar and thence to various offices on the surface.

Near the collar of the shaft is located a brick junction house where all cables leading into the mine are led through switches, so that any circuit can be cut off.

The cable used for signalling has twelve conductors of No. 10 wire, rubber-covered, taped, jute-wound, lead-sheathed, steel-wire wound and weather-proofed. At each level this is led into a water-tight junction box for distribution to the various signals at that level. The distribution from the junction box to the signals is usually by means of weather-proof wire led into conduit.

The pulls are specially designed and are waterproof. The bells are single stroke, the striking hammer being a soft iron plunger set loosely in a solenoid. The current used to operate the bell is alternating current of 110 volts and a frequency of 25 cycles. The single stroke bell admits of fast signalling, and there is less chance of confusion than there would be with a vibrating bell.

During the time that this system has been in use, there have been no accidents due to signalling, and very few delays attributable to the derangement of the system.

Accidents at Metallurgical Works and Quarries

The metallurgical works which come under the Mining Act of Ontario include blast furnaces, copper-nickel smelters and converter plants, silver smelters and acid plants.

At these works during 1915, there were 71 accidents which were reported to this department, only one of which was fatal. In the preceding year five men were killed and 101 injured.

The fatal accident occurred in the roast yards of the Mond Nickel Company at Coniston. An Italian labourer was killed while riding on the locomotive crane.

Eleven accidents were reported from the quarries during the year, none of which were fatal.

The following schedule shows the cause of the non-fatal accidents in 1915, at the metallurgical works, and the number injured:—

Burned	13
Falling objects	7
Falling from elevated places	5
Slipped and fell	7
Caught by machinery	11
Injured by cars	11
Crushed between two objects	4
Cut by slag, matte, etc.	5
Struck by hammer	1
Foreign substance in eye	2
Miscellaneous	4
Total	70

In the subjoined table is given the occupation and nationality of the men injured in metallurgical works.

Occupation.	English-speaking.	Italian.	Russian.	Austrian.	Belgian.	Finn.	Swede.	Hungarian.	Roumanian.	Total.
Stove tender	1	......	......	......	......	......	......	......	......	1
Engineer	1	......	......	......	......	......	......	......	......	1
Furnace keeper	......	1	......	......	......	......	......	1	......	2
Labourer	5	13	......	10	......	......	......	1	1	30
Mechanic	7	......	......	......	1	......	......	......	......	8
Fireman	......	1	......	......	......	......	......	......	......	1
Railway conductor	1	......	......	......	......	......	......	......	......	1
Baleman	......	1	......	3	......	......	......	......	......	4
Brakeman	3	......	......	......	......	......	......	......	......	3
Tapper	......	......	1	1	......	......	......	......	......	2
Carpenter	6	......	......	......	......	......	......	......	......	6
Electrician	1	......	......	......	......	......	......	......	......	1
Teamster	......	......	......	......	......	1	......	......	......	1
Nitric runner	1	......	......	......	......	......	......	......	......	1
Ladle liner	......	1	......	......	......	......	1	......	......	2
Hooker-on	1	......	......	......	......	......	......	......	......	1
Chute man	1	......	......	......	......	......	......	......	......	1
Scrapper	......	1	......	......	......	......	......	......	......	1
Skimmer	2	......	......	......	......	......	......	......	......	2
Converterman	1	......	......	......	......	......	......	......	......	1
Total	31	18	1	14	1	1	1	2	1	70

Table of Fatal Accidents in

Number.	Date 1915	Name of Mine.	Name of Owner.	Name of Deceased.	Occupation of Deceased.
1	April 9	Acme	Acme Gold Mines, Ltd.	G. Buklajczruk	Trammer
2	" 23	do	do do	H. Lyne	Electrician
3	Aug. 19	Creighton	Canadian Copper Co.	W. Cristoff	Trammer
4	" 20	No. 2	do do	P. L. Walker	Drill helper
5	Sept. 3	Creighton	do do	N. Vartiniuk	Chute blaster
6	Oct. 12	do	do do	M. McCarthy	Blockholer
7	" 12	do	do do	B. Benbentento	Trammer
8	" 14	do	do do	H. Romanka	Blockholer
9	Dec. 16	Crean Hill	do do	P. Stasiuk	Drill helper
10	April 21	Drummond	Cobalt Comet Mines, Ltd	C. Peterson	Drill runner
11	Dec. 20	do	do do	M. McFarland	Foreman
12	Sept. 25	Dome	Dome Mines Co.	A. Maurice	Mule driver
13	June 25	Kerr Lake	Kerr Lake Mining Co.	W. Eldredge	Surveyor
14	Feb. 18	Craigmont	Manufacturers Corundum Co.	M. Cannon	Blacksmith
15	July 15	Levack	Mond Nickel Co.	G. Policiuk	Drill helper
16	Sept. 8	Garson	do do	G. Parolin	Drill runner
17	Nov. 6	Worthington	do do	G. Zakula	Drill runner
18	Feb. 18	Nipissing	Nipissing Mining Co.	E. Sauve	Drill runner
19	" 23	O'Brien	M. J. O'Brien	W. Lennox	Timberman
20	July 15	Mount Nickel	Sudbury Leasing & Development Co.	H. Poutanen	Drill helper
21	Aug. 4	Temiskaming	Temiskaming Mining Co.	H. Savage	Pumpman

Table of Fatal Accidents

Number.	Date of Accident.	Name of Works.	Name of Owner.	Name of Deceased.	Occupation of Deceased.
1	April 2	Roast yards	Mond Nickel Co.	G. Trocatto	Labourer

or about the Mines, 1915.

Nationality of Deceased.	Age.	Married or single.	Below ground.	Above ground.	Cause of Accident.
Austrian	48	M	1	......	Leaned over guard rail to look for cage and was struck by descending cage.
English-speaking	28	S	.....	1	Electrocuted in transformer house.
Bulgarian	33	M	1	......	Crushed between two cars and bowel ruptured. Died August 22nd.
English-speaking	24	M	1	......	Fell from bench into stope. Died Aug 21st.
Austrian	20	S	1	......	In underground magazine with lighted carbide lamp when explosion occurred.
English-speaking	37	S	1	......	Drilled into explosive, while blockholing in stope.
Italian	26	S	1	......	Fell down ore pass with timber truck.
Austrian	20	S	1	......	Fall of ground in stope.
Austrian	21	S	1	......	Fell off bench into stope.
Finn	49	M	.....	1	Struck by slide of surface material.
English-speaking	49	M	1	......	While sampling, pick struck explosive.
English-speaking	23	M	1	......	Loaded car broke away at top of incline.
English-speaking	28	S	1	......	Walked into blast.
English-speaking	57	M	.....	1	Thawing powder beside boiler in blacksmith shed.
Roumanian	21	S	1	......	Riding skip with material.
Italian	30	S	1	......	Drilling bench, fell into stope. Deceased had not life line on.
Austrian	31	M	1	......	Drilled into explosive.
English-speaking	34	M	1	......	Overcome by gas in raise, and fell.
English-speaking	42	M	1	......	Got on bucket when hoistman was away from hoist, friction loosened and bucket dropped to bottom of shaft.
Finn	24	M	1	......	Struck by skip while in sump for water. Died July 21st.
English-speaking	20	S	.....	1	Caught by setscrew and drawn into gears of pump.

at Metallurgical Works, 1915.

Nationality of Deceased.	Age.	Married or single.	Nature and Cause of Accident.
Italian	20	S	Crushed while riding on locomotive crane.

MINES OF ONTARIO

Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, E. A. Collins, Kingston; J. G. McMillan, Cobalt; Jas. Bartlett, Sudbury.

I.—NORTHWESTERN ONTARIO

Bannerman and Horne Quarries.—Messrs. R. C. Bannerman and Wm. Horne of 126 Polson Avenue, Winnipeg, did not work their quarry at Ignace in 1915, but opened up another granite quarry at Butler, a few miles west of Ignace. They employed ten men part of the summer cutting paving blocks. The owners report that the granite in this new quarry is particularly adapted for paving and building purposes.

Big Master, Jubilee and Laurentian.—The Dominion Reduction Company of Cobalt unwatered the above-mentioned mines in the Wabigoon locality in January, 1916, and completed sampling in the following month. It is understood that the results of the examination were unsatisfactory and that the options were relinquished.

Cameron Island Mine.—The Cameron Island Syndicate, Limited, started work on June 1st, 1915, at the mine situated on Cameron Island (Island S. 170) near the centre of Shoal Lake, District of Kenora. This property has been idle since July, 1912. At the time of inspection (Oct. 11, 1915), the mine was unwatered but no underground work was being done, the thirteen men employed all being engaged in remodelling the mill.

The mine has a 7 foot by 12 foot shaft, 132 feet deep with an inclination of approximately 80 degrees. Levels have been driven at 62 feet and 127 feet. On the first level 32 feet of drifting has been done to the north and 48 feet to the south of the shaft. On the second level a 268 foot drift extends to the south and 140 feet of crosscutting has been done from it. Above this drift a small stope has been worked to a height of 20 feet. On the east side of the island an adit has been driven due west 64 feet.

The ten stamps and two Frue vanners which the mill formerly contained have been discarded and the machinery arranged as described below. A brick obtained from a trial run of 5 tons gave, when refined, $47.81 in gold and over 6 ounces of silver. The ore is fed through a Farrell jaw crusher with an opening about 7 inches by 10 inches. From this it passes to two Forsythe pulverizers. A bucket elevator then carries the material to a cylindrical 40-mesh wire screen, 18 feet in diameter by 12 feet long. Oversize from this screen returns to No. 2 pulverizer. The undersize passes through a bin to a rotary roasting kiln placed outside the mill. The kiln discharges the roasted material to a cement floor, where water is added and the whole elevated by a maple screw conveyor to a circular wooden tank fitted with a revolving rake. Thence it passes over two amalgamating plates. It is intended to put in Wilfley tables to concentrate the tailings from these plates.

The power plant consists of an 80-h.p. r.t. boiler, with a 35-h.p. locomotive type in reserve, a 360 c.f. Ingersoll-Sergeant air compressor, a 12-h.p. engine to drive the rotary kiln, and a 50-h.p. Corliss engine to drive the remainder of the mill machinery.

The head office is at Hamilton, Ont.; mine office address is Cameron Island, P.O., via Kenora, Ont. The officials of the company are:—

President and Managing Director—Donald M. Cameron, Hamilton.
Vice-President—J. G. Palmer, Toronto.
Secretary-Treasurer—Mrs. Lucy O. Cameron, Hamilton.
Directors—Frank Grew, Toronto.
Alfred Rolph, Toronto.
Dr. J. M. Jury, St. Catherines.

Donald M. Cameron is in charge of the work on the property.

Hewitson and Johnston Claims.—These claims are situated about four miles west of Mine Centre and about half a mile from the track of the Canadian Northern Railway. The claims were located on June 5th, 1916, and by August 5th two cars of copper ore, said to be run about eight per cent. copper, had been shipped to the Trail Smelter, B.C.

The ore body is said to be 75 ft. wide and has been exposed over a length of 340 feet. It occurs in a schist formation. Since first located a party of six men have been working on the property mining out the pockets of high grade ore.

Intercities Quarries.—The trap quarry at Port Arthur owned by the Intercities Quarries Company, Limited, was not worked in 1915.

Mather and Beveridge Soapstone Claims.—Shipments of soapstone were made in 1915 from a deposit on an unpatented mining claim owned by Mather and Beveridge, and situated on Pipestone portage, near Pipestone bay, Lake of the Woods. The material was shipped to the Dryden Timber and Power Co., Dryden, Ont., for lining soda-smelting furnaces. It is used in blocks 18 inches by 12 inches by 8 inches.

Northern Pyrites Mine.—The Northern Pyrites Company, controlled by the General Chemical Company of New York, worked the pyrites mine at Northpines, Ont., to capacity in 1915 and shipped approximately 95,000 tons—a larger quantity than in any previous year. In order to take advantage of the remarkable demand for pyrites, energy was concentrated on increased production with the existing equipment. Consequently the greater part of the proposed programme of alterations outlined in the 24th Annual Report of the Bureau of Mines was deferred until the close of navigation in 1915. Active construction was then begun.

A new power and engine-house is now being built of steel and hollow tile. This measures 46 feet, by 124 feet and will contain the following machinery:—

Two Ingersoll-Rand, cross-compound air compressors, Class R.R. 3, with cylinders 20 inches and 20 inches by 18 inches. Each is to have a capacity of 1046 c.f. of free air per minute at 160 r.p.m.

One Corliss tandem engine, 150-h.p., with cylinders 22 inches and 12 inches by 42 inches.

A battery of five return tubular boilers—four 100-h.p. and one 125-h.p. These will be fitted with Dutch oven furnaces. Forced draught, furnished by turbo-blowers, will be used to burn 75 per cent. anthracite screenings and 25 per cent. bituminous coal.

The mine is served by two shafts:—No. 1, 242 feet deep, is vertical for 145 feet and at 60 degrees for the remainder of the distance; it is used only for handling steel and timber. No. 2 shaft is 376 feet deep and is inclined at 59 degrees for the first 320 feet and at 55 degrees for the remaining 56 feet. No. 2 is the main working shaft and from it four levels have been opened at 68, 130, 240 and 340 feet respectively.

The orebody has proved to be from 30 to 70 feet in width and is worked by a shrinkage method in stopes 100 to 150 feet long; 30-foot pillars are left between stopes. Above the first level no stoping has been done. On the second level three stopes west of the shaft have been exhausted and three others are now being worked. East of the shaft five have been opened. On the third level west of the shaft two stopes are worked out and two are being worked, while east of the shaft one stope is being mined and four are being developed. On the fourth level drifting has been done to 162 feet east and 164 feet west of the shaft.

H. V. Smythe is superintendent. About 135 men are employed.

Olympia Mine.—The Olympia gold mine is situated on Claim M. 11, on Helldiver bay, Shoal lake, District of Kenora. The mine is owned by the Olympia Gold Mining Co., Limited. The mill was started on June 23, 1915, and was expected to close down about the end of October.

There are five prospect shafts on the property—110, 75, 70, 32 and 25 feet deep. Three tunnels also have been driven—one near the mill is 125 feet long and connected with the 70-foot shaft; the second is 40 feet long; the third measures 460 feet and stoping has been carried to surface in two places, one connection being near the inside end. At the time of inspection stoping by means of hand-drills was in progress in the last-mentioned tunnel.

The mill contains a 7 inch by 10 inch Blake crusher, 5 Allis-Chalmers stamps, 5 Jenckes stamps, amalgamating plates and two locomotive type boilers, 35 and 60 h.p. The officers of the company are:—President and treasurer, Franklin Floete, Spencer, Iowa; secretary and manager, George H. Vernon, St. Paul, Minn.; foreman, Emil Hubner, Kenora. The head office is at 973 Hague Ave., St. Paul, Minn. Seven men are employed.

St. Anthony Mine.—The Kerr Lake Mining Company of Cobalt sampled the St. Anthony mine on Sturgeon lake during the summer of 1915 and began work under an option in October.

The mine can now be reached by taking the canoe route from Wako, on the Fort William-Graham branch of the G.T.P. Ry., or by taking a four-mile road south from Bucke station, on the National Transcontinental Railway, to Trapper's Cabin. The latter point is on the north bay of Sturgeon lake and is nine miles from the mine.

The mine has been described in previous reports of the Bureau of Mines.

M. C. H. Little is superintendent and Duncan McPhail mine foreman.

II.—SUDBURY, NORTH SHORE AND MICHIPICOTEN

Algoma Steel Corporation

Helen.—The Helen mine of the Algoma Steel Corporation was worked continuously in 1915. During the year the shipments were as follows:—93,356 tons of hematite, about 7,000 tons of pyrite concentrates, and 38,000 tons of hematite tailings. The hematite came from the 6th, 7th and 8th levels. On the 6th level a body of pyrite was developed at the eastern end of the mine. The Wilfley table plant was started on June 1st on the concentration of this pyrite. The hematite tailings, which were shipped to Sault Ste. Marie, Ont., to be roasted by the Greenawalt process, came from a wash-plant operated at this mine a few years ago. They averaged 58 per cent. iron and 2½ per cent. sulphur.

One hundred and twenty-five men are employed under superintendent G. R. McLaren.

Magpie.—The Magpie mine and roasting plant of the Algoma Steel Corporation were started up on May 16th, 1915. Both had been closed down since Oct. 31st, 1914, on account of conditions due to the war. The production of roasted siderite for the year 1915 amounted to 129,722 tons.

On the second level all of the stopes are now developed. On the third level the orebody has been drifted on for a distance of 180 feet east and 180 feet west of the station.

A. Hasselbring is general superintendent; John M. Knote, roast plant superintendent; and Roland Irwin, mine captain. About 225 men are employed; of these 11 are in the roast plant and coal-grinding departments.

Canadian Copper Company

Mines operated by the Canadian Copper Company shipped 940,338 tons of nickel-copper ore to the Copper Cliff smelter in 1915. This ore came from the Creighton, Crean Hill, No. 2 and Vermilion mines, and is by far the largest production in the history of the company.

The officials of the company are:—

President, A. D. Miles.
General Superintendent, J. L. Agnew.
Superintendent of Mines, J. C. Nichols.
Assistant Superintendent of Mines, J. P. Hussey.
Chief Engineer, E. H. Jones.
Chief Metallurgist, J. W. Rawlins.
Safety Engineer, E. T. Corkill.

Canadian Copper Company Smelter.—At the beginning of 1915 only four out of the six furnaces at the Copper Cliff Smelter were in operation. A fifth was started on January 10th, and the sixth on February 8th. In August a new furnace, No. 7, was blown in. This furnace is deeper than the old one and is 25 ft. 6 inches by 50 inches. The older furnaces are now being made 3 feet 6 inches deeper and the settlers lowered to conform with this alteration. There were 865,169 tons of ore smelted in 1915. All smelter employees are now on an eight-hour basis. W. Kent is smelter superintendent.

Crean Hill.—The Crean Hill mine of the Canadian Copper Company, which was closed in August, 1914, was started again in February, 1915. Shipments for 1915 amounted to 104,550 tons of ore. This came from the sides of the open-pit above the second level, from the 5th and 7th level floors, which were removed, and from the 8th level stope.

The shaft is now 915 feet deep. It is being made of 4-compartment size throughout. Formerly it consisted of four compartments to the 6th level and three below this point. The 9th level has been opened at 900 feet.

A new transformer house has been completed.

About 180 men were employed during the year under superintendent Charles Collins.

Creighton.—In 1915 the Creighton mine was worked continuously and produced the largest tonnage in its history—the shipments for the year amounting to 778,976 tons.

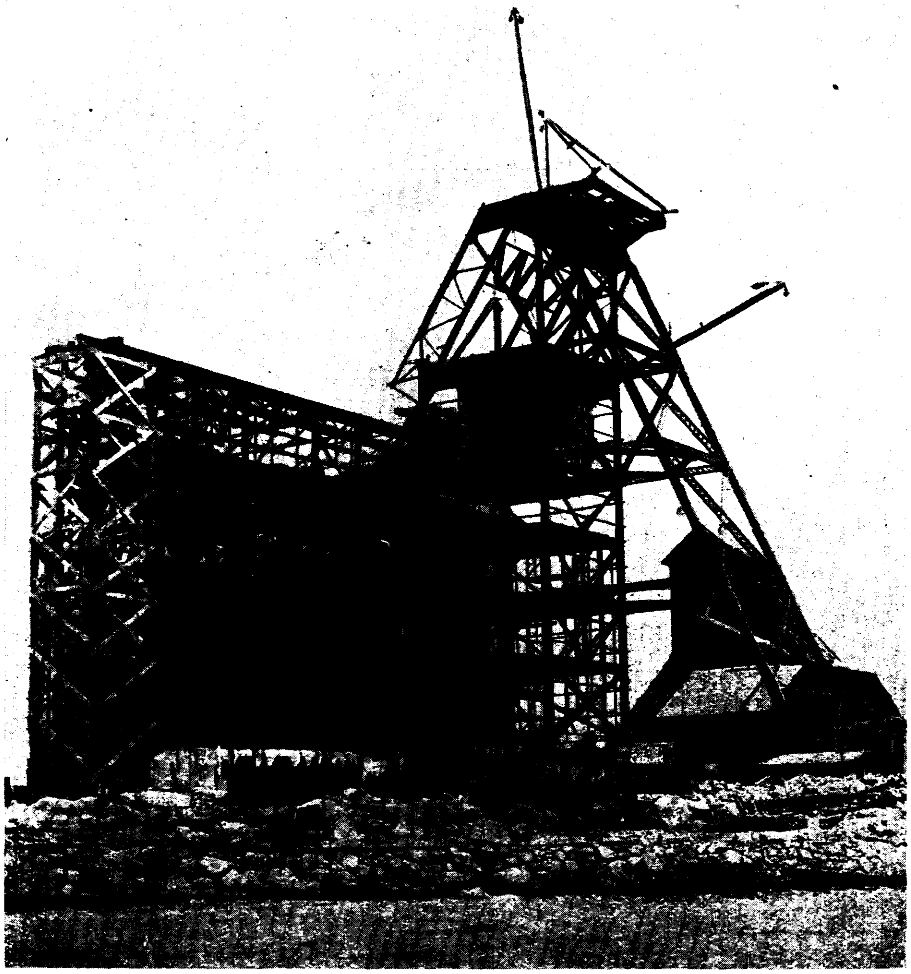
Below the 10th level of No. 2 shaft a Farrell jaw crusher, 32-inch by 42-inch, is being placed. The arrangement will be similar to that on the 6th level of this shaft, which was described in the 24th Annual Report of the Bureau of Mines.

The new five-compartment shaft, known as "No. 3," is being sunk in the footwall 145 feet west of No. 2 shaft. It is being driven at an angle of 55 degrees and on April 14th, 1916, was 1,275 feet deep. It measures 8 feet by 33 feet and contains a manway, two skip compartments and two compartments for handling men and material. The shaft is concreted for a distance of 40 feet below the collar. The skip-track consists of 85-pound rails resting on the wall-plates, which in turn are supported on concrete piers at 7½-foot centres. Four stations have been cut—the 6th, 8th, 10th and 14th. The first three correspond with similarly numbered levels from No. 2 shaft. These main levels are 150 feet apart, measuring along the incline. Intermediate levels are to be driven half-way between these main levels and will be numbered 7, 9, 11 and 13.

On the 6th and 10th levels 4½ and 5-ton storage battery locomotives are now in use. Each locomotive hauls four 56-c.f. side-dumping steel cars, which are automatically dumped at the crushers.

A new magazine has been built by driving an adit into a hill about 1,200 feet west of the main shaft. Near the face of this adit a chamber 27 feet by 50 feet by 9 feet high was excavated. At the face itself a raise with an offset or jog about midway was driven to surface a distance of 45 feet. At this offset a bulkhead extends part way across the raise to catch anything that may fall down. The top of the raise is fitted with two 18-inch elbows and a flanged length of pipe embedded in concrete. The pipe-opening is covered with a screen. The magazine chamber is equipped with bulkheads and floored with two inch by 12 inch lumber resting on 4 inch by 4 inch. All nails are well countersunk and ample provision is made for drainage. The magazine has a capacity of 2,026 boxes of explosive. Near the portal a lateral drift leads to a second chamber, 18 feet by 26 feet by 8 feet high, where a thawing-room is being equipped. The latter will have a capacity of 150 boxes.

A Nordberg double-drum hoist is now in use at the No. 2 Creighton shaft for handling ore. The drums are 7 feet 0 inches diameter and 4 feet 0 inches face, grooved for 1⅛-inch rope. The hoist is equipped with parallel motion post brakes operated by oil thrust cylinders. The hoisting speed is 1,100 feet per minute with



New shaft and rock house under construction, Creighton mine.

a 5-ton load of ore. It is driven by a 350-h.p., 480-r.p.m., 25-cycle motor with limit switches positively geared to each drum. The main gears are of the Wuerst herringbone type. It is proposed to use this hoist for handling the man-cage in the No. 3 Creighton shaft when the permanent installation is made.

A great deal of construction work has been done during the past year and the following new buildings are now completed: Seventy-five dwellings, five boarding-houses, a mechanical shop built of brick and divided as follows—carpenter shop 40 feet by 40 feet, electrical shop 40 feet by 40 feet, machine shop 70 feet by 40 feet, and blacksmith shop 90 feet by 40 feet. No. 3 shafthouse, brick, 80 feet by 60 feet; main warehouse, brick, 100 feet by 40 feet; storage plant, 80 feet by 40 feet; pipe and steel rack, 60 feet by 40 feet.

The average number of men employed at this mine in 1915 was 1,125. In

Completed shaft and rock house, Creighton mine.

December the employees numbered 1,450, and of these 1,017 were underground workmen. Charles Miller is superintendent.

Dill Quartz Quarry.—The Canadian Copper Company worked the quartz quarry in Dill township during six months of 1915. The average working force during the period was 45 men. H. Whitehead, Quartz., Ont., is superintendent.

No. 2 Mine.—No. 2 mine of the Canadian Copper Company was reopened on February 8th, 1915, and 55,923 tons of ore were shipped during the year. This came from stopes above the 8th, 9th, 10th and 11th levels, and from the 6th level floor which was broken down.

At a point on the 11th level, 300 feet westerly from the bottom of the winze which connects this level with the 8th, a winze has been sunk. The latter has a dip of 45 degrees and is 140 feet deep. Diamond drilling is being done from the bottom of this new winze to locate the lower part of the orebody which is believed to have been displaced by faulting. W. J. Hambly is superintendent. About 100 men are employed.

Vermilion Mine.—The Vermilion mine was worked during all of 1915 by the Canadian Copper Company. Shipments during the year totalled 889 tons. The ore in this deposit is said to contain considerable platinum and palladium as well as nickel and copper.

A two-compartment shaft has been sunk to a depth of 150 feet and levels opened at 75 and 150 feet. Stoping has been carried on above the first level to the northwest and southeast of the shaft. On the second level drifting has been carried on to 53 feet northwest and 92 feet southeast of the shaft. Some cross-cutting has also been done on this level. The orebody has so far proved to be very irregular in form.

The average number of men employed at this property was 25. Charles Collins, of Crean Hill, is superintendent.

Mond Nickel Company

From the five mines of the Mond Nickel Company, in the Sudbury field, 376,602 tons of nickel-copper ore were shipped to the Coniston smelter. A small quantity of siliceous copper ore was also produced from the old Bruce Mines, which are now the property of this company.

Two furnaces were in blast at Coniston until May, 1915, when the third was started, and the three were kept running for the remainder of the year.

The Canadian officials of the company are:—Manager, C. V. Corless; mines superintendent, Oliver Hall, and smelter superintendent, J. F. Robertson.

Bruce Mines.—The Bruce Mines were purchased by the Mond Nickel Company from Messrs. Leonard and Longwell in the summer of 1915. The Taylor shaft (now called "No. 2 Mine"), 65 feet deep, was unwatered in July and drifting was started both northwest and southeast of the shaft at this depth. This shaft is not timbered save for a division between the ladderway and hoisting compartments. The northwest drift was stopped 220 feet from the shaft and the south-east 320 feet. The ore on the west side was stoped out and stoping was begun on the east side. The shaft is to be sunk 100 feet deeper.

At the old No. 4 shaft (now known as "No. 1 Mine"), pumping was started in September. The mine was finally unwatered to the 4th level by the end of November, between thirty and forty million gallons having been handled. This shaft is divided into three compartments and extends to the 4th level, a depth of

327 feet. On the 4th level a drift connects with old No. 2 shaft some 900 feet northerly. Considerable ore is blocked out above this connecting drift. Above the third level, which is at 262 feet, some ore remains on the south side. The north side has been stoped. There were formerly two levels above the third, but this ground also has been stoped.

West of this No. 1 or main vein lies a second parallel vein at a distance of 60 feet. The latter was known as the "Fire lode," or No. 2 vein. It has not been worked since 1878, and but little is known about it. It was connected to the main vein by crosscuts on the first and second levels and apparently has been stoped out to the second level. About 100 feet of drifting was done on this vein on the third level but no ore was encountered.

The necessary mine buildings have been completed near the No. 4 shaft. The machinery includes the following:—

One 300-h.p. Heine tubular boiler.
One 80-h.p. locomotive type boiler.
One 1,000 c.f. cross-compound Rand compressor.
One 600 c.f. straight-line Ingersoll compressor.
One double-drum Jenckes hoist, 12 inches by 18 inches.
One small electric light plant.

Stoping is done with Waugh stopers and drifting with No. 43 Rands. The ore is shipped to Coniston smelter where it is used as converter flux. It consists of chalcopyrite in a white quartz gaugue and contains about 85 per cent. free silica; 1,961 tons of ore were shipped in 1915.

J. H. Stovel was superintendent until March, 1915, when he resigned and was succeeded by A. D. Carmichael. About 75 men are employed.

Garson Mine.—The Garson mine is still the principal producer of the Mond Nickel Company. Ore shipments in 1915 amounted to 193,562 tons. The ore was obtained from the first, second, third, fourth and sixth levels. Most of the floors between the first and second levels were removed and the first level is now worked out except for one small stope.

The orebody between the fourth and sixth levels is being developed. The drifts on the sixth level have been widened to give room for double tracks and preparations made to handle a heavy tonnage, as the orebodies between the fourth and sixth are much larger than on the upper levels. Two-ton cars will be used. These will dump on a grizzly above a raise leading to measuring pockets on the seventh level. A new blacksmith shop, a club house and a combined office and warehouse were completed during the year. About 375 men were employed under Superintendent A. L. Sharpe.

Kirkwood.—The Kirkwood mine of the Mond Nickel Company worked until the latter part of December, 1915, when the machinery was removed. The shaft on the main ore body was sunk to a depth of 210 feet and timbered to 130 feet. The ore produced from this deposit during the year came from a stope west of the shaft on the 210-foot level and east of the shaft on the 130-foot level. East of the shaft on the lower level no ore was found. A small tonnage was obtained from two other ore bodies. One of these, situated some 600 feet west of the main shaft, was worked to a depth of 110 feet. The second, situated about 500 feet east of the main shaft, was worked to a depth of 50 feet. The ore shipped during 1915 amounted to 38,448 tons. Superintendent J. R. Thoenen had seventy men employed.

Levack Mine.—The developing of the Levack mine was carried on actively in 1915. The five-compartment shaft is now 433 feet deep on the slope. Levels have been opened at 150, 250 and 350 feet vertical depths. Winzes have been sunk from the first to the second level and one raise has been completed from the third to the second level. On the second level drifts have been driven through the centre of the orebody.

On the third level the orebody is larger than on the upper levels, and the following system of development is being followed:—The stopes are planned to be 100 feet long and separated by 40-foot pillars. A drift is run through the centre of the orebody and two crosscuts at right angles to this drift are driven below each stope. The millholes are cut on each side of these crosscuts. The ore from these millholes will be shovelled from wooden platforms into the mine cars. One crosscut also is cut in each pillar. After the outlines of the orebody on the level have been determined by drifting and crosscutting a main haulage drift will be driven in the footwall and connected with all the crosscuts. As the orebody dips at 45 degrees raises will be driven from the main haulage drift to the stope above and these will be used for removing the ore from the upper part of the stope. Raises will also be carried in the centre of every second pillar and will be used as manways and pipeways, connections being made with the stope as required. The ore will be trammed in two-ton cars to a chute leading to a loading pocket below the third level.

A total of 31,755 tons of ore was shipped during the year. This came from two underhand stopes below the first level and from general development work.

The rockhouse was completed and put in operation during the year. It has one feature in which it differs from the other rock houses in the district, viz., the ore from the skips, after passing over a grizzly into a storage bin is fed to the crushers by a pan-conveyor belt. Approximately 30 per cent. of the rock is picked off this belt. After crushing the ore passes through the usual trommels to rubber picking belts, from which the remainder of the rock is picked. The coarse rock is sold to the C.P. Railway for track ballast.

The following buildings of metallic lath and cement plaster construction were completed during 1915:

Office and warehouse	78′ x 33′.
Change house	97′ x 46′.
Machine shop	73′ x 31′.
Round house	72′ x 20′.

The heating plant was equipped by the Taylor-Forbes Company and contains two heating boilers.

Two wooden buildings, a carpenter shop, and a carbide house were completed. In the village one boarding-house, two residences, and fourteen cottages were added.

F. L. Eager, Levack, Ont., is superintendent. About 225 men were employed.

Victoria Mine.—At the Victoria mine of the Mond Nickel Company work continued on both orebodies, and 58,248 tons were shipped.

The shaft was 2,530 feet deep on April 20, 1916, and will be continued to 2,600 feet. The 16th level station was cut at 2,312.

The eastern orebody is now being removed by underhand stoping below the 11th level, and good ore is being obtained. This orebody has not yet been found on the 12th level, but it is now thought that the 12th level crosscut is too far to the south and that further exploration will locate the deposit.

The western orebody is being worked on the 14th and 15th levels. A winze is being sunk below the 15th level to meet a raise from the 16th.

The new Nordberg hoist was put in operation during 1915. It has two drums each 10 feet in diameter and 6 feet 6 inches wide, grooved for 1¼-inch rope. It is driven through herringbone gears by a 470-h.p. motor made by the Siemens Electric Co. of England. The hoist is equipped with the Welch safety device whereby the brakes are automatically applied in case of either overspeeding or overwinding. W. J. Mumford, Mond, Ont., is superintendent.

Worthington.—Shipments from the Worthington mine of the Mond Nickel Company in 1915 totalled 54,589 tons. Of this amount 6,750 tons came from the No. 2 deposit, which was closed down on August 31st, 1915. The main shaft is now (April, 1916) 618 feet deep on the slope. For the first 388 feet it dips at 61 degrees; from this point to 450 feet it is curved to 80 degrees, and below 450 feet it has been sunk at the latter angle. Sinking is still in progress.

On the first level the east drift has been extended to 591 feet east of the shaft and a second ore-shoot opened up. On the second level the east drift is now 525 feet from the station. The third level has been opened at 445 feet vertical depth and drifting done to 245 feet east and 188 feet west of the shaft.

As the ore body on the third level is wider than on the upper levels the method of development has been modified. The main drift runs through the orebody with alternating right and left crosscuts. Raises are put up from the crosscuts and shovelling platforms of the height of the mine cars are built at the bottom of these raises. The stope is then undercut 21 feet above the main level floor instead of on the level as elsewhere in the mine. The crosscuts are placed so as to bring the raises at 30-foot centres. The stope varies from 20 to 50 feet in width. Two-ton cars are used dumping directly into the skips.

The rock-house was burned down on June 25th. A new one, with timber frame and concrete and metallic lath siding, was completed and put in operation on September 15th. The crushing and sorting arrangements are now as follows:—

The skips dump into small bins with grizzly bottoms. These bins feed small dumping tables where the coarse rock is picked out. The ore goes to crusher No. 1 and is fed to two 3-stage bumping tables actuated by belt-driven cams. The ore is picked off and the rock falls upon belt conveyor No. 1 which feeds same to fine rock-crusher No. 3. The coarse rock is fed into crusher No. 2 and passes to a one-stage bumping table, where any ore is picked out and the rock falls upon belt conveyor No. 1 and thence goes to fine rock crusher No. 3. The product from No. 3 crusher is sold to the C.P.R. for track ballast. All crushers are 18 inch by 24 inch Hadfields jaw crushers.

The following construction work was also completed: A brick combined office and warehouse, brick mechanical shop, a pump house containing an eletrically-driven fire-pump, a 30-foot addition to the change house, three new dwellings and a central heating plant. The latter was equipped by the Taylor-Forbes Company and contains two small heating boilers sunk below the ground level. It is a hot-water return-system operating at 5-pound pressure.

R. N. Palmer is superintendent, and 265 men are employed.

Other Nickel Properties

Howland.—The Howland nickel prospect was worked under lease by A. D. Carmichael of Worthington, Ont., during the latter half of 1915. The property is situated in the north half of lot 1, concession II., Drury township, and lies near the Worthington. It is owned by the Canadian Nickel Company of which H. M. Mowat, K.C., Toronto, is president.

Three hundred and seventy-five tons of nickel ore were shipped to the Coniston smelter. This was extracted from an open cut which was carried to a depth of 35 feet. The lessee built a small head frame and provided a boiler and hoist.

Mount Nickel.—The Sudbury Leasing and Development Company, Limited, operated the Mount Nickel mine from March to December, 1915, under lease. The mine is situated in the south half of lot 5, concession 2, Blezard township. It had been idle since 1900.

The shaft, which was straightened by the new company, is now 158 feet deep and is sunk at an angle of 40 degrees. The levels are at 78 and 142 feet. The ore which remained above the first level was stoped out both east and west of the shaft. On the second level stoping had just been started by the lessees when work was discontinued because the Mond Nickel Company did not wish to buy any more ore.

The orebody is from 30 to 40 feet wide. 270,000 tons have been proved by diamond drilling. Shipments for the year totalled 13,000 tons. The ore was teamed to the Stobie branch of the C.P. Ry. and sent to Coniston smelter.

The machinery on the property consisted of a Lambert 125-h.p. boiler, locomotive type, a 5-drill compressor and a 7-inch by 10-inch hoist.

The company is capitalized at $40,000. The officers are:—President, J. A. Holmes; vice-president and manager, Thos. Travers; secretary-treasurer, W. N. Smith, all of Sudbury.

Miscellaneous Mines

Goudreau Mine.—The Madoc Mining Company, a subsidiary of the General Chemical Company of New York, has completed construction work on the Goudreau property and is prepared to ship pyrites beginning with the opening of navigation in 1916.

The deposits on this property have been described in previous reports of the Bureau. "C" deposit, which is 1,500 feet from the rock-house, has been partly diamond drilled and stripped and will be the first deposit to be worked. The open-pit method will be used—the ore being loaded by a Marion steam shovel into

Western side dump cars. The latter will be hauled on a 36-inch guage railroad by a Vulcan Iron Works steam locomotive to the rock-house. The "A" and "Bear" deposits will also eventually be worked. Both have been partly diamond-drilled.

The following buildings were completed in 1915: Boarding-house, office, store, machine shop and magazine, the exterior of all of which is covered with asbestos building lumber and asbestos shingles; warehouse, power house and rock-house, built of steel and reinforced concrete.

The power-house contains the following machinery:—

Two r.t. Keeler boilers, 250 h.p. each, equipped with Sandford-Riley underfeed stokers.

One Ingersoll-Sergeant duplex compressor, 1,200 c.f.

One Cochrane feed-water heater.

Three Worthington pumps for boiler-feed and water tank.

One Hamilton Corliss engine, about 450 h.p. This drives all rock-house machinery by means of a rope drive.

One Ideal engine, 9 inches by 10 inches, driving a 25 k.w. dynamo.

At the rock-house a chute leads to a 30 inch and 48 inch Traylor jaw crusher which crushes to from 4 to 5 inches. A belt conveyor delivers all the crushed material to a No. 6 McCully gyratory crusher set to from 2 to 2½ inches. This product passes to a trommel whence the lump goes to elevator No. 1 and the fines to elevator No. 2. The over-size after being crushed in a No. 3 McCully gyratory passes throught a small storage bin to belt conveyor No. 1. This delivers half of the product to a pair of Superior rolls and half to No. 2 belt conveyor leading to a second pair. The pair of rolls are of the same size, but the second pair will be used only when a large quantity of fines is desired; 100 per cent. fines can be produced if desired. Fines here still comprise ⅜ inch material and under. Both pairs of rolls discharge to elevator No. 2, which delivers to a circular steel storage bin, 20 feet by 20 feet. No. 1 elevator delivers to a similar bin. Both of these bins are placed above the railway tracks and are each equipped with three loading gates.

The company has completed a two-mile railway spur from Goudreau siding to the mine, and has a 30-ton switching engine in use.

The General Chemical Company gave to all employees who, on Dec. 1st, 1915, had been in the employ of the company for a year or more, a sum equal to 10 per cent. of their gross annual earnings; and to each employee who had been in the service for a shorter period a sum equal to 5 per cent. of his gross earnings.

The officers are: President, W. H. Nichols, Jr., 25 Broad St., New York; general manager, Robt. K. Painter, New York; mine superintendent, J. A. Battle, Jr., Goudreau, Ont., via Sault Ste. Marie. At the time of inspection 90 men were employed.

Long Lake Gold Mine.—The Canadian Exploration Company, Limited, worked the Long Lake gold mine, south of Naughton station, continuously in 1915. The mine and plant has been described in former reports of the Bureau.

A 100-foot winze has been sunk at 52 degrees from the second to the third level and considerable exploratory work done on the latter level. R. W. Brigstocke, Naughton, Ont., is manager, and Wm. Rowe, mine foreman.

Massey Mine.—The Massey copper mine, situated north of the village of Massey, on the Soo branch, was reopened in June, 1915, by James F. Flynn. This mine has been idle since 1906, with the exception of a few weeks in 1911, when it was pumped out and sampled. In January, 1916, the Sable River Copper Company, Limited, with a capitalization of $100,000, was organized to work the property. A lease and option to purchase was obtained from the owners, the Massey Station Mining Company. The property involved comprises part of the south halves of Sections 14, 15 and 16, Salter township.

The main, or No. 1, shaft is 530 feet deep with an average dip of 78 degrees to the north. Seven levels have been opened from this shaft. Up to April, 1916, no work had been done at this shaft by the new operators other than pumping and repair work.

A second shaft, known as No. 4, is being sunk 1,600 feet west of the main shaft and was 46 feet deep at the time of inspection.

Several shipments were made during 1915—most of the ore being obtained from an open cut near No. 4 shaft.

Experiments have been conducted on this property with the Callow system of oil flotation and very encouraging results have been obtained. When the alterations in the mill, which was originally built to try out the Elmore oil process, are completed the process will be as follows:—

The ore is first crushed to two-inch ring in a 9 inch by 16 inch jaw crusher and then reduced to ten mesh in a No. 8 Krupp ball mill. An elevator delivers it to a 75-ton bin, from which it is fed by a Challenge feeder to a drag classifier. The overflow goes directly to the Callow flotation machine and the coarse material to a 6 feet by 8 feet tube mill to be reground. The tube mill product then passes to a flotation machine. One Callow roughing or flotation cell is now in use, but it is planned to add three more and also a cleaner cell. The discharge from the roughing and cleaner cells will pass over Wilfley tables as a check on the work done by the flotation process.

The temporary organization of the company is as follows:—President, James F. Flynn, Massey, Ont.; secretary and director, Miss Annie Bell, Toronto; directors, Charles Shiels, R. A. Armstrong, and H. Hanna, all of Massey. The head office is at 76 Adelaide St. West, Toronto. C. G. Daimpre is mine foreman, and Hayden Rood mill foreman. Forty men were employed at the time of inspection.

Moose Mountain.—This iron mine at Sellwood Ont., was not worked in 1915. The experiments in the briquetting plant were continued until December, when all work ceased. Fred. A. Jordan was manager.

A power-house, 48 feet by 65 feet, was built of concrete and metallic lathing. It contains a Westinghouse-Parsons steam turbine with an A.C. turbo-generator rated at 940 k.v.a. maximum, 906 amperes per terminal, 600 volts 3 phase, 60 cycles, 3,600 r.p.m. There is in addition a Robb-Armstrong steam engine, 14 inches by 20 inches, driving a D.C. generator 10 k.w., 125 v., 80 amps., 112 r.p.m.; and a Babcock and Wilcox watertube boiler with a working pressure of 175 pounds. This is equipped with a B. and W. patent steam superheater capable of imparting 150 degrees F. of superheat to the steam when boiler is operated at its normal rating of 400 h.p.

Quarries

Daniels Quarry.—The Oscar Daniels Company, care of Ship Canal, Sault Ste. Marie, Mich., opened a trap quarry in the fall of 1915 on Humbug point, St. Joseph island, Ont. The trap will be used for concrete work at the ship canal.

East Neebish Quarry.—The Dominion Mines and Quarries Company, Limited, are operating a quartzite quarry on East Neebish Island, St. Mary's River. The quartzite, which is said to run 99 per cent. silica, is shipped to the Electro-Metallurgical Company of Niagara, N.Y., to be used in the manufacture of ferro-silicon.

The quarry has a 30-foot face and is at present about 300 feet long. Drilling is done by means of two motor-driven, Clipper churn-drills. The quartzite is loaded by two locomotive cranes into a car which runs to the crushing plant. It is crushed to a maximum size of 3½ inches and then delivered by a system of conveyor belts to a stockpile. Another conveyor belt, running in a tunnel below the stockpile, transfers the quartzite to the wharf and dumps directly into the holds of the boats. An automatic weighing-machine is attached to the last conveyor belt. The present output is about 280 tons daily, but this will be increased to 400 tons daily.

The power plant consists of a 200-h.p. boiler and a 15-inch by 15-inch Skinner steam engine. The latter drives a 125 k.w. generator as well as the crushers and screens. The generator supplies power for the churn drills, conveyors and for lighting.

About 40 men are employed under superintendent I. Appleton. The head office of the company is at Sault Ste. Marie, Mich.; the quarry post office is McLennan, Ont.

Willmott and Co. Quarry.—The Wilmott and Company quartz quarry, near Killarney, on the north shore of Georgian bay, was worked during the season of navigation. A new incline has been built up which the quartz is hoisted in self-dumping cars and delivered to a bin above the crushers. Otherwise, conditions are as mentioned in the 24th Annual Report.

The officers are:—President, Alex. Longwell, Toronto; manager, George W. Rayner, 410 Crown Office Bldg., Toronto; superintendent, Dan Chisholm, Killarney, Ont. At the time of inspection, Aug. 7th, 1915, 20 men were employed.

III.—DISTRICT OF TIMISKAMING

Gold in Beatty, Munro and Maisonville Townships

Cartwright.—The Cartwright Gold Fields, Limited, worked during part of 1915 on the north half of lot 8, concession 5, Beatty township.

The claim was visited on May 11th, 1915, when a shaft had been sunk to a depth of 96 feet. Equipment consisted of two boilers, 40 and 60 h.p., a 280 c.f. compressor, and a 6-inch by 8-inch Jenckes hoist. Twenty-two men were employed at that time.

The company is capitalized at $1,000,000, with head office at 147 Roncesvalles Ave., Toronto. The officers are: President, H. C. Crow, 184 Sunnyside Ave., Toronto; manager, George H. O. Hansen, Matheson, Ont.

Croesus.—The Croesus Gold Mines, Limited, was formed to develop the N.W. ¼, N. ½, lot 10, concession 1, Munro township. This claim was formerly known as the "Dobie-Leyson." The present owners began work in August, 1915, and since that date the mine has produced what are probably the most spectacular specimens of gold-bearing quartz ever discovered in Ontario. While sinking the first 60 feet of the shaft 765 pounds of quartz was removed which contained $47,000 worth of gold.

When the mine was last inspected (March 9, 1916) the shaft, which is inclined at 26 degrees, was 300 feet deep. The drifting done on the several levels was as follows:—

On the 100-foot, 164 feet north and 263 feet south.
On the 150-foot, 175 feet south.
On the 200-foot, 93 feet north and 180 feet south.
On the 250-foot, 110 feet south.
On the 300-foot, 135 feet south.

The following buildings have been completed:—Office, sleeping camp and cook camp; a change-house equipped with steel lockers; a power-house containing: two Goldie and McCullough r.t. boilers, 100 h.p. each; one Sullivan air compressor, type WB2; a 13 k.w. dynamo and an 8-inch by 10-inch steam engine; a machine and carpenter shop containing: a McDougall gap lathe 12-inch by 18-inch by 30-inch, a pipe-threader, a 12-inch rip saw, a 20-inch planer and a 15 h.p. steam engine.

The hoist at present in use is a 6-inch by 8-inch Jenckes, but a 10-inch by 10-inch is on order.

The officers of the company are:—

President, D. M. Steindler, New York.
Secretary-Treasurer, E. L. Steindler, Cobalt.
General Manager, Samuel Cohen, Cobalt.
Manager, Julius Cohen, Matheson, Ont.
Mine Captain, George Thomas, Matheson, Ont.

The head office is at 42 Broadway, New York.

Boston Creek

The gold mines and prospects in the vicinity of Boston Creek are described by A. G. Burrows in another part of this report.

Kirkland Lake Gold Area

Goodfish.—The Goodfish Gold Mines, Limited, owns three claims—L.2194, L.2022 and L.2571—in Morrissette township, near the southwestern corner.

Work was done on these claims from June to November, 1915. This consisted of surface prospecting on all three claims and the sinking of an 80-foot shaft on L.2194. About 80 feet of drifting was done from the bottom of this shaft to the north.

The officers of the company are:—President, Harry Oakes, Kirkland Lake; vice-president, M. J. Brennan; secretary, J. W. Morrison, Kirkland Lake; treasurer, Wm. Costello; director, Edwin W. Kearney, Haileybury.

Kirkland Lake.—The Beaver Consolidated Mines, Limited, has taken an option on the stock of the Kirkland Lake Gold Mines, Limited. The latter company owns 365 acres of land in the township of Teck. Under the terms of the agreement the Beaver company is to expend at least $2,000 a month on development for the next year.

At the present time work is being done on the McKane claim, which adjoins the Teck-Hughes mine. The main shaft has been sunk from 79 to 200 feet and a station is being cut at the 175-foot level.

Floyd Weed, Kirkland Lake, Ont., is superintendent.

La Belle Kirkland.—The La Belle Kirkland Mines, Limited, is capitalized at $2,000,000 and owns the following claims in Teck and Lebel townships, near the south end of Goodfish lake: L 1619, L 1686, L 1687, L 1688, L 1749, L 1750 and L 1751.

Underground work is being confined to Claim L 1751. On April 5th, 1916, when last inspected, the shaft was 265 feet deep. It is at an angle of 60 degrees for 80 feet and 72 degrees for the remainder of the distance. It measures 6 feet by 10 feet outside. The manway is situated above the hoisting compartment, the object of this arrangement being to expose as great a width of the vein as possible during the sinking. On the 100-foot level 70 feet of drifting and 30 feet of crosscutting has been done.

The machinery in use consists of: 2 Robb-Mumford, 60 h.p. boilers; a Canadian Ingersoll-Rand, 480 c.f. compressor and an 8" x 12" Canadian Ingersoll-Rand hoist.

The head office is Sterling Bank Building, Fort Erie, Ont. The officers are: President, Dr. Edward J. Meyer; vice-president, Alfred A. Berrick; treasurer, Frederick A. Meyer; secretary, Chas. S. Cadwallader, all of Buffalo, N.Y.; general manager, Frank C. Loring, Kirkland Lake, Ont.; superintendent, Ernest M. Loring; mine foreman, Andrew Cullen; 30 men are employed.

Lake Shore.—The Lake Shore Mines, Limited, continued the development of one of their claims—L 1557—situated on the south shore of Kirkland Lake.

On April 4th, 1916, the shaft was 312 feet deep and drifting and crosscutting had been done as follows:—On the 100-foot level, 368 feet of drifting; on the 200-foot level, 320 feet of drifting; on the 300-foot level, 340 feet of drifting and 10 feet of crosscutting.

The officers are: President and treasurer, Harry Oakes; secretary and manager, J. W. Morrison; mine foreman, James McMillan, all of Kirkland Lake, Ont. About 20 men are employed.

Lucky Cross.—Interests connected with the Trethewey mine are working the Lucky Cross mine under option. H. S. Robinson of the Trethewey is in charge of the work.

Swastika.—The Swastika mine was purchased at a liquidation sale by F. L. Culver, of Toronto.

Teck-Hughes.—The Nipissing Mining Company, who had an option on the Teck-Hughes mine, stopped work on March 1st, 1915, and later relinquished the option.

On August 1st interests connected with the Buffalo Mines, Limited, obtained control of the stock of the Teck-Hughes Gold Mines, Limited, and construction of a 50-ton cyanide mill was begun. The proposed method of treating the ore is thus described by Mr. A. A. Cole in his report to the T. & N. O. Ry. Commission for 1915, as follows:

"The mill represents a slight deviation from the general practice of slime treatment in Ontario. Certain changes in the general practice were considered advantageous owing to the richness of the ore to be treated and the difficulty with which Kirkland Lake ores are cyanided.

"The primary crushing is to be done in a 16 in. x 10 in. crusher of the Blake type. The ore is then conveyed to a storage bin, from which it is fed to a 5 ft. x 5 ft. ball-mill. The discharge from the ball-mill goes to a Dorr classifier and 5 ft. x 20 ft. tube-mill in closed circuit. The overflow from the classifiers is conducted through the slime plant, completing the treatment.

"Continuous agitation in Dorr tanks is used, and the solution is changed on the pulp when the agitation period is two-thirds over. By this removal of the solution high in gold and by the addition of an active barren solution, an additional recovery of values is anticipated.

"The dissolved values are removed by counter-current decantation in Dorr tray thickeners, followed by a short wash in an Oliver revolving filter. By the use of trays a given washing effect is secured by the use of one-half the number of tanks required for the ordinary thickener installation. The filter is expected to materially reduce the mechanical loss of cyanide as well as to effect an additional recovery of the dissolved gold over what would be obtained by thickeners alone. This feature of the plant is especially advisable, due to the high gold content of the solution and the relatively high strength of cyanide necessary."

A new compressor has been purchased. This is a Canadian Ingersoll-Rand, Class R.P., duplex, power-driven, 20 in. and 12 in. x 16 in.

The mine was pumped out in April, 1916, preparatory to starting underground work.

The officers are:—President, Chas. L. Denison, New York; vice-president, Robt. W. Pomeroy, Buffalo; treasurer, Henry C. Clark, Cobalt; general superintendent, Thos. R. Jones, Cobalt; superintendent, L. W. Ledyard, Kirkland Lake, Ont.; mine foreman, Thos. Whitebread.

Tough-Oakes.—The Tough-Oakes Gold Mines, Limited, worked their mine in Teck and Lebel townships with good results in 1915.

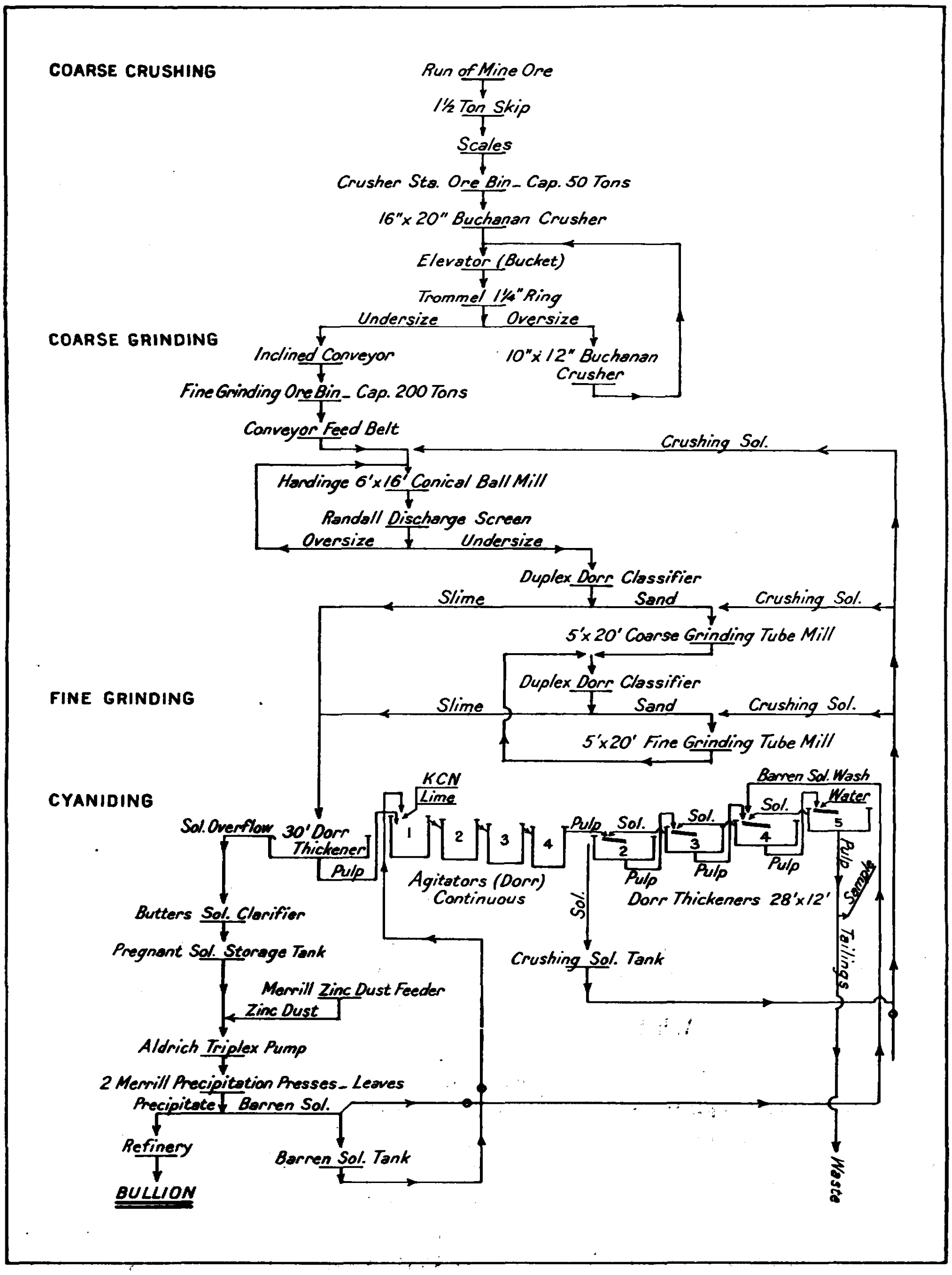
The development work done was:—Shaft sinking, 6 feet; winze sinking, 218 feet; drifting, 1,608 feet; crosscutting, 947 feet; raising, 428 feet; total, 3,207 feet.

A 2½ per cent. dividend, amounting to $66,437.50, was paid.

The new mill began to operate on March 15th, 1915. The total amount treated for the year was 26,196 tons of ore, yielding $551,069.07 worth of gold, and $4,470.07 worth of silver. This was average recovery of $21.21 per ton.

The officers are:—President, C. A. Foster, Haileybury; vice-president, Harry Oakes, Kirkland Lake; secretary, E. W. Kearney, Haileybury; treasurer, J. H.

Tough, Haileybury; C. A. O'Connell, Kirkland Lake, Ont., is manager; John A. Murphy, mine foreman, and Charles A. Randall, mill foreman.



Flow sheet of mill at Tough-Oakes mine. The capacity is 100-125 tons of ore daily.

Smith-Labine.—The Kerr Lake Mining Company of Cobalt began work in December, 1915, under a six-months' option on a group of claims in Maisonville township belonging to Dan Smith and Gilbert Labine. The claims in question are L 3687, L 3688 and L 3689, in concession 2. The camps are about 1¼ miles due north of Sesikinika station.

The claims were visited on March 10th, 1916, when work was in progress on L 3689. A shaft, with an average dip of 35 degrees had been sunk to a depth of 80 feet on a narrow quartz vein carrying free gold and tellurides.

Albert Terrill, Sesekinika, Ont., was in charge of the work and 15 men were employed.

Porcupine Gold Area

Anchorite.—The Coniagas Mines, Limited, has taken an option from the Anchorite Mining Company, Limited, on the three claims known as the Dobie or Armstrong-McGibbon property. The claims in question are M.E. 60, M.E. 61 and M.E. 62, and lie in Deloro township half a mile south of Lot 6, Tisdale township.

The property is an extremely interesting one as a large mass of rusty-weathering carbonate is being tested. The carbonate is cut by many quartz veins. The strike of the vein or band is North 20 degrees East.

The Coniagas company after building camps has started to drive a tunnel into the orebody on claim M.E. 61 and is also doing diamond drilling on the same claim. Two shafts were sunk by the original owners, one 50 feet and one 120 feet in depth; 85 feet of drifting was done from the bottom of the former. C. E. C. Smith, South Porcupine is manager, and John A. MacDonald, superintendent.

Dobie.—The Dobie Mines, Limited, owns 17 claims in different parts of Tisdale township. The Tisdale Gold Mining Company is the holding company.

In 1915 a shaft was sunk by hand-drilling to a depth of 50 feet west of and near the boundary of the Dome Lake Mining and Milling Company property. Considerable trenching was also done. H. G. Carmichael was in charge of the work.

The directors of the holding company are:—President, F. C. Armstrong, New York; vice-president, D. L. McGibbon, Montreal; secretary-treasurer, S. J. LeHuray, Montreal; S. J. Dobie, Haileybury; Wallace Nesbitt, Toronto.

Dome.—The Dome Mines Company, Limited, has an authorized capitalization of 500,000 shares of $10 par value each; 400,000 shares have been issued.

The officers of the company are:—President and treasurer, J. R. DeLamar, New York; 1st vice-president, W. S. Edwards, Chicago; 2nd vice-president and general manager, C. D. Kaeding, South Porcupine, Ont.; 3rd vice-president, H. P. DePencier, New York; secretary, Alex. Fasken, Toronto; directors: J. R. DeLamar, A. H. Curtis and A. V. Stout, New York; W. S. Edwards, Chicago; Alex. Fasken, Toronto; G. C. Miller, Buffalo; J. S. Wilson, Massey, Ont.

For the year ending March 31st, 1916, a total of 347,640 tons of ore was treated in the mill, the average yield per ton being $5.117. The total cost per ton amounted to \$2.559, and was made up as follows:—Mining and hoisting, \$0.621; crushing and conveying, \$0.104; development charge, \$0.60; milling, \$0.910; administrative expense, \$0.057; general expense, \$0.174; taxes and insurance, \$0.093. All mining cost on the broken ore reserve left in the stopes (63,000 tons), has been charged directly to current mine operating expense and not to a suspense account.

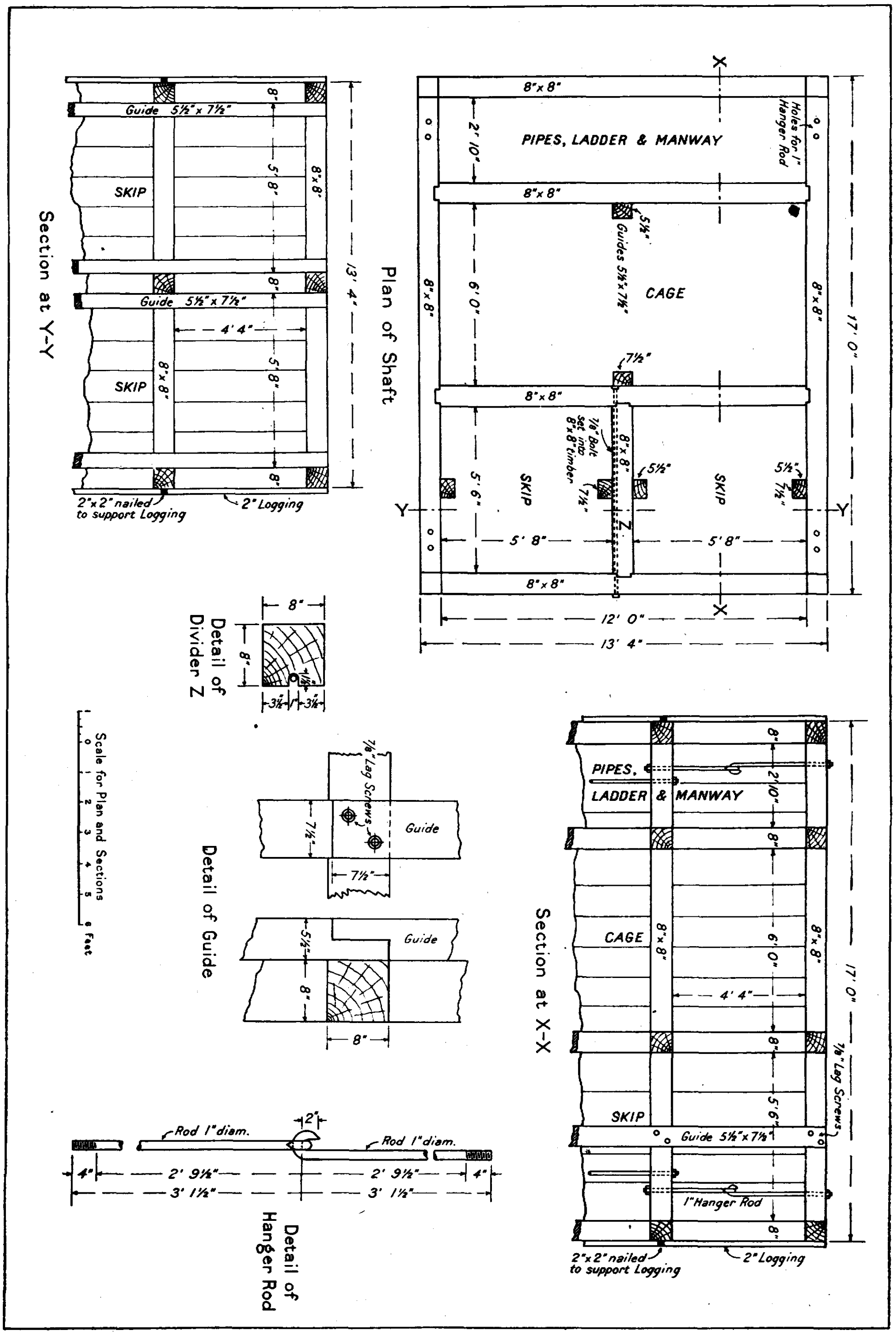
A summary of the development footages for the year follows:—

Level	Drifts	Cross-cuts	Raises	Box-holes	Shafts	Stations	Pockets	Total	Diamond Drilling	Total
1st......	....	679	982	188	....	....	....	1,849	24,866	209,766
3rd......	399	229	369	180	....	25	....	1,202	109,750	229,950
4th......	155	180	....	....	....	....	....	335	7,500	41,000
5th......	486	871	502	175	....	40	....	2,074	....	207,400
6th......	1,166	1,575	566	264	....	35	37	3,643	343,366	707,666
7th......	349	1,006	....	....	....	120	250	1,725	56,400	228,900
Shaft ...	....	....	....	....	877	....	....	877	....	87,700
Surface..	....	....	....	....	....	....	....	....	23,500	23,500
Total....	2,555	2,540	2,419	807	877	220	287	11,705	565,382	1,735,882

The additional knowledge gained of the structural geology of the deposit has rendered it possible to segregate from the main mass large zones or bodies of ore which can be separately valued and mined on a selective principle as against the former assumed necessity of non-selective mining. This revision of the ore reserve has eliminated 783,792 tons of unprofitable material and raised the grade of the remaining tonnage. The tonnage developed during the year in new territory was of much higher grade than the average of the ore milled; hence the gross value of the ore reserve has been materially augmented. The reserve as at April 1st, 1916, is estimated at 2,600,000 tons at \$6.20=\$16,120,000.00.

In order to permit the handling of a large tonnage a new vertical shaft, known as "No. 3," was started in November, 1915. This shaft is the first of its kind in Ontario, being nearly square in cross-section. It measured 13′ 4″ by 17′ outside, and is divided into four compartments. The principal advantage in a shaft of this type lies in having a large cage compartment. Drill steel, timber, track ties and miscellaneous material up to 11 feet in length can be loaded on trucks on the surface and these trucks can be run off on the levels without rehandling the material. The large 5-ton mine cars and storage battery locomotives can be taken to surface for repairs or moved from level to level without dismantling them. On May 1st, 1916, this shaft was 730 feet deep and the timbering, etc., was completed to the 7th level. Stations were cut at the 3rd, 5th, 6th and 7th levels at the following depths respectively: 257, 427, 577 and 727 feet. A loading pocket, 12′ by 14′ by 90′ deep, has been cut below the 6th level. Below this pocket doors will extend across the shaft and deflect the spillage into a small pocket, 3′ 6″ by 5′ 8″, which will be cut at one end of the shaft. This spillage pocket will lead to the next storage pocket below. Sinking will be continued for another 150 feet to the 8th level.

The cage-hoist for the No. 3 shaft is on order from the Nordberg Mfg. Co. It has a single drum, 8′ diameter and 7′ 6″ face, grooved for 1¼″ rope. Two ropes will be attached, one being for a counterbalance. The hoist will be designed to handle these ropes in counterbalance at a depth of 1,500 feet. The estimated



Framing of No. 3 shaft, Dome Mines.

weights are: Cage, 9,500 lbs.; load, 6,000 lbs.; rope, 3,750 lbs. (1,500 feet of 1¼" rope); counterweight, 12,500 lbs. The hoisting speed is 800 feet per minute. It will be driven through herringbone gears by a 150 h.p. motor, 500 r.p.m., 25 cycle, 550 volts. The brake is of the gravity post type. The safety devices consist of—

(1) A solenoid-operated valve which becomes de-energized and applies the brake in case of interruption of the current, whether due to the power falling or to overwinding.

(2) A Welch safety stop which opens the power circuit for any of the following reasons:—

(*a*) In case the hoisting speed exceeds normal at any point.

(*b*) In case operator fails to slow down the hoist at a predetermined and adjustable point and fails to continue to slow down between this point and the landing level.

(*c*) In case of overwind.

(*d*) In case the operator fails to reverse the hoist after the cage has reached the landing or limit of travel.

(*e*) In case power goes off the line for any cause brake will be automatically set.

The skip hoist is also on order from the same company. It is a double-drum hoist driven by a 350 h.p. motor, 500 r.p.m., 25 cycle, 550 volt, through a special herringbone gear. The drums are 7' diameter with a 4' smooth face for 1⅛" rope wound in two layers. One drum will be clutched to the shaft and the other keyed. The hoist is to operate normally in balance with the following loads: Ore, 7,000 lbs.; skip, 5,500 lbs.; rope, 3,000 lbs.; a total of 15,500 lbs., including 1,500' of rope. The hoisting speed is 1,000 feet per minute. The brakes are of the parallel motion post type. The hoist is equipped with a safety device consisting of a solenoid-operated valve, similar to that described above for the cage hoist.

The new shaft is being equipped with a steel head frame, 125 feet high to sheave centres, and ore and waste bins of 850 tons capacity.

The third and lower levels of the mine are being prepared for mechanical haulage. Baldwin-Westinghouse storage battery locomotives with Edison cells are to be used and each is expected to haul a train of six 85-cubic-foot side-dump ore-cars.

Below the fifth level station of the No. 2 shaft a crusher has been placed and is ready to operate. This is a Buchanan jaw crusher with 36" by 54" opening and is driven by two 75 h.p. motors.

In the power plant three 600 k.w. transformers and a second 2,500 c.f. Belliss and Morcom air compressor have been added. The latter is direct-connected to a 450 h.p. motor.

The mill operated 95.0 per cent. of the possible time crushing and treating 347,640 tons of ore with an expenditure equal to $0.910 per ton, a net reduction of $0.089 from the previous year. The treatment results were:—

		Per Ton	Per Cent.
Heads	347,640 tons	$5.50	
Amalgamation Bullion	$1,130,748.95	3.252	59.04
Cyanidation Bullion	648,209.96	1.865	33.84
Total Recovery	$1,778,958.91	$5.117	92.88

The extraction in 1914 was 90.6 per cent. At the close of the fiscal year the mill was treating 34,300 tons per month, compared with 23,630 tons at the beginning of the year. Additions to the equipment are now being made which are expected to increase the capacity up to 45,000 tons per month by about July 1st.

An 8-foot diameter by 30-inch Hardinge conical ball mill, direct connected to a 125 h.p. motor, has been substituted for ten of the stamps leaving 70 stamps still in use. This mill was first run at 26.6 r.p.m. and the capacity was 400 tons per day; it is now being operated at 23 r.p.m. and the capacity has increased to 490 tons. A second mill is being added. Two additional 5′ by 22′ tube mills, direct-connected to 100 h.p. motors, were added for fine grinding. Two 9-foot diameter by 45-foot depth Pachuca tanks, one primary and two secondary Dorr thickeners, 30-foot diameter by 10-foot depth, and two additional 90-frame Merrill slime filter presses, together with the necessary pumps, pipe lines, launders, etc., constitute the slime treatment extension. The sand plant was amplified by raising the sides of the six existing leaching vats 3′ 6″, making them 12 feet deep and adding two more vats, 40-feet diameter by 12 feet deep.

As it was considered possible that the Dome ore body might dip across the eastern boundary into the Dome Extension claim, the Dome Mines Company has secured an 18 months' option on all of the property of the Dome Extension Mines Company.

The Dome now employs approximately 600 men. In addition to the general manager the resident officials now are:—General superintendent, J. C. Houston; mine superintendent, T. P. McNamara; mill superintendent, C. W. Dowsett; mechanical superintendent, W. F. Cowsser; mine captain, A. R. Richards; safety engineer, George Webber.

The above information is taken largely from the fifth annual report of the general manager.

Dome Extension.—In January, 1916, the Dome Extension Mines Company, Limited, reopened their mine near South Porcupine. It had lain idle since 1912. Crosscutting and drifting are now being continued on the second level.

The Dome Mines Company, Limited, which has an eighteen months' option on the property, is also prospecting it by diamond drilling.

The officers are:—President, W. S. Edwards, Toronto; secretary, Alex. Fasken, Toronto; directors, J. S. Wilson, Massey, Ont.; Joseph Tomenson, Toronto; H. C. Anchor, South Porcupine, Ont., is superintendent, and Robert Sloan, mine foreman.

Dome Lake.—In August, 1915, the capital stock of the Dome Lake Mining and Milling Company, Limited, was increased from $1,000,000 to $2,000,000. The total issued capital stock at the end of the year amounted to $1,247,077.

The footages to December 31st, 1915, are as follows:—

	For year 1915.	Total to end of 1915.
Shaft sinking	27	905.6
Winze sinking	40.9	82.9
Raising	157	823
Drifting	796.5	5047.6
Crosscutting	136.0	2297.6
	1157.4	9156.7

The ten-stamp mill treated 11,727.6 tons of ore with an average value of $9.12 per ton. The extraction was 79.93 per cent.—66.1 per cent. being recovered by amalgamation and 13.83 per cent. by concentration. There was 1.89 per cent. of concentrates in the ore crushed. Milling costs amounted to $2.457 per ton.

The directors are:—President, George Taylor; vice-president, A. A. McKelvie; T. McCamus, S. S. Ritchie; all of New Liskeard, Ont.; Chas. L. Sherrill, Buffalo, N.Y.; secretary-treasurer, F. L. Hutchinson, New Liskeard.

Arthur H. Brown, South Porcupine, Ont., is manager, and D. E. Keeley, superintendent.

Hayden.—The Hayden Gold mines, Limited, own five claims, H.R. 937, H.R. 938, H.R. 939, 6899 P and 6900 P in the eastern part of Ogden township about 3½ miles south of the town of Timmins.

The company began work in August, 1915, and built a boiler house, blacksmith shop, carpenter shop, water-tank and a very comfortable set of camps.

A two-compartment shaft has been sunk to 109 feet. On the 100-foot level a crosscut has been driven to 114 feet north of the shaft and at 48 feet north of the shaft 21 feet of drifting has been done to the west and 47 feet to the east; south of the shaft 146 feet of crosscutting has been done.

The officers are:—President and general manager, Wm. H. Hayden, Box 439, Timmins, Ont.; 1st vice-president, H. M. Witbeck, Lockport, N.Y.; 2nd vice-president, W. H. Higgs, Lockport, N.Y.; secretary-treasurer, Willis M. Spaulding, 509 Brisbane Bldg., Buffalo, N.Y. Fifteen men are employed under mine foreman Alex. J. Lawson.

Hollinger Consolidated Mines, Limited.—In May, 1916, a consolidation was arranged whereby the Hollinger Gold Mines, Limited, Acme Gold Mines, Limited; Millerton Gold Mines, Limited, and Canadian Mining and Finance Company, Limited, were merged into one company known as the Hollinger Consolidated Mines, Limited. The capitalization of the new company is $25,000,000.00 in shares of $5.00 par value each. The stock is to be distributed as follows:—

	Shares.	Par value.
In treasury	200,000	$1,000,000.00
Issued to Hollinger shareholders	2,400,000	12,000,000.00
Issued to Acme shareholders	2,100,000	10,500,000.00
Issued to Millerton shareholders	200,000	1,000,000.00
Issued to C. M. & F. Co., Ltd.	100,000	500,000.00
	5,000,000	$25,000,000.00

On the above basis Hollinger shareholders will receive four shares of the new stock for each share of their present holdings.

Canadian Mining and Finance Company, Limited.—Up to the time the Hollinger Consolidated Mines, Limited, was formed, the Canadian Mining and Finance Company, Limited, owned and operated Acme Gold Mines, Limited; Millerton Gold Mines, Limited, and Claim No. 13147, as well as managing the Hollinger Gold Mines, Limited.

The officers are:—President, L. H. Timmins, Montreal; vice-president, J. McMartin, Cornwall, Ont.; treasurer, D. A. Dunlap, Toronto; secretary, John B. Holden, Toronto; general manager, P. A. Robbins, Timmins, Ont.

The "Central" six-compartment shaft, which is situated on Claim No. 13144 near the southwest corner has been sunk to depth of 500 feet. This shaft is concrete-lined. Two compartments have been sunk to a depth of 800 feet and the remaining four compartments will be completed during 1916. Stations have been cut at the 425 and 800-foot levels. The accompanying plan shows the dimensions of this shaft and the arrangement of the concrete lining.

A steel headframe, 120 feet high, has been completed above this shaft, and within it a crushing plant with a capacity of 5,000 tons per 24 hours is to be placed.

A concrete hoist house has also been completed, but the machinery is not yet installed.

Claim No. 13147, which has been included in the consolidation, is the north-east quarter of the south half of lot 10, concession 2, Tisdale township. It lies north of and adjoining the Vipond mine. Near the south-west corner of this claim a shaft has been sunk to a depth of 230 feet and it is intended to continue it to the 400-foot level.

Hollinger Gold Mines, Limited.—The fifth annual report of Hollinger Gold Mines, Limited, shows that this company has developed one of the world's great gold mines. The following information is abstracted from the above-mentioned report, covering the operations of the company for the year 1915:—

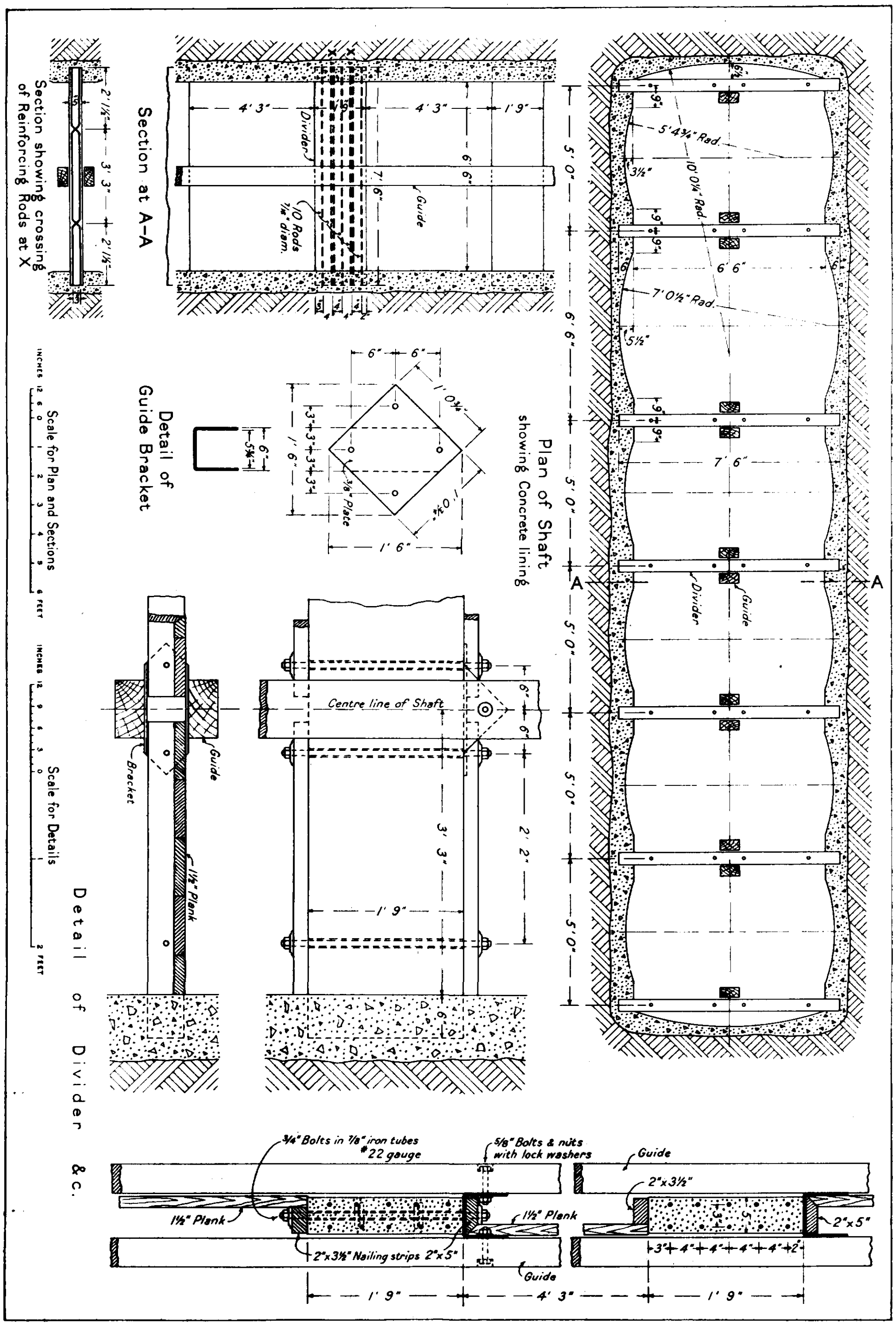
The gold bullion produced in 1915 was valued at $3,169,813.84, an increase of $480,459.04 over the production for 1914. Values per ton were $10.11 in 1915, as compared with $13.67 the previous year. The difference of $3.56 per ton in the value of the ore was compensated for somewhat by a reduction of $1.20 in the working costs per ton. The gross profits amounted to $2,063,466.77.

The progress underground during the year was as follows:—

DEVELOPMENT

Level	Shafts	Drifts	Crosscuts	Raises	Winzes	Diamond Drilling	Timbering Shafts and Winzes	Stopes
	feet	feet	feet	feet	feet	feet	feet	feet
100-foot	....	262	....	74	....	1,054	....	167
200- "	....	865	581	87	....	3,305	....	1,366
300- "	....	1,314	85	106	....	1,029	....	1,519
425- "	....	1,542	1,694	302	....	1,941	24	403
550- "	106	851	477	99	....	748	115	62
675- "	125	374	....	135	20	....	125	....
800- "	30	589	573	119	125	109	165	....
950- "	....	25	7	....	150	....	150	....
1,100- "	....	....	59	....	29	192	12	....
Total........	261	5,822	3,476	922	324	8,378	591	3,517

Total development, 10,805 feet.



Framing of central shaft, six compartments and concrete lined, Hollinger Consolidated Mines, Ltd.

STOPING.

Level	Broken ore in stopes, Jan. 1, 1915	Ore broken during 1915	Ore removed during 1915	Broken ore in stopes, Dec. 31, 1915
	Tons	Tons	Tons	Tons
100-foot	18,900	14,039	31,064	1,850
200-foot	36,500	124,813	112,623	48,690
300-foot	11,400	138,662	116,847	33,210
425-foot	....	39,985	22,265	17,720
550-foot	....	3,412	2,912	500
675-foot	....	141	141	....
800-foot	....	30	30	....
	66,800	321,052	285,882	101,970

No. 8 winze now extends from the 300-foot to the 1,100-foot level, and No. 1 vein has been found to persist to the latter depth. The main shaft has been completed to the 800-foot level. Disused stopes are being filled with waste rock. Most of the work of the year has been confined to the upper levels, but a small amount has been done upon the 675 and 800-foot levels.

Trolley-type locomotives are now used for haulage on the 425-foot level.

The ore hoisted from the mine amounted to 334,570 tons, 14.5 per cent. of which came from development.

The net cost of mining is given as $1.898 per ton of ore milled.

The mill treated 441,286 tons of ore, of which 334,750 tons came from the Hollinger and 106,486 tons from the Acme. The costs of treatment were $0.999 for the Hollinger and $1.09 for the Acme ore. The average number of tons of Hollinger ore milled per day was 917. The stamp duty per 24 hours of running time was 14.72. The value per ton in the tailings was $0.40 and the cyanide consumed per ton of ore was 0.574 lbs.

Since April, 1915, 100 stamps have been in operation. Extra tube mills and screening plants are now being provided to relieve the stamps from crushing that portion of the ore which comes from the crushers in a condition fine enough for direct tube milling. The continuous decantation plant is being increased by the addition of two rows of 40-foot tanks. Six Dorr agitators, 26 feet in diameter by 18 feet deep, have been installed to secure a longer period of treatment for the ore. The concentrating plant has been rearranged to make room for the agitators, and a tube mill has been arranged in circuit with two smaller agitators for treating concentrates. It is expected that these alterations will increase the mill capacity to 1,900 tons per day and that a slightly higher extraction will be obtained owing to the increased agitation.

The following is a summary of the reserves:—

——	Tons	Value per ton	Estimated gross value, Dec. 31, 1915	Estimated at Dec. 31, 1914
		$ c.	$	$
No. 1 vein....................	402,000	12 30	4,946,500	4,958,210
No. 2 vein (north)	144,700	12 75	1,844,500	1,775,740
No. 2 vein (south)	135,700	7 89	1,070,500	885,690
No. 3 vein	21,400	5 28	113,000	169,000
No. 4 vein	223,700	7 84	1,755,100	1,857,670
No. 5 vein	55,100	11 97	659,700	637,760
No. 7 vein	17,000	10 47	178,000	178,000
No. 8 vein	47,300	7 64	361,600	390,740
No. 10 vein	25,400	7 35	186,800	108,000
No. 13 vein	15,600	8 80	137,400	....
No. 14 vein	131,500	10 25	1,347,700	....
No. 15 vein	23,500	11 37	267,200	....
No. 16 vein	27,800	10 67	296,600	[illegible]
No. 37 vein	31,100	9 41	292,700	400,900
No. 38 vein	4,100	10 88	44,600	93,800
No. 41 vein	256,900	8 06	2,069,700	756,780
No. 44 vein	8,000	20 00	160,000	160,000
Miscellaneous....................	30,000	10 00	300,000	500,000
	1,600,800	10 02	16,031,600	13,358,420

Regarding the future possibilities Mr. Robbins says:—

The entire volume of ore (727,000 tons) so far removed from the mine is the equivalent of approximately the first 160 feet below the surface of those veins which have been developed; or, in other words, the entire tonnage treated to date could have been taken from the first 160 feet below the surface, if each vein had been worked throughout its entire length to that depth. In the present estimate of ore reserves there still remains above the 300-feet level a greater tonnage than has been removed from the mine since operations were first started. In the present estimate of ore reserves there is shown to still remain above the 425-feet level a greater gross value of ore than has been removed since operations were first started. Broadly speaking, our entire productions for the years 1912-13-14-15 of 726,992 tons, containing $9,778,783.77, may be considered to have come from the equivalent of the first 200 feet of depth.

The number of men employed during the year averaged 735.

The officers of the company are:—President, Noah A. Timmins, Montreal; vice-president, John McMartin, Cornwall; secretary-treasurer, David A. Dunlap, Toronto; general managers, Canadian Mining and Finance Co., Limited, P. A. Robbins, Timmins, Ont., general manager.

In addition to the general manager the resident officers are:—Assistant general manager, A. R. Globe; mine superintendent, V. H. Emery; mill superintendent, L. B. Eames; mechanical superintendent, R. W. Robbins; mechanical engineer, Arthur H. Sancton; mine inspector, Benjamin Richards.

Acme.—The Acme Gold Mines, Limited, owns three claims, Nos. 13142, 13143 and 13144, lying to the east of the Hollinger mine.

The company has a capitalization of $3,000,000, divided into 600,000 shares of $5.00 par value each. All the stock has been issued and is held by the Canadian Mining and Finance Company, Limited. The latter company advanced funds for the development work and plant construction, and during 1915 sufficient ore was mined and treated in the Hollinger mill to enable the Acme to pay off its entire indebtedness to C. M. and F. Co.

The report of General Manager Robbins recommending the consolidation of the Acme-Hollinger-Millerton properties gives the following information regarding the Acme Gold Mines, Limited:—

Geological conditions upon claim 13142 are very favorable for the occurrence of gold, and there is a well-mineralized belt extending entirely across the central part of the claim from east to west, from the surface of which very spectacular showings of gold have been obtained in local spots. Surface sampling has shown the existence of a large area of low-grade rock, cut by several high grade stringers within this mineralized zone. Underground development upon this claim has been limited to the sinking of No. 12 shaft to a depth of 179 feet and the driving of 260 feet of crosscuts at that depth. There has also been done 250 feet of drifting.

Claim 13143 possess great possibilities. Conditions are right for the occurrence of gold, and the neighboring McIntyre Company has developed several good ore bodies at points along the north boundary. The limited amount of work which has been done upon this claim has proved up a large amount of ore, but all work has been confined to a narrow strip along the north boundary. The south half of the claim is unexplored except for a few surface trenches.

Claim 13144 is by far the most valuable of the Acme claims at present developed, Within an area of seven acres at the south-west corner there has been exposed by underground and surface workings 1,500,000 tons, estimated to contain over $13,000,000.00. Beyond this there is indicated by the adjacent workings of Hollinger Gold Mines, Ltd., and by surface outcrops, an additional tonnage which will increase the figures given above.

The plant of Acme Gold Mines, Ltd., consists of the following:—

At No. 9 shaft—

Two 100 h.p. double drum electric hoists; one 1,500 c.f. electrically driven compressor; one transformer station of 700 k.w. capacity; one crusher station having a capacity of 700 tons per day; one aerial gear for transporting ore to mill of Hollinger Gold Mines, Ltd.; one hoist house, 43′ by 56′; one timber headframe covered with galvanized iron; one steam boiler for heating; one office and store building, 26′ by 36′; one workshop, 34′ by 54′; one change house with accommodation for 300 men.

At No. 10 shaft—

One hoist house and shop, 18′ by 50′; one head gear; one 10″ by 12″ single-drum hoist.

At No. 11 and No. 12 shafts—

Same as at No. 10 shaft.

The total cost of the plant to date has been $120,507.07.

The development work is described in the above-mentioned report as follows:—

There are four shafts. No. 9 shaft near the centre of claim 13144 has three compartments and is 825 feet in depth, with levels opened at 100, 200, 300, 425, 550, 675 and 800 feet. This is the principal shaft, and is the one at which the largest amount of work has been done. It is the only shaft at present in operation.

Shaft No. 10 is located at about the centre of the north boundary of claim 13143. It is 388 feet in depth, with levels opened up at 140, 240 and 365 feet. This shaft has been shut down for approximately two years, the owners not caring to tie up capital unproductively for an indefinite period, when there was an abundance of other more important work to be carried on.

No. 11 shaft is located near the northeast corner of claim 13144. It has three compartments, is 419 feet in depth, and has levels opened up at 175, 275 and 400 feet.

No. 12 shaft is located near the middle of the east half of claim 13142. It has three compartments, is 179 feet in depth, and has a level opened up at 159 feet.''

Shafts 11 and 12 have been closed down for over a year for the same reason as that affecting No. 10 shaft.

Underground workings consist of:—	Crosscuts.	Drifts.	Raises.
At No. 9 shaft	3,220 feet	8,709 feet	578 feet
At No. 10 shaft	250 feet	675 feet	
At No. 11 shaft	90 feet		
At No. 12 shaft	260 feet	250 feet	
	3,820 feet	9,634 feet	578 feet

Below is given Mr. Robbins' "Summary of Estimated Ore Reserves" of the Acme based on the results of surface sampling and of underground development. An arbitrary allowance of 50 feet has been made for the persistence of ore beyond the exposed faces and bottoms in underground workings. In the case of veins which have had no work done upon them other than the sampling of surface outcrops, an arbitrary allowance of 100 feet in depth for the persistence of these outcrops gives an estimated tonnage of 133,840.

SUMMARY OF ESTIMATED ORE RESERVES.

—	—	Value per ton	Estimated gross value Dec. 31, 1915
	Tons	$ c.	$ c.
No. 5 vein	13,350	7 00	93,580 00
No. 14 vein	33,220	11 48	381,220 00
No. 38 vein	24,500	9 25	226,630 00
No. 50 vein	551,860	8 09	4,465,450 00
No. 51 vein	14,600	6 37	92,900 00
No. 52 and 52A veins	42,770	11 21	479,630 00
No. 53 and 53A veins	333,970	9 54	3,187,430 00
No. 54 and 54A veins	105,020	9 88	1,037,170 00
No. 56 vein	35,460	6 03	213,770 00
No. 58 vein	175,440	8 57	1,502,730 00
No. 59 vein	57,970	9 88	628,690 00
No. 65 vein	49,300	12 47	614,760 00
No. 74 vein	14,000	4 24	59,000 00
No. 79 vein	17,730	5 52	97,800 00
No. 83 vein	24,780	5 80	143,660 00
No. 84 vein	7,230	5 48	39,620 00
No. 85 vein	138,360	8 67	1,199,840 00
No. 88 vein	2,960	14 80	43,800 00
Surface veins	133,840	11 89	1,592,500 00
	1,776,360	9 06	16,100,180 00

Probably the most important surface exposure upon the Acme is vein 55, the outcrops of which may be followed at intervals along the surface for a distance of approximately 1,500 feet. The eastern end of this showing for the last 500 feet of length has an average width of 4.12 feet and carried an average value of $18.76 per ton. No work has been done upon this part of the vein other than the sampling of the surface outcrops.

In the vicinity of shafts 10 and 12 it is probable that future exploration work will develop ore bodies of importance, and it is also probable that careful search will reveal ore bodies upon other, as yet unexplored, portions of the property.

There is also the probability of the various ore bodies persisting to depths considerably below those as yet reached, so the estimate of ore reserves given above cannot be taken as final, but must be considered as an indication of much greater values which we may expect to be disclosed by future developments.

There were treated during 1915 in the Hollinger mill 106,486 tons of Acme ore.

Millerton.—The Millerton Gold Mines, Limited, has a capitalization of $3,000,000.00 divided into 600,000 shares of $5 par value each. The stock, which has all been issued, was owned by the Canadian Mining and Finance Co., Limited, until May, 1916, when the property was transferred to Hollinger Consolidated Mines, Limited.

The Millerton claims are three in number, viz., Nos. 13218, 13219, and 13220. They are situated in lot 11, con. II, Tisdale township, west and southwest of the Hollinger mine.

The underground development is as follows:—

On claim 13218—Shaft No. 6 has been sunk to a depth of 394 feet, with levels at 55, 150, 250 and 379 feet. A total of 876 feet of crosscutting and 435 feet of drifting has been done on the four levels.

On claim 13220—two shafts have been sunk near the south boundary: No. 7 170 feet deep with a level of 167 feet; and No. 8, 45 feet deep.

No work has been done on claim 13219.

Regarding ore reserves Mr. Robbins says in his report of March 30, 1916, recommending the consolidation:—

Owing to the small amount of underground development which has been accomplished, it is not possible to form any dependable estimate of developed ore reserves.

The sampling in underground workings has shown an average value of $7.08 per ton for the ore encountered, and allowing for the persistence of ore for a distance of 50 feet from underground exposures, gives 115,490 tons, with a gross gold content of $818,120.00.

The surface outcrops indicate 1,480 tons, containing $8,880.00 for every foot of depth to which the veins persist.

Throughout the territory explored by underground workings, the country has been subjected to a great crushing action, the rock being fragmental and full of innumerable little quartz veinlets with occasional short, well-defined veins of quartz.

In the crosscut upon the 55-foot level, one section shows an average value of $4.80 over a width of 126 feet, and two portions of this mineralized section show a value of $6.30 over a width of 22 feet.

A consideration of the results so far obtained leads to the conclusion that future development will show a comparatively large tonnage of ore averaging in the neighborhood of $6.50 per ton, and for the purpose of this report we are justified in assuming that 400,000 tons of ore having an average value of $6.50 per ton. It will be understood that these figures are arbitrary assumptions, but they are based upon the data so far collected, together wtih reasonable allowances for the persistence of ore below the surface and beyond underground exposures.

Maidens-McDonald.—The La Rose Mines, Limited, took an option on the Maidens-McDonald claims in Deloro township and commenced work in February, 1916. The claims are H.R. 832 and H.R. 926, and lie three-quarters of a mile south of lot 7, Tisdale township.

There are two prospect shafts on the property. At the time of inspection, May 19th, 1916, both of these were 50 feet deep. It is intended to sink the west shaft, which is on claim H.R. 832, to a depth of 125 feet.

J. C. Nicol, South Porcupine, is doing the work under contract.

McIntyre.—The McIntyre Porcupine Mines, Limited, has a capitalization of $3,000,000.00, divided into shares of $1.00 par value each, all issued. Thirty-one thousand dollars' worth of first mortgage seven per cent. bonds remain outstanding. The company controls the McIntyre Extension Company, which was formed to take over the property and assets of the Pearl Lake Gold Mines, Limited, and also controls and is furnishing working capital to the McIntyre-Jupiter Company, which now owns the Jupiter mine.

The following is extracted from the annual report of the company, covering operations for the year ending March 31st, 1916:—

$779,990.94 in gold bullion was produced during the year, the result of milling 105,758 tons of ore at an average value of $7.71 per ton. Since the beginning of milling operations on the property in 1912 a total of $1,800,241.28 in gold bullion has been recovered from 237,891 tons of ore of an average value of $8.10. The operating profit for the year was $327,524.04.

The development work done is as follows:—

—	Stations	Shafts	Sumps	Drifts	Cross-cuts	Raises	Winzes	Total
Total for year ending March 31, 1916......	99.40	301.60	26.20	4006.5	1161.7	988.9	....	6584.5
Total for year prior to April, 1915..........	44.7	1534.3	12.0	10260.6	4821.3	2194.0	221.2	19088.1
Total to date	144.1	1835.9	38.2	14267.1	5983.0	3182.9	221.2	25672.6

5787.3 feet of diamond drilling was also done during the year, making a total of 10,337.4 feet of holes drilled to date.

No. 4 shaft is now being sunk from the 600-foot to the 800-foot level. Sixty-five per cent. of the ore produced from the property to date has been mined in the workings of this shaft.

No. 5 shaft was sunk from the 400-foot to the 700-foot level. Levels were opened at 500, 600 and 700 feet and ore bodies have been found on each. The development work at this shaft during the year has been very satisfactory. The grade of ore mined has increased from $9.20 on the 400-foot level to $12.62 on the 600-foot and $18.72 on the 700-foot.

The McIntyre extension shaft is to be equipped with new hoisting machinery and will be the main hoisting shaft for the works north of Pearl lake. It was sunk from 670 feet to 1,083 feet. A station was cut at 1,000 feet and a pocket station at 1,050. A crosscut is being driven on the 1,000-foot level to connect with the McIntyre No. 5 shaft. On the boundary line between the two claims this crosscut passed through an ore body assaying $15.30 per ton over a width of 25 feet.

Operating costs for the year amounted to $4.2783 per ton. The ore reserves were estimated to be as follows on March 31, 1916:—

	Tons.	Average Value.	Total Value.
No. 4 shaft	17,970	10.15	$182,570.00
No. 5 shaft, No. 5 vein	107,747	12.60	1,359,097.00
No. 5 shaft, contact zone ore bodies.	60,851	9.95	605,054.00
Broken ore in stopes	15,352	6.54	100,407.00
	201,920	11.12	$2,247,128.00

The reserves on March 31, 1915, were estimated at 109,693 tons, with an average value of $7.79, or a total value of $854,436.00. All development work during the year has been on Claim 13307. No attempt has yet been made to develop Claim 13308 or the water lot.

The mill ran 94.4 per cent. of the possible running time, treating 105,758 tons of ore at a cost of 96.8 cents per ton, with a recovery of 95.6 per cent.

Work on the third or "C" unit was begun in September and completed in March. This is a duplicate of units "A" and "B." The capacity of the mill is now 450 tons per day.

New workshops and a transformer house addition, containing three 200 k.v.a. transformers, have been built.

Two hundred and twenty men are employed at the McIntyre and McIntyre-Extension mines.

The directors and officers are: President, A. M. Hay, Toronto; vice-president, Sir H. M. Pellatt, Toronto; J. P. Bickell, Toronto, I. J. R. Muurling, Warrenton, Va.; C. B. Flynn, New York; W. J. Sheppard, Waubaushene, Ont.; J. B. Tudhope, Orillia, Ont.; secretary, M. P. Van Der Voort, Royal Bank Bldg., Toronto.

The operating officers are: Mine manager, R. J. Ennis, Schumacher, Ont.; mine superintendent, J. E. McAllister; mill superintendent, A. Dorfman.

McIntyre-Jupiter.—The McIntyre-Jupiter Company was formed in 1915 to acquire the property of the Jupiter Mines, Limited. The new company is controlled by the McIntyre Porcupine Mines, Limited, and the latter is furnishing working capital for the operations.

Since November, 1915, construction work has been in progress. A new head frame, a sampling house, a power house and a transformer house have been built.

The sampling house arrangements are as follows:—

From a 40-ton bin the ore passes over a Jeffrey travelling grizzly to a 10″ by 20″ Allis-Chalmers Blake crusher. A 12-inch bucket elevator delivers it to a Snyder sampler which removes 20 per cent. The sample passes through an 8″ by 12″ Mitchell jaw crusher to a second Snyder sampler which takes out a 10 per cent. sample. The sample goes to a two-ton steel pocket and thence through a set of 10″ by 16″ Krone rolls. A third sampler then removes 10 per cent. After passing through a pocket to dryers, it is delivered to a Sturtevant sample crusher where it is split. It then goes through a James sample cutter to a Braun grinder. All rejects go to a crushed ore bin.

The power house contains: One Waterous loco. type boiler and one Jenckes r.t. boiler; one Sullivan steam compressor, 14″ and 10″ by 16″, and two Alley and McLennan "Sentinel" compressors of 750 c.f. capacity each, driven by 125 h.p. motors.

A 3,000-foot track leads from the Jupiter shaft to the McIntyre No. 5 shaft, whence the Leschen tramway will carry the ore to the McIntyre mill. R. J. Ennis is manager, and 33 men are employed.

North Thompson.—The North Thompson Associated Gold Mines, Limited, have been actively developing their mine near Timmins, and have been successful in finding several very promising ore-shoots.

A three-compartment shaft has been sunk to a depth of 310 feet and levels opened at 50, 100, 200, and 300 feet. The drifting and crosscutting done to the end of the year was approximately as follows:—

On the 50-foot, less than 50 feet of work.

On the 100-foot, north of shaft a total of about 400 feet and south of shaft have worked to a point 400 feet distant from the shaft.

On the 200-foot, to points 250 feet north and 440 feet south, with considerable intermediate crosscutting.

On the 300-foot, 270 feet of drifting to the north-east and 280 feet of drifting to the south.

The head frame was completed during the year and the plant increased by the addition of a 130 h.p. Robb-Mumford boiler and a 12¼″ by 15″ double-drum Flory hoist.

The directorate consists of: Chairman of board, F. H. Hamilton, Austin Friars, London, Eng.; directors, E. T. McCarthy, London, Eng.; Edward Hooper, London, Eng.; managing director, Dr. J. M. Bell, Montreal. Canadian office, Dominion Express Bldg., Montreal.

From 40 to 45 men are employed. N. J. Evered, Box 189, Timmins, Ont., is manager.

Porcupine Crown.—The Porcupine Crown Mines, Limited, produced gold in 1915 to value of $613,565.43, after deducting the Mint charges.

The main shaft has been extended to the 500-foot level and the 600 and 700-foot levels are being opened from a winze. A total of 4,569 feet of development and prospecting and 2,616 feet of diamond drilling was done.

The length of ore shoot found to date on the several levels is as follows: 100-foot, 465 feet; 200-foot, 1,062 feet; 300-foot, 1,189 feet; 400-foot, 1,097 feet; 500-foot, 500 feet; 600-foot, 20 feet; 700-foot, 30 feet.

The reserves are given as 150,000 tons with an approximate value of $1,250,000.00.

The mill treated 41,326 tons of ore during the year, having an average value of $14.46 per ton, and 5,093 tons of tailings from the first amalgamation mill, averaging $3.15. The average extraction was 97.70 per cent. for the ore and 85.77 for the tailings. One hundred and twenty men were employed. Costs were as follows:—

		Cost per ton milled.
Mining, development, exploration and underground	$121,242.54	$2.93
Hoisting and tramming	13,482.50	.325
Mill operations	45,036.48	1.09
Power, heat and maintenance	50,935.07	1.23
Mine, general expense	21,394.81	.52
Administration, depreciation, insurance and taxes	25,870.88	.625
Total	$277,962.28	$6.72
Tailings, handling and treatment	4,954.60	.97
	$282,916.88	
Total average cost per ton milled		$6.095

The officers and directors of the company are the same as for the Crown Reserve Mines. M. W. Summerhayes is resident manager and A. S. Crowe, mine foreman.

Porcupine Imperial.—The Porcupine Imperial Mining Company, Limited, worked from June to November, 1915, on claim H.R. 950 in the northern part of Deloro township. This prospect had been idle for some three or four years.

The shaft is, as before resuming work, 112 feet deep. On the 100-foot level about 370 feet of crosscutting and drifting was done in 1915, making a total of approximately 500 feet on the level.

The machinery consists of a 40 h.p. boiler, a 3-drill compressor and a 6″ by 8″ hoist.

Harry L. Taylor, 402 McKinnon Building, Toronto, is president and manager of the company. Nine men were employed under mine foreman Robert Sloan.

Porcupine Miracle.—The Porcupine Miracle Mining Company, Limited, worked their mine in Langmuir township until December 1st, 1915. No. 2 shaft was sunk to a depth of 200 feet. On the 105-foot level 300 feet of drifting was done and on the 200-foot level a station was cut. No. 4 shaft was sunk to 70 feet and a shaft-house built above it.

The manager reports that the crushing capacity has been increased and the cyanide plant completed.

The officers of the company are: President, H. Burton Ransom; vice-president, Wm. S. Mohr; secretary and general manager, George J. Miller, Box 518, South Porcupine, Ont.; treasurer, E. S. Bryant; director, Thomas Wright.

Porcupine Vipond.—Porcupine Vipond Mines, Limited, has an authorized capital of $1,500,000, divided into shares of $1.00 par value each. At the end of 1915, 900,000 shares were outstanding.

The following is extracted from the annual report of the company covering the operations for the calendar year 1915:—

EXPLORATION AND DEVELOPMENT.

The drifts on the 200-foot level were extended to the west limits of the north Vipond lot and the continuation of the ore-bearing zone proven to the boundary of the property.

A vertical two-compartment winze was sunk 220 feet from the 300-foot level and stations were cut at both the 400 and 500-foot points. The winze has been equipped with a cage and exploration work started on both the 400 and 500-foot levels. These levels will be extended to a point under the main working shaft and a connection made with it.

A summary of the work done to date follows:—

	Prior to 1915.	During 1915.	Total to date.
Sinking and raising	795.0	381.5	1176.5
Drifting	2902.4	1198.9	4101.3
Crosscutting	1757.0	218.6	1975.6
	5454.4 ft.	1799.0 ft.	7253.4 ft.
Diamond drilling		524.0 ft.	524.0 ft.

PRODUCTION.

The mill has been in continuous operation during the year. The installation of a 6-foot Hardinge ball mill to replace one of the 4½-foot units and the building of a storage bin for the crusher resulted in increasing the capacity of the mill from 3,000 to 4,000 tons per month.

35,899 tons of ore were treated in the mill, with the following results:—

Gold bullion produced, 11,978.66 fine oz.	$247,598.56
Silver bullion produced, 1,455.39 fine oz.	713.73
Total value recovered	248,312.29
Total value lost in tailings	21,355.13
Gross value of ore treated	269,667.42
Average value per ton treated	7.51
Loss per ton treated (tailings)	.59
Recovery per mile milled	6.92
Extraction per ton milled	92.1 per cent.

The tonnage milled was drawn from the following sources: Stopes, 31,598 tons; development, 4,077 tons; dump, 224 tons; total, 35,899 tons.

ORE RESERVES.

The ore reserves on December 31st were 90,000 tons, valued at $587,280.00, of which 17,130 tons valued at $93,000.00 were broken and stored in the stopes.

The officers and directors are: President, Henry H. Ward; vice-president, H. A. Poillon; vice-president and treasurer, Chas. C. Dickson; secretary, H. F. Karst; all of New York; manager and director, C. H. Poirier, Schumacher, Ont.; directors, R. T. Shillington, Haileybury, and D. I. Jackson.

H. W. Heine is superintendent and F. J. Young, mine foreman. Seventy-five men are employed.

Premier-Langmuir.—The Premier-Langmuir Mines, Limited, own six claims, Nos. P 1307 to P 1312, situated on the Night Hawk river, near and adjoining the southern boundary of Langmuir township.

The geology of the township was described by A. G. Burrows in Vol. XX, Part II, Report of the Ontario Bureau of Mines.

Work was conducted on these claims during part of 1915. Two prospect shafts, 20 and 70 feet in depth, have been sunk and a tunnel has been driven 100 feet on a vein of barite. High silver values are said to have been obtained from parts of the vein.

A tramway, 2,400 feet long, has been built from the mine to the river, and four 40-ton scows have been completed to carry barite to Connaught Station.

The officers of the company are: President, J. A. McIntosh, Toronto; secretary-treasurer, J. B. Aikenhead, London; directors, A. B. Greer, J. W. Cawrse, A. E. Somerville, Geo. McBroom, Fred Rumble, R. H. Cullis, all of London, Ont. Charles W. Dalby, Connaught, Ont., is manager.

Schumacher.—The development work done during 1915 at the mine of the Schumacher Gold Mines, Limited, Schumacher, Ontario, was as follows:—

The three-compartment shaft sunk to 624 feet.

Crosscutting amounting to 1,086 feet on the 300-foot, 400-foot and 600-foot levels.

Drifting amounting to 436 feet on the 300-foot and 400-foot levels.

Raising amounting to 293 feet above the 100-foot and 200-foot levels.

On the 500-foot level a station was cut.

The 150-ton cyanide plant with counter-current decantation was started on September 1st, 1915, and up to the end of the year 9,240 tons had been treated.

The following buildings were also completed during the year: Crusher and conveyor building, assay office, refinery, change house and an addition to the power house to contain a 100 h.p return tubular boiler and a 744 c.f. cross compound compressor. An office building is being constructed.

The costs per ton of ore treated for the month of December are given as follows: Mining cost, $3,533; milling cost, $0.997; total cost, $4.53. These figures do not include any allowance for depreciation.

The officers of the company are: President, F. W. Schumacher, Columbus, O.; vice-president, John B. Holden, Toronto; manager, Joseph C. Houston, Schumacher, Ont.; mine foreman, Maurice Hastie; mill foreman, Robert C. Coffey.

Mr. Houston resigned in February, 1916, and was succeeded by S. A. Wookey as manager.

About 90 men are employed.

Triumph.—Triumph Mines, Limited, bought the property consisting of four claims, in lots 8 and 9, concessions 1 and 2, Tisdale township, formerly known as the "Success Gold Mines." The new company commenced work in December, 1915.

On March 1st, 1916, a shaft inclined at 62 degrees had been sunk 117 feet and about 100 feet of drifting and crosscutting had been done on the 100-foot level.

The equipment consists of a 60 h.p. locomotive type boiler, a two-drill compressor, and a 6" by 8" Jenckes hoist.

The underground work is done by E. S. Henley and H. S. Badger under contract. Eighteen men are employed.

The officers are: President and general manager, Harvey L. Holmes, Box 10, Schumacher, Ont.; secretary and treasurer, N. Nelles, Auburn, N.Y.; directors, J. H. Young, Auburn, N.Y.; Fred W. Thomas, Buffalo; James R. Roaf, Toronto. Head office, Daily Star Building, Toronto.

Dundonald and Clergue Townships

Alexo Nickel Mine.—The Alexo Mining Company, Limited, operated its nickel mine continuously in 1915. The company owns five claims in Concession 3, Clergue and Dundonald townships, near Porquis Junction on the T. & N. O. Ry. All mining to date has been done on the N.E. 1/4, S. 1/2, Lot 1, Concession 3, Clergue township.

Two levels have been opened—the 75-foot and the 125-foot. Part of the ore above the first level has been stoped out to surface, leaving an open pit through which the hoisting is done. A winze connects the first and second levels. The ore body on the first level averages 20 feet in width for a distance of 170 feet and on the second level 37 feet for a distance of 100 feet.

The officers of the company are: President, treasurer and manager, Captain E. F. Pullen, Porquis Jct., Ont.; directors, G. H. Hanning, Toronto; Alex. Kelso, Kelso, Ont.; Frank Pullen, Toronto; Captain C. W. Allen, Toronto; mine foreman, Wm. Dunmead. Captain Pullen left in February to go on active service and was succeeded by Wm. Anderson as manager.

From 20 to 25 are employed. 11,923 tons of ore were shipped in 1915 to the Mond smelter at Coniston.

Timagami Forest Reserve

Golden Rose.—The Golden Rose Mining Company, Limited, worked from March until December, 1915, on a claim situated on the east shore of Emerald Lake, Timagami Forest Reserve. The work done consisted of trenching, opencutting and sinking test-pits. A 6-foot Hardinge Mill and amalgamating plates were used for extracting the gold. About 8 men were employed.

The officers of the company are: President and manager, Edward J. Townsend, North Bay, Ont.; treasurer, James Townsend.

Rand Syndicate.—The above syndicate has been doing some opencutting on claim T.R. 3187 in the township of Strathy about three-quarters of a mile south of Cedar lake in the Timagami Forest Reserve. Shipments of iron pyrites started in the early part of 1916.

A. W. Jackson, 853 Ellicott Square, Buffalo, N.Y., is in charge.

Silver Mines of Cobalt and Vicinity

Adanac.—The Adanac Silver Mines, Limited, commenced work in June, 1915, on the property formerly known as the Pan-Silver in the southeastern part of Coleman township.

There are two shafts—the north or Calumet shaft, 200 feet deep, and the south or Patterson shaft, 226 feet deep. The new company did 375 feet of drifting east of the Calumet shaft on the 200-foot level, making a total of 425 feet of drifting to the east of the shaft. This shaft was then abandoned and a winze started from the 200-foot level of the Patterson shaft at a point 85 feet northeast of the shaft. On the day of last inspection (January 12th, 1916), this winze was 42 feet deep. Fifteen men were employed under superintendent A. W. Grierson, Cobalt, and mine captain Isaac E. Mosure.

The directors of the company are: President, Burr E. Cartwright, Toronto; treasurer, J. P. Bickell, Toronto; secretary, D. A. McArthur, Toronto; J. J. Calvin, Toronto; P. M. Bushnell, New York.

Aladdin.—The Aladdin Cobalt Company, Limited, continued to operate the Chambers-Ferland mine in 1915.

Only No. 4 shaft, which is west of the railway, is now worked. About 1,800 feet of development work was done during the year. A winze, near the west boundary of the claim, has been sunk to a depth of 103 feet below the 350-foot level and levels opened at 76 feet and at the bottom. High-grade ore has been encountered on both levels of the winze.

A new hoist house is being built, and a 10" by 12" double-drum Flory hoist will be used in future.

The officers of the company are: President, Major Conrad Jorgenson; secretary-treasurer, F. F. Fuller; directors, Major Chas. Gold, Dennis Herbert, H. B. Sedgwick, all of London, Eng. There is also a Canadian board consisting of R. T. Shillington, C. A. Richardson and Arthur Ferland, all of Haileybury, with Alex. Fasken, of Toronto, secretary. J. A. McVichie, Cobalt, is manager. About 45 men are employed.

Alexandra.—The Alexandra mine on Diabase mountain, Cobalt, was leased by Sydney Smith, of Haileybury, and associates, from the owners, the Canadian Gold and Silver Mining Company. The lessees worked from October, 1915, to March 1st, 1916. The work was done from the 300-foot level and consisted of approximately 300 feet of drifting, 50 feet of crosscutting and 70 feet of raising.

Beaver.—The Beaver mine is situated in the southeastern part of Coleman township and is owned by the Beaver Consolidated Mines, Limited. The officers are: President and general manager, Frank L. Culver, Toronto; vice-president,

C. C. James, Ottawa; secretary-treasurer, H. E. Tremain, Toronto. The board of directors consists of the above-mentioned gentlemen and also F. L. Lovelace, W. T. Mason, W. E. Stevenson, and F. C. Finkenstaedt. J. W. Moffett, Cobalt, is mine superintendent. The head office is 810 Lumsden Building, Toronto, Ont.

Development work done during the fiscal year ending February 29th, 1916, consisted of: Drifting, 3,077.5 feet; crosscutting, 808.5 feet; raising, 848.5 feet; sinking, 476.5 feet; total, 5,211.0 feet. Stoping amounted to 8,480.5 cubic yards.

The main shaft is now 1,400 feet deep and stations have been cut at the 900 and 1,200-foot levels. It is intended to continue sinking until the lower edge of the diabase sill is reached; this contact has been determined by diamond drilling to be approximately 1,670 feet below the surface.

The mill is now treating from 125 to 150 tons a day; 30,093 tons of ore were treated during the year, producing 474 tons of concentrates which yielded 349,900 ozs. of silver. The total recovery of silver for the year was 746,310 ozs.

Two dividends of 3 per cent., or $60,000 each, were paid in 1915.

The company is now carrying out exploratory work on the McKane claim of the Kirkland Lake Gold Mines, Limited. Further mention is made of this work in the description of the mines of the Kirkland Lake area.

Buffalo.—The following information is taken from the tenth annual report of the Buffalo Mines, Limited, covering operations for the year ending April 30th, 1916.

The progress underground was as follows:—

	Raising.	Drifting.	Stoping.
1st Level	80 ft.	128 ft.	30,152 cu. ft.
2nd Level	268	950	112,598
3rd Level	300	480	123,271
4th Level	30	170	25,615
5th Level	30	60	......
Totals	708	1,788	291,636

Totals to date are,—for shaft sinking, 2,009 feet; for drifting, 18,486 feet; for stoping, 2,657,542 cu. ft.

The mill treated 37,152 tons of milling ore and 1,005 tons of sand and slime tailings, or a total of 38,157 tons treated. Of this amount, 30,079 tons, averaging 19.8 ozs. of silver per ton, were treated by wet concentration and yielded 431,512 ozs. silver, while 8,078 tons, averaging 25.46 ozs. of silver per ton, were treated by combined concentration and oil flotation with a recovery of 197,601 ozs. The cyanide plant treated 6,340 tons of slime averaging 10.54 ozs. of silver per ton and 55,161 ozs. were recovered. The total recovery in mill and cyanide plant was 684,274 ozs.

The total production of silver for the year was 705,055 ozs.

Experiments were conducted with a 50-ton oil flotation plant using the Callow process. The results obtained were so satisfactory that a 600-ton flotation plant is to be built.

The officers and directors are:—President, Charles L. Denison, New York, N.Y.; vice-president, Robt. W. Pomeroy, Buffalo; 2nd vice-president, Harland B. Crandall, New York; secretary and treasurer, George C. Miller, Buffalo; director, Albert W. Johnston, New York. Tom R. Jones, Cobalt, Ont., is general superintendent.

Calumet and Montana.—The Calumet and Montana Consolidated Mining Company, Limited, commenced work in September, 1915, on the property in Coleman township formerly known as the Cyril Lake or Airgiod. This claim has not been worked since December, 1912.

On the date of the last inspection (January 10, 1916), development work done consisted of a two-compartment shaft 225 feet deep and the following drifting and crosscutting: On the 45-foot level, 50 feet to the east of the shaft; on the 90-foot level, 148 feet to the west; on the 150-foot level, 30 feet to the north, 110 feet to the northeast and 60 feet to the southwest; on the 220-foot level, 120 feet to the north and 55 feet to the south. All the work done in 1915 was on the 90-foot level. The number of men employed was 9.

The officers of the company are: President, H. O. Oswald, Minneapolis, Minn.; secretary, C. A. O'Leary, St. Paul, Minn.; directors, C. V. Patterson, St. Paul, Minn.; W. W. Sloan, Toronto, Ont.; W. G. Weichel, M.P., Waterloo, Ont.; and superintendent, G. G. Thomas, Box 227, Cobalt, Ont.

Casey Cobalt.—The Casey Cobalt Mining Company, Limited, worked their mine in Casey township continuously in 1915.

The ore produced in 1915 came from the 180 and 210-foot levels of No. 3 shaft and from the second and third levels of No. 6 shaft. Diamond drilling has been done from both the 180 and 210-foot levels of No. 3 shaft.

At the time of last inspection, February, 1916, all work on the western claim and in the old workings had ceased and only No. 6 shaft was in use. Ninety-three men were then employed.

The officers are: President, W. R. P. Parker; vice-president, J. P. Watson; secretary, W. W. Perry; all of Toronto. The head office is at 1514 Traders Bank Building, Toronto. John W. Shaw, New Liskeard, is mine manager, and Wm. Hooper, mine foreman.

Casey Mountain.—The Casey Mountain Cobalt Mining and Development Company, Limited, own a mining claim in lot 6, concession II, Casey township.

The property was visited on May 25th, 1915, and at that time the No. 1 shaft was 135 feet deep and 90 feet of drifting had been done on the 50-foot level. No. 2 shaft was 160 feet deep and 30 feet of drifting had been done on the 90-foot level. The manager writes that since that date about 75 feet more sinking has been done. The machinery consists of a 6" by 8" Jenckes hoist and a 50 h.p. boiler.

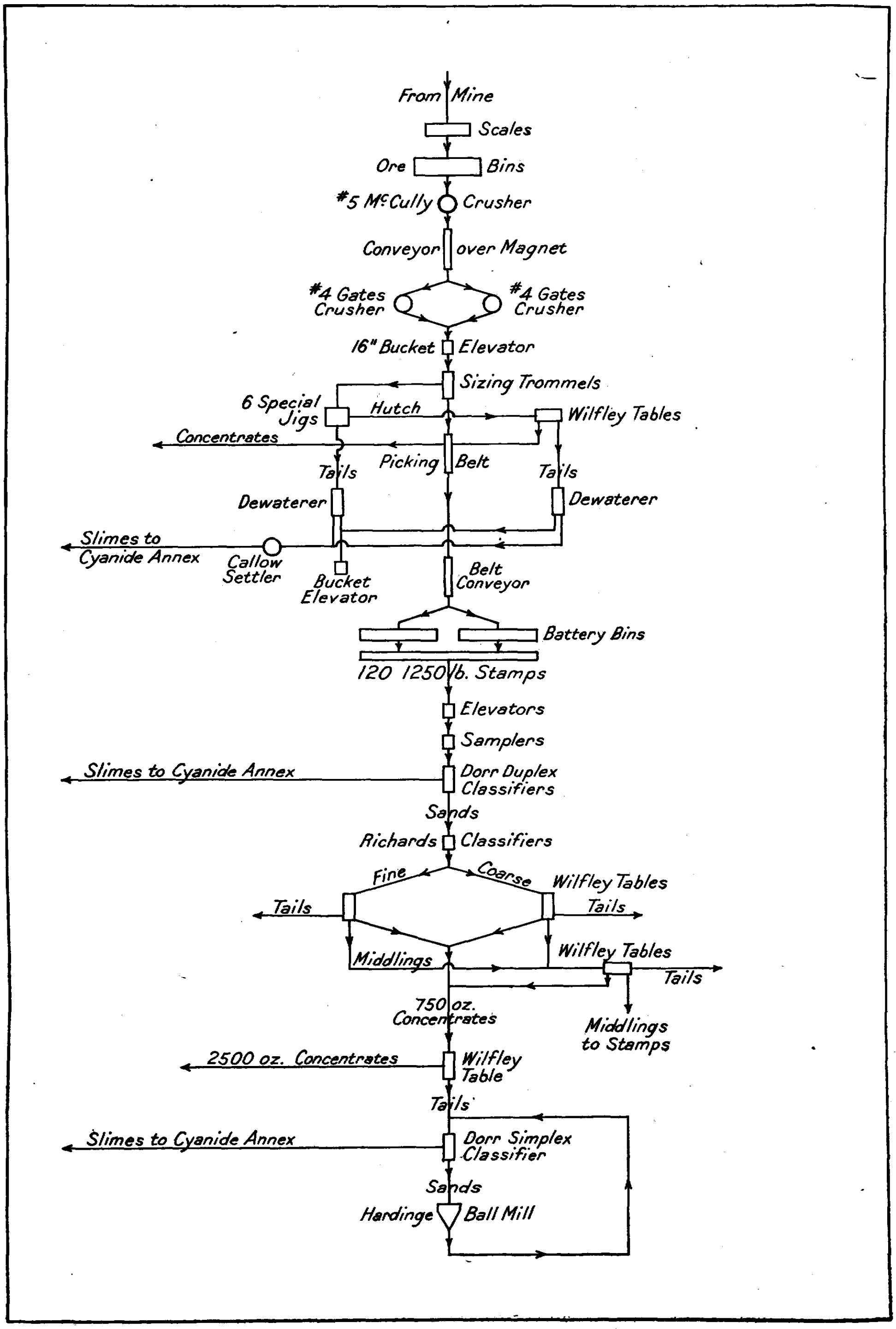
The operating company was the Casey Mountain Syndicate, Regina, Sask.

The officers of the Development Company are: President and manager, R. G. Williamson, Regina, Sask.; vice-president, James Thompson, M.P.P.; secretary, W. A. Staples, 115 Stair Bldg., Toronto, Ont.

Casey Seneca.—The Casey Seneca Silver Mines, Limited, commenced work in July, 1915, on a claim situated in lot 6, concession VI, adjoining the Casey Cobalt mine.

A shaft, 374 feet deep was sunk, and by February 1st, 1916, 244 feet of crosscutting had been done to the east and 256 feet to the west of the shaft on the 345-foot level. John N. MacGuire is doing the work by contract and has 19 men employed.

The officers are: President, S. Harry Worth, Philadelphia, Pa.; consulting engineer and managing director, W. E. Segsworth, Toronto; secretary-treasurer, R. F. Segsworth, Toronto; mine manager, A. C. Bailey, Cobalt. The head office is at 103 Bay Street, Toronto.



Flow sheet, Cobalt Reduction Company, Limited, October, 1915.

Cobalt Comet.—The Cobalt Comet mine, formerly known as the "Drummond," was worked during the first half of 1915 by the Cobalt Comet Mines, Limited, under the management of Mr. E. V. Neelands. The stock of this company is owned by the Caribou Cobalt Mines Company.

In July, 1915, the Kerr Lake Mining Company acquired control of the stock of the Caribou Cobalt Mines Company, and since that date have been carrying on the work principally above the 100-foot level.

Some 30 men are employed. Robert Livermore is manager.

Cobalt Reduction Company.—The mill of the Cobalt Reduction Company, Limited, ran for 96.8 per cent. of the possible time in 1915, six days being lost for lack of power. The stamp duty averaged 2.44 tons per 24 hours. 97,133 tons of ore were milled containing 2,305,900 ounces of silver. The extraction from the milling ore and slime treated was 86.51 per cent. The ratio of ore milled to concentrate produced was 55.83 to 1.

The cyanide plant was started on April 26th, 1915, and ran continuously for the balance of the year. The average daily tonnage cyanided was 135.1.

The chief change made in the practice at this mill is that all the table concentrates are now reconcentrated. The low-grade portion of the re-treated concentrate is passed through the cyanide plant (after sliming in a tube mill) with the slime from the mill tailing.

The company is controlled by the Mining Corporation of Canada, Limited. M. F. Fairlie, Cobalt, is mill superintendent.

Columbus.—Work was resumed in April, 1915, on the property of the Columbus Cobalt Silver Company, Limited, which had lain idle since September, 1914.

No. 2 shaft was sunk to a depth of 415 feet and the third level opened at 400 feet. On this level 300 feet of drifting and crosscutting was done to the north and 70 feet to the east of the shaft. Seven men were employed. Work was discontinued in January, 1916.

The officers of the company are: President, E. L. Woodward, Pittsburg, Pa.; secretary, J. L. Lawson, Toronto; manager, George E. McDonald, Box 64, Giroux Lake, Ont.

Coniagas.—The Coniagas Mines, Limited, with an authorized capital of 800,000 shares of $5.00 par value each, owns and operates the Coniagas mine at Cobalt and also owns the issued capital stock of the Coniagas Reduction Company, Limited.

The following report covers the operations of the mine for the fiscal year ending October 31st, 1915:—

The concentrating mill was operated for 98.83 per cent. of the possible time. Total tonnage milled was 55,437, or an average of 3.02 tons a stamp for 24 hours. Mill heads averaged 23 ounces per ton.

Development work done during the year and the total work done to date are given below:—

	For year ending Oct. 31, 1915.	Total to Oct. 31, 1914.	Total to Oct. 31, 1915.
Shaft sinking, feet	73	802	875
Drifting, feet	626	15,982	16,608
Crosscutting, feet	1,910	6,805	8,715
Winzes, feet	17	519	536
Raises, feet	109	895	1,004
	2,735	25,003	27,738

The total ore reserves are estimated as follows:—

2,136.3	tons high grade ore at 3,000 ounces	6,408,900 ozs.
585	tons high grade ore at 2,000 ounces	1,170,000
117,344	tons mill rock ore at 20 ounces	2,346,880
52,000	tons broken ore at 40 ounces	2,080,000
42,930	tons broken ore at 20 ounces	858,600
1,000	tons mill rock on surface dump at 30 ounces	30,000
	Total	12,894,380

Allowing 20 per cent. for possible over-estimation leaves an ore-reserve on October 31st, 1915, of 10,315,504 ounces.

The average force at the mine for the year was 141 men.

During the year the company earned the title to claims C 1030 and C 1141 on the Gillies Limit and also acquired the Agaunico mine in lot 15, concession 1, Bucke township.

A canvas-table plant was completed and put in operation on October 5, 1915. This is housed in a building 60′ by 70′, and treats 70 tons of 6-ounce slimes per day.

A 6-ton cyanide plant with Butters filter and Dorr agitation is being constructed. This will treat decomposed material which will be diverted at the head of the mill and also the concentrates from the canvas-table plant.

The officers of the company are: President and general manager, R. W. Leonard, C.E., St. Catharines; vice-president, Alex. Longwell, Toronto; assistant to the president and director, R. P. Rogers, Cobalt; secretary-treasurer, J. J. Mackan, St. Catharines; directors, F. J. Bishop, Brantford, and Welland D. Woodruff, St. Catharines.

Major R. P. Rogers, who has been superintendent of the mine for some years, left for overseas service in command of No. 1 Tunnelling Company. Fraser D. Reid is now in charge as superintendent.

Crown Reserve.—The Crown Reserve Mining Company, Limited, capital 2,000,000 shares of $1.00 par value each, operate the Crown Reserve and Silver Leaf claims near Cobalt, and employ about 140 men.

The officers are: President, John W. Carson; 1st vice-president, W. I. Gear; 2nd vice-president, J. G. Ross; secretary and treasurer, James Cooper; assistant secretary-treasurer, John Reid; general manager, S. W. Cohen; resident manager, H. J. Stewart, Giroux Lake, Ont.

Production for the year ending December 31st, 1915, aomunted to 657,395 ounces of silver. This makes the total production of this company to date 19,086,536 ounces. The cost per ounce for the year was 45.01 cents distributed as follows:

Mine operation cost, 25.48 cents; smelting and milling cost, 16.58 cents; other costs, 2.95 cents.

Development work in 1915 amounted to 3,387 feet. This consisted of 214 feet of sinking and raising, 1,976 feet of drifting and 1,197 feet of crosscutting. Total mine development to date amounts to 29,586 feet.

The Drummond Fraction of Cobalt Comet claim was worked until August 1st, 1915, in conjunction with the Kerr Lake Mining Company, Limited.

The Crown Reserve has acquired control of the Globe Consolidated Lease Incorporated Company. The latter will operate a producing gold mine in Trinity county, California.

Dominion Reduction Company Customs Mill.—The Dominion Reduction Company, Limited, operated their 40-stamp mill near Cobalt throughout the year. The ore treated came from the Crown Reserve, Kerr Lake, Cobalt Comet and Drummond Fraction mines. About 60 men were employed at this mill.

The officials of the company are: President, D. M. Steindler, New York; vice-president, M. B. Davis, Montreal; secretary, Eugene L. Steindler, Cobalt; manager, A. G. Kirby, Cobalt; assistant manager, P. L. Blodgett, Cobalt.

Genesee.—The Genesee Mining Company, Limited, was formed in 1915 to prospect the S. W. ¼ of the S. ½ of lot 9, concession I, Bucke township. This claim was acquired under a six-year lease from the United States Cobalt Mining Company.

Work began in the early part of 1916. The property was visited on March 17th, 1916, when the shaft was 60 feet deep with sinking in progress. A drift extends 35 feet to the north of the shaft on the 55-foot level. A 10" by 12" Jenckes engine is used for hoisting. Eight men were employed at the time of inspection.

The directors of the company are: President, Ralph H. Gorsline, Rochester, N.Y.; vice-president, — VanZant, Rochester, N.Y.; secretary and treasurer, Alex. Russell, Rochester, N.Y.; A. A. Amos, Toronto, Ontario; manager, Leonard F. Steenman, Cobalt, Ontario.

Glen Lake.—The Glen Lake Mines, Limited, is working the Foster under lease from the Foster Cobalt Mining Company, Limited.

Some drifting and stoping has been done on a vein on the 50-foot level of the 110-foot, or north shaft.

On the 210-foot level of the No. 5, or main, shaft, a crosscut about 1,600 feet long has been driven northwest from the shaft beneath Glen lake. This crosscut started in Keewatin, then passed into diabase and finally into slate. A winze is being started near the face of the crosscut. Fourteen men are employed.

A joint survey of the bed of Glen lake has been made by the Glen Lake, Penn-Canadian and Bailey companies.

The officers are: President, C. B. Flynn, New York; secretary and treasurer, M. P. Van der Voort, 13 Wellington Street East, Toronto; manager and assistant treasurer, Thos. J. Flynn, Haileybury.

Hudson Bay.—The Hudson Bay Mines, Limited, did no work at their No. 1 mine in 1915, but continued exploration at the No. 2 workings situated on the east side of the T. & N. O. Ry. south of the McKinley-Darragh mine. Fourteen men were employed.

During the year ending August 31st, 1915, the work done consisted of: 345 feet of drifting and crosscutting on the second level; 399 feet of drifting and crosscutting on the third level; 16 feet of sinking and 77 feet of raising.

The total footage driven at the No. 2 mine of this company to August 31st, 1915, was as follows:—

	Sinking.	Raising.	Drifting.	Crosscutting.
Shaft No. 1	116	....	....	....
Shaft No. 2	346	....	....	....
1st Level	....	....	849	....
2nd Level	....	....	148	604
3rd Level	....	77	255	144
Totals	462	77	1,252	748

The directors are: President, George Taylor; vice-president, A. A. McKelvie; S. S. Ritchie, T. McCamus, D. M. Ferguson, J. J. Grills, all of New Liskeard; C. L. Sherrill, Buffalo, N.Y.; secretary-treasurer, F. L. Hutchinson, New Liskeard. Arthur H. Brown, South Porcupine, Ont., is manager.

Kerr Lake.—The Kerr Lake Mining Company of New York owns all the stock (600,000 shares of $5.00 par value) of Kerr Lake Mining Company, Limited, of Ontario, 150,000 shares of Wettlaufer Lorrain Silver Mines, Limited, and 200,000 shares of Kerr Lake Majestic Mines. In July, 1915, 837,400 shares of Caribou Cobalt Mines Company were acquired. The latter was the holding company for the Cobalt Comet or Drummond Mine and the acquisition of this stock gives the control of 70 acres adjoining the Kerr Lake claim.

The officers are: President, Adolph Lewisohn; vice-president, Sam A. Lewisohn; secretary and treasurer, E. H. Westlake; mine manager, Robert Livermore, Box 929, Cobalt, Ont.; mine foreman, Wm. Beeton, Giroux Lake, Ont. The New York office is at 61 Broadway.

Development work for the fiscal year ending August 31st, 1915, amounted to 4,226 linear feet. This consisted of: Drifting, 1,996 feet; crosscutting, 2,104 feet; raising, 59 feet, and sinking, 67 feet.

The southeastern part of the Kerr Lake claim is being prospected from No. 3 shaft, which is 340 feet deep. On the sixth or 320-foot level drifts were extended east and west on a strong vein. About 400 feet northwest of the shaft a winze is being sunk from the sixth level on a vein in the Keewatin below the diabase sill. At 50 feet below the collar of the winze 74 feet of drifting has been done. From this same vein on the second level of No. 3 shaft a crosscut was driven through the south central part of the property to the south boundary. The results of the prospecting from this shaft in both diabase and Keewatin have so far not been encouraging.

The largest amount of development work from the main or No. 7 shaft was done on the 140-foot level. As a result of this work the ore reserves in two of the veins are maintained at nearly the figure of the preceding year.

During the year 47,436 tons were hoisted at a mining cost of $4.15 per ton. Of this tonnage 38,286 tons was ore and 9,150 tons waste. The production amounted to 2,036,962 ounces of silver at a total cost of 21.45 cents per ounce. This cost is made up as follows: Mining and development cost, 9.67 cents; shipment and treatment charges, 11.09 cents; administration and general cost, 0.69 cents.

The ore reserves on September 1st, 1915, were estimated to contain 4,172,400 ounces of silver.

La Rose Consolidated.—La Rose Consolidated Mines Company owns the entire capital stock of La Rose Mines, Limited, The Lawson Mines, Limited, Violet Mining Company and 7,262 shares of University Mines, Limited.

The officers and directors are:—President, D. Lorne McGibbon, Montreal; vice-presidents, Shirley Ogilvie and Edwin Hansen, Montreal; secretary and treasurer, Stephen J. LeHuray, Montreal; E. W. Nesbitt, Woodstock, Ont.; W. A. Black and Victor E. Mitchell, Montreal; W. M. Dobell, Quebec; manager, R. B. Watson, Cobalt. The Montreal office is at 201 Inspector St.

The underground work done in 1915 was as follows:—

	Shafts. feet.	Drifts. feet.	Crosscuts. feet.	Raises. feet.	Stopes. c.y.
La Rose	244.5	424	2686.5	106	3991
Lawson	36	230	324.5	143	584
University	...	39	99	61	783
Total	280.5	693	3110	310	5358

La Rose

At the La Rose mine the main work of the year was the exploration of the Extension claim on the west side of the Cobalt lake fault. All the ore heretofore found in the La Rose mine has been on the east side of the fault, where the depth of conglomerate is 150 feet or less. On the west or downthrow side of the fault there is about 400 feet of conglomerate, and to explore this area a new shaft, 407 feet deep, was sunk to the contact, and a level established at 350 feet. On this level 2,225 feet of crosscutting has been done, but to date no ore of value has been encountered.

Lawson

One hundred and fifty-one thousand ounces of silver were produced during the year. Underground prospecting is still being carried on with a small force.

Princess

The company did not operate this mine, but it was worked under lease from May to November, 1915, on a 25 per cent. royalty basis by Sydney Smith and R. T. Walker, of Haileybury. The lessees shipped some ore, the greater part of which came from the party wall between the Princess and Right-of-Way.

University

A total of 1,479 tons of ore, averaging 17.42 ounces, was sent to the concentrator from this mine.

The production of silver for the year amounted to 1,135,142.87 ounces, the net value of which was $526,996.77. The cost of production was 31.64 cents per ounce and the net selling price 50.88 cents per ounce. The net profit on production was $230,662.73.

The only high grade ore at present in sight is a small amount contained in pillars in the La Rose mine.

T. J. Harwood is mine superintendent. Joseph B. Fyfe is mine captain of the La Rose and John Bunclark mine captain of the Lawson.

McKinley-Darragh-Savage.—The McKinley-Darragh-Savage Mines of Cobalt, Limited, during 1915 recovered 838,147 ounces of silver from McKinley-Darragh mine ore and 269,668 ounces from Savage mine ore. This makes the total production of these mines to the end of 1915:—McKinley, 12,682,781 ounces, and Savage, 2,805,786 ounces.

At the McKinley-Darragh mine the underground work done was:—

Levels.	Winze sinking	Raising	Drifting	Cross-cutting	Station cutting	Stoping
	ft.	ft.	ft.	ft.		tons.
50-foot	....	29.5	114	....	....	1,333
60-foot	....	....	20.5	....	....	192
75-foot	....	12	342	316	....	74
110-foot	....	20	147	....	....	20,326
150-foot	....	129	525.5	348.5	31c.y.	11.406
185-foot	....	....	46.5	....	....	98
200-foot	....	4	216	242.5	....	7,005
235-foot	....	....	61	....	....	42
250-foot	14.5	40	301.5	35.5	....	6,919
Totals	14.5	234.5	1,774	942.5	31c.y.	47,395

The total footage driven in the mine to date is 38,471.

At the Savage mine the work done during the year was distributed as follows:

Levels.	Shaft sinking	Winze sinking	Raising	Drifting	Cross-cutting	Station cutting	Stoping
	ft.	ft.	ft.	ft.	ft.		tons
70-foot	....	....	....	48	....	....	179
140-foot	....	26	27.5	81.5	....	....	1,176
162-foot	....	....	....	69.5	....	....	116
165-foot	....	....	....	39	....	....	142
190-foot	....	....	156.5	304.5	425	....	1,524
195-foot	....	....	....	69	44.5	....	179
240-foot	58.5	37.5	....	....	....	....	42
290-foot	....	....	24.5	142	19	27 c.y,	....
Totals	58.5	63.5	208.5	733.5	488.5	27 c.y.	3,358

The mill treated 50,912 tons of McKinley ore and 12,749 tons from the Savage. The heads averaged 17,165 ounces and the extraction was 80.9 per cent.

The annual report of the company for 1915 states:

The McKinley property has been so thoroughly prospected that the chance of discovering any ore bodies of great importance is very slight. . . . There remains a considerable amount of exploration to be done at the Savage before the possibilities of the property are entirely exhausted.

The officers and directors of the company are:—President, J. R. L. Starr, Toronto; vice-president, Thos. W. Finucane, Rochester, N.Y.; secretary, J. H. Spence, Toronto; treasurer, Harper Sibley, Rochester, N.Y.; assistant treasurer, Joseph S. Hunn, Rochester, N.Y.; Hiram W. Sibley and G. L. Thompson, of Rochester, N.Y. The head office is in the Canada Life Building, Toronto.

The operating officers are:—Manager, T. R. Finucane; mine captain of the McKinley-Darragh, H. C. McCluskey; mine captain of the Savage, Robert Brocklebank.

Mercer.—The Mercer Silver Mines, Limited, was formed to work the ground lease which reverted to the Peterson Lake Silver Cobalt Mining Company, Limited. The new company began work on August 11th, 1915.

On the 208-foot level of No. 1 shaft, which is on the west side of Cart lake, 40 feet of drifting was done. A shipment made from these workings contained 81,998 ounces of silver.

No. 3 shaft on the east side of Cart lake was sunk from 40 to 212 feet, and on the date of last inspection (March 16th, 1916,) 557 feet of crosscutting had been done to the southwest of the shaft and 290 feet to the north on the 195-foot level.

The footage driven during the fiscal year ending April 30th, 1916, consisted of: Crosscutting and drifting, 1,221.5 feet; sinking, 172 feet; station cutting, 2,688 cubic feet.

The officers are:—President, S. Harry Worth, Philadelphia, Pa.; secretary-treasurer, R. F. Segsworth, Toronto; consulting engineer and managing director, W. E. Segsworth, Toronto; manager, A. C. Bailey, Cobalt.

Thos. D. MacGuire is doing the work under contract and has 16 men employed.

Meteor.—The Meteor Silver Mining Company, Limited, worked their claim on Diabase mountain during all of 1915, closing down in February, 1916.

Drifting and crosscutting were done on the 80 and 115-foot levels.

D. D. Flanagan was in charge and had 12 men employed.

Mining Corporation of Canada.—The Mining Corporation of Canada, Limited, owns 183½ acres in the Cobalt camp comprising the Cobalt Townsite, Cobalt Lake, City of Cobalt, Townsite Extension and Little Nipissing mines. The Cobalt Reduction Company, Limited, is also controlled by the corporation. The company is capitalized at $2,075,000 in shares of $1.00 each, all issued; 1,911,319 shares are held by an English company, Canadian Mining Corporation, Limited.

The ore tonnage statement for 1915 follows:—

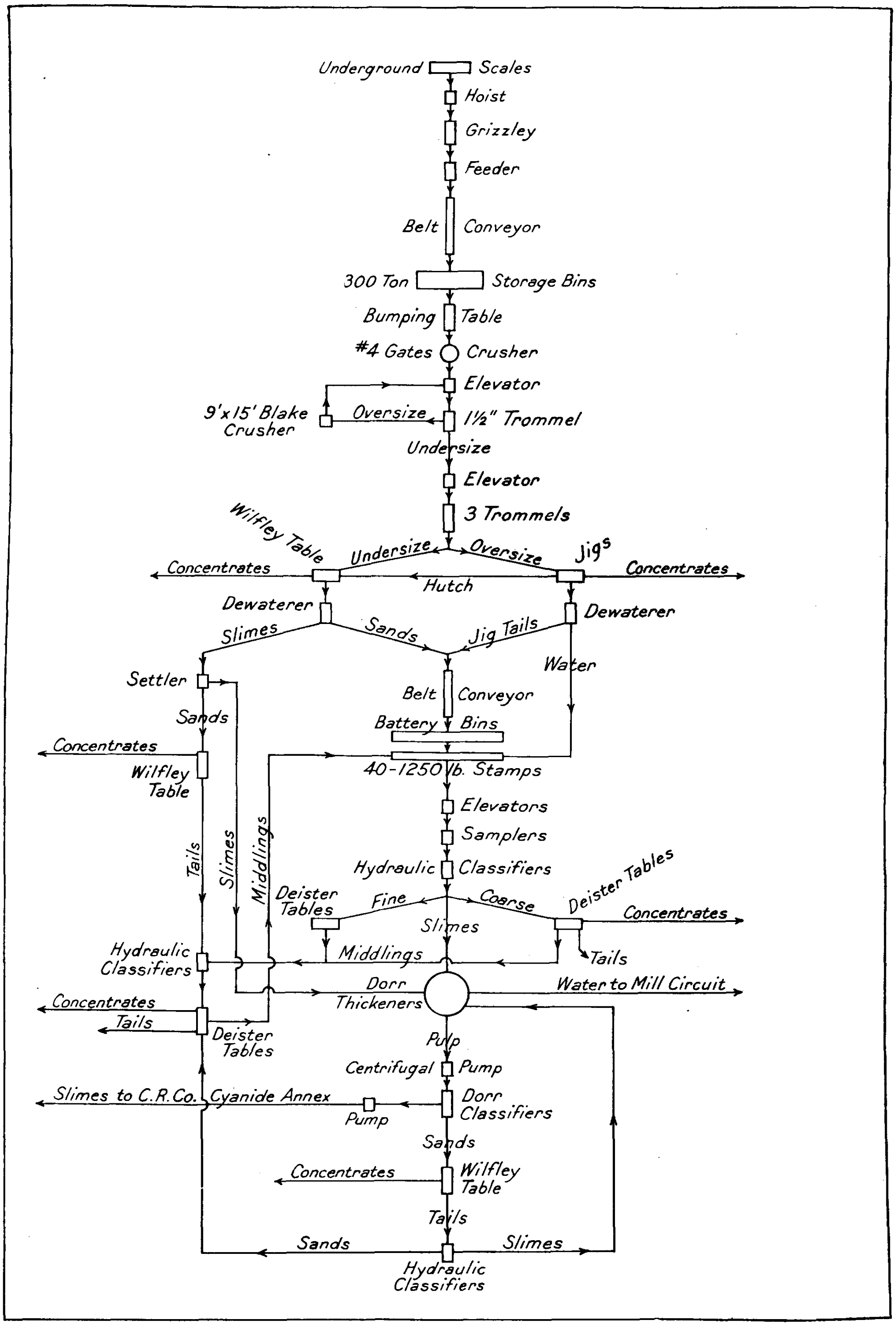
Mine	Hoisted	Broken	Treated
Cobalt Townsite	56,196	51,534	62,528
City of Cobalt	35,252	26,787	35,262
Cobalt Lake	35,678	26,818	35,089
Total	127,126	105,139	132,879

Of the total ore tonnage hoisted, 1,026.31 tons were sent to the smelter; 125,511 tons were treated in the company's mills, and 589 tons were placed on the dump.

The company is now producing more silver than any other company in Canada. The following summary gives an account of the silver produced during the year:—

Shipping Ore	Townsite-City Mine		Cobalt Lake Mine		Total	
	Tons	Ounces	Tons	Ounces	Tons	Ounces
High grade ore............	396.6	928,301	369.2	656,685	765.8	1,584,986
Low grade cobalt ore......	260.4	56,587	....	....	260.4	56,587
Milling ore	97,133.0	2,002,517	34,720.0	919,866	131,853.0	2,922,383
Total	97,790.0	2,987,405	35,089.2	1,576,551	132,879.2	4,563,956

The development and exploration done was as follows:—Drifting and cross-



Flow sheet, Cobalt Lake mill, October, 1915.

other public and private users depended largely on the water of the lake, an alternative supply had to be provided before undertaking the dewatering. A supply was found in the string of lakes south of Cobalt lake, which includes Short lake, Brief lake, North and South Pickerel lakes and Bass lake. The dewatering of Cobalt lake commenced on April 26th, 1915, and was completed on June 5th. To keep the lake dry, the pumps have to operate about half time. The technical details of the project were worked out by O. L. Flanagan.

The Cobalt Lake mill ran 97.3 per cent. of the possible time, deducting 29 days on which the mill was shut down due to shortage of power; 34,719 tons were milled, containing 1,083,280 ounces of silver. The ratio of ore milled to concentrate produced was 37.9. The stamp duty averaged 2.91 tons per 24 hours.

Mention of the Cobalt Reduction mill will be found elsewhere in this report under the heading, "Cobalt Reduction Company."

The average number of men employed by the corporation was 426.4 per working day.

Sir Henry M. Pellatt, Toronto, is president; D'Arcy Weatherbee, Toronto, consulting engineer, and C. E. Watson, Cobalt, resident manager.

National.—The National Mines, Limited, started work on April 1st, 1916, on the King Edward claim, west of Cross lake. The property was last worked by the York Ontario Silver Mines, Limited, who held a lease from the King Edward Silver Mines, Limited. This lease has been acquired by the new company.

Work done in previous years on this claim consists of several shallow shafts and a tunnel driven 1,000 feet in a westerly direction, starting about 30 feet above the level of Cross lake. About 400 feet from the portal a winze was sunk on vein No. 4 to a depth of 352 feet below the tunnel or 500 feet below the surface. In 1913 diamond drilling at this point proved the diabase-Keewatin contact to be at 1,171 feet below the surface. The winze is now to be sunk 500 feet deeper and crosscutting will be done above this contact. The work is to be done by Thomas D. MacGuire, of Cobalt, on contract.

The officers of the company are:—President, H. E. Jackman, Rochester, N.Y.; secretary-treasurer, Ernest C. Whitbeck, 17 Elwood Building, Rochester, N.Y.

Nipissing.—The following information is extracted from the eleventh annual report of the Nipissing Mines Company, covering operations for the year 1915:—

The company produced 4,097,391 ounces of silver, valued at $2,222,256.29. The net receipts were $1,441,427.67. The cost was 19.06 cents per ounce of silver produced, or $10.02 per ton of ore milled.

Twenty per cent. was paid in dividends, or $1,200,000. This makes the total dividends of the company to date 224 per cent., or $13,440,000.

In the high grade mill there was treated 921 tons of Nipissing ore, averaging 2,474 ozs. per ton and 533 tons of custom ore, averaging 2,917 ozs. per ton. The refinery also treated the product from the low grade mill containing over two million ounces. The shipments of cobalt residue amounted to 326 tons. The amalgam is now melted to bullion in one heat in large graphite crucibles mounted in tilting furnaces.

The following is a summary of the work done in the low grade mill:—

	Dry Tons.	Assay Ozs.	Silver Ozs.
Ore treated	77,071	29.62	2,282,614
Bi-products treated	112	1,322.34	148,036
	77,183	31.49	2,430,650
Bullion recovered from above			2,127,372
Extraction			87.52 per cent.

The treatment costs on low grade ore were $3.913 per ton.

Owing to the present high cost of aluminum dust, experiments are now being carried on with the use of sodium sulphide as a precipitant, the resulting silver sulphide being desulphurized by the use of aluminum ingots in a caustic soda solution, before being melted down to bullion.

A small oil flotation plant of four cells is being installed.

The use of Callow screens in the tube mill circuit to collect metallics has been discontinued as the extraction and the cost in the cyanide plant were not improved.

The hydraulic (surface prospecting) plant was operated for six months to remove the soil from an area to the east of Cart lake and to the south of Peterson lake. Some 111 acres were washed at a cost of $372.08 per acre. The amount of overburden removed was 445,563 cubic yards at a cost of 9.27 cents per cubic yard. The average depth of soil was 2.49 feet.

A summary of the underground work done in 1915 follows:—

Shaft No.	Drifting feet	Crosscutting feet	Raising feet	Sinking feet	Total feet	Stoping cubic yards
14 O'Brien ...	....	499.0	....	....	499.0	....
63	316.0	521.5	53.0	....	890.5	2,356
64	171.0	673.0	....	37.0	881.0	....
73	1,520.0	3,202.0	744.0	136.5	5,602.5	15,154
80	172.0	757.0	86.5	....	1,015.5	106
81	....	....	....	6.0	6.0	....
96	248.0	280.0	85.0	28.0	641.0	551
150	139.5	676.5	105.5	....	921.5	....
H. veins 55 & 63	....	....	....	39.0	39.0	365
Totals.....	2,566.5	6,609.0	1,074.0	246.5	10,496.0	18,532

Diamond drilling (all underground at No. 80 shaft), 503 feet.

Claim R. L. 402, lying north of the O'Brien mine, is now being explored from the O'Brien No. 14 shaft. Crosscuts are being run east and west along the boundary between this lot and the O'Brien.

The Little Silver veins were developed through shaft 63 and proved much better than expected. After a steady production throughout the year the reserves in these veins are higher than the estimates of a year ago and amount to 675,000 ozs.

From shaft 64 a crosscut is being driven north on the second level to prospect the conglomerate between vein 64 and the Bucke township line.

The workings from shaft 73 produced the greater part of the ore sent to the mill. Geological study, confirmed by diamond drilling, has shown the conglomerate on the east side of this lot to continue to a depth of 150 feet below the fourth level over a considerable territory.

As the Cobalt lake fault enters Nipissing ground on the dip, and as two of the ore shoots on Cobalt lake ground were found near the boundary, it has been decided to sink shaft 81 to the contact, and from it to thoroughly explore the fault on the Nipissing side of the line.

The reserves of developed and partly developed ore were estimated to be as follows on Dec. 31st, 1915:—

Shaft No.	High Grade Ore		Mill Ore		
	Tons	Ounces	Tons	Assay	Ounces
64	203.1	200,403	4,049	20	80,980
73	1,621.2	2,743,190	73,118	25	1,827,950
80	179.9	385,250	5,570	25	139,250
100	260.4	609,400	11,391	25	284,800
63	195.5	469,900	8,425	24.3	204,770
96	51.9	148,300	2,263	25	56,575
	....	....	104,816	24.7	2,594,325
Dumps	....	....	75,420	23.5	1,770,950
	2,512.0	4,556,443	180,236	24.2	4,365,275

The following is a summary of estimated ore reserves:—

	Tons.	Assay.	Ounces.
High grade ore	2,512	1,814.	4,556,443
Mill ore	180,236	24.2	4,365,275
Total	182,748	48.8	8,921,718

The officers of the Nipissing Mining Company, Limited, are:—David Fasken, Toronto, president; R. B. Watson, Cobalt, general manager; Hugh Park, Cobalt, manager. The officers and directors of the Nipissing Mines Company, which is a holding company, owning all the stock of the Nipissing Mining Company, are:—President, E. P. Earle, New York; secretary, R. T. Greene, New York; W. H. Brouse, Duncan Coulson and David Fasken, of Toronto; John L. Feeny and August Heckshher, of New York; Denis Murphy, of Ottawa; R. B. Watson, Cobalt.

Northern Customs Concentrators, Limited.—The customs concentrator of the above company at mileage 104, ran continuously in 1915. The ore treated came from La Rose, Seneca-Superior and Right-of-Way mines; 45 men were employed.

The officers of the company are:—President, A. J. Young, 702 Excelsior Life Bldg., Toronto; vice-president, C. J. Booth, Ottawa; secretary-treasurer, A. J. Bourne, Cobalt; directors, M. J. O'Brien, Renfrew, and Dr. C. W. Haentschel, Haileybury; superintendent, A. S. Holmes, Cobalt.

O'Brien.—The development work done at the O'Brien mine in 1915 was as follows:—Drifting and crosscutting, 3,335 feet; raising, 31 feet; sinking, 113 feet; total, 3,479 feet.

The main shaft has been sunk to a depth of 340 feet. The winze (No. 20) from the 300-foot level of No. 6 shaft has been sunk to a depth of 250 feet and four levels have been opened.

A total of 52,883 tons was treated in the mill.

On claim A1 on the Gillies Limit the O'Brien mine has sunk a shaft to a depth of 210 feet and cut stations at 100 and 200 feet. On the 200-foot level 60 feet of drifting had been done to the west and the same amount to the east when last inspected in March, 1916. The work is being done on a vein in the Keewatin series. Considerable graphite is contained in the rock in these drifts.

The mine is owned by M. J. O'Brien. R. H. James resigned as manager in May, 1916, to go on active service and was succeeded by J. G. Dickenson.

Ophir.—The Ophir Cobalt Mines, Limited, began to unwater the north shaft of their mine in southeast Coleman in December, 1915, and then started diamond drilling to determine the depth of the Keewatin-diabase contact. All the work done in past years was in the Keewatin series.

The north shaft is 300 feet deep—the first 140 feet of which is vertical and the remainder dips at about 80 degrees. Drifting has been done on the 100, 200 and 300-foot levels.

The officers of the company are:—President, H. H. Lang, Toronto; secretary, F. L. Cody, 615 C.P.R. Bldg., Toronto; consulting engineer, B. Neilly, Box 542, Cobalt; mine captain, Wm. J. Donaldson, Cobalt.

Penn-Canadian.—The Penn-Canadian Mines, Limited, operated during all of 1915.

For the year ending May 31st, 1916, the development work done was as follows:

—	Drifting	Crosscutting	Raising	Winze Sinking	Totals
3rd level	293.5	137	....	....	430.5
Sub-levels	94	27	....	....	121
4th level	1,261.5	747.5	53	....	2,062
Sub-levels	516	....	48	....	564
5th level	592	372.5	63	82	1,109.5
Sub-levels	75.5	....	....	18	93.5
6th level	143	118	10.5	....	271.5
Totals	2,975.5	1,402	174.5	100	4,652

There was also 777 feet of diamond drilling done.

By the addition of a Hardinge ball mill the capacity of the mill has been increased to 115 tons per day. To take care of the additional tonnage one roughing table, one double-compartment Hartz jig and two sand tables have been added. The efficiency of the mill has been increased by a system of vortex classifiers and by a table to re-treat the concentrates.

The officers of the company are:—President, Wm. J. Haines, Philadelphia; directors, Spencer D. Wright, Philadelphia; Robt. B. Haines, Jr., Philadelphia; Jansen D. Haines, Des Moines, Ia.; Elliott C. P. Laidlaw, New York. Balmer Neilly, Cobalt, is manager.

Peterson Lake.—The Peterson Lake Silver Cobalt Mining Company, Limited, has an authorized capital of $3,000,000 divided into shares of $1.00 par value each; 2,401,820 shares have been issued.

The work done under Peterson lake for the fiscal year ending April 30th, 1916, consisted of:—Crosscutting, 2,497 feet; drifting, 1,422 feet; raising, 50 feet; winze-sinking, 60 feet; total, 4,479 feet. Most of the work was done from No. 2 shaft. This shaft was connected by a raise with the Little Nipissing, and work was carried on along the northeast shore of the lake. In February, 1916, the workings from Nos. 1, 2 and 3 shafts were abandoned. In October, 1915, the Nova Scotia shaft was unwatered and crosscutting begun on the 200-foot level to intersect some veins outcropping near the shore of Nova Scotia bay.

In February, 1916, an option was taken on the Reliance claim which lies south of the Nova Scotia claim. A limited amount of development work will be done.

Portions of the company's lands were worked under lease by the Seneca Superior Silver Mines, Limited, and the Mercer Silver Mines, Limited.

Dividends paid during the fiscal year amounted to $168,127.40.

The directors are:—President, Sir H. M. Pellatt, Toronto; 1st vice-president, Hugh Blain, Toronto; 2nd vice-president, J. W. Scott; Col. A. M. Hay, Haileybury; Major J. A. Murray. C. H. Manaton, 420 Traders' Bank Bldg., Toronto, is treasurer.

Frank G. Stevens is consulting engineer, and Norman Milne, superintendent.

Right of Way.—The Right of Way Mines, Limited, worked their No. 3 mine near the Silver Queen from March, 1915, to February, 1916. The work was done on the 75 and 120-foot levels. In February, 1916, the No. 2 mine, near the north end of Cobalt lake, was reopened.

The quantity of silver produced in 1915 was as follows:—

Ore shipments containing	102,274.38 ounces.
Ore on hand containing	11,262.76 "
Total	113,537.14 "

The development work done amounted to 522 feet. This consisted of 122 feet of raising, 130 feet of crosscutting and 270 feet of drifting. With the exception of 66 feet of raising all the above work was done at No. 3 mine.

The head office of the company is at 46 Elgin St., Ottawa. The directors are: President, E. Seybold; vice-president, A. W. Fraser, K.C.; secretary-treasurer, E. A. Larmonth; director, C. Jackson Booth, all of Ottawa. D. H. Angus, Cobalt, is mine superintendent.

Rochester.—The Trethewey Silver Cobalt Mining Company, Limited, commenced work in July, 1915, on the Rochester claim in southeast Coleman. A crosscut is being driven in a southwesterly direction from the 300-foot level of the Lumsden Mining Company's main shaft to prospect the Keewatin formation beneath Brady lake. Eight men are employed. H. S. Robinson is superintendent and Chas. A. Froats, mine captain.

Seneca-Superior.—The Seneca-Superior Silver Mines, Limited, has a capital of 500,000 shares of $1.00 par value each. 478,884 shares have been issued.

Exploration was continued on the second and third levels, but no new ore bodies were found. A winze, 79 feet deep, was sunk from the floor of the fourth or 335-foot level at a point 430 feet southeast of the east shaft. Fifteen feet below the collar this winze entered the Keewatin formation. The ore continued into the Keewatin about 45 feet. The mine will probably be worked out in the spring of 1916.

The following is a summary of underground development to the end of 1915:

—	1912	1913	1914	1915	Total.
Drifting on vein—feet	346	645	780	85	1,856
Drifting—exploratory—feet.	737	3,453	2,514	960	7,664
Sinking and raising—feet	121	351	152	106	730
	1,204	4,449	3,446	1,151	10,250

During the year 25,194 tons of ore and 4,375 tons of waste were hoisted. This tonnage of ore was put through the mill and produced:—

Shipping ore		481.0 tons
Fines for concentrating—8,654 tons which produced—		
Jig concentrates	145.6 tons	
Table concentrates	387.6 "	
		533.2 tons
		1014.2 tons

Ratio of ore milled to concentrates, 16 to 1.

Production for the year was 2,047,150 ounces of silver, making a total production of 5,001,870 ounces since 1912.

The officers of the company are:—President, S. Harry Worth, Philadelphia, Pa.; vice-president, F. W. Zoller; treasurer, R. F. Segsworth, Toronto; managing director, W. E. Segsworth, 103 Bay Street, Toronto; manager, R. H. Lyman, Cobalt.

Shamrock.—The Shamrock Consolidated Mines, Limited, renewed operations in August, 1915, on their claim north of and adjoining the Beaver mine.

The shaft is 417 feet deep with levels at 100, 200, 300 and 400 feet. All of the work done since reopening has been on the 400-foot level. 197 feet of cross-cutting was done here in 1915 in the diabase at about 40 feet below the Keewatin-diabase contact. Nine men were employed.

The officers are: President, Peter Kirkegaard, Toronto, Ont.; secretary, Joseph Montgomery, Confederation Life Bldg., Toronto; superintendent, A. M. Bilsky, Cobalt; mine foreman, Walter Purdy.

Silver Queen Mine.—The Silver Queen mine was worked under lease from June 22nd, 1915, to Jan. 22, 1916, by E. V. Neelands and D. H. Angus, of Cobalt.

The mine is the property of the Cobalt Silver Queen, Limited. Dr. E. P. Smith, 1323 Traders' Bank Bldg., Toronto, is president.

Temiskaming.—The main shaft of the Temiskaming Mining Company, Limited, is being sunk to the lower diabase-Keewatin contact. At the date of last inspection (March 14, 1916) it was 1,050 feet deep with sinking in progress. A station has been cut at the 835-foot level.

The work done in the mine in 1915 consisted of:—Drifting, 2,717.5 feet; cross-cutting, 1,301.0 feet; shaft sinking, 43.5 feet; winze sinking, 84.0 feet; raising, 617.5 feet; making a total of 4,763.5 feet.

Stoping was carried on to the extent of 8,835.1 cubic yards.

The mill treated 26,927 tons of ore and produced 390.85 tons of concentrates from which 509,073.62 ounces of silver were recovered.

The production for the year was 1,456,894 ounces of silver. This makes the total production of the mine to date 9,116,404 ounces. The high grade ore averaged 6,413 ounces per ton and the mill concentrates averaged 1,302 ounces per ton.

The officers are:—President and general manager, F. L. Culver; vice-president, W. T. Mason; treasurer, H. E. Tremain; secretary, R. Graham. The head office is in the Lumsden Building, Toronto.

The resident officers are:—Superintendent, J. W. Moffett, Cobalt, Ont.; mine foreman, W. D. Cooper; mill foreman, C. E. Reese.

Trethewey.—The mine of the Trethewey Silver-Cobalt Mine, Limited, was worked only from January 1st to February 28th in 1915. During this period 295 feet of development work was done, making the total development to date 24,130 feet. In the mill 6,113 tons of ore were treated at a cost of $1.18 per ton and yielded 85,004 ounces of silver.

The positive ore reserves at December 31st, 1915, are estimated at 26,774 tons, with a total silver content of 507,339 ounces.

The company has purchased control of the Rochester mine in southeast Coleman. The work done at this property is described elsewhere in this report.

Claim A.98 on the Gillies Limit was also acquired during the year. This claim is on the diabase-Keewatin contact south of Giroux lake.

On two claims adjoining the Huronia mine, in Gauthier township, 1,725 feet of diamond drilling was done. As no orebody of economic importance was cut, the option was allowed to lapse.

The officers of the company (with head office at 1428 Traders' Bank Building, Toronto) are as follows:—President, Alex. M. Hay, Haileybury, Ontario; vice-president, S. R. Wickett, Toronto; secretary-treasurer, L. J. Pashler, and directors: Alex. M. Hay; T. E. Leather, Hamilton; W. J. Sheppard, Waubashene; Gordon Taylor, Toronto; James B. Tudhope, Orillia; S. R. Wickett, Toronto.

Stuart M. Thorne retired from the management to go on active military service. He was succeeded by H. S. Robinson as manager.

Twentieth Century.—The Twentieth Century Mining Company, Limited, did some work on the property in lot 1, concession 6, Coleman township, formerly known as the "Century." The shaft was pumped out in July and work was carried on intermittently until January, 1916. It is reported that 200 feet of drifting was done on the 350-foot level east of the shaft.

Sidmore Seager, Buffalo, N.Y., is president, and L. R. Lipton, Buffalo, manager.

Elk Lake

Mapes-Johnston.—The Mapes-Johnston Mining Company, Limited, own claim R.S.C. 79, situated north of Silver lake, in the township of Mickle. Work was suspended from March to November, 1915.

Since last Annual Report was written a little stoping has been done on the 100-foot level east of the shaft, and a winze has been sunk to a depth of 80 feet below the 190-foot level. At a depth of 65 feet in the winze a level has been opened and 40 feet of drifting done to the northeast and 38 feet to the southwest. The winze is now being sunk deeper. Twenty-two men are employed.

The officers of the company are:—President, John J. Cohoe, Brantford; managing director, E. L. Gould, Brantford, Ont.; superintendent, D. G. Oliver. Elk Lake, Ont. The head office is at Brantford, Ont.

Paragon.—The Paragon Silver Mining Company, Limited, worked their property in Willett township until December 1st, 1915. The shaft has been sunk to a depth of 168 feet. The drifting done consisted of 40 feet on the 90-foot level and 32 feet on the 160-foot.

The officers of the company are:—President, Donald McKay, M.D.; first vice-president, Thomas C. Brown; second vice-president, A. G. McKean; treasurer, W. A. Hamilton; secretary, David Melville, Collingwood, Ont.; director and superintendent, Joseph P. Welsh; director, W. H. Habgood.

Gowganda

Barbara Mine.—The Barbara Mine consists of six claims, S.W. 6, S.W. 7, S.W. 8, S.W. 9, G.G. 4108 and G.G. 4109, situated on the north shore of Irene or Flatstone lake, in the Gowganda area. The claims are owned by Edmund B. Ryckman, K.C., Toronto, and George R. Rogers, Wigwam, Ont.

Camps have been built and a 25 h.p. Jenckes vertical boiler and a 6-inch by 8-inch Jenckes hoist set up. The underground workings on February 10th, 1916, consisted of a two-compartment shaft sunk to a depth of 100 feet and crosscuts on the 100-foot level to a distance of 52 feet west and 8 feet east of the shaft.

George R. Rogers is manager, and had nine men employed at the above date.

Bishop.—The Bishop Silver Mines of Canada, Limited, are working Claim L. O. 313, situated on the east side of Calcite lake.

An adit has been driven from the shore of Calcite lake eastward 246 feet. At a distance of 216 feet from the portal, drifting has been done 464 feet north and 127 feet south on a vein in which native silver has been found at several points. All the work is in diabase.

The officers are:—President, Stuart Lindsley, Orange, N.J.; treasurer, C. S. McKune, New York; secretary, George Rosendale, New York. Head Office: 409 West 55th St., New York.

Eight men are employed under superintendent Wm. J. Shields, Wigwam, Ont.

Crews-McFarlan.—The Crews-McFarlan Mining Company, Limited, own mining claims G.G. 3927 and G.G. 3937, situated west of Hewitt lake in Milner township in the Gowganda area. The officials of the Company are:—President, Wm. McFarlan; secretary, H. R. Crews; treasurer, C. H. Streit; all of Patterson, N.J.; manager, Thos. F. Malloy, Gowganda, Ont. The head office is Room 104, Colt Building, Patterson, N.J.

Camps and a blacksmith shop have been built and a two-compartment shaft was started on claim G.G. 3927 on November 1st, 1915. This shaft was 70 feet deep on February 11th, 1916, when the property was visited. A horse whim was in use and 12 men were employed.

Hewitt Lake.—The Hewitt Lake Mining Syndicate continued work on their property in Milner township during all of 1915 and closed down on Jan. 3, 1916. Drifting was continued on the 300-foot level of the main shaft and a new shaft, known as No. 2, was sunk 70 feet.

The officers are:—President, T. B. Clevenger, Rochester, N.Y.; manager, M. F. Cottrell, Gowganda, Ont.

Miller Lake-O'Brien.—The above mine worked all of 1915. Work is now confined to No. 2 and No. 7 shafts. At No. 2 considerable drifting was done on the 140 and 350-foot levels and stoping was carried on above the 140, 240 and 350-foot. At No. 7 shaft, which is 200 feet deep, a winze is being sunk at the end of the east drift on the 200-foot level.

J. G. Dickenson, Cobalt, is manager and B. C. Crowe, Gowganda, Ont., superintendent. At the time of last inspection 78 men were employed.

Powerful.—The Powerful Development Company started work in June, 1915, on mining claim H.R. 397, situated in Lawson township near the west boundary.

This claim was first worked by the Powerful Mining Company. In the summer of 1914 the Oliver Silver Mining, Limited, took a lease on the property but worked for only three weeks. In 1915 the Powerful Development Company acquired the Oliver lease.

The machinery on the claim consists of a Leonard boiler, 80 h.p.; a Laidlaw-Dunn-Gordon compressor, 14" x 14" x 12"; a Jenckes hoist, 6" x 8".

The following is a statement of the underground work done to February 14th, 1916:—

A tunnel runs north-east into a hill and 900 feet of crosscutting and drifting has been done on 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 officers of the Development Company are:—President, O. Champeau, chief of police, Montreal; secretary-treasurer, J. A. Bonneville, Montreal; manager, Oliver Deschamps, Wigwam, Ontario; head office, 709A Power Building, Montreal.

Reeve-Dobie.—The Reeve-Dobie silver property, comprising claims S.W. 3, S.W. 4 and S.W. 5, west of Gowganda lake has been purchased by the following gentlemen:—A. J. Skobba, Minneapolis, Minn.; Chas. Moore, Bay City, Michigan; F. C. Moore, Sudbury, Ont.; S. Christopherson, Gowganda, Ont.

Work was started in December, 1915. Up to the date of last inspection (Feb. 11th, 1916) the work done by the new management was confined to extracting high-grade silver ore from an open-cut a few feet east of the power plant. Eight men were employed under Mr. Christopherson.

Lorrain and South Lorrain

Bellellen.—On claim R.L. 470, South Lorrain, work was resumed in September, 1915, by the Bellellen Syndicate. On the 100-foot level, about 100 feet north of No. 2 shaft, a winze has been sunk 75 feet. On the 40-foot level of this winze 30 feet of drifting has been done and at the bottom of the winze a drift extends to the south a distance of 125 feet.

Chas. A. Richardson, Haileybury, is manager and Sylvester Carroll, mine foreman. About 15 men are employed.

Currie.—The Currie mine on claim H.R. 105 in South Lorrain was worked continuously in 1915 by the Pittsburg Lorrain Syndicate.

The shaft has been sunk 275 feet on the slope, the first 175 feet is at 45 degrees and the remaining 100 feet at 85 degrees. On the 4th or 175-foot level a winze was started about 500 feet southeast of the main shaft and was sunk for 115 feet at 80 degrees. Levels were opened off the winze at 50 and 100 feet and by February, 1916, the drifting done on these winze levels was: On the 50-foot, 50 feet to the north-west and 50 feet to the south-east; on the 100-foot, 20 feet to the north-west and 75 feet to the south-east. A No. 1½ special Sirocco reversible fan is used for ventilating the winze workings.

Just above the winze a body of high-grade ore was encountered. The shoot is about 60 feet long and north of the winze it extends to a known height of 85 feet above the level, while south of the winze it runs for 40 feet above. It is in the Keewatin series just above the Keewatin-diabase contact.

Thos. B. Rice, Silver Centre, is superintendent, and Mr. J. A. Rice, 208 Mills Bldg., El Paso, Tex., consulting engineer. The syndicate employ 25 men.

Giroux Claim.—On a claim situated on the north shore of Latour lake, Concession 2, Lorrain township, a shaft has been sunk to a depth of 50 feet and 24 feet of crosscutting done on the 50-foot level. The claim is owned by Fred Giroux.

Keeley.—The Keeley mine was worked by the Associated Gold Mines of Western Australia from May to Oct. 1st, 1915. The work performed consisted of 59 feet of drifting from No. 1 shaft and 328 feet from No. 2.

Dr. J. M. Bell, 310 Dominion Express Building, Montreal, was managing director, and J. G. Harkness, Silver Centre, Ont., mine superintendent.

Tallen.—On Claim H.R. 106, South Lorrain, the Tallen Mining Company, Limited, has sunk a two-compartment shaft 200 feet. On the 200-foot level a drift is being run N. 40 degrees W. In February, 1916, the face of this drift was 200 feet from the shaft. Eight men are employed.

All the work done in this shaft is in diabase with the exception of the last 20 feet at the face of the above-mentioned drift, which is in Keewatin.

The officers of the company are:—President, C. Ferguson, McDonald, Pa.; consulting engineer, J. A. Rice, El Paso; superintendent, Thos. B. Rice, Silver Centre, Ont.

Maple Mountain

Rubicon.—On the property of the Rubicon Silver Mining Company, Limited, in Whitson township, the shaft was sunk to 100 feet and 14 feet of crosscutting was done to the south of the shaft at the 100-foot level. Work ceased in March, 1915.

The officers of the company are:—President, M. J. Morrison, K.C.; secretary-treasurer, E. J. F. Markgraf, Montreal; manager, S. J. Callaghan, Montreal; head office, 180 St. James Street, Montreal.

Taylor.—On mining claim, H.S. 574, on the south shore of McKenzie lake, Speight township, a shaft was started in July, 1915. On February 14th, 1916, this shaft was 155 feet deep and 25 feet of crosscutting had been done on the 150-foot level.

The claim is owned by E. O. Taylor, 244 St. George Street, Toronto. The underground work is being done by L. Peterson, Elk Lake, under contract. Nine men are employed.

White Reserve.—The White Reserve property in the Maple Mountain district is owned by the White Reserve Mining Company, Limited, which has an authorized capital of $200,000 in shares of $1.00 par value each.

During 1915 about 200 feet of drifting was done upon one vein and 30 feet of sinking on another. A prospecting shaft has been sunk to a depth of 35 feet on a third vein. Surface prospecting has been continued to date (May, 1916). The plant has not been in operation since September, 1915, all work since that month being done by hand.

J. A. McAndrew, Lumsden Building, Toronto, is managing director.

IV.—EASTERN ONTARIO

Iron Pyrites

Caldwell.—On lots 1 and 2, in the first concession of Blithfield township, Renfrew county, T. B. Caldwell, of Lanark, is developing a deposit of iron pyrites.

Work was commenced in the spring of 1916, and on the date of inspection in July an incline shaft had been sunk on the vein to a depth of 60 feet. The walls are well defined and from foot to hanging walls there is an average width of 8 feet, and the shaft has been carried 12 feet in width.

A short siding has been built about four miles north of Flower station, on the K. & P. ry., and eventually this will be used as a shipping point when the road to the mine is completed. The plant consists of an 18 h.p. upright boiler, one single drum hoist and guyed derrick.

There are several outcrops on the strike of the vein, east and west of the main shaft, and in the proposed development of the property a station will be cut at the 70-foot level and drifts run east and west to decide the extent of the vein in length. Two cars of ore were shipped as a sample lot from shallow workings, and hauled out before the spring break-up.

Twelve men were employed under superintendent, Samuel Jackson.

Nichols Chemical Company.—The pyrites mine and acid plant operated by the Nichols Chemical Company, a subsidiary of the General Chemical Company, are situated at Sulphide, on lot 23, concession XI, township of Hungerford.

Work in the mine during 1915 was confined to stoping on the north vein and drifting about 250 feet on the new south vein. The main shaft is now 575 feet deep.

Mention has been made in previous reports of the splendid and successful efforts made by the management of this company along the lines of accident prevention and emergency treatment of minor injuries.

During the year 1915, although the working force was trebled, necessitating the employment of unskilled and inexperienced men, the accident rate showed a decided decrease.

At the plant a new brick wash and bath house was erected, containing lavatories, shower baths, etc. Later a similar building will be erected at the mine.

W. H. DeBlois is manager, employing 35 men at the mine and from 125 to 150 at the chemical plant.

Queensboro Mine.—This mine is situated near Queensboro, in the township of Madoc, and is owned and operated by the Canadian Sulphur Ore Company. During 1915 the main shaft was sunk to a depth of 307 feet, and stoping continued on the east and west ore bodies.

The only addition to the plant during the year was one small Marsh and Henthorn hoist, for handling cars on the incline from the crusher bins to the railway. A new 7 drill compressor will be installed early in 1916 to take care of the proposed development work.

The officers of the company are:—Alex. Longwell, president; Geo. H. Gillespie, manager; W. Coleman, superintendent; and 45 men were employed throughout the year.

Iron

Canada Iron Mines, Limited.—There was no production of iron ore in eastern Ontario during 1915. Both the mine at Bessemer and the concentrator at Trenton owned by the Canada Iron Mines, Limited, were closed during the year.

Early in the year 1916 the company shipped 15,000 tons of magnetic concentrates to Buffalo. This shipment averaged: iron (natural), 55, and phosphorus, .020 per cent.

No definite arrangements for 1916 operations have been made, but it is highly probable that the Hastings County mines will be opened up in the spring. The officers of the company are:—F. B. Richards, president; A. W. Holmestead, secretary, and W. J. McLaughlin, manager.

Gold

Cordova.—In the Twenty-Fourth Annual Report of the Bureau of Mines a full description is given of the many improvements and additions to the plant at Cordova mine, made during the last half of 1914 and the early part of 1915. In April, 1915, the mine was closed for the balance of the year.

Peter Kirkegaard is managing director of the operating company, known as Cordova Mines Limited.

Golden Fleece.—The Golden Fleece Mine is situated on the west half of lot 24 and on lot 25 of the sixth concession, township of Kaladar. The property was described in the Twenty-Second Annual Report of the Bureau for 1913, and at the time was being operated by the A. B. P. Mining company. Late in 1915 it was acquired by the Cobalt Frontenac Mining company. The old workings were dewatered and sampled and preparations are being made to place the mine on a producing basis.

No. 1 shaft is 85 feet deep, with a station cut at 61 feet. At this level a drift runs to the north 66 feet, with 21 feet of crosscutting.

No. 2 shaft is 40 feet deep.

The plant from the Cobalt Frontenac mine at Elk Lake has been transferred to the Golden Fleece. D. H. Fletcher, Hamilton, is president of the operating company, and the work at the mine is in charge of E. Craig. The post office of the mine is Flinton, about two miles distant.

Ore Chimney.—The Ore Chimney Mining Company, Limited, continued to develop its property in Barrie township during 1915. At the close of the year the development to date was as follows:—

Shaft, depth 340 feet.

1st level at 108 feet, east drift 17 feet, south drift 6 feet, and crosscut 25 feet.

2nd level at 150 feet, north drift 107 feet, south drift 79 feet, and total crosscutting 78 feet.

3rd level at 250 feet, north drift 83 feet, south drift 100 feet, and total crosscutting 237 feet.

4th level at 300 feet, crosscutting 31 feet.

5th level at 332 feet, crosscutting 44 feet.

Stations have been cut at the first three levels. A new safety cage has been installed and the 20-stamp mill mentioned in the last report has been erected. The stamps only are in place, but it is the intention of the management to add a magnetic concentration process. The gold values will be recovered by amalgamation, but the process for the zinc and copper values has not yet been decided. During the year a small assay laboratory was installed. The mine closed down in December, 1915, and it is expected that operations will be resumed in March, 1916.

No ore was shipped from the property during the year.

From 30 to 40 men were employed throughout the year. The officers of the company are:—D. E. Fletcher, president, Hamilton; Chas. Narraway, secretary, Hamilton, and W. G. Anderson, manager, Northbrook.

Ore Mountain.—The Ore Mountain Mining Company, Limited, continued to prospect its property on lot 32, concession I, Barrie township. The original shaft was abandoned and a small amount of work done at other points on the property. The Pay Ore Mines, Limited, and Ore Extension Mining Company were closed throughout the year.

Talc

Connolly Mine.—The Connolly talc mine is situated near the village of Madoc and adjoins the Henderson mine on the east. During the year the Anglo-American Talc Corporation, Ltd., was formed and took over the lease held by the former operators. Development work was continued and the shaft sunk to a depth of 140 feet—with levels at 65 feet and 130 feet.

A grinding plant is in course of erection at the mine and a building 100 feet by 30 feet has been erected.

The officers of the corporation are:—H. S. Predmore, president, New York; R. J. Gilchrist, secretary, New York; Thomas Carswell, superintendent, Madoc.

Eldorite Limited.—Eldorite Limited, formerly the Canadian Talc and Silica Company, worked intermittently during the year. The work was under the direct supervision of J. A. Haig, representing the principal owners. Further changes were made in the grinding plant, and it is expected that in 1916 this property will be a steady producer. Robert Phillips was succeeded as superintendent by R. C. Millington.

Gillespie Mill.—Messrs. George H. Gillespie and Company operated their talc grinding plant steadily during the year. This company purchases its supply of talc from Messrs. Cross and Wellington and takes about 90 per cent. of the output of the Henderson mine. The plant was described in the Twenty-Fourth Annual Report, and remained the same, with no additions during 1915. Twenty-five men are employed.

Henderson Mine.—This property, near the village of Madoc, has been described in successive Annual Reports of the Bureau of Mines, and is one of the largest producers of pure white talc in the world.

It is operated under lease by Messrs. Cross and Wellington, of Madoc. During the year 1915 work was confined to the sub-level drift through caved material between 1st and 2nd levels. This drift when completed will connect the two shafts. The output of the mine was greater than in any year since the mine was opened. S. Wellington is in charge of the mine, employing an average of 10 men.

Fluorite

On lot 11, concession XIII, in the township of Huntington, known as the Perry lot, Messrs. Cross and Wellington are developing a deposit of fluorite. The vein varies from 1 to 3 feet in width and has been stripped a distance of 200 feet. Near the Madoc-Belleville branch of the Grand Trunk a shaft is being sunk which was down 25 feet when inspected on February 9th, 1916. About 100 tons of fairly clean spar had been produced from this shaft, and stock-piled near the siding.

On lot 10, concession XIV, of Huntington, known as the Rogers lot, Messrs. Cross and Wellington have pumped out the old workings and are preparing to resume sinking operations. A syndicate headed by C. M. Bowman did some work on this lot in 1914, and sunk the shaft to a depth of 65 feet.

There are several known deposits of fluorite near Madoc, and it is quite possible that the coming year will see considerable activity in this district. The fluorspar is apparently of high grade, and the work now being done will demonstrate the importance of the deposits.

Lead

Galetta Mine.—This property was described in Volume XXIV under the name of the Kingdon mine. It is owned by the Estate James Robertson, Limited, Montreal, and for descriptive purposes may be called the Galetta mine. It is located on lot 22, in the sixth concession of the township of Fitzroy, on Chats island, about two miles west of the village of Galetta, and five miles directly east of the town of Arnprior.

Since last Report very little work has been done underground. The shaft remains the same depth, 112 feet. A winze is being sunk in the west drift about 160 feet from the shaft, and on August 8th, 1916, the winze was down 30 feet in good ore. At the same time stoping was in progress on the main vein, west of the shaft, with two hammer-drill crews.

The mill mentioned in last Report was completed in August, 1915, and the ore on the dump milled in addition to the small amount hoisted. A new double drum, electrically operated, Flory hoist, and a two-stage Ingersoll-Rand compressor, 1,500 feet capacity, have been installed.

On the date of inspection excavating was in progress for a smelter to be erected near the mill. A. G. Munich is manager for the James Robertson Estate, employing 70 men.

The geology and character of this ore deposit is very fully described in Dr. W. L. Uglow's report on the Lead and Zinc Deposits of Ontario, being Part II of the Twenty-fifth Annual Report of the Ontario Bureau of Mines, 1916.

Feldspar

Canadian Feldspar Corporation, Limited.—During 1915 a considerable tonnage of high-grade spar was mined by the above company on lot 4 in concession X, township of Portland. The property is located about 2½ miles west of the village of Verona on the Reynolds farm.

On the date of inspection in September, work was in progress in an open pit measuring 40 feet long, 35 feet wide and 40 feet deep. The spar was mixed with quartz in places, and most of the product had to be cobbed before shipment. L. E. Austin is manager of the company, and H. A. Hawley secretary-treasurer. Twenty men were employed.

Hurlburt.—On lot 1, con. XI, township of Loughborough, George Hurlburt, of Toronto, is developing a feldspar property formerly owned by L. E. Austin. Several test pits have been sunk and fairly clean spar exposed in places. Work was started on this lot on March 20th, 1916, and a small boiler and hoist installed. During the summer of 1916 Mr. Hurlburt expects to do considerable stripping where the dike shows the highest grade spar, and the product will be stock-piled at the mine in readiness for the winter haul to Verona. George Hurlburt is in charge of operations, employing six men; post-office address, R.R. No. 1, Hartington.

McIntyre Prospect.—A small quantity of feldspar was extracted in 1915 from a deposit in the District of Muskoka, on the McIntyre farm, lots 26 and 27, con. II, Stephenson township. The deposit occurs in gneiss. At the time of inspection, July 15th, 1915, Stewart W. Hall, of 118 Barton Ave., Toronto, had taken out nearly a carload of feldspar and hauled it 2½ miles west to Metler siding for shipment.

Richardson Mine.—Owing to the destruction by fire of the grinding plant at Charlotte, New York, the Kingston Feldspar and Mining Company was not able to ship until late in the season of navigation. The spar was stock-piled at the mine and a large tonnage shipped by rail to potash plants. The company also own a large amount of high-grade spar in stock at Verona station on the C. P. railway, the output of the Reynolds mine.

Considerable stripping was done at the Desert Lake mine in the south end of the pit. At this point there is a heavy over-burden of clay, in places 30 feet deep, and it is believed that the spar extends a considerable distance in this direction.

The plant and method of mining remained same as in previous reports.

H. W. Richardson, Kingston, is manager of the company, employing 55 men throughout the year.

Victoria Feldspar Quarry.—On the north half of lot 32, and all of lot 33, in the third concession of Bedford township, Messrs. J. M. Stoness & Sons opened a feldspar quarry late in 1915. The spar is unsuited for use in the manufacture of pottery, but contains about ten per cent. of potash and will be sold to the fertilizer trade. One car was shipped in 1915, and two cars in March, 1916, and it is the intention to work on a large scale, when a spur line to the Canadian Pacific railway is completed. This spur is 584 feet long and is now graded for that distance. The property is located about three miles west of Crow Lake station, and is practically cut in two by the new lake shore line of the C. P. Railway. It is the intention of the owners to erect a grinding plant at the property.

Mica

Anglin Mine.—In October, 1915, the Anglin Mica Mining Company acquired the mining rights to 200 acres, being part of lot 10 in the tenth concession of the township of Loughborough. This is a promising prospect and has already produced about 30,000 lbs. of mica. The mica is rough cobbed at the mine and shipped to the trimming works at Kingston recently erected by the company. Fifteen men are employed at the mine under J. E. Anglin.

Grierson and Gallagher.—On lot 4, about three miles west of Oliver's Ferry, on Rideau lake, Messrs. Grierson and Gallagher, of Perth, are operating a mica mine, leased from Edward Smith. Six men are employed and a fairly large production has been maintained since September, 1915. Most of the product is sold to S. H. Orser and Company, of Perth.

Lacey Mine.—This mine in Loughborough township, near the village of Sydenham, continued to be the largest producer of mica in the Province. Most of the product in 1915 came from the Milky vein, which is now being stoped. This vein was discovered by crosscutting from the old workings a distance of 60 feet, and has been a steady producer for the past three years. The stope measures 100 feet long, 75 feet to the back, and has been carried on at an average width of 18 feet. The main shaft is 185 feet deep, with workings on seven levels. The output during 1915 was somewhat curtailed owing to the restricted operations of the largest consumers. There was a good demand for the smaller sizes, 1 in. by 1 in. and 1 in. by 2 in. Old dumps supplied the demand for 1 in. by 1 in., the splittings of which may be built up to any required thickness by the use of a shellac binder.

It is interesting to note that the Lacey mine has produced in the past 15 years over 10,000,000 lbs. of closely rough cobbed mica. Prevailing average prices received in 1915 were as follows:—

1 x 1	5 cents.	2 x 4	50-55 cents.
1 x 2	10 cents.	3 x 5	60-75 cents.
1 x 3	16 cents.	4 x 6	80 cents-$1.00
2 x 3	32-35 cents.		

George W. McNaughton is manager of the mine, employing from 11 to 15 men.

Sidney H. Orser Mica Company.—In the vicinity of Perth, in the townships of Burgess and Bathurst, S. H. Orser and associates have done considerable prospecting for mica, and also operate a mica cleaning house in Perth.

During 1915, Mr. Orser operated a property under lease from Edward Stafford. This prospect is located in concession VI of Bathurst township, near Bennet lake. A pit measuring 12 feet by 5 feet by 20 feet deep was sunk, and about 12,000 pounds of rough cobbed mica produced. About three miles west of Oliver's Ferry on the shore of Rideau lake, in the township of North Burgess, Mr. Orser operated an old abandoned mine, under lease from Messrs. Webster and Stewart, of Perth. This mine was in early days a large producer of phosphate, and a small amount of work developed a considerable quantity of mica. The option expired in June, 1915, and no work has been done since that date. On lot 6 in concession VIII of Burgess, about six miles south of Perth, Mr. Orser began operations in January, 1916, on what was formerly known as the Burns mine. An old pit 45 feet deep has been cleaned out, and is being timbered and lagged over. A vein of mica about six feet in width has been uncovered. Adjoining this property on the west half of lot 3 in concession VI of Burgess, Mr. Orser and associates expect to commence work about May 1st, 1916. A small plant has been purchased for this property, all the others being worked with hand steel and horse whim.

Scott Mine.—This prospect, on lot 7, concession 9, Bedford township, was discovered and originally operated by Scott Bros., of Bedford. By them it was transferred to the Anglin-Stonness-Gilbert Mica Company, who operated it in 1914. During 1915, the holdings of this latter company were taken over by the Anglin Mica Mining Company, Limited. The Scott property was worked for three months in 1915, then closed down, and the force of 15 men transferred to the Tett lease. This lease was operated for four months and produced about 15,000 lbs. of cobbed mica.

The headquarters of the company are at Kingston, and the officers are: S. Anglin, president; J. E. Anglin, vice-president and manager; F. R. Anglin, secretary, and C. S. Anglin, treasurer.

Taggart Mine.—This mine is situated on the west shore of Bobs lake, in Bedford township.

In 1915 it was worked with a small force from September to the end of the year. The product is trimmed and finished for the market at Kingston by Kent Bros. J. M. Stoness is manager.

Trimming and Splitting.—The following firms are engaged in trimming and thin splitting mica: At Ottawa, General Electric Company, Laurentide Mica Company, S. O. Fillion, Eugene Munsell and Company, and R. Blackburn; and at Kingston, the Anglin Mica Mining Company and Kent Bros. are operating.

Molybdenite

In the Twenty-fourth Annual Report of the Bureau of Mines a complete summary is given of the sources of molybdenum ores in the British Empire and their uses in steel making and in the various arts and industries. Due to this demand from England and the information given by the Director of the Imperial Institute of London, considerable activity was shown throughout the year in exploiting known deposits of this mineral and prospecting in likely territory. In eastern Ontario molybdenite has been found in the counties of Haliburton, Lennox and Addington, Frontenac and Renfrew.

A considerable quantity of almost pure hand-picked crystals was shipped, but the amount recovered in this manner formed only a small percentage of the total content in the ore, and concentration methods had to be developed.

Concentrators.—(1.) G. C. Mackenzie, of the Mines Branch, examined most of the deposits for the Dominion Department of Mines, and several trial shipments were made to the testing plant at Ottawa. A workable process was finally evolved giving a good extraction. Custom ore is being treated and concentrates shipped to England.

(2.) The Orillia Molybdenum Company was formed in 1915, to mine, concentrate and refine ores of molybdenum. Early in the year the company purchased the Jamieson molybdenite prospect near Eganville, county of Renfrew, and in addition to the production from this property have purchased custom ores from other properties. The plant erected at Orillia by the Canadian Smelting and Refining Company was taken over and part of it utilized for experimental work on molybdenite ores. A process finally was worked out which the company state is quite successful. At the close of the year the concentrating plant had a capacity of twenty tons per day. The company shipped a small quantity of concentrates, but most of the product is being shipped in the form of molybdic acid. Further experimental work is in progress, and by April 1st, 1916, the company expect to be producing ferro-molybdenum.

The officers of the company are: President, G. P. Grant; manager, F. G. Cross; metallurgist, B. C. Lamble; manager ore department, J. F. McKenzie, and mine superintendent, J. G. Sipprell.

The following tariff of treatment charges is in effect at the Orillia works of the company:

TARIFF OF TREATMENT CHARGES.

Ore or concentrates over	10%	MoS_2	—	$15.00 per ton	—	85% recovery
Between	8-10	"	—	14.50 "	—	" "
"	7-8	"	—	13.50 "	—	" "
"	6-7	"	—	12.50 "	—	" "
"	5-6	"	—	11.50 "	—	" "
"	4-5	"	—	10.50 "	—	" "
"	3-4	"	—	9.50 "	—	" "
"	2-3	"	—	8.50 "	—	" "
"	1½-2	"	—	7.50 "	—	80% "
Under	1½	"	—	No tariff, and only treated subject to special terms to be made on each shipment.		

Settlement is made at the rate of $1.00 per lb. of MoS_2 within 21 days after date of sampling.

No credit is allowed for any molybdic oxide present in ore—all samples must first be leached with ammonia to remove any oxide present. Special penalties dependent upon character of ore for presence of copper, bismuth or arsenic.

(3.) W. J. Spain, of New York, purchased the Legree prospect in Renfrew county and, after considerable development, decided to erect a concentrating plant at the mine. In all, the production end was placed on a fairly substantial basis during the year, and developments during 1916 will be awaited with interest.

Belgian Syndicate.—In 1914, a group of capitalists with head office in Brussels, Belgium, started operations on a promising molybdenite discovery, on lots 7, 8 and 9, in the 11th concession, and lot 8, in the 12th concession of Brougham township. An adit was driven 75 feet and the ore body prospected with about 150 feet of drifting.

When inspected in October, 1915, the camps were being prepared for a renewal of operations which were suspended when war was declared.

The directors of the company, formerly known as the Algunican Development Company, which in 1915 was succeeded by the Renfrew Molybdenum Mines, Limited, included Jean Vanophen, A. E. Goyette, P. C. Neault, and Victor Mienwenhuyse, with Horace Young as Canadian manager.

Burns Prospect.—On lot 4, in the 15th concession of Sheffield township, H. C. Bellew, of Montreal, began work in September, 1915, developing a molybdenite prospect on the Burns farm. This property is situated near the Chisholm prospect, about seven miles south of the village of Enterprise. Trenching and stripping was in progress on the date of inspection.

Cailloux Prospect.—On lots 8 and 9, in the 15th concession, and on lot 11, in the 12th concession of Sheffield township, L. L. Cailloux, of Montreal, started work about September 1st, 1915, developing molybdenite prospects on the Spratt and Oderdike farms.

On the date of inspection, a fairly good deposit had been discovered on the Spratt farm and work was in progress in an open cut, measuring 30 feet by 25 feet and by 20 feet deep. Five men were employed by Mr. Cailloux.

Jamieson.—This prospect is situated on lots 5 and 6, in the 8th concession of Lyndoch township, and was originally owned by the Jamieson Bros., of Renfrew. Early in 1915 it was acquired by the Orillia Molybdenum Company, and worked by them throughout the year. At this prospect there is a fairly well-defined vein running about 5 degrees east of north, which has been open cut for a distance of 220 feet. The average width of the open cut was 21 feet, and average depth 21 feet. The pit measured 24 feet at the deepest point. Substantial boarding camps, office, stables and shops were built during the year, and preparation made for operating on a larger scale if conditions warranted. The ore was hoisted by a stiff leg derrick, 35-foot boom, and dumped on a platform, where the pure crystals were picked out and shipped separately. By careful hand cobbing a 20 to 30 per cent. product was secured, for shipment to the company's smelter at Orillia.

Up to October 5th, 1915, 80 tons had been shipped, of which about 2 per cent. was pure leaf. Forty men were employed. The officers of the company are:—J. B. Tudhope, president; J. F. McKenzie, manager, and J. G. Sepprell, superintendent.

Legree.—On lots 35 and 36, in the fourteenth concession of Brougham township, county of Renfrew, Joseph Legree, of Renfrew, is developing a molybdenite prospect. The occurrence is practically the same as at the Spain and Jamieson properties. The ore body has an average width of four feet, and the molybdenite is closely associated with sulphides in the gangue.

O'Brien.—A number of molybdenite discoveries were made in the township of Brougham by Joseph Charron, of Renfrew, who, in conjunction with Dr. Connolly, held the mining rights on several lots, including lots 15, 16, and 17, in the 11th concession, and lot 16, in the 10th concession. These were divided up and transferred in part and otherwise.

On parts of the above lots is situated the O'Brien prospect, owned by M. J. O'Brien, of Renfrew. In October, 1915, J. C. Murray took charge of this property, and it developed into a steady shipper of ore running from 3 to 6 per cent. MoS_2.

The ore body runs east and west, and ore has been found over an area of 1,000 feet in length by 100 feet in width. Substantial buildings have been erected, including cook camp, ore sorting house, sleep camp, stables and shops.

The ore is hauled twelve miles to Ashdod station, on the C. P. railway, and shipped to the Orillia smelter for treatment.

The postoffice of the mine is at Dacre R.F.D. No. 1.

J. C. Murray is in charge of the property, employing twelve men.

Orr.—About ten miles southeast of the village of Wilberforce, in the 5th concession of Cardiff township, Fred. O. Orr, of Peterborough, discovered molybdenite and did a small amount of development work. The molybdenite occurs in small flakes through the capping of gneiss. Several test pits were sunk, but at no point was the showing sufficient to warrant further work. Mr. Orr also prospected several adjoining lots, but on the date of inspection, October 14th, no work was in progress.

Paterson.—On the west half of lot 28, concession 4, Bagot township, Mark J. Paterson, of Toronto, did considerable development work on a molybdenite prospect.

The ore occurs in the usual manner over a large area, which had been stripped 35 feet in width, over a distance of 400 feet. At one point a pit was sunk 20 feet deep and from this some 4,500 lbs. of pure flake molybdenite had been shipped.

Work was in charge of Mr. Paterson, but had been discontinued on the date of inspection, October 7th.

Richardson Prospect.—On lot 22, in the second concession of Ross township, Renfrew county, a promising molybdenite prospect has been opened up on the John Rose farm by Thomas E. Richardson, of Portage du Fort, Quebec. The property is reached by good wagon road and is convenient for shipping, being situated about one mile southwest of Haley station, on the main line of the Canadian Pacific Railway. The mineral occurrence differs somewhat from others in the district, in that the ore occurs in a well defined quartz vein, having an average width of five feet. On the date of inspection in April, 1916, a prospect pit had been sunk 35 feet in length by 10 feet deep, and varying in width from 3 feet to 12 feet. The ore is of good quality, and is associated in the quartz with pyrites and feldspar. The prospect will be further developed during the year.

Russell.—Near the village of Norland, on lot 5, concession 11, township of Laxton, Capt. A. J. H. Russell is developing a molybdenite prospect. A vertical shaft 7 feet by 9 feet has been sunk to a depth of 35 feet on the shore of Mud Turtle lake. The molybdenite at this property is disseminated throughout a gangue of pyroxenite and apparently no other sulphides are present. In this respect it differs from the deposits described above in Renfrew county.

This deposit of molybdenite was probably the first discovery of this mineral in the Province. Specimens from lot 5, Laxton township, have been for many years in the old Toronto Museum, and mention was made of this deposit in Sir William Logan's Report.

Sheffield.—On lot 5, of the fourth concession of Sheffield township, county of Addington, A. M. Chisholm, of Kingston, re-opened his molybdenite prospect, which had been lying idle for several years. Mr. Chisholm owns the mineral rights on 50 acres, and did considerable work in 1904 and 1905 on this prospect.

The ore occurs in crystals of various sizes, disseminated in a gangue of pyroxene, pyrrhotite and iron pyrites. At the Chisholm property there appears to be several distinct mineralized zones with a fairly definite strike N.E. and S.W. Mining is carried on in an open pit, which on the date of inspection in September, measured 80 feet long by 80 feet wide, with an average depth of 20 feet. The plant included one guyed derrick with a single-drum March and Henthorn hoist and 15 h.p. upright boiler.

Twelve men were employed under the direct supervision of Mr. Chisholm, the owner of the property.

Snake Lake.—On the west half of lot 28, in the 12th concession of Bagot township, on the shore of Snake lake, near the boundary line between Bagot and Blythfield townships, R. R. Gamey did some prospect work on molybdenite showings. The work consisted of trenching and sinking test pits, under the direction of W. J. Urquhart.

Spain.—On lot 31, in the 4th concession of the township of Griffith, W. J. Spain, of New York, did considerable development on what was known locally as the Legree prospect. This discovery was made on property owned by Joseph Legree, of Renfrew, and by him transferred to Mr. Spain in the spring of 1915.

A plant was installed consisting of one Wicker double drum hoist, one 60-h.p. Nagle boiler, portable locomotive type, pump and derrick. On the date of inspection in September, ore was being taken from an open pit, measuring 75 feet long by 50 feet wide, and with a depth of 15 feet at the deepest point. A vertical shaft

7 feet by 8 feet had been sunk to a depth of 35 feet. About six tons of pure leaf molybdenite had been shipped to various firms in the United States, and another ton was in cases ready for shipment. On dump at the mine, between 400 and 500 tons of ore running 4 per cent. MoS_2 was stock piled for treatment.

On account of the long haul to the railway, Mr. Spain decided to erect a concentrating plant at the mine. Construction work had not been started, but plans for the mill followed closely the process developed at the testing plant in Ottawa. The original design included jaw crusher, cylindrical drier, 3 sets rolls, Newago screens of various sizes, two 30-foot picking belts, one 10-ton roaster, and 4 water flotation units.

George Gray was in charge of the work, employing 20 men.

Treasure Hill Mine.—This property is situated on the Alex. Evans farm, near Cheddar postoffice, in Cardiff township, about ten miles south of the village of Wilberforce. Molybdenite was discovered here by Messrs. Elliott and Bolmer. From November, 1913, to March, 1914, it was worked under option by M. J. O'Brien. A vertical shaft was sunk to a depth of 35 feet, and several test pits sunk in various parts of the property. A small plant was installed, including a 50 h.p. locomotive type boiler, Wettlaufer crusher and a set of 12-inch rolls.

The ore occurs with pyrites in a schist gangue. No work has been done since March, 1914.

Warren.—On the west half of lot 27, in the 4th concession of Bagot township, Renfrew county, R. R. Gamey had the mineral rights on the Warren farm under option.

Work was started September 1st, 1915, under the direction of W. J. Urquhart, of Toronto, and seven men were employed in trenching and sinking test pits. Molybdenite occurs on this lot in connection with the sulphides of iron, under a capping of gneiss about 8 feet in thickness. No shipments had been made from this property up to October 7th, 1915.

Wilson.—In the township of Matawatchan, on lots 3 and 4, near Wilson postoffice, and close to the boundary of Miller township, there is an occurrence of molybdenite on the farm owned by James Wilson. Very little work has been done on this prospect at the time of inspection, but the fact that molybdenite occurs in a pegmatite dike extending several hundred feet, would warrant further development.

Graphite

Black Donald.—The Black Donald mine is situated on Whitefish lake, about 14 miles from Calabogie, in Renfrew county. The company's mining rights include lots 17 to 20 inclusive, in concessions 1, 2 and 3, township of Brougham.

Mining operations are generally stopped about November 1st and resumed in the spring, sufficient ore being hoisted in the summer months to supply the mill for the year. In 1915, pumping was commenced on May 1st, and two weeks later hoisting was resumed. It is the intention of the management to keep the mine in operation during the winter of 1915-16 for the first time in its history.

The workings have reached a depth of 145 feet. The winter's supply of ore will be taken from a 10-foot stope starting from the shaft.

During the year there was a largely increased demand for Canadian graphite, due to the interruption to foreign shipping from Ceylon and Korea. A large proportion of the best pencil stock comes from Senora, Mexico, and, due to the revolution in that country, our trade was increased. Foundries running on a 25 per cent. efficiency basis in 1914 were working double shifts in 1916. As a result the Black Donald increased its output of refined graphite by 50 per cent. Large consumers in the United States are beginning to look with favor on the Canadian product, and the outlook for the future is exceedingly bright.

The officers of the company are:—A. H. Munger, president, Kansas City; R. F. Bunting, general manager, Calabogie; and J. N. Snead, secretary, Calabogie. Fifty men were employed under superintendent J. G. Patno.

Globe.—In October, 1915, the Globe Graphite Mining and Refining Company, Limited, was organized and work resumed in the old Globe mine, situated about three miles south of Port Elmsley, in concession 6, township of North Elmsley. This property was worked many years ago and was in early mining days in Ontario known as the Pyne mine. In 1900 it was acquired by Rinaldo McConnell, who formed the Globe Refining Company. For the past three years the mine has been closed, but the increased demand for Canadian graphite, particularly for the flake variety, has again placed it in the producing class.

The mine was first worked by the open-cut method, but work at present is confined to timbering the shaft which is now 125 feet deep, and stoping on the vein at this level. Considerable work will be necessary to clean out old working and place the mine on a safe working basis with an increased production.

The present output is about 30 tons per day of ore running 10 to 12 per cent. flake graphite. The mill at Port Elmsley has a capacity of 40 tons per day, a dry process of refining being used.

The officers of the company are:—President, Rinaldo McConnell; vice-president and manager, H. F. Meech, and secretary, J. L. Wells.

Fifteen men are employed at the mine and twelve at the mill.

National.—National Graphite, Limited, was organized in the spring of 1915, and is an amalgamation of the interests held by Messrs. Matthews and Foster in certain mining lands in Hastings county, and the milling and mining interests of the New York Graphite Company. The latter company owned a large mill at Harcourt on the I. B. and O. railway, and ore from the Matthews mine is shipped to this mill for refining.

The mine is situated near the village of Maynooth, in Monteagle township. The graphite is of the flake variety disseminated in a limestone gangue, and is easily concentrated. The orebody appears to have a definite strike northwest, and is worked by the open-cut method. On the date of inspection, in September, the pit was 40 feet long by 18 feet wide and 25 feet deep.

R. W. Matthews is manager of the company, employing 21 men at the mine and 12 at the Harcourt mill.

Corundum

The Manufacturers Corundum Company operated its property in Carlow township, Hastings county, for the first two months of the year. The mine and mill at Burgess were closed March 1st, and nothing was attempted in the line of production at this property for the balance of the year. Some diamond drilling was done on the company's holdings on the York branch of the Madawaska river and small shipments made for testing purposes. D. A. Brebner, president of the company, states that nothing will be done till the results of these tests are known.

Marble

Ontario Marble Quarry.—Ontario Marble Quarries, Limited, own lots 29 and 30 in the 10th concession of Dungannon township, and lots 41 and 42 in Faraday township. High grade marble of various colors is produced, the chief output coming from No. 1 quarry, pink and green variety, and No. 2 quarry, which produces a pure white marble.

At No. 1 quarry, the plant includes a stiff leg steel derrick, and double-drum hoist, and a Whitelaw 90 h.p. horizontal tubular boiler.

At No. 2 quarry are 2 Sullivan channeling machines, one guyed derrick and 2 upright 35 h.p. boilers. The two workings are connected by a standard gauge railway. At the sawing plant there are 4 sets of gang saws, with 50 saws to the set. The marble from this quarry can be delivered in any size required and in a great variety of colors. It takes a perfect polish and compares favorably with the imported marbles. Thomas Morrison is manager of the company, employing 20 men.

White Marble Co. of Canada, Ltd.—A description was given in the 24th Annual report of the plant and quarry of this company, in the township of Horton, near Haley station, Renfrew county. Operations were carried on till September 15th, 1915, on which date the quarry and sawing plant were closed. J. A. McLaughlin, who was left in charge of the property, stated that operations would be resumed in the spring of 1916, by new interests, allied to the Canada Glass Mantles and Tile Company of Toronto.

Quarries

Britnell and Company.—This Company resumed operations on a reduced scale in their quarry on lot 13, in the 6th concession of Somerville township, Victoria county. No dimension stone was shipped during the year, the product being confined to crushed limestone of various sizes. The plant consists of 4 upright boilers, 15 h.p. each; 3 stiff leg derricks; 3 double drum hoists; one locomotive boiler, 35 h.p.; one Gates breaker, No. 3; screens and bucket conveyers.

Five men were employed on the date of inspection in October, under foreman J. A. Lumby.

Canada Cement.—The Point Anne quarry and plant situated on the Bay of Quinte, about six miles east of Belleville, resumed operations in the spring of 1915, and closed again in December. The quarry was based on a basis of greater production during the year by improved methods of working. Drilling was kept well in advance of requirements. The average depth of the quarry is now 20 feet. The large 36 by 60-inch Fairmount crusher, installed in 1914, worked satisfactorily.

H. L. Shock is local manager, employing 12 men in the quarry.

Canada Lime Company.—This company is one of the largest producers of pure white lime in the Province. They own lots 37 to 40 inclusive in the township of Somerville, and lots 4, 5 and 6 in the village of Coboconk. One kiln with a capacity of 10 tons per day was operated during 1915, owing to the slack trade. The company's quarry and kilns at Sand Point, near Renfrew, were closed most of the year. Mr. Ballantyne, formerly in charge at Coboconk, moved to the Sand Point property and was succeeded by C. R. Christie, president of the company,

Ten men were employed during the year.

Crushed Stone Limited.—The crushing plant of this company is situated on the Trent Valley canal, on lot 49, in the township of Eldon, Victoria county, near the village of Kirkfield. For a number of years this company has been crushing the material thrown on the bank when excavating for the Trent canal, working under lease from the federal government. The plant consists of one No. 7½ McCully crusher, one No. 4 Gates crusher, two 100 h.p. Goldie-McCullough boilers, elevators and screening plant. All sizes of crushed stone are shipped.

W. H. Essery is president of the company and A. E. Oliphant superintendent, employing thirty men.

Crookston.—Messrs. Quinlan and Robertson began operations for the year at their Crookston quarry on May 10, 1915, and continued throughout the year. The quarry is situated on lot 19, in the 9th concession of Huntingdon township, near Crookston station, on the Madoc branch of the Grand Trunk railway. Most of the material discarded as unfit for dimension stone, the accumulations of many years of steady operations by different owners, was used up during the year and quarrying started in the old workings.

W. E. Tummon is superintendent, employing fifteen men.

Delta Lime Company.—On lot 27, in the 8th concession of Bastard township, the Delta Lime company operated their quarry during the year. The product is a high grade crystalline limestone, which is burned at Delta village. One kiln with a capacity of 150 bushels of lime per day is operated during the summer months. Omar Brown, Delta, is manager of the company.

Eganville Quarry.—The Standard Chemical, Iron and Lumber Co. operated their quarry on a reduced scale during 1915. The quarry and lime kilns are situated near the village of Eganville, on lot 19, in the 20th concession of the township of Grattan. One kiln, with a capacity of 450 bushels of lime per day, was kept in commission.

J. S. Shane succeeded Mr. Arveson as manager during the year. Ten men were employed on the date of inspection in October.

Gosselin.—On lot 22 in the township of Gloucester, on the Montreal road, Charles Gosselin continued to operate his limestone quarry. The plant in this quarry consists of one stiff-leg derrick, one upright boiler, 15 h.p., one Climax jaw crusher, one Case steam thresher engine, elevator, and screens. Crushed stone, rubble, dressed building stone, and dimension stone of all sizes is supplied to the Ottawa trade. Thirteen men were employed on the date of inspection.

Gordon and Son.—During the summer months the firm of Gordon and Son quarried granite near the village of Escott in Leeds county, about 12 miles east of Gananoque.

Large pieces are broken by the plug and feather method, and these subdivided into paving setts, for which the grey granite is admirably suited. Fifteen men are employed.

Kingston.—The quarry owned by the City of Kingston and located on Montreal Street was operated at intervals during the year by Henry MacRow. All of the product was used by the city for street purposes. Some building stone was taken by different contractors from the Division Street quarry, which for many years has supplied the building trade with the high-grade stone to be seen in all of Kingston's public buildings. The penitentiary officials operated their quarry at Portsmouth throughout the year. Convict labor is employed, and the product used in the erection and maintenance of walls and buildings around the prison.

McMillan.—On lot 19 in the 7th concession of the township of Williamsburg, near the village of Dunbar, James McMillan quarries limestone for building purposes. A 12-foot bed of high-grade stone is worked by the plug and feather method, and most of the product is made up into sills and lintels. No plant is required, and operations are carried on in a small way, as the building trade in the locality demands.

Mille Roches.—On lots 24, 25 and 26, in the 4th concession of Cornwall township, there are four large quarries which have been worked at short intervals since 1895. They are situated about two miles west of the village of Mille Roches, near the Grand Trunk railway, and during the construction of the Cornwall canal were large producers of cut stone and crib filling material. The limestone is of good quality, and shipping facilities are excellent.

Messrs. Philip and Urquhart Thompson, James Henderson, and Larkin and Sangster own the several lots.

Ontario Rock Company.—The trap rock quarry owned by this company at Preneveau, near Havelock, in Belmont township, was closed till May 31st, 1915, when operations were resumed and it ran continuously till the close of the year. The working face is now 65 feet deep by 200 feet wide.

The plant consists of one horizontal tubular boiler 100 h.p., one locomotive type 150 h.p., one 175 h.p. Brown mill engine, one No. 8 Austin gyratory crusher, one Jenckes jaw crusher, two Simons disc crushers numbers 24 and 36, one Marsh and Henthorn 7 by 10 hoist, one guyed derrick and clam for use in loading from stock pile.

The limestone quarry in Prince Edward county owned by this company was not in operation during the year.

The officers of the company are: Alex. Longwell, president; George Rayner, manager, and S. Bradley, superintendent. Thirty men are employed at the Preneveau works.

Point Anne.—Point Anne Quarries, Limited, operating near the Canada Cement Company plant on the Bay of Quinte, ran steadily throughout the season of navigation. The quarry has been opened for a distance of three-quarters of a mile in length by 100 feet wide, with an average depth of 24 feet. An electric trolley line runs through the quarry from the loading dock to the siding on the Canadian Northern railway.

Drilling is done with a large Armstrong churn drill, which operates during the whole year and insures a constant supply of broken stone. Seymour electric power is used throughout the quarry and crushing plant, with the exception of the 60-ton Marion shovel, which is steam driven. The company ships rubble, crib-filling material, and all sizes of crushed stone.

The officers of the company are: M. J. Haney, president; J. H. M. Stewart, manager, and A. G. Bennett, superintendent. Forty men are employed during the season of navigation.

Pembroke.—Most of the crushed and building stone used in Pembroke and vicinity is supplied from the quarries owned by Wm. Markus, Limited, and Messrs. Kehoe Bros. Both are worked in a small way as the trade demands. They are situated on adjacent lots in the township of Pembroke about two miles east of the town. Rubble, crushed and building stone is supplied to the trade.

Renfrew Quarry.—The Jamieson Lime Company continued to operate their quarry near the town of Renfrew during the year. This company operate three quarries, one inside the town limits of Renfrew, and two in the second concession of Horton township, about two miles south of the town. Some years back a considerable quantity of stone from these quarries was shipped to the Sudbury smelters for fluxing purposes, but that trade gradually diminished as other sources were found nearer the works. When working to capacity the company produce 30 tons of white lime per day. J. A. Jamieson is manager.

Rideau Canal Supply Company.—In the township of Nepean, near the city limits of Ottawa, the Rideau Canal Supply Company operated their limestone quarry throughout the year. The working face is 20 feet deep over a distance of 300 feet; crushed stone supplied in five sizes, also rubble and building stone are delivered to the trade in Ottawa. Robert Foster is manager, employing 40 men.

H. Robillard and Son.—This quarry on lots 22 and 23 in the township of Gloucester, near the city of Ottawa, on the Montreal road, worked with reduced force during 1915. One lime kiln was in commission, and only 10 men employed in the quarry on the date of inspection. Shipments include rubble, dressed and dimension stone and white lime, most of the product going to the trade in Ottawa. R. E. Robillard is manager.

Street and O'Brien.—On lot 7, concession II of the township of Leeds, near Gananoque, Messrs. Street and O'Brien quarry grey granite for use in making paving setts. No plant is required, and all the work is done by experienced stone cutters who are employed on a contract basis of a price per 1000 setts. Work is carried on during the summer months only. Fifteen men are employed.

Toronto Brick Company.—The quarry and lime kilns of this company at Coboconk, Victoria county, were closed most of the year. When running to capacity the company operate three kilns with a total output of 150 tons of lime per week. Charles Callan is superintendent, employing 15 men.

V.—SOUTHWESTERN ONTARIO

Quarries

Amherstburg Quarry.—This quarry, situated near the village of Amherstburg, and owned by the Solvay Process Company of Detroit, Michigan, was being pumped out in July, 1915, when the inspector visited the property. This quarry has been idle for several years. J. W. Foley is superintendent.

Beachville White Lime Company.—Near the village of Beachville, the company operate a limestone quarry for the manufacture of lime. The quarry and kilns, two in number, adjoin the property of the Standard White Lime Company.

On account of the low magnesia content, this stone is desirable for fluxing in blast furnaces, and for use by chemical plants. Charles Downing is manager, employing fifteen men.

Brown Quarry.—This quarry has been described in previous reports as belonging to the Owen Sound Lime Works. It is now owned and operated by O. C. Brown, of Owen Sound. Operations were carried on and lime manufactured for about eight months in 1915, the demand for lime coming mostly from the farmers in the vicinity of Owen Sound.

Canada Crushed Stone Corporation.—The quarry operated by this company is situated on lots 12 to 16 inclusive, concession I of the township of West Flamborough, near the town of Dundas. The quarry is worked in two benches. the upper bench being 244 feet above the level of the Grand Trunk Railway, and the lower, 175 feet. The quarry proper is 1,000 feet long by 500 feet wide with a working face of 30 feet. This stone is shipped to the Hamilton steel plant for fluxing purposes. A second bench with a 25-foot working face is crushed for concrete and road material.

The stone is crushed in a No. 21 Power and Mining Company gyratory crusher. From the crusher it is conveyed to a set of rolls 72 inches by 30 inches, and from the rolls on a 30-inch belt conveyor to the revolving and shaking screens and properly sized for shipment.

An average sample of the stone shipped for fluxing purposes shows the following analysis:—

Silica	Iron Oxide	Alumina	$CaCo_3$	$MgCo_3$	Sulphur	Phosphorus
.41	.43	.59	55.20	43.60	.016	.005

An average sample of stone shipped for road material was tested at the Public Roads Department, Washington, D.C., with the following results:—

Specific gravity	2.80
Weight in pounds per cubic foot	175
Absorption per cubic foot	.24
Percentage of wear	3.6
Hardness	16
Toughness	11
French co-efficient of wear	11.1
Cement value	good

The company also have a contract with the Steel Company of Hamilton to take all their blast furnace slag, and this product is ground and sold to the trade for concrete purposes. Charles M. Doolittle is president and general manager of the company, employing eighty men.

Canada Cement Company—What is known as plant No. 8 of the above company is situated near Port Colborne, on lots 30 to 32 inclusive, township of Humberstone, Welland county. During 1915, the works were closed from February 13th to April 12th. The plant in the quarry and clay bank consists of two Marion 60-ton shovels, one Thew shovel used for stripping overburden, two Clipper churn drills, and one Browning hoist. S. R. Preston is local manager, employing twenty-five men in the quarry.

Canadian Quarries, Limited.—The quarry owned by this company was in operation during the year, with a force of thirty-five men. Crushed stone only is shipped from the quarry, which is located on lots 28 to 30 inclusive, concession V., township of Saltfleet.

The plant consists of one 35 h.p. horizontal boiler, one 25 h.p. portable boiler, one 40 h.p. horizontal boiler, one No. 6 and one No. 4 Austin gyratory crusher, and one six-section revolving screen, 24 feet long by 4 feet in diameter. D. D. O'Connor is president of the company and R. S. Stone, manager.

Coast and Lakes Contracting Corporation.—The quarry owned by this company in the township of Bertie, county of Lincoln, near Ridgeway, was in operation for three months only during the year, beginning September 1st, closing November 28th, and only large blocks of stone weighing from five to eight tons are shipped. The whole output for 1915 went to the Buffalo breakwater contract.

H. J. Eggleston of Cleveland, Ohio, is manager of the company, and M. E. Gloven, local superintendent, employing thirty-five men.

Chalmers Quarry.—Due to a decreased demand for white lime by the building trade in Owen Sound and vicinity, the above quarry and kilns operated for only eight months in the year. A force of four men was sufficient to supply the demand. The kiln has a capacity of 275 bushels per day, Stewart Chalmers succeeded his father as manager during the year.

Cook Quarry.—Near the town of Wiarton, Bruce county, on lots 7 and 8, in concession XXIV of Annabel township, J. S. Cook operates a small quarry for supplying dressed stone to the building trade. The plant consists of a small 5 h.p. gasoline engine and air compressor, drilling for plug and feather work being done by pneumatic tools. Five men are employed.

Empire Limestone Company.—The quarry operated by this company is one of the oldest in the Province. It is situated on lots 4 to 6, concession I., of Humberstone township, near Skerkston station, on the Grand Trunk line from Pt. Colborne to Buffalo. An area of 40 acres has been worked out, the average depth being 35 feet. During 1915, work in the quarry was practically abandoned, and sand from the shores of Lake Erie was shipped during the season of navigation. The demand for this product increased during the year both for domestic and United States shipments, and facilities were installed for all rail shipments. The company own four gas wells, with an average daily production of 82,800 cubic feet. M. B. Fuller is president of the company and John Haston manager. Fifty men are employed.

Fleming Quarry.—This quarry is owned by J. H. Fleming, of Toronto, and is situated on lot 26, concession IX, of Esquesing township, Halton county, adjoining the Logan quarry. During 1915 the output of the brown and blue sandstone produced at this quarry was greatly reduced owing to slack demand by the building trade. M. G. Bell, Glenwilliams, is manager of the quarry, and during the year a force of ten men was employed.

Gallagher Lime and Stone Company.—Near the Marshall quarry on lot 15, concession VI, of Barton township, the above company operate a small quarry for use in the manufacture of lime. The city of Hamilton affords a good market for the lime output, also for the rubble and building stone produced. Dan Gallagher, Hamilton, is manager of the company, employing ten men.

Gravenhurst Quarry.—The Gravenhurst Crushed Granite Company, Limited, worked a quarry in the town of Gravenhurst during part of the summer of 1915. The rock, which is a biotite granite gneiss, is sold only in the crushed form. The product is shipped by rail. The rock is trammed on the level and fed into a No. 8 Kennedy gyratory crusher. Thence it passes to two No. 6 Kennedy gyratorys and is carried by a bucket elevator to the upper floor of the building, where two rotary screens remove the undersize. The oversize is returned to a bin which feeds into one of the No. 6 crushers, while the undersize, with the fines removed, is shipped. George H. Harper, Gravenhurst, is manager, and forty men were employed at the time of inspection.

Hagersville Crushed Stone Company.—The quarry owned by this company was opened in 1913 and operated at intervals since. During 1915 work was carried on for eight months. The quarry is situated about one mile east of the village of Hagersville on the line of the Michigan Central railway. The plant consists of one 60 h.p. locomotive type boiler, one No. 4 Austin crusher, one No. 5 Gates crusher, and a screening plant, with a capacity of 400 tons per day. Robert Hambleton is manager, employing thirty-five men.

Hagersville Contracting Company.—The quarry operated by this company is located on lot 14, concession XIII of Walpole township, near the village of Hagersville. Operations were carried on for eight months during 1915. The plant includes one 60 h.p. Fairbanks gas engine, one 150 h.p. St. Marys gas engine, one No. 7½ Gates crusher, two return tubular boilers of 100 h.p. each, two locomotive type-boilers, and one new 150 h.p. Jenckes boiler. The plant has a capacity of 1,000 tons of crushed stone per day, with shipping facilities on the Michigan Central, Grand Trunk and T. H. and B. railways. This quarry has been worked for many years and an area of 30 acres has now been worked out to a depth of 12 feet. John C. Ingles is manager of the company, and thirty-five men were employed during the year.

Harrison Quarry.—This quarry adjoins the Oliver-Rogers on the south and was opened by H. B. Harrison, of Owen Sound, during 1914. The stone is of particularly fine quality for building purposes, the whole output being shipped in rubble form for foundations. During 1915 the quarry operated for a short time only, and in November was closed entirely owing to the death of Mr. Harrison. The plant consists of one guyed derrick, one stiff-leg derrick, and one 15 h.p. upright boiler.

E. Harvey, Limited.—Messrs. E. Harvey, Limited, of Guelph, operated their limestone quarry near the village of Rockwood during the year.

The stone is well suited for the production of white lime, and the whole output of the quarry is burned in three large kilns, having a combined capacity of 40 tons of lime per day. Hydro-electric power is used to operate the quarry machinery and kiln fans. E. Harvey is manager, employing twenty-five men.

Hurst Quarry.—On lot 21, concession V of Esquesing township, Samuel H. Hurst, of Toronto, has reopened an old sandstone quarry which was first operated some sixty years ago. Work was commenced in one of the old openings, and on the date of inspection, in May, seven men were engaged in stripping the clay overburden at a point where the working face measured 15 feet in depth. The stone breaks easily, is of good, uniform color, and will be manufactured into sills, coursings, lintels and all kinds of building stone. A. Norton was in charge of the work for Mr. Hurst.

Logan Quarry.—This quarry, on lot 27, concession VIII of Esquesing township, operated at intervals during the year. For the first six months of the year building stone was in good demand, but during the latter half of the year the quarry was closed most of the time and only operated to fill small orders. The stone here is of excellent quality and a uniform grey color. The plant consists of one portable traction engine, three steam drills, and two guyed derricks. Rubble and building stoned is shipped, chiefly to the trade in Toronto. Hugh Logan, of Glenwilliams, is owner and manager.

Longford Quarry.—This quarry is situated near the village of Longford Mills, about seven miles south of Orillia, on lots 21 to 24 inclusive, township of Rama. The product is shipped mostly in the form of rough and dressed building stone. Up to 1913, when the furnaces of the Canada Iron Corporation at Midland closed down, stone from this quarry was used for fluxing purposes and found to be equal to any in Ontario for that purpose. The plant includes 13 guyed derricks, a small Rand compressor and one portable boiler. In 1915 the quarry was in operation from April 1st to December 31st. Fourteen men were employed, eight of these being stone cutters working piece work at a price per lineal foot. The officers of the Longford Quarry Company are:—President, Wm. Thompson; secretary-treasurer, Allen McPherson, and manager, C. C. Howlett.

Marshall Quarry.—On lot 14, in concession VII of Barton township, about three miles west of Hamilton, James Marshall operated his quarry for the production of lime during the summer months. Mr. Marshall is in charge of the work and operates two kilns, employing twenty-five men.

McCormick Quarry.—On the northwest corner of Pelee Island, at the old North Dock, is a limestone quarry which has been worked for rubble and building stone for many years. It is situated on subdivisions 17, 18 and 19, of lot 22 or lot 23, and is owned by John McCormick, Scudder, Ont. Very little work was done in this quarry in 1914 or 1915.

McKay and McPherson.—During 1915 Messrs. Alex. McKay, of Toronto, and Benjamin McPherson, of Owen Sound, opened a quarry for the production of rough building stone, on property lying adjacent to and south of Harrison's quarry, in Owen Sound. The working face is now 22 feet deep, and during 1915 four men were employed for eight months. About 1,800 tons of stone were shipped to the trade in Toronto.

Michigan Central Quarry.—Near the town of Hagersville, and adjoining the quarry of the Hagersville Contracting Company, the Michigan Central railway have opened up a large limestone quarry for supplying crushed stone for surfacing material, rubble for pier filling and in addition some dimension stone for buildings. The quarry was idle throughout 1915, but began operations in January, 1916, with seventy men. D. E. Cronin is manager for the railway company.

Oliver-Rogers Quarry.—The crushed and rubble stone business in Owen Sound fell off considerably during 1915, the output showing a decided decrease. The above quarry is the largest in Owen Sound and enjoyed a steadily increasing business up to 1915. During the year operations were carried on for nine months with a force of fifteen men. The plant includes three guyed derricks, one stiff-leg derrick, one Thew steam shovel, one No. 4 McCully crusher, screening plant and storage bins. The normal output is about 250 cars of crushed stone monthly, in addition to large shipments of rubble. S. J. Oliver is president and manager of the company.

Queenston Quarry Company.—This quarry, one of the largest in the Province, is situated on lots 47 to 49, in concessions II and III of Niagara township. The stone at this quarry is particularly well suited for building purposes, and consequently a large portion of the business is in dimension stone. Crushed stone for concrete work and road material, also rubble for cellars and pier filling, is shipped. The plant was enlarged during the year, and two large gang saws, one diamond saw and planer added. These will be utilized in getting out large dimension orders for building contracts. The boiler, compressor, and crushing plants remain the same. As noted in previous reports of the Bureau of Mines, Charles Lowery is president and manager of the company, employing during the year an average of seventy-five men.

F. Rogers and Company.—On the east half of lot 30, in concession VI, and the east half of lot 31, in concession V of Chinguacousy township, Messrs. F. Rogers and Company, of Toronto, are operating quarries in the Credit Valley sandstones. The plant consists of one Abel traction engine, one D. D. Robertson hoist, one 16 h.p. upright boiler and one guyed derrick with 54-foot boom. The product is shipped in the form of building stone and rubble, and is hauled to the Grand Trunk railway siding at Terra Cotta. R. M. McIntyre is superintendent, employing thirty men.

Standard Crushed Stone Company.—This company, with head office at Niagara Falls, operated two quarries during 1915. The St. David quarry is located on lot 44, in Niagara township, a short distance from the Queenston quarry. The plant at this quarry includes one Bury compressor, two dinky locomotives, one No. 5 Gates crusher, revolving screens and storage bins.

In the township of Bertie, near the village of Ridgeway, the company continued to operate the quarry opened in 1914. The pit at the close of 1915 had the following dimensions: Length 250 feet, width 125 feet, average depth 26 feet. The plant here is electrically driven with power from the Canadian and Niagara Power Com pany. Crushed stone in all sizes is shipped. The officers of the company are:—John Symmes, president; Robin Boyle, secretary, and J. H. Barbeau superintendent. Each quarry employs thirty-five men.

Standard White Lime Company.—This company operated quarries for the production of lime at Guelph, Beachville and St. Marys. The plant in the city limits of Guelph was closed during the year. In the township of Puslinch, a short distance west of the city limits of Guelph, the company operated a large quarry with three kilns, having a combined capacity of 20 tons of lime per day. At this quarry also is situated the largest plant manufacturing hydrated white lime in the Province. At Beachville, near Ingersoll, there are five kilns with a capacity of 50 tons of white lime per day. The St. Marys quarry worked during the summer of 1915. Twenty feet of limestone is used, but, as the clay overburden is becoming deeper, being from 8 to 18 feet in depth, costs are increasing. Black powder is used for blasting. Eleven men are employed. D. D. Christie is president of the company and J. Kennedy manager, with head office in Guelph.

St. Marys Portland Cement Company.—The quarry and plant of this company are situated in the town limits of St. Marys, and operations were carried on continuously during the year, the output being considerably increased. The quarry proper is now 400 feet long by 350 feet wide and has an average depth of 30 feet. The stone is broken in a No. 8 Kennedy crusher, capacity 150 tons per hour, and conveyed to the cement plant by a belt conveyor, 400 feet in length. A churn drill will be installed at once to replace the two No. 43 Rands at present in use. Every care is taken to prevent accidents at this quarry, and the rule of "Safety First" is everywhere observed. About forty-five men are employed in the quarry.

Clay, for mixing with the crushed limestone, is found in close proximity to the quarry, and in places forms the overburden. At the close of the year the clay excavation measured 400 feet long by 250 feet wide, with an average depth of 25 feet.

The officers of the company are:—Geo. H. Gooderham, president; Mark Irish, secretary, and J. G. Lind, manager.

St. Marys Horse Shoe Quarry.—This quarry is located in the town of St. Marys, near the cement plant, and during 1915 was in operation from April 1st to December 15th, and 25 men were employed. Crushed stone and rubble for pier filling was shipped. R. H. McWilliams, of St. Marys, is manager for the St. Marys Horse Shoe Quarry, Limited.

Thames Quarry Company.—This quarry, in the town of St. Marys, is a steady producer of crushed stone, rubble and dressed stone for coursings. A small plant for the manufacture of lime brick is also in operation, and utilizes the fines from the quarry operations. During the year a new crusher building was erected in the south end of the quarry, doing away with the long haul to the former plant. The quarry was in operation from April 1st to December 15th and thirty-five men were employed. David Bonis is manager of the company.

Toronto Lime Company.—This company operates quarries for the manufacture of white lime, at Dolly Varden, in concession III of Esquesing township, and at Limehouse, in the same township. When running to capacity the combined kilns produce 45 tons of lime per day. The Limehouse quarry and plant closed in March, 1915, and for the balance of the year the Dolly Varden plant supplied the demand. Wm. Gowdy is superintendent, employing twenty men.

Wentworth Quarry Company.—The limestone quarry operated by this company is situated on lot 4, concession V of Saltfleet township, near Vinemount Station, T.H. & B. Railway. Crushed stone of the usual sizes is shipped to the trade throughout the Province, and during 1915 the output was slightly increased in spite of the prevailing depression in the building trade. A second Marion shovel has been added to the plant, giving increased loading capacity. The crushing plant includes one No. 7½ McCully crusher, one No. 5 McCully crusher, one 6-section revolving screen, 20 feet in length by 4 feet in diameter. The plant is driven by a Duddbridge, twin-cylinder gas engine, supplied by a 115 h.p. gas producer plant. F. W. Schwendiman is manager, employing twenty-five men.

Gypsum

Caledonia Mine.—The Alabastine Company, Limited, are the largest producers of gypsum products in the Province. The chief producing mine and large plaster mills are located near the village of Caledonia, on lots 10 and 11, in the township of Seneca, range I, west of the Hamilton road. The deposits of gypsum along the valley of the Grand river have been worked for many years and described in successive annual reports of the Bureau. During the year the mine worked continuously with a reduced force of 20 men. The three-foot seam on the 3rd level has been further developed by the pillar and room method.

The following gypsum products are manufactured at the Caledonia mine:—Paristone wall plaster, pulpstone wall plaster, fireproof blocks, and land plaster. The head office of the company is at Paris, and the officers are as follows:—M. B. Church, president; R. E. Haire, general manager, and A. J. Parkhurst, superintendent.

Carson Mine.—This mine is owned by the Alabastine Company, and is situated about three miles south of Caledonia, in Oneida township.

During 1915 it was worked for four months with a force of four men, and the output teamed to the mill at Caledonia. The gypsum here is of the pure white variety and is used for manufacturing finishing plaster, resembling Keene's cement when finely ground. The bed is only four feet in thickness, overlaid by four to six feet of dolomitic shales and limestones. On account of the bad roof great care has to be taken in mining to protect the men. The mine is under the management of Mr. Parkhurst.

Crown Gypsum Company.—The mine from which this company secures its supply of gypsum is situated on the Martindale farm, lots 58 and 59, township of Oneida. It is reached by good wagon road from Caledonia to the village of York. The gypsum is of the pure white variety, occurring in a four-foot bed. The product is hauled from the mine to the grinding plant and plaster mill at Lythmore on the company's narrow gauge railway.

C. E. Williams is manager of the company and G. C. Fischle, mine superintendent, employing thirty men at the mine.

VI.—ONTARIO IN GENERAL

Blast Furnaces

Algoma Steel Corporation.—Two of the blast furnaces at Steelton, Ont., were operated during 1915. These two furnaces produce about 575 tons of pig iron per day and suffice to keep the open hearth plant running. The ores used are approximately thirty per cent. Helen and Magpie ores combined, thirty-five per cent. Old Range ores and thirty-five per cent. Mesabi ores.

A duplex plant is being added and will be in operation early in 1916. When this is completed the No. 3 or 500-ton blast furnace will be blown in. By means of the duplex process the basic pig from the blast furnace is blown in a Bessemer converter to remove the greater part of the carbon and silicon. The metal is then taken to a Talbot tilting open-hearth furnace where it is charged in the molten condition and finished. By thus using the Bessemer converter in conjunction with the open-hearth furnace the time required to bring the pig metal to steel is materially reduced, because the Bessemer converter removes both carbon and silicon at a much faster rate than the open-hearth furnace can if used alone.

The merchant mill has been working since the summer of 1915.

At the time of last inspection of the blast furnaces (December, 1915), 2,255 men were employed at the steel plant.

The officers are: President and general manager, J. Frater Taylor; vice-president, W. C. Franz; assistant to general manager, C. J. Wilson; general superintendent, Lawrence Cooney; superintendent of blast furnaces, James H. Bell.

The Greenawalt experimental roasting plant at Sault Ste. Marie, Ont., was idle during the greater part of 1915. The crushing plant in connection with the same worked from September 1st to October 15th, crushing dolomite from Michigan to pass ½-inch ring. This crushed dolomite was calcined at the Magpie mine roasting plant and used for lining the basic open-hearth reverberatories at the steel-plant in place of the Austrian grain magnesite. From October 15th to the end of the year, the experiments on the roasting of the Magpie ore by the Greenawalt process were continued. The plant is also used for sintering blast furnace flue dust. When iron ore is being treated a Symons disc crusher first reduces it to about ¾-inch. It is then passed through a trommel and the oversize reduced by a pair of superior rolls. All is then taken by a bucket elevator to a bin. It is then charged into a concrete mixer and coke and water added. A bucket elevator delivers the mixture to a charging car. J. M. Knote is superintendent.

Canadian Furnace Company.—The blast furnace of this Company at Port Colborne was in continuous blast from March 10th, 1915, to the close of the year, with the exception of a fortnight shut down in November, for relining.

An average production of 360 tons of pig daily was maintained throughout the operating period. The ore charged was all imported, the 2,800 tons of magnetite from the Ledyard mine in Hastings county, being still in stock. The limestone used came from the quarries at Calcite, Michigan. The advantages in using this imported limestone in preference to the local product, are uniformity of size, facilities for unloading and placing on stock pile, and low price f.o.b. Port Colborne.

During the year the Company purchased a pulmotor for use at the Port Colborne plant, and installed many safety appliances for the protection of the 130 men employed. B. Marron is president and general manager, and D. J. Higgins, superintendent.

Standard Iron Company.—The blast furnace of the Standard Iron Company began operations April 9th, 1915, and continued to the close of the year. An average daily production of 60 tons of high grade charcoal pig was produced. Foreign ores were charged exclusively, although experiments were made with local magnetites. The furnace at Parry Sound, owned by this company, was not in blast during the year, but operations will likely be resumed at this plant early in 1916.

G. L. Shook is manager of the company, employing 80 men.

Steel Company of Canada.—This Company operate two blast furnaces at their plant in Hamilton, and during 1915, the large furnace "B," ran to capacity throughout the year. This furnace has a capacity of 325 tons of pig iron per day. The smaller furnace "A" was not in continuous blast.

Early in 1916, what is known as the Metal Trades Safety Association was formed, and a set of safety rules drawn up. These will be presented to the Workmens' Compensation Board for their sanction and approval, with the object of enforcing a uniform set of safety regulations for all branches of the metal trade.

Robert Hobson is vice-president of the company and R. G. Wells, works manager.

Refineries

Canadian Smelting and Refining Company—As stated in the Twenty-Fourth Annual Report of the Bureau of Mines, this company was formed in October, 1914, and took over the assets of the Canada Refining and Smelting Company at Orillia. During the early months of 1915, the company continued to treat Cobalt ores and residues from the high-grade mills. In May, 1915, the company went into liquidation, and the plant was taken over by the Orillia Molybdenum Company, the whole attention of the management for the balance of the year being directed to processes for treating molybdenite ores.

Coniagas Reduction Company, Limited.—The head office of this company is at St. Catharines, with works near Thorold, in Welland County. This plant was the third in Ontario erected to treat Cobalt ores, and the first shipment was smelted in May, 1908. Since that date the plant has operated continuously. When first erected, the output consisted of refined silver and the oxides of cobalt and nickel, but other products were manufactured as new methods were worked out in the metallurgy of cobalt ores. At present, silver, arsenic, cobalt oxide and metal, and nickel oxide, are refined and shipped. The company has treated all the ore produced by the Coniagas mine and has been a large purchaser of custom ores and mill products.

The system of sampling varies somewhat from that at Deloro. The ore is first ground in a Krupp mill, and passed through a double Vizen sampler, which takes two independent samples from the pulp. These are subdivided, and constitute the basis of the final sample of about twenty pounds, on which the purchase is completed. The treatment process may be roughly described as follows:

The crushed ore is mixed with the required flux and smelted in a blast furnace, producing silver bottoms, speiss, slag, and arsenical fume. The speiss is first crushed and roasted, then sent to the cobalt plant where the cobalt and nickel are extracted. The silver bearing residues are returned to the furnace department. The silver bottoms are treated in a reverberatory furnace, then cast into anodes and refined electrolytically. The arsenical fume is collected in the bag house, and then treated in refining furnaces, which by a volatilization process yield refined white arsenic and non-volatile product which is returned to the smelting department.

The officers of the company are: R. W. Leonard, president and general manager; R. L. Peek, superintendent of works and J. J. Mackan, secretary.

*Deloro Mining and Reduction Company**.—This company has its head office and works at Deloro, Hastings County, and its plant was the second in the Province, erected to treat cobalt ores. The first car of ore was smelted in December, 1907, and operations have been carried on continuously since that date, each year showing an increased production. When first erected the product was confined to silver, refined arsenic and cobalt oxide, but the plant has been gradually extended and at present the company refine and ship silver, cobalt oxide and metal, nickel oxide and metal, and arsenic. There is also a plant for the manufacture of stellite, a high grade tool steel. In the metal department, experiments are being conducted in electro-plating with cobalt, and investigations made in an endeavour to find other uses of that metal.

Ores and mill products from the Cobalt district are purchased on a basis of silver content. Sampling is done very carefully under the supervision of a representative of the seller, and the process in use is as follows: Each car-load is stored in a separate bin and the lump ore crushed to 15 mesh in a ball mill, to which is attached a Snyder sampler. This machine takes about 50 samples per minute, each one representing about ten per cent. of the volume of crushed material leaving the mill. The total sample thus obtained is subdivided until a final sample of about 20 pounds, representing the whole car-lot, is obtained. The coarse scales of silver which did not pass the ball mill screens are melted, and the bar thus obtained is added to the assay of the sample taken as above, and this represents the total value of the parcel purchased.

The following are typical assays, of ores and mill products received at the smelter:

* The company was reorganized in 1916, and is now known as The Deloro Smelting and Refining Company, Limited.

	Fine Ounces per ton	Percentages.								
		Co	Ni	Cu	Fe	As	S	SiO_2	CaO_2	MgO
Ore (hand-picked).	2,194	7.9	4.3	0.1	5.0	30.2	1.7	4.17	15.0	2.7
Ore Jig product...	1,442	10.4	5.8	0.2	6.5	47.2	3.7	4.5	5.2	0.8
Ore Table Concentrate.....	1,426	8.2	3.8	0.25	11.6	37.1	8.25	9.5	......	......
Ore Slime.........	324	2.1	.5	......	6.8	10.0	2.98	58.3	2.5	1.92

The treatment process may be roughly outlined as follows: The crushed ore, with the required fluxes, is mixed in a pug-mill and smelted in a low pressure blast furnace, producing slag, speiss, and crude silver bottoms. The speiss is re-crushed, calcined in coal-fired reverberatory furnaces or in oil-fired Bruckner furnaces, and the calcined product conveyed to the chloridizing furnaces where it is roasted with salt.

The calcined speiss after the above treatment goes to agitating tanks, and the silver extracted by sodium cyanide. Metallic silver is precipitated from the cyanide solution by the addition of aluminum dust. This is known as the Kirkpatrick process, being the invention of Prof. S. F. Kirkpatrick, School of Mining, Kingston. The silver obtained is exceptionally high grade, and the cyanide is to a large extent regenerated.

The residues pass to the cobalt and nickel department, and the crude arsenic oxide recovered in flues and bag-houses. The crude silver bottoms are heated in an oxidizing atmosphere in oil-fired, cylindrical, rotary furnaces, and the impurities removed. The silver thus obtained is mixed with the silver precipitate from the cyanide process, and given further treatment with borax and nitre in an oil-fired tilting furnace, from which it is poured into moulds for the market.

The residues from the cyanide treatment are given further treatment for the separation by precipitation of cobalt and nickel.

The works has a capacity of 400 to 500 tons per month and is producing monthly about 50,000 to 60,000 pounds of cobalt oxide and metal; 15,000 to 20,000 pounds of nickel oxide and metal and 500,000 ounces of silver.

The officers of the company are:—M. J. O'Brien, president; Thos. Southworth, vice-president and managing director; S. B. Wright, general manager; S. F. Kirkpatrick, consulting metallurgist and F. A. Bapty, secretary-treasurer.

Electro Zinc Company, Limited.—This company began operations in November, 1915, at Welland. The plant at present has a maximum capacity of 30,000 lbs. of refined zinc per month. Roasted zinc concentrate is used in this production. A specimen analysis of the product is as follows:—

Zinc	Iron	Lead	Tin	Cadmium	Total
99.98	0.01	0.01	nil	nil	100.00

The Watts process is used, an electrolytic process wherein the same tanks serve for leaching and electrolysis. The process and the apparatus were invented by Ernest E. Watts.

The officers of the company are:—President, Weston Lewis; 1st vice-president, L. D. Adams; 2nd vice-president, C. H. Maxcy; treasurer, J. H. Maxcy; secretary, J. P. Wells and manager, E. E. Watts. The secretary's office is Sherbrooke, Que., and that of the treasurer, Gardiner, Maine, U.S.A.

Metals Chemical, Limited.—This company was organized in February, 1915, under Dominion charter, for the purpose of treating low-grade Cobalt ores and residues.

The plant of the Metals Chemical Company, Limited, situated at Welland, Ontario, was purchased and various extensions and alterations made for treating ores, using processes evolved by C. Gordon Richardson. The plant includes two horizontal tubular boilers, 150 h.p., filter presses, mixing and settling tanks, crystallization tanks, and one new blast furnace, with a capacity of 30 tons of ore per day. The speiss from the blast furnace is crushed in a Sturtevant jaw crusher, then through a set of Sturtevant rolls and Hardinge ball mill to the roasting department.

The blast furnace stack is connected with a concrete return flue 600 feet in length, by 6.5 feet by 4 feet inside dimensions, which collects most of the arsenical fumes, the remainder from the blast furnace and roasting furnace going to the bag house. The blast furnace slag is very low in metallic contents and is rejected. The roasted speiss is re-ground and given further treatment.

The following products are shipped: Cobalt oxide, cobalt carbonate, cobalt sulphate, nickel oxide and sulphate, refined silver and arsenic.

C. G. Richardson, Welland, is president of the company and J. H. Charles, secretary. An average of 60 men are employed.

Sand and Gravel

Washing Plants.—There are now three plants for washing sand and gravel in the Province. These are operated by The Armstrong Supply Co., Limited, at Hamilton; Hamilton Sand and Gravel, Limited, at Hamilton; Windsor Sand and Gravel Co., Limited, near Leamington.

The Armstrong Supply Company, Limited.—On March 13th, 1915, the Armstrong Supply Company, Limited, put in operation a gravel washing plant at their gravel pit on York Street, Hamilton, Ont. The plant was built by the Cable Excavator Co., of Philadelphia, Pa., and is guaranteed to produce 500 tons of prepared material in ten hours. Storage capacity is provided for 600 cubic yards.

The sand and gravel is dug by a cable drag excavator, made by the American Road Machine Co., of Goderich. This excavator is operated by a Fleury Mfg. Co. hoist, driven by a 75-h.p. motor and mounted on a turntable at the top of the washing plant building, which is 100 feet high. The sand is dumped into a hopper in the upper part of the building and then passed over a grizzly. The oversize goes to a No. 5 Champion jaw crusher. The undersize and also the crushed material pass to a set of three shaker screens upon which water is fed through a perforated 5-inch pipe. The oversize from the top screen, which is 15 feet long and has 1½-inch round perforations, is delivered to a No. 4 Champion crusher and is then elevated by a 30-foot bucket elevator and rewashed. The oversize from the two lower screens is collected in storage bins. The undersize from the screens passes into a settling tank equipped with a travelling scraper. The sand is discharged at one end of the tank and the mud and water over the other. Water is supplied by a No. 5 Smart-Turner centrifugal pump with a capacity of 370 U.S. gallons per minute.

Hydro-Electric power is used and is transformed from 2,200 to 550 volts. The pump is driven by a 30-h.p. motor; the hoist by a 75-h.p. and the crushers, screens, scraper and elevator by a 75-h.p.

Five men were employed at the time of inspection (September 28th, 1915), in the washing plant and pit.

The officers of the company are: President, Chas. Armstrong; secretary-treasurer, C. K. Armstrong; and manager, Z. M. Armstrong. The office is at 1050 Cannon Street East, Hamilton, Ont.

Hamilton Sand and Gravel, Limited.—So far as is known this company constructed the first gravel washing plant in the Province of Ontario. This plant is at Junction Cut, Burlington Heights, York Street, Hamilton, Ontario, and was first operated April 7th, 1915. It has a rated capacity of 300 cubic yards of gravel per day of ten hours.

The excavating is done by means of a one-yard drag-line bucket. This is hoisted by a Wettlaufer double-drum hoist and dumped into a chute. A grizzly removes part of the sand, by passing it to a bucket elevator. The remainder passes through a No. 5 Mitchell jaw crusher. The material discharged from the crusher is taken by the bucket elevator to a small galvanized iron box out of which it is washed by jets of water. Then it passes to stationary wire screens. The water and material passing through the first screen are collected in a wooden settling box fitted with five spouts near the bottom. The water does not play on the lower coarser screen. The muddy water overflows from the settling tank and a float discharges the sand through the spouts at intervals. Two of the spouts yield coarse sand, one medium and two fine. The water is supplied by a Smart-Turner centrifugal pump rated at 400 U.S. gallons per minute against a head of 218 feet.

The plant is driven by Hydro-Electric power. A 75-h.p. motor drives the hoist and a 40-h.p. motor the crusher and bucket elevator. Four men were employed at time of inspection.

The officers of the company are: President, Fred. Yapp, Hamilton; manager and secretary, Wm. Kerr, 806 Bank of Hamilton Building, Hamilton, Ont.

Windsor Sand and Gravel Company, Limited.—The Windsor Sand and Gravel Company, Limited, operate a gravel pit and washing plant in Lots 1 and 2, Con. 2, Mersea Township, about two miles west of the town of Leamington.

The gravel is loaded into a two-yard Stephens-Adamson steel skip by a Browning Engineering Co. crane. The skip is hauled up a timber incline and emptied into a hopper. This hopper is discharged by means of a reciprocating feeder into a revolving screen 42 inches diameter by 16 feet long. The upper ten feet of this screen has one-inch perforations; the lower six feet has two-inch perforations. Water is fed into this screen through a 2½-inch pipe. The oversize from No. 1 screen passes to a No. 3D Gates gyratory crusher which reduces it to 1½ inches. The crushed rock is carried back to the above-mentioned hopper by means of a bucket elevator. The undersize from the No. 1 screen is fed into No. 2 screen, a 72-inch Gilbert conical with ⅜-inch round perforations. The undersize from the No. 2 screen is delivered to two 72-inch Gilbert conical screens with ⅛-inch by ½-inch slot perforations. The undersize from screens 3 and 4 passes into an automatic settling tank equipped with a counterweight which causes the sand to be discharged at intervals. The muddy water and very fine sand overflows from the settler into a tank divided into two compartments which are used alternately. The 1-inch to 2-inch material from screen No. 1 and the oversize from the three conical screens passes directly into storage bins.

The machinery is operated by electric power supplied by the Essex County Light and Power Company, Leamington, and transformed to 220 volts. The crusher is driven by a 15-h.p. motor; the screens by a 35-h.p. motor, and the bucket elevator temporarily by a 35-h.p. motor. Water is supplied by a 5-inch Mather and Platt centrifugal pump capable of delivering 400 gallons per minute against a head of 85 feet. The plant is said to have a capacity of 400 cubic yards of washed gravel per day, and was put in operation in July, 1915.

The head office of the company is at Walkerville and the officials are: President, Wm. Woollatt, Walkerville, Ont.; manager, J. E. Laughlin, Walkerville, Ont.

Inspection of Excavations.—The excavations of the following sand and gravel operators were inspected during the year. In addition to the 249 inspections noted below, there were 162 inspections of clay and shale excavations made during the year. A fairly complete list of the important brick and tile manufacturers is given in the statistical part of this Report, and for this reason is not repeated here.

EASTERN ONTARIO AND NIAGARA PENINSULA.

Name.	Material.	Address.
Armstrong Supply Company	Gravel	**Hamilton.**
Allen Bros.	Gravel	**Toronto.**
Armstrong, John J.	Sand and Gravel	**Iroquois.**
Annable, Albert	Gravel	**Moulinette.**
Aube, Ephraim	Gravel	**Berwick.**
Arnold, Thomas	Gravel	**Lindsay.**
Aldworth, John	Gravel	**Bowmanville.**
Arnott, James	Gravel	**Georgetown.**
Ackroyd, Robert	Gravel	**Stanley Mills.**
Bartonville Gravel Pit	Gravel	**Hamilton.**
Burns, Dean	Gravel	**Pembroke.**
Blair, James	Gravel	**Arnprior.**
Brouse, James	Gravel	**Iroquois.**
Becksted, Albert	Gravel	**Morrisburg.**
Bowles, William	Gravel	**Newington.**
Bazinet, Joseph	Gravel	**Chrysler.**
Brisson, Charles	Gravel	**Brisson.**
Baltimore and Cobourg Gravel Road Co.	Gravel	**Baltimore.**

EASTERN ONTARIO AND NIAGARA PENINSULA.—*Con.*

Name.	Material.	Address.
Brown, W. B., and Sons	Gravel	Peterboro'.
Bonnell, T. W.	Sand	Whitby.
Broughton, W. A.	Sand	Whitby.
Beaument, Joseph	Sand	Glen Williams.
Buck, James	Gravel	Georgetown.
Bovaird, James	Gravel	Brampton.
Clifton Sand and Gravel Corporation	Sand and Gravel	Stamford.
Clarke, Richard	Gravel	Smiths Falls.
Colquhoun, George	Gravel	Williamsburg.
Casselman, Emma	Gravel	Williamsburg.
Cleary, Thomas	Gravel	Mille Roches.
Casselman, Alfred	Gravel	Berwick.
Creeper, John	Sand and Gravel	Belleville.
Curtis, Edward	Gravel	Peterboro'.
Croft, Robert	Gravel	Peterboro'.
Curtis, Walter	Gravel	Lindsay.
Corley, Richard	Gravel	Lindsay.
Collacutt, Robert	Gravel	Bowmanville.
Conlin, Fred.	Gravel	Oshawa.
Clifford, Burton	Sand	Oshawa.
Crawford, Bert	Gravel	Brampton.
Crawford, John	Sand and Gravel	Brampton.
Chesney, W. J.	Gravel	Huttonville.
Campbell, D. K.	Gravel	Dunvegan.
Corporation, Town of Lindsay	Gravel	Lindsay.
Corporation, City of Peterboro'	Gravel	Peterboro'.
Corporation, City of Oshawa	Gravel	Oshawa.
Corporation, Town of Prescott	Gravel	Prescott.
Doyle, William	Gravel	Caledonia.
Doyle, Michael	Gravel	Caledonia.
Daniels, William	Gravel	Domville.
Day, Alexander	Gravel	Mille Roches.
Durivage, A. F.	Sand	Casselman.
Davis, M. J.	Sand	Brampton.
Empey, Guy	Gravel	Finch.
Foster, F. W.	Sand	Caledonia.
Forgues, Dieudonne	Gravel	Casselman.
Griffith, Johnson	Gravel	Pembroke.
Gillespie, John	Sand	Perth.
Gowland, Isaac	Gravel	Caledonia.
Gillard, David	Gravel	Williamsburg.
Garlough, Jacob	Gravel	Williamsburg.
Godard, Michael	Gravel	Crysler.
Gauthier, Nap.	Sand	Alexandria.
Gibson, James	Sand	Belleville.
Graham, James	Gravel	Canton.
Garvey, Timothy	Gravel	Peterboro'.
Griffin, J. A.	Gravel	Georgetown.
Hamilton Sand and Gravel Company	Sand and Gravel	Hamilton.
Healey, Frank	Gravel	Smiths Falls.
Hamilton, Robert	Gravel	Caledonia.
Hume, R. Wesley	Gravel	Northfield.
Honey, Stephen	Gravel	Bowmanville.
Hyland, George	Gravel	Oshawa.
Harlock, Joseph	Gravel	Whitby.
Jackson, F.	Gravel	East Toronto.
Johnson, H. L.	Sand	North Toronto.
Jack, Daniel	Gravel	Oshawa.
Kingston Sand and Gravel Company	Sand and Gravel	Kingston.
Keefer, C. H.	Sand and Gravel	Ottawa.
Kerfoot, George	Sand and Gravel	Smiths Falls.
Kennedy, Duncan	Gravel	Maxville.
Lecuier, Louis	Gravel	Bowesville.

EASTERN ONTARIO AND NIAGARA PENINSULA.—*Con.*

Name.	Material.	Address.
Larioiere, Alex.	Sand	Alexandria.
Laidlaw, Matthew	Gravel	Norval.
Laird, Alfred	Gravel	Norval.
Maher, William	Gravel	Western Road.
Maple Sand and Gravel Company	Sand and Gravel	Maple.
Morrison, Jos. H.	Sand and Gravel	Brockville.
Markus, William	Sand and Gravel	Pembroke.
Moore, George	Gravel	Caledonia.
Merkeley, Charles	Gravel	Williamsburg.
Mattice, Herbert	Sand	Wales.
Murphy, William	Gravel	Wales.
Montgomery, Chapman	Gravel	Moose Creek.
Magladery, Thomas	Gravel	Leonard.
Mitchell, Thomas	Gravel	Peterboro'.
Murphy, Patrick	Gravel	Lindsay.
Montgomery, John	Gravel	Bowmanville.
Malleable Iron Works Company	Sand	Oshawa.
Miller, Robert	Sand	Norval.
Metcalfe, William	Gravel	Greenfield.
Municipality, Township of Cumberland	Gravel	Cumberland.
Municipality, Township of Hamilton	Gravel	Cobourg.
Municipality, Township of Hope	Gravel	Welcome.
Municipality, Township of Ops	Gravel	Lindsay.
Municipality, Township of East Whitby	Gravel	Columbus.
McKay, Charles	Gravel	Toronto.
McLean, David	Sand and Gravel	Perth.
McMillan, Arthur	Gravel	Chesterville.
McGillis, Hugh	Gravel	Harrison.
McMillan, Ronald	Gravel	Finch.
McKinnon, Angus	Gravel	Alexandria.
McPhee, D. A.	Gravel	Vankleek Hill.
McGuire, Patrick	Gravel	Lindsay.
McIntosh, Hugh	Gravel	Dunvegan.
McLeod, Norman R.	Gravel	Dunvegan.
McDonald, A. K.	Gravel	Greenfield.
McDonald, D. A.	Gravel	North Lancaster.
New, Edward	Gravel	Hamilton.
Norton, John	Gravel	Newtonville.
Nichols, H.	Gravel	Richmond Hill.
Nesbitt, Robert A.	Sand and Gravel	Ottawa.
Nicholas, Gideon	Sand	Caledonia.
Ollman Bros.	Gravel	Hamilton.
Ontario Sand Company	Sand	Niagara Falls.
O'Connell, J. T.	Sand	Peterboro'.
Prosser, Edward	Gravel	Toronto.
Pringle, Frank	Gravel	Toronto.
Porter, Thompson	Sand and Gravel	Toronto.
Patterson, Thomas	Gravel	Arnprior.
Pascoe, Oliver	Gravel	Whitby.
Quinn, John S.	Gravel	Peterboro'.
Reinville, Adolphe	Sand and Gravel	Casselman.
Rice, John	Gravel	Whitby.
Robinson, William	Gravel	Prescott.
Robinson, Alfred	Sand and Gravel	Lindsay.
Robinson, Richard	Gravel	Lindsay.
Robinson, Albert	Gravel	Oshawa.
Rudd, John	Gravel	Huttonville.
Rumble, Harry	Gravel	Maple.
Sherwood, Geo. E.	Sand and Gravel	Brockville.
Shanks, James	Gravel	Smiths Falls.
Smith, Arthur	Sand	Caledonia.
Sterritt, David	Gravel	Prescott.
Smith, John	Sand	Prescott.

EASTERN ONTARIO AND NIAGARA PENINSULA.—*Con.*

Name.	Material.	Address.
Styles, Geo.	Sand	Morrisburg.
Shanette, Alexander	Gravel	Williamsburg.
Sleeman, Philip	Gravel	Welcome.
Snowden, Thomas	Gravel	Bowmanville.
Sully, W. J.	Gravel	Hampton.
St. David Sand Company	Sand	St. David.
Stamford Sand Company	Sand	Stamford.
Scott, Harold G.	Sand and Gravel	Niagara Falls.
Taylor, Frank	Gravel	Madoc.
Thompson, Albert	Gravel	Port Hope.
Thomas, William	Gravel	Oshawa.
Union Stock Yards	Sand and Gravel	West Toronto.
Webb, William	Gravel	Hamilton.
Watson, John	Sand and Gravel	Maple.
Whittaker, H. M.	Gravel	Williamsburg.
Weaver, Thomas	Gravel	Williamsburg.
Winters, Howard	Gravel	Mille Roches.
Woods, Cory	Gravel	Moulinette.
Winter, James	Gravel	Newington.
Walsh, W. J.	Gravel	Bearbrook.
Walker, Hiram	Gravel	Port Hope.
Weese, William	Gravel	Lindsay.
Willoughby, J. A.	Gravel	Georgetown.
York Sand and Gravel Company	Sand and Gravel	East Toronto.
Yates Gravel Pit	Gravel	Hamilton.
Young, David	Gravel	Caledonia.

SOUTHWESTERN ONTARIO

Name.	Material.	Address.
Armitage, Michael	Gravel	Lucan.
Aitcheson, Thos. W.	Gravel	R.R. No. 3, Stratford.
Baskerville, Henry	Gravel	R.R. No. 4, Thorndale.
Bott, Raywood	Gravel	R.R. No. 4, Thorndale.
Bassow, William M.	Gravel	R.R. No. 3, Zurich.
Collins, John	Sand	Putnam.
Conn, Malcolm	Gravel	R.R. No. 4, St. Marys.
Cann, John	Gravel	R.R. No. 3, Exeter.
Carroll, Robt.	Gravel	Watford.
Clendenning, James	Gravel	Copleston.
Cann, John W.	Gravel	Copleston.
Copling, Peter	Gravel	R.R. No. 2, Zurich.
Dowding, Albert	Gravel	R.R. No. 1, Kerwood.
Durr, Lewis H.	Gravel	R.R. No. 8, Parkhill.
Eckstein, John	Gravel	R.R. No. 2, Zurich.
Erb, Christian	Gravel	R.R. No. 2, Zurich.
Erb, John G.	Gravel	R.R. No. 2, Zurich.
Erb, Dilman K.	Gravel	R.R. No. 3, Stratford.
Finnegan, Chas.	Gravel	R.R. No. 5, Stratford.
Frazer, Wilmot	Gravel	R.R. No. 5, Stratford.
Fewster, Robt.	Gravel	R.R. No. 4, St. Marys.
Fleming, Robt.	Gravel	R.R. No. 5, Watford.
Francis, J. G.	Gravel	Mossley.
Grieves, John, M.P.P.	Gravel	Parkhill.
Graves, Geo.	Gravel	Leamington.
Harris, James	Gravel	R.R. No. 4, St. Marys.
Hill, Roland	Gravel	Crediton East.
Hunt, Alfred E.	Gravel	Bracebridge.

SOUTHWESTERN ONTARIO.—*Con.*

Name.	Material.	Address.
Hodgins, Geo.	Gravel	R.R. No. 1, Lucan.
Klopp, Elmer M.	Gravel	R.R. No. 2, Zurich.
Kirby, Henry	Gravel	Stratford.
Karr, James	Gravel	Petrolia.
Kerr, John	Gravel	Petrolia.
Kettle, Robt.	Gravel	Petrolia.
Kettle, Wm.	Gravel	Petrolia.
Lucas, Robt. J.	Gravel	Watford.
Litt, Geo. S.	Gravel	Sebringville.
Mills, James	Gravel	R.R. No. 3, Stratford.
Malloy Bros.	Gravel	R.R. No. 1, Sebringville.
Moody, Wm.	Gravel	R.R. No. 3, Exeter.
Morrison, W. E.	Sand	Ridgetown.
Munroe, John L.	Gravel	R.R. No. 1, Cairo.
Mawson, Mrs. Agnes	Gravel	R.R. No. 8, Parkhill.
Merner, J. J.	Gravel	Zurich.
McRann, Samuel	Gravel	R.R. No. 1, Clandeboye.
McShedran, John	Gravel	R.R. No. 3, Petrolia.
McKay, Wm., Sr.	Gravel	R.R. No. 2, Stratford.
Park, John S.	Gravel	Lucan.
Parish, Thomas	Gravel	R.R. No. 2, St. Thomas.
Rice, Geo. A., & Sons	Sand	Dresden.
Richards, Jos.	Sand	Dresden.
Robinson, Wm. J.	Gravel	R.R. No. 1, Crediton.
Rollins, John	Gravel	R.R. No. 1, Crediton.
Riehl, George	Gravel	R.R. No. 1, Sebringville.
Roadhouse, Mrs. Margaret	Gravel	R.R. No. 5, Stratford.
Smith Bros.	Gravel	R.R. No. 1, Cairo.
Sherman, Mrs. Wm.	Sand	Thamesville.
Stevens, Marshall A.	Gravel	St. Marys.
Smith, J. W.	Gravel	Leamington.
Showler, Geo.	Gravel	R.R. No. 1, Dorchester.
Smithers, Wm.	Gravel	R.R. No. 8, Parkhill.
Smith, Wm.	Gravel	R.R. No. 4, Thorndale.
Schwartzentrauber, Jacob	Gravel	Wyoming.
Siemon, Conrad	Gravel	Zurich.
Turtle, Samuel	Gravel	R.R. No. 1, Aberfeldy.
Tiffin, Arthur	Gravel	R.R. No. 1, Thamesville.
Triebner, Frank	Gravel	R.R. No. 1, Exeter.
Varley, Walter	Gravel	R.R. No. 8, Parkhill.
Watts, Wm.	Gravel	Thamesville.
White, Wm. M.	Gravel	R.R. No. 5, St. Marys.
Whitlock, Peter	Gravel	R.R. No. 1, Hensall.
Wood, John	Gravel	Exeter.
Windsor, Essex & Lake Shore R'y.	Gravel	Kingsville.
Windsor Sand & Gravel Co.	Gravel	Walkerville.
Wooley, John N.	Gravel	R.R. No. 3, Petrolia.
Whiting, Robt.	Gravel	Copleston.
Weber, Arthur	Gravel	Dashwood.
Walper, Louis	Gravel	R.R. No. 3, Dashwood.
Watson, John	Gravel	Bracebridge.

IRON DEPOSITS OF HUNTER ISLAND

with Notes on the

Gunflint Lake Area

By ARTHUR L. PARSONS

Introduction

In accordance with instructions from T. W. Gibson, Deputy Minister of Mines, the writer, accompanied by his assistant, Ellis Thomson, left Toronto on May 31st for Fort Frances, where provisions were secured, for an exploration of the iron ranges of Hunter island, Rainy River district. At Fort Frances, the party was joined by N. McDougal, who acted as canoeman during the season.

The work was impeded by extremely unfavourable weather, so that in many cases the ranges could not be examined in such detail as was desirable; more particular attention, however, was paid to the ranges which appear to give most promise of successful economic development.

The larger part of the work was on the range located on This Man lake and the lakes lying in the same rock trough. The ranges extending from Carp lake to Jasper lake were also studied carefully, but in less detail than the first mentioned deposit, while the final work on the Hunter island deposits was devoted to an examination of the magnetite deposits on the north shore of Saganagons lake.

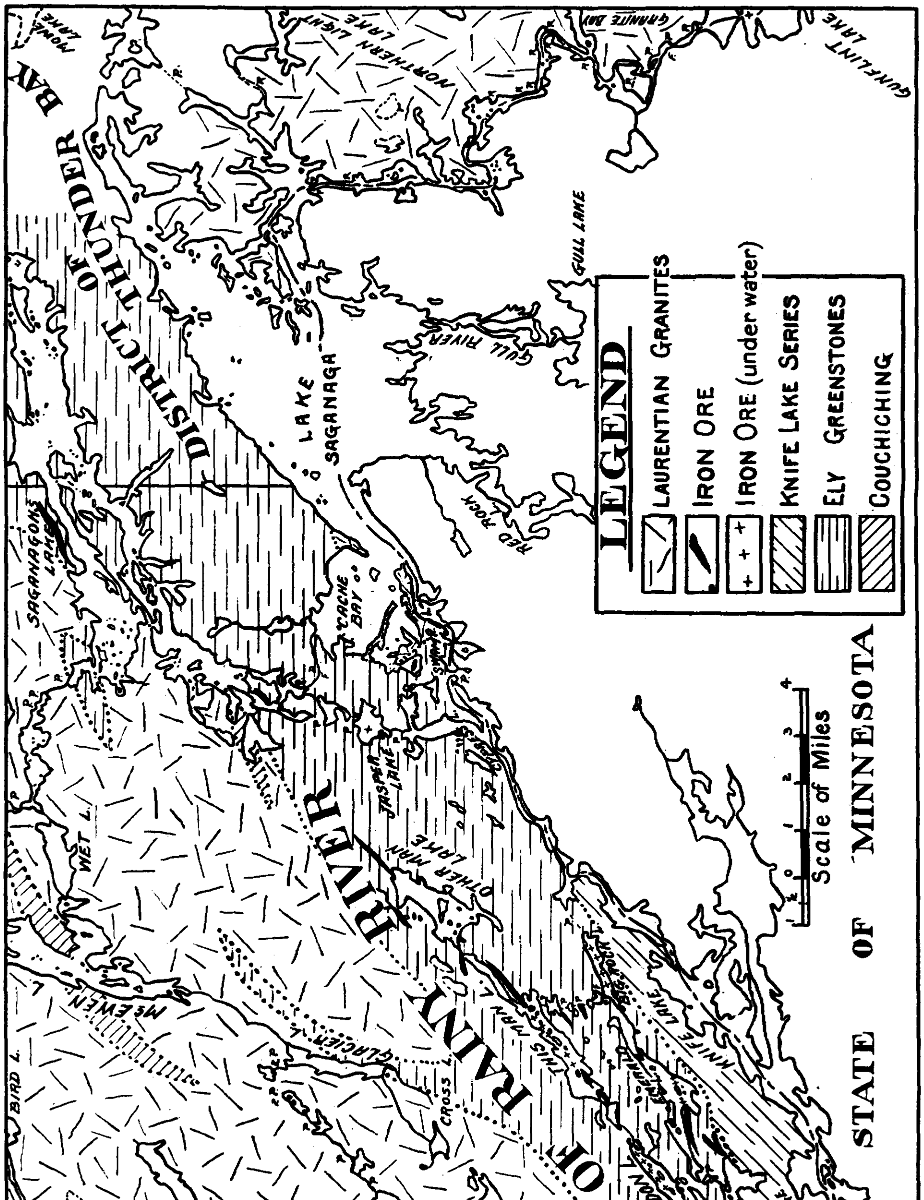
During the latter part of August a hurried examination of the outcrops of iron formation in the Gunflint area was carried on.

At present, the iron deposits of Hunter island can be reached in summer only by a canoe journey from North Lake, Fort Frances, or Kawene stations, on the Canadian Northern Railway. The best route is probably the one from North Lake, by which, with favourable weather conditions, the journey can be made in two or three days. The approach to This Man lake and Sarpedon lake from the southwest is difficult, as the region around Carp lake and the southwest end of Sarpedon lake has been burned within a few years, and the portages, which were never easy, have been made almost impassable. A safer, but still difficult, route may be taken from Emerald lake through a small mountain lake to the upper end of Sarpedon lake. With the exception of these few portages, the route is easy, as the portages are well cut out and good camping places are to be found on most of them.

Previous Geological Work in the Area

The literature relating to the geology of the Hunter island iron deposits is, considering the size of the deposits and the nearness to the old Dawson route, surprisingly meagre, and detailed work of importance is limited to the Report on Hunter island by W. H. C. Smith,[1] and the Report on the Vermilion Iron Range by J. Morgan Clements.[2]. Both these reports are accompanied by maps. In

[1] Geol. Sur. Can., Vol. 5, 1889-90-91, Part "C."
[2] U. S. G. S., Mon. XLV., 1903.



Geological sketch map of Hunter island iron ore deposits.

Smith's map the major part of the island is mapped as Laurentian with a large area of Couchiching on the northwest side connected with deposits of the same kind on Rainy lake, and an area of, approximately, equal size on the southeast side which is mapped as Keewatin. In this latter area he indicates numerous iron ore locations, but makes no attempt to indicate an iron formation distinct from the main mass of the Keewatin. In this report the deposits of iron ore are dismissed in a few words.

The report by Clements deals primarily with the great Keewatin area which contains the iron ore deposits in Minnesota known as the "Vermilion Range," and also deals with the Keewatin area on the southeast side of Hunter island. In his map, he subdivides this area outlined by Smith as "Keewatin" into five parts: Ely greenstones, Soudan formation, Ogishke conglomerate, Agawa formation and Knife Lake formation. The map is apparently, so far as the topography of the Canadian portion is concerned, an enlargement of Smith's map, and covers only the southern portion of the area.

Aside from these two reports, there is practically nothing published concerning the geology of the interior of Hunter island that has any bearing on the iron deposits, though much has been written descriptive of the geography of the region, particularly of the boundary chain of lakes. Among the latter class of descriptions may be mentioned the charming account of the region from Grand Portage, Minnesota, along the old boundary route, given by Sir Alexander Mackenzie.[3] The description of the route from Grand Portage to Basswood lake, which covers the part considered in this report, is reprinted in Clements' Report on the Vermilion Iron range.[4]

Topography

The area covered by this report is most emphatically one of lakes, the character of whose shore lines is determined largely by the nature of the contiguous rocks. Where Keewatin rocks are found, the shores are almost universally precipitous, and the lakes are likely to be long and narrow. In such instances the longer direction of the lakes is determined by the strike of the rocks or the general direction of schistosity. In the case of the lakes on the strike of iron deposits, there is good reason for supposing that they have resulted largely from the oxidation of the iron ores accompanied by a sinking, due to a decrease in bulk of the iron deposits. This is shown in a remarkable manner on This Man lake and Sarpedon lake.

Where granite rocks predominate, the shore lines are not so rugged. Sand beaches are more common, and the hills have a more gentle slope and rounded contour. In the absence of definite outcrops, the character of the underlying formation can usually be judged by the contour of these hills and the presence of sand beaches. This is, however, not always the case, as sand beaches are occasionally found near the head of lakes in the Keewatin rocks, but in such cases the sand is probably derived from the quartz accompanying the iron formation.

[3] Voyages from Montreal, on the River St. Lawrence, through the Continent of North America, to the Frozen and Pacific Oceans, in the years 1789 and 1793, by Alexander Mackenzie, London, 1801.

[4] U. S. G. S., Mon. XLV, pp. 57-63.

Laurentian

The Laurentian rock in this region is characteristically granite, and is easily recognized by the rounded dome-like character of its outcrops. In the iron region proper, very few outcrops of granite are to be found, but a short distance to the northwest the whole region is characterized by its presence. It does not come into the consideration of the ores, except on Saganagons lake, though contact features may be seen on Saganaga lake. There is, apparently, no good reason to assume for the granite northwest of the iron deposits an age different from that of the granite of Saganaga lake, but as this latter mass is traced to the east along Gunflint lake, where it is found very near, if not in contact with the Animikie, the relationships of these two are at times somewhat puzzling, and point to the possibility of a much later date for this granite than has heretofore been suggested.

Keewatin and Huronian

In the work of Smith, the series, which was later subdivided by Clements, was all mapped as Keewatin. In doing this, he undoubtedly followed Lawson who worked with a similar series on the Lake of the Woods and on Rainy lake. In those areas the principal subdivisions of the Keewatin are the greenstones and green schists, and the quartz porphyries and hydromica or sericite schists, with large masses of agglomerate and clay slate.

Clements subdivides the rocks, which are classed by Smith as Keewatin, as follows--

LOWER HURONIAN	Knife Lake formation Agawa formation Ogishke conglomerate
ARCHEAN	Soudan formation Ely greenstone

In the map accompanying Clements' report, all these formations are shown in the area under consideration, but by far the most important, considering the area covered, are the Ely greenstone and the Knife Lake formation. The Ogishke conglomerate was not recognized by the writer, and is evidently, from Clements' mapping, of insignificant proportion on Hunter island, though covering large areas in Minnesota, near Ogishkemuncie lake. The Soudan formation and the Agawa formation cannot be distinguished by petrographic means, but depend for their differentiation upon their stratigraphy.

The committee on pre-Cambrian nomenclature recognized the validity of the classifications in their principal features of both Lawson and Clements, and, later, Van Hise in correlating the pre-Cambrian rocks of the Lake Superior region definitely correlates the Ely greenstones and the Soudan formation with the Keewatin [5] while keeping the same subdivisions for the upper series.

In the region under discussion, the outstanding features are that there are two series of rocks which usually may be distinguished in the field by the colour of the weathered surface. One of these, the Knife Lake formation, is usually light coloured on the surface, though dark on an unweathered surface, while the other, the Ely greenstone, is dark both on the weathered and unweathered material. In

[5] U. S. G. S., Bull. 360, p. 328.

both these formations bodies of iron ore are found, but in their petrographic features no distinction can be drawn between Soudan iron formation and Agawa iron formation. The deciding criterion is stratigraphy, and for this it would seem to be necessary to find the Ogishke conglomerate. This conglomerate was not recognized by the writer, although indicated in Clements' map in the vicinity of This Man lake.

The field distinction between the Knife Lake series and the Ely greenstones in the vicinity of This Man lake and Sarpedon lake is not clear, and this difficulty is recognized by Clements for the region around Carp and Birch lakes. In consequence, the writer in mapping the region has adopted the following divisions for the Keewatin and Huronian:—

Knife Lake formation
Iron formation
Ely greenstones

Couchiching

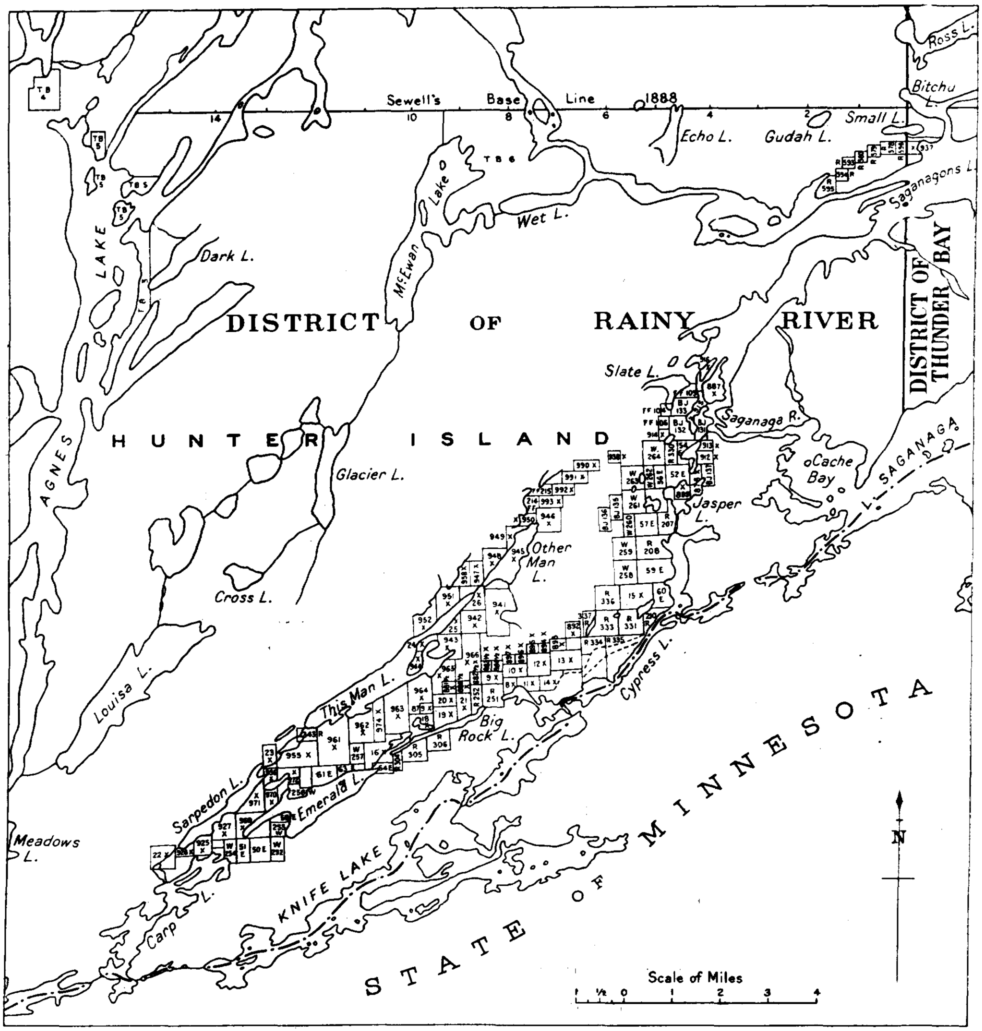
In mapping the Couchiching in the area under consideration, the writer has followed Smith's map. The only area examined is the one on Slate lake, which Smith maps as Couchiching, but in a note explains that the rocks are "characterized by the presence of muscovite as a constituent mineral." The other area on McEwen lake was not visited, as iron was not known to be present here, and the probability of its occurrence seemed slight. The rocks are highly metamorphosed and are principally mica schists.

Iron Deposits of Hunter Island

The iron ores of Hunter island and the north side of Saganagons lake are of three types, banded magnetite, banded hematite and carbonate. Of these, the carbonate would appear to be the original ore, though found in only two places; on a small island in This Man lake, and on a large island on the Minnesota side of Knife lake. These bodies of carbonate are not of pure siderite, but rather a ferruginous limestone or dolomite. The relations of this latter outcrop were not traced, but the former was correlated by dip needle readings and the strike of the formation with the principal range of iron ore on This Man lake. It is not possible to assert positively that it is part of this main ore body, as dip needle readings on siderite bodies are frequently not high, and on ferruginous limestones the readings might be disregarded, so that in many cases no definite indication can be secured in this way. In the case of the carbonate bodies, no marked banding was observed and almost no quartz. Such quartz as was present was white or light coloured and appeared to be vein quartz which is possibly of a later generation.

The other two ores are all more or less banded and, with few exceptions, consist of hematite or magnetite, or both, interbanded with red jaspilite and some vein quartz. The deposits on the north shore of Saganagons lake consist of magnetite with light coloured quartz, which has very much the character of vein material.

In estimating the value of iron deposits an approximation can be made by measuring the width of the iron bands and those of silica. In case the bands of silica are wider than those of the iron, it may safely be said that the ore body is of



Map showing mining claims on Hunter island.

low grade, and cannot be worked at a profit unless the bands of ore are so wide that a fairly clean product can be obtained by mechanical separation. This serves as negative information. Positive information concerning the value of a deposit can be obtained only by a chemical analysis, even in the case of bodies of ore which show no particular banding.

This Man Lake

This lake, which is about four and a half miles long, and at its widest point approximately a half mile wide, is bordered by rugged shores which, for the most part, are decidedly precipitous. The iron ore is principally confined to the southeast shore and the lake bottom, and it outcrops on the following claims:—R-343, 928-X, 968-X, 944-X, 24-X, 25-X, and 26-X.

The ore is in almost vertical position, and consists principally of hematite, jaspilite and vein quartz with some sericite and chlorite schists, and extends in a straight line from the southwest end of the lake to the southern shore of the northeast end. The continuity of the deposit is shown by the dip needle readings between the outcrops. On a small island near the middle of the lake and on the line of strike of the deposit, the oxidized ore is lacking, but in its place ferruginous limestone, which is oxidizing to limonite, is present. In addition to the main body of iron ore, insignificant outcrops of iron formation not more than ten feet wide were seen on the northwest shore of the lake and in a bay on claim 943-X. Samples from the main ore body were taken, and analyses have been made to show the character of the ore. Descriptions of individual claims follow. In some cases more than one deposit is found on a claim, but although an effort has been made to locate all these on the map no deposit less than twenty feet wide is described, unless it shows more than ordinary richness, or is of importance in its relation to larger bodies.

In the field, the writer supposed that the ferruginous limestone could be looked upon as siderite, and took a sample for analysis, the result of which is as follows:—

SiO_2	FeO	Fe_2O_3	P	S	Ti	CaO	CO_2	MgO	Fe
47.82	7.68	11.34	.063	.501	nil	3.74	8.45	1.67	13.91

The silica percentage in this is so great as to render the material of no value either as an ore or a flux.

Claim R-343.

In two places the ore body in this claim is easily seen, on the shore of This Man lake and on the portage between this lake and Agawa or Buzz lake. The outcrop on the shore is covered with moss and trees and, in places, a shallow mantle of soil so that it was impossible to expose the full width of the deposit with the facilities at hand. The ore was, however, exposed by stripping the moss to a width of forty-six feet, which is the smallest measurement obtained on the outcrops of This Man lake. On the portage between This Man lake and Agawa lake the full width of the formation is exposed on a rather steep incline. Estimating the elevation from the lower edge to the top as forty feet, and measuring the width on the slope as one hundred and sixty-seven feet, the actual width was determined to be about one hundred and sixty-two feet; being the widest exposure seen in the entire district. There are several minor bands of greenstone and green schist in this outcrop, but the width of ore and jasper is about one hundred and twenty-five feet.

During a previous visit to this claim in 1904, the writer took from the claim a sample of ore which was analyzed by Prof. C. F. Sidener, of the University of Minnesota, with the following result —

SiO_2	FeO	Fe_2O_3	Al_2O_3	P	S	Ti	Undetermined	Fe
30.50	20.81	41.32	3.55	.148	.009	.15	3.513	45.74

Claim 928-X.

This claim is shown in Figure 1, being the island in the foreground at the right. It is about one hundred and fifty feet wide, and from four hundred to five

Fig. 1.—This Man lake from outcrop of ore on R-343. The island in the foreground is 928-X and is nearly all iron ore. The range follows the shore of the lake at the far end, and a line of islands at the southwest end.

hundred feet long. Approximately two-thirds of the width of the island is banded iron ore, consisting of hematite and jaspilite.

Two samples of the ore were taken, one (No. 5) being considered a fair average of the deposit as a whole, while the other (No. 6) is from one of the richer bands. The analyses follow:—

	SiO_2	FeO	Fe_2O_3	P	S	Ti	Co_2	Fe
No. 5	48.24	8.44	35.28	.102	.002	nil	.49	31.26
No. 6	37.60	6.30	51.52	.061	.423	nil	.59	40.96

Claim 968-X.

The ore on this location is a continuation of the body on R-343 and 928-X, and appears at the water's edge. From the contact with the schist wall on the southeast side of the ore body to the water's edge, the width is sixty feet. The formation as a whole at this point appears to be low grade, but in some of the depressions in the ore body higher grade material was present. In the midst of the ore body some bands of green schist were found, and in this schist veinlets of jaspilite were seen filling cross fractures. In some parts the ore is much brecciated, but the writer could find no evidence of a corresponding brecciation in the adjoining schists and greenstones. This is a feature which is observed very commonly in the ores of the region.

Sample No. 18 is thought to be a fair average of the outcrop on this claim, and the analysis which was made by W. K. McNeill, Provincial Assayer, is supplemented by an analysis (No. 20) made in 1904 for the writer by Prof. C. F. Sidener, of the University of Minnesota:—

	SiO_2	FeO	Fe_2O_3	P	S	Ti	CO_2	Al_2O_3	Undetermined	Fe
No. 18 (1915)	55.40	9.70	21.42	.157	.041	....	1.02	....		22.55
No. 20 (1904)	44.45	12.69	28.45	.123	.013	.10	....	6.56	7.614	29.8

Island N. E. of 968-X.

In direct line with the outcrops on 928-X and 968-X is an island about equal in size to 928-X, which exhibits the continuation of the ore body. The ore is hematite, and is located on the nothwest side of the island. The width of the better grade ore is about forty feet, but adjoining this is a banded schistose material containing considerable ore, but hardly good enough to be of economic importance, which, with the ore, makes a total width of ninety-four feet. The island is about six hundred feet long, and the ore extends the entire length. One sample was taken for analysis, and the results obtained by W. K. McNeill, Provincial Assayer, are given herewith:—

SiO_2	FeO	Fe_2O_3	P	S	CO_2	Ti	Fe
40.25	12.60	45.92	.102	.219	.43	....	41.94

Although this is not a high-grade ore, it is equal in quality to some of the Lake Superior ores which have been shipped in large quantity.[6]

The deposits at the northeast end of the lake are upon claims Nos. 24-X, 25-X, 26-X, 942-X, 943-X and 944-X. The ore body merely cuts across the corners of 942-X and 943-X, and was not traced into 26-X, but is well exposed along the

[6] Crowell and Murray. The Iron Ores of Lake Superior, 1914, pp. 183, 188, 226, 244.

shore on 25-X and 944-X, and outcrops at the lake shore at the west end of the line between 24-X and 944-X, and another outcrop of about the same quality as the ore on 944-X and 25-X was seen on the shore near 25-X. Samples to represent this portion of the range were taken on 944-X and 25-X, as the ore body is better exposed and it was possible to get a more representative sample.

Claim 944-X.

The ore body on 944-X consists of banded jaspilite and hematite with probably some magnetite, as the dip needle is much affected. The northwest boundary of the ore, being beneath the lake, could not be located, but a width of fifty-four feet was measured across the ore from the southeast wall to the lake shore. The ore

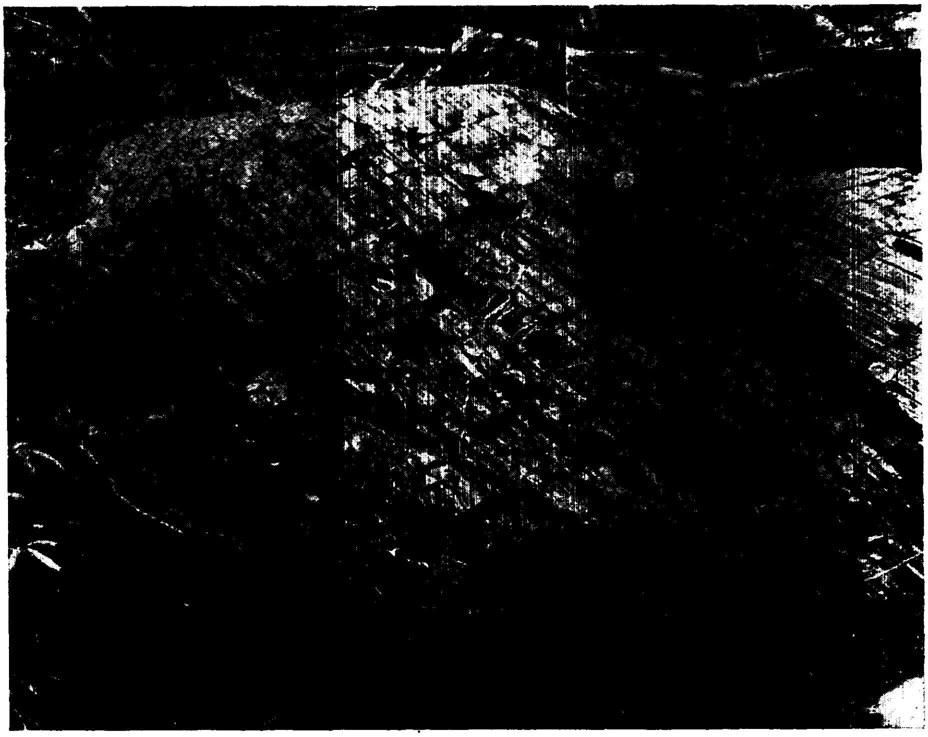


Fig. 2.—Banded hematite on claim 944-X.

bands are broad, and about two-thirds to three-fourths of the width exposed appears to be good ore. The low-grade material is principally jaspilite, and would be separated easily on a picking belt. The ore body at this point is on the lake shore, and jaspilite was seen under the water at least forty feet from shore, so that the total width of ore in this band is not less than ninety feet. The banded character of the ore is shown in Figure 2.

Three samples of the ore were taken for analysis from the better portions of the outcrop and have been analyzed by W. K. McNeill, Provincial Assayer, with the following results:—

	SiO_2	FeO	Fe_2O_3	P	S	Ti	CO_2	Fe
No. 10	44.33	9.80	34.58	.081	.182	nil	.58	31.85
No. 11	41.06	5.29	51.38	.143	.004	nil	.24	40.08
No. 12	37.96	9.32	44.94	.059	.118	nil	.16	38.71

Of these, No. 10 is too low grade to be of value, but numbers 11 and 12 come within the limits for iron and silica that are found in actual shipments from Lake Superior ports.

Claim 24-X.

There is a showing of iron ore at the lake shore at the corner between 944-X and 24-X, as well as on the northeast side of the claim near 25-X. This claim was not sampled, there not being sufficient difference in the character of the ore from that found in the two adjoining claims to make it necessary or advisable.

Claim 25-X.

The continuation of the ore body seen on 944-X and 24-X is found on 25-X, and consists as on the other claims of hematite and jaspilite. Apparently the ore is of good quality, though there is considerable jaspilite. This, however, could easily be removed on a belt. The best portion of the ore body consists of a band of hematite about fifteen feet wide (Sample 15). In places, vein quartz is present with the jaspilite, and nodules of the same material were seen in the ore near the wall. The width of the entire outcrop is sixty-one feet. Some green schist is present in the midst of the ore body, but in comparatively small amount.

Three samples were taken for analysis, and the results obtained by W. K. McNeill, Provincial Assayer, are shown below for samples Nos. 13, 14 and 15. To these is added an analysis made by Prof. C. F. Sidener of the University of Minnesota for the writer in 1904, of material from the same claims:—

	SiO_2	FeO	Fe_2O_3	P	S	Ti	CO_2	Al_2O_3	Undetermined	Fe
No. 13	41.9	16.0	37.10	.210	.135	nil	.65	....	....	41.24
No. 14	46.50	12.34	37.52	.186	.008	nil	1.15	....	....	35.86
No. 15	31.85	9.95	41.72	....	....	....	....	....	....	36.95
1904	29.75	8.40	57.10	.072	.023	.01	....	3.75	2.608	46.06

Next Man Lake.

At the northeast end of the portage between This Man lake and Next Man lake is a large outcrop of low-grade iron ore. The relations between this deposit and the main range on This Man lake are uncertain, but the deposit appears to extend towards the north side of This Man lake rather than towards the ore body on the south side. At the northeast end of Next Man lake, the iron formation again outcrops and extends through claims 946-X, 993-X, 992-X and presumably through 991-X and 990-X, but the writer did not trace it beyond 992-X. At this point, the body of iron ore is very lean, and, as it would not be of commercial value

Fig. 3.—Island on Next Man lake, showing sericite schist in foreground, and iron ore in background. The small pole lying on the rock in the foreground is parallel with the planes of schistosity, while the pole lying on the ore near the water's edge is parallel with the banding of the ore.

without mechanical concentration, no samples were taken. About the middle of the lake, almost in line between these two outcrops, is an island upon which the iron formation is found (see Figures 3 and 4), but strangely enough the strike of the formation is northwest-southeast instead of northeast-southwest. If this belongs to the same range as the other two, there is evidently a decided fold in the formation. This, however, cannot be verified. Upon this island, the adjoining rock is somewhat schistose, and the planes of schistosity are in a northeast-southwest direction. The outcrop of ore and rock on this island is shown in Figures 3 and 4.

Going over the portage between Next Man lake and the small lake shown west of claim 950-X, another range of iron ore is found near the end of the portage on 949-X. This range is known to extend through 949-X, 948-X and 947-X. It is,

Fig. 4.—Iron ore seen in Fig. 3.

however, only about twenty feet wide, and of low grade. An analysis made by Professor C. F. Sidener of the University of Minnesota of a sample taken from 948-X, for the writer in 1904, is given below:—

	SiO_2	FeO	Fe_2O_3	P	S	Ti	Al_2O_3	Undetermined	Fe
No. 25 (1904)	27.30	15.77	48.26	.142	.007	.15	5.83	2.541	46.06

This analysis, however, does not represent an average of the deposit, but may be looked upon rather as the product that might be obtained by crushing the ore and concentrating by a magnetic separator. The sample from which the analysis was made was from one of the bands of magnetite. An average of the whole deposit would show a much lower iron content. If, after crushing, the ore were put through rolls, it is probable that a much higher grade ore might be secured, but in view of the limited extent of the ore body, it is doubtful whether this would be commercially feasible. The ore of this deposit consists of magnetite and nearly black quartz, which gets its black colour from a small quantity of disseminated magnetite. It resembles the deposit on the north side of Saganagons lake, except that the latter deposit contains more white quartz that would ordinarily be called vein quartz.

So far as the writer is able to judge, the iron bodies on Next Man lake will not be of economic importance for some time.

Sarpedon Lake.

The outcrop of iron ore on Sarpedon lake is of a character that gives promise of value only when its relation to the other parts of the same range is considered. Several minor bands of banded iron formation are to be seen in the region between this lake and Emerald and Carp lakes, and some of these outcrop on the southeast shore of Sarpedon lake. The most important band of ore, however, outcrops near the southwest end of the lake and extends to the next lake to the southwest. This band consists in part of sericite schists with siderite, and in part of hematite and magnetite interbanded with quartz. It is doubtful whether any of the outcrops

Fig. 5.—View from the head of Sarpedon lake.

are sufficiently rich to warrant exploitation, but the lake itself offers a field of considerable promise. At the northeast end of the lake, no outcrop of ore was seen that could be looked upon as an extension of the deposits on This Man lake, but it was found that dip needle readings from 45° to 90° were obtained on crossing the lake at this end. The lake was then traversed by canoe in a zigzag, and it was assumed that a dip needle reading of more than 45° indicated a body of iron ore. In this way it was considered that a good-sized body of ore may extend from one end of the lake to the other with a maximum width of not more than two hundred feet and a probable minimum of seventy-five feet. The direction of this ore body is shown in Fig. 5, which is a view taken from the northeast end of the lake and showing the hills at the far end. The line which has been drawn on the surface of the water indicates the direction of the ore body, and the narrows between the large island and the mainland on the right is somewhat more than the maximum width of the ore body. The length of this line is, approximately, three and one-half miles. As will be seen by reference to the map this body of ore is directly in line with the outcrops of hematite on the southeastern shore of This Man lake, and although the writer did not locate an outcrop on the southwest shore of Agawa lake there appears to be no good reason for looking upon this as other than the continuation of the well-exposed deposits of This Man lake. Strangely enough the area underlying Sarpedon lake has apparently never been taken up as a mining claim, though all the area between this lake and Emerald and Carp lakes has been surveyed into mining claims. These latter, while showing bands of iron formation, are not promising. In no case was an outcrop found of sufficient magnitude or purity to warrant development, and so far as could be ascertained, little development work, if any, has been done. In fact, the amount of development in the entire area, with a few exceptions which will be noted in the proper place, is negligible. This is due to the fact that the principal deposits when they are above water are usually well exposed near the water's edge, or are covered with a thin growth of moss.

If we assume this deposit in Sarpedon lake to be continuous for the entire length of the lake with an average width of seventy-five feet, and having a specific gravity of four or a weight of two hundred and fifty pounds per cubic foot, which is probably the minimum for commercial hematite, we find a total of 173,250 tons for each foot in depth. When we consider the constancy of the deposit on This Man lake, together with the elevation of some of the outcrops, there seems to be no good reason for estimating a depth of less than one hundred feet on the oxidized ore. This supposition of the size and value of the ore body, however, can be proven only by diamond drilling, but the existence of the ore body is not to be doubted.

Area Between Sarpedon and Carp Lakes.

Claim 22-X, which is on the shore of the small lake between Sarpedon and Carp lakes, shows two outcrops of iron formation, the smaller one at the point indicated by Clements, the larger one in line with the Sarpedon Lake deposit. The first of these is too small to be of economic importance, while the latter is a lean ore, though more than a hundred feet wide. To be of value, this material would have to be concentrated, and with the large reserve of higher grade material this is economically possible only in exceptional circumstances. The extension of this deposit to the southwest could be located for only a very short distance, and no further outcrops of commercial ore were located in that direction.

Pewabic Lake.

Pewabic being the Indian name for iron, it was thought that an outcrop of ore might be found on this like, but a careful examination of the shores failed to show any except a band of siderite about three feet wide in schist near the outlet. Traversing the lake with a dip needle gave no indication of a body of ore.

Area Between This Man Lake and Emerald Lake.

In the area south of This Man lake and north of Emerald and Big Rock lakes, there are several small deposits of iron ore ranging in width from 4 or 5 feet to 25 or 30 feet. These, however, are all of low grade, and give little promise of being commercially important in the near future.

Carp Lake.

On Carp lake, which is on the boundary between Canada and the United States, there are three bodies of iron formation, only one of which, however, is of any possible economic importance. These three bodies are shown on the map, the

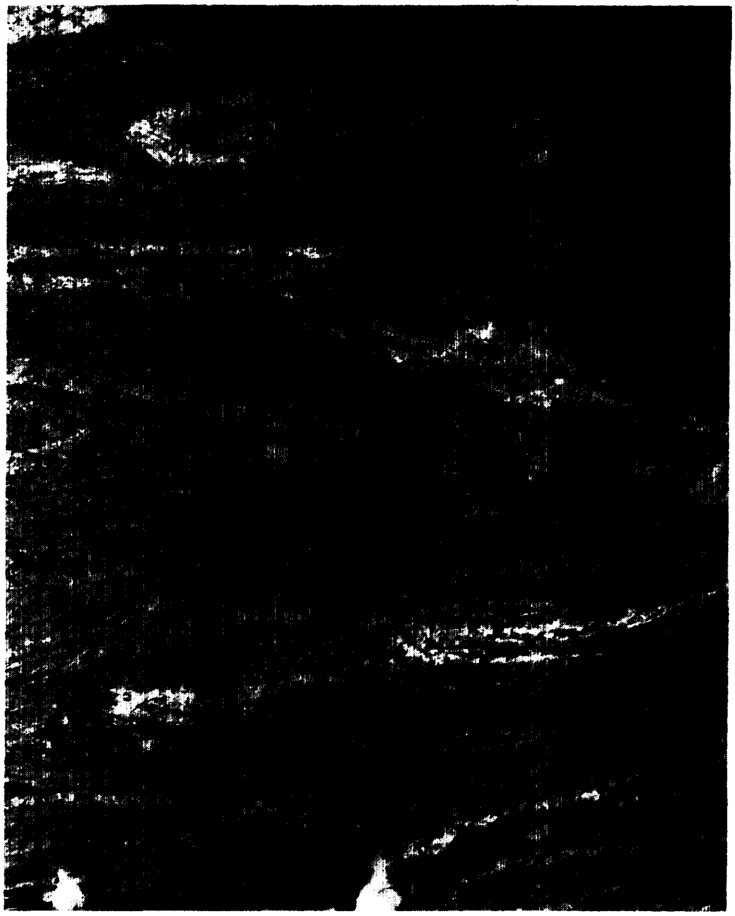


Fig. 6.—Folded iron ore, Merritt's camp.

first being on the northwest side nearly in the line of strike of the Emerald Lake deposit. On Carp lake this body is not more than ten feet wide, and decidedly low grade. The second indication of iron formation is immediately to the south of this on a small island, and also on a point of the main line where a yellowish, rusty outcrop indicates the presence of a low-grade ferruginous carbonate of no economic importance. The third body is in a bay at the east end of the lake, which is known as Merritt's camp, where there is a large body of much contorted banded iron ore which is somewhat V-shaped in its outcrop. This is one of the few locations upon which any trace of development work is to be found. Several trenches and pits were opened up, and in the summer and autumn of 1904, the property was drilled. The ore body is much folded and contorted without a corresponding contortion in the adjoining rock. The V shape of the outcrop probably indicates a major folding here, but this is not sufficient to account for the wonderful crumpling in the ore when no such plication is shown

Fig. 7.—Folded iron ore, Merritt's camp.

in the adjoining rocks. This crumpling is shown in Figs. 6 and 7, which also show well the character of the ore. Inside the V is a knob of porphyritic rock of light colour. The width of the ore body from the contact with the porphyry to the lake shore measured on a slope of 19° is 153 feet, which is equivalent to a width of 141 feet on the level. This ore body appears to be an isolated one, and no connection could be found between it and the deposits on Emerald lake with which it might be supposed to be connected. On account of the banded character of the ore, it was difficult to obtain a fair sample, but the sample taken for analysis was thought to be fairly representative. As will be seen in Fig. 7, the ore is made up of bands of ore and silica of comparatively narrow width. On this account it would yield a product that would be rather expensive to concentrate if the ore did not come up to the expected grade. A sample was taken for analysis, and the results obtained by W. K. McNeill, Provincial Assayer, are given below—

SiO_2	FeO	Fe_2O_3	P	S	Ti	CO_2	Fe
61.76	10.44	11.41	.145	.261	nil	1.25	16.12

This analysis confirms the estimate that can be deduced from the photographs.

Emerald Lake.

In Emerald lake, there are two, and possibly three distinct bands of iron formation. These are indicated on the maps of both Smith and Clements. The most important of these outcrops is on E-58 and extends beneath the lake to the east shore, cutting on the way a small island. The extension under the lake was located by the dip needle, but no outcrop was found on the east shore. There is, however, a valley between the overhanging cliffs which probably represents this formation. To the southwest of E-58 the banded ore and jaspilite are replaced by a cellular sericite schist with vein quartz, and farther along by siderite sericite schist.

On claim E-58 is a very striking outcrop of banded iron ore, consisting of hematite and broad bands of red jaspilite. Although this is probably the most striking outcrop in the whole region on account of the beautiful colour of the jaspilite, the writer was unable to find a place where the deposit as a whole, or even in large part, is rich enough to be of economic importance under present conditions. The dip needle shows a continuation of this deposit to the northeast extending to an island about half a mile from the point on E-58, and thence nearly to the east shore of the lake, when no further reading could be obtained with the dip needle. Samples were taken on the island as the bands of silica are narrower, and it was thought that it might possibly be of a high enough grade to warrant exploitation. The analysis is given below:—

SiO_2	FeO	Fe_2O_3	P	S	Ti	CaO	CO_2	MgO	Fe
67.70	7.18	8.12	0.038	.16	nil	4.80	3.13	trace	11.27

As will be readily seen, this is altogether too low in iron to be of any importance.

Although the several indications are not particularly encouraging, it is worthy of mention, however, that diamond drilling, particularly under the lake, may show a body of much higher grade ore.

Big Rock Lake.

On the portage between Emerald lake and Big Rock lake, some fragments or pieces of iron formation were observed, but the outcrop could not be located. In traversing Big Rock lake, however, in a canoe, it was found that dip needle readings could be obtained nearly the entire length of the lake, and two outcrops of banded iron ore were located along the line of these dip needle readings, one of them on a point on claim R-305, the other on a similar point on R-306. The

Fig. 8.—Cliff of iron ore, showing major folds and rounded surfaces.

deposit, however, could not be traced to the shore at the northeast end of the lake, but the dip needle readings ceased about a half mile from the end of the lake. A sample was taken from the outcrop on R-305, and an analysis was made by W. K. McNeill, Provincial Assayer, as follows:—

SiO_2	FeO	Fe_2O_3	P	S	Ti	CO_2	Fe
62.98	13.61	19.19	0.041	.17	nil	0.76	24.01

As will readily be seen the iron content is too small to be of economic value.

Otter Track Lake.

Banded iron formation was found in only one place on this lake, and is too limited in quantity to be of value. This outcrop is on the west side of the lake near claim 60-E. Although limited in its extent, it exhibits some remarkable folding and crumpling, as will be seen in Figs. 8, 9 and 10. In Fig. 8 major folding is shown, while in the others, the remarkable crumpling is seen nearer at hand, Fig. 10 being a closer view of part of Fig. 9. There is no good explanation, that occurs to the writer, of this remarkable crumpling, particularly as the iron ore alone is subject to this type of disturbance. The adjoining rocks show a more or less well developed schistosity parallel with the general strike of the iron ore form-

Fig. 9.—Near view of part of the outcrop shown in Fig. 8, exhibiting crumpling of iron ore.

ation, while the iron ore body itself is crumpled and twisted in all directions. Similar phenomena were noticed in other bodies of banded iron ore, but were always looked upon as minor folding, and possibly connected with great earth movements affecting the adjoining rock. It would appear, however, that this folding is intimately connected with some change in the iron ore itself, and it has occurred to the writer that it may possibly be due to the oxidization of an original carbonate with the formation of vugs containing more or less quartz, which, by a combination of vertical and lateral pressure have developed a structure simulating ordinary folding. The wonderfully contorted character of this

Fig. 10.—A closer view of part of the outcrop shown in Fig. 9.

Fig. 11.—Otter Track lake, looking northeast from United States side, near R-335.

outcrop was noted by H. V. Winchell,[7] but unfortunately his account was unaccompanied by photographs showing the remarkable character of the outcrops, though a drawing is given which represents a cross section of these more or less rounded masses.

The general character of the topography of the parts of the region covered by Keewatin rocks is shown in Fig. 11, which is a view on Otter Track lake.

Jasper Lake.

An outcrop of iron ore of low grade is found at the north end of the portage between Otter Track and Jasper lakes. The continuity of this deposit under the lake was not shown by dip needle readings, but nearly north of this point on 878-X and E-52 a body of banded ore shows up, which is about fifty feet wide. Two samples were taken which were thought to represent an average of the deposit, and analyses have been made by W. K. McNeill, Provincial Assayer, with the following results:—

	SiO_2	FeO	Fe_2O_3	P	S	Ti	CO_2	Fe
No. 52	44.97	13.48	27.02	0.055	0.13	nil	0.78	29.40
No. 52-A	50.78	14.74	24.50	0.072	0.15	nil	0.56	28.50

Although not sufficiently high grade to be at the present time economically important, these are sufficiently rich to encourage further prospecting, preferably by diamond drilling, to see whether a higher grade material cannot be found in quantity.

Saganagons Lake.

Two bodies of iron ore were seen by the writer on this lake. The first is near the south end of the lake on claim 887-X. The outcrop consists of banded iron ore in a nearly vertical attitude, but appears to contain too much silica to make it of commercial value at the present time. The other deposit is on the north side of the lake north of the iron monument on the boundary line between the districts of Rainy River and Thunder Bay. Upon these latter claims considerable development work has been done; the timber has been cleared up to a width of about 100 feet along the outcrop of the iron formation, and numerous trenches have been opened up to show the extent of the body, and four pits have been sunk to as great a depth as possible without hoisting machinery. This is the best development work that was seen by the writer in the entire Hunter Island region. The width of the ore body would average about 25 feet. Two samples were taken

[7] Minn. Geol. & Nat. Hist. Sur., 17th Ann. Rep., pp. 111-115.

for analysis, which were thought to represent the average content of the ore body and the results of analyses are given below:—

	SiO_2	FeO	Fe_2O_3	P	S	Ti	CO_2	Fe
No. 55	48.92	14.61	28.70	0.80	0.056	nil	0.39	31.45
No. 60	47.10	13.22	33.60	0.087	0.14	nil	0.61	33.81

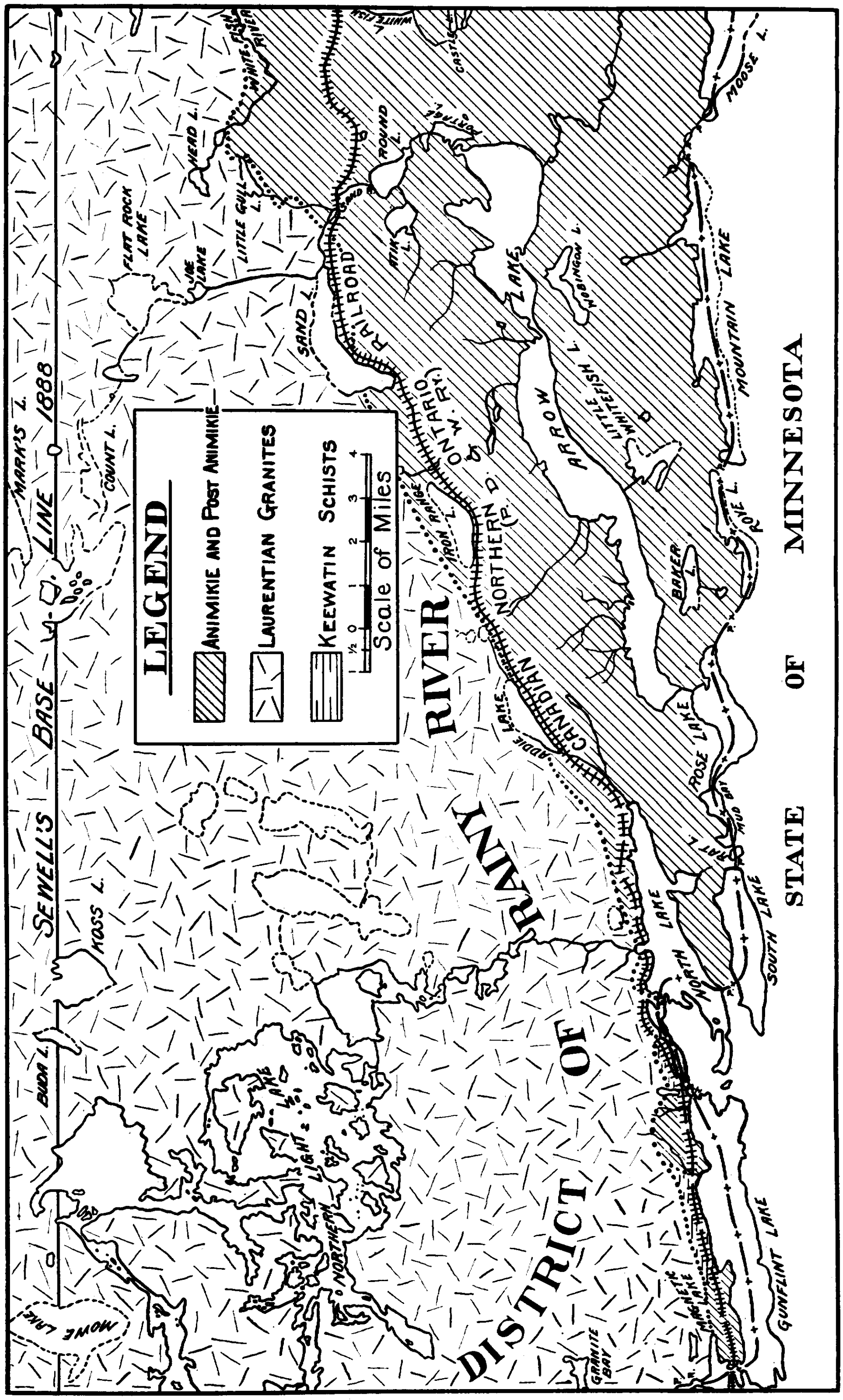
The ore of this place consists of banded magnetite and quartz, and although the grade is low, ore of similar grade, under favourable conditions, is concentrated by magnetic concentrators to make a high-grade product. The bands of quartz are quite distinct, and it should be possible to secure without difficulty a 50 per cent. product with minor losses in iron. The character of the ore body is very similar to that on 948-X, near Next Man lake.

Iron Deposits in the Gunflint Area

During the latter part of August, the writer made a hurried examination of the area between Gunflint lake and Whitefish lake to ascertain, if possible, the value of the Animikie iron formation in this locality. The existence of the iron formation on Gunflint lake has been known for nearly a century. Dr. John Bigsby, in 1824, mentioned the fact that " on Gunflint lake are considerable deposits in trap of jasper ", this being one of the first references to the jaspilite of the iron ranges of the Lake Superior region.[8] This jasper, or jaspilite as it has been more recently called, is intimately associated with bodies of iron ore of greater or less purity. On Gunflint lake, the writer found no deposits that were of sufficient extent, or of sufficient promise, to warrant sampling for commercial purposes, but there was a deposit or low-grade carbonate near the western end of the lake in the Animikie or Rove lake series. Analyses of the iron-bearing carbonate show that it is extremely low grade, being for the most part high in silica, and in certain parts containing large amounts of calcium and magnesium carbonates.[9]

Owing to the fact that the iron-bearing member is largely covered with loose material brought down from the overlying deposits, the writer was unable to observe any considerable outcrops of a higher grade iron ore, which was a source of considerable diappointment, as high-grade ores have been reported from this region in the state of Minnesota, just a short distance west of Gunflint lake.[10] In going east from Gunflint lake small outcrops of iron formation were seen at various places, but nothing that gave promise of economic value was observed until the area of Whitefish lake and Round lake was reached. About midway between these lakes on the north side of the Canadian Northern Ontario railway, some stripping has been done on several claims belonging to Mr. McGugan, but as the owner was absent at the time of the visit, it was impossible to secure the numbers of the claims,

[8] Amer. Journal of Science, Vol. 8, p. 64.
[9] U. S. G. S., Mon. XIX, p. 192.
[10] U. S. G. S., Mon. XLV, p. 385.



Geological sketch map of Gunflint Lake area.

or even to know whether the most promising trenches had been visited or not. In the trenches visited the amount of iron ore was not great, and many of the pits had been partially refilled with débris, so that no fair estimate could be made, but the impression made upon the writer was discouraging. It is possible, however, that more thorough stripping would reveal an encouraging deposit. Samples of the best material that could be seen were taken, and the analysis of No. 128 made by W. K. McNeill, Provincial Assayer follows:—

SiO_2	FeO	Fe_2O_3	P	S	Ti	CO_2	CaO	MgO	Fe
34.02	9.32	31.50	0.048	0.18	nil	5.30	13.50	trace	29.31

North of the west end of Whitefish lake, about a mile from the railroad, Messrs. Brown & Bishop, of Whitefish lake and North lake have done development work on several claims, with the result that they have exposed a body of low-grade iron ore, which appears to be from ten to fifteen feet in thickness. The stripping has been done on a nearly level spot, and consists of a trench about two hundred and fifty feet long, clearly exposing the surface of the ore body. It was, however, impossible to get exact data as to the thickness of the body. The ore body is overlain by taconite, and, underneath, jaspilite is exposed. Samples were taken, and the analyses were made by W. K. McNeill, Provincial Assayer, with the following results:—

	SiO_2	FeO	Fe_2O_3	P	S	Ti	CO_2	Fe
No. 131	32.98	3.53	54.04	0.054	0.15	nil	0.44	40.57
No. 132	45.00	4.28	40.88	0.043	0.19	nil	0.34	31.94

Sample Number 131 is of a grade that will pay for shipping, if found in sufficent quantity, but sample 132 is probably too low in iron and too high in silica, to be of commercial value.

A trip was made along the shores of Arrow lake to see whether any outcrops of iron-bearing members of the Animikie could be found, but without success.

The map showing this region is compiled from plans in the Surveys Branch of the Ontario Department of Lands, Forests and Mines, Ingall's Sketch Map of the Thunder Bay Mining region of Lake Superior.[11] and maps of Gunflint lake by A. Winchell,[12] and a map of Gunflint and part of North lake by W. N. Merriam.[13] No effort has been made to differentiate the Animikie and post-Animikie formations, as the post-Animikie consists almost entirely of diabase sills included in the Animikie, so that where this formation is present, it is reasonably safe to assume that the Animikie underlies it. The iron-bearing member is not exposed, except

[11] Geol. Sur. Can., N.S., Vol. III, Pt. H, p. 20, 1887-88.
[12] Minnesota Geol. Sur., 16th Ann. Rep., p. 236.
[13] U. S. G. S., Mon. XIX, p. 521.

in a few places along railroad cuttings or the shores of lakes and where trenching has been done for the purpose of developing the iron deposits. Much of the country has been burned over, so that it is extremely difficult to make an examination at any distance from the railroad or the water-courses. On account of the length of time that has elapsed since the surveys of this area were made, it is seldom that a corner post of a claim is found, in consequence of which it is difficult to locate the deposits on any particular claim. In mapping the formation on the north side of Gunflint lake, the writer has followed Winchell's mapping, so that it will be observed that there are two areas mapped as Keewatin. This material consists of highly altered hornblende schists in a vertical attitude near the outcrop of granite. The best exposure of this rock is found in a railway cutting just east of Gunflint lake, and the character of the exposure is well shown in the accompanying illus-

Fig. 12.—Keewatin (?) outcrop on railway east of Gunflint lake.

tration, Fig. 12. The outcrop north of the central part of Gunflint lake is not so highly metamorphosed as the last mentioned, but shows some major folding with schistose development, and is shown in Fig. 13.

Water Powers

Along the international boundary between Rainy lake and Gunflint lake are numerous waterfalls which might easily be developed for the production of power. The heights of the falls are given in the "Report on the Exploration of the Country between Lake Superior and the Red River Settlement," by S. J. Dawson. As being more intimately connected with the iron deposits on Hunter island and the Gunflint area, it may be noted that at the outlet of Gunflint lake there are two excellent falls, the first about 21 feet in height, and the second about 46 feet. The higher of these falls was not seen by the writer, as the portage did not bring him within sight of the fall. The first one, however, is shown in Fig. 14, and is well

Fig. 13.—Keewatin (?) outcrop, showing major folding on north side of Gunflint lake.

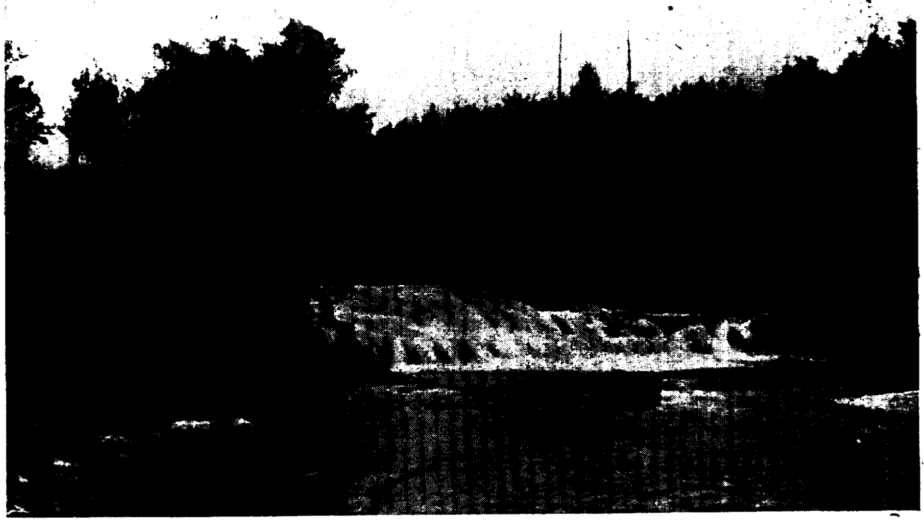


Fig. 14.—Falls on the outlet of Gunflint lake.

adapted to the development of electric power. The other falls along the international boundary that are of importance are at the outlet of Carp lake, where there is a fall of about 27 feet, and at the outlet of Birch lake, where there is a fall of about 40 feet. In Dawson's profile, the lake that is now called Birch lake is given as Carp lake. Another fall of about 20 feet comes at the outlet of Knife lake, but as the writer did not go from Carp lake to Knife lake, he can say nothing about the possibility of utilizing this power. On the outlet of Saganaga lake, there is a magnificent waterfall, which is shown in Fig. 15. As the writer's aneroid was

Fig. 15.—Waterfall on the outlet of Saganaga lake.

injured in the summer, it was impossible to measure the height of this fall, but from the picture it would appear to be about 30 feet.

Smaller waterfalls which are of doubtful value in the development of power, as the watershed is of limited extent, are at the outlet of This Man lake and the small lake between Sarpedon and Carp lakes. The height of fall in these cases is sufficient, but the quantity of water is too small for an extensive plant. Another similar fall is found on the west side of Big Rock lake, but as this merely drains a portion of the area between This Man lake and Big Rock lake, it will readily be seen that the watershed is too small to furnish an extensive permanent water power.

Fish

The lakes along the International boundary are well stocked with fish, and on the American side, in the larger of these lakes, commercial fishing is carried on, but as far as the writer saw, no development of this important industry has been made on the Canadian side. The principal varieties of fish taken at these fishing stations are white fish, pickerel, pike, lake trout and sturgeon, the last being found in all the lakes from Rainy lake up to and including Lac LaCroix. The lakes in the iron region of Hunter island are well stocked with fish, principally pike, pickerel and lake trout, the last being of exceptionally fine quality. Hunter island lies wholly within the Quetico Provincial Park and in consequence comes under the Provincial Parks Act, which strictly prohibits all fishing within the park boundaries except with hook and line, and after obtaining a license for the privilege.

Game

Inasmuch as Hunter island forms a part of the Quetico Provincial Park, which is also a game reserve, it is natural to expect that there would be plenty of moose, deer, and other animals. The moose and deer are in comparative abundance, though the writer did not see a greater number than in the region around the Lake of the Woods. In addition, fur-bearing animals are quite abundant. Fox, fisher, mink and wolves are fairly numerous, while the porcupine, which can hardly be called a fur-bearing animal, is so abundant as to be a nuisance.

Forests

In going from Fort Frances to Hunter island, and thence to North lake, it is of interest to note that the forest on the Canadian side has, as a rule, not been injured by fire, and little of the timber has been cut. On the Minnesota side, except in the Superior National Park, practically all the forest has been cleared or burned. On Saganaga lake, however, and on Gunflint lake, the Minnesota side has not been stripped of its forest growth, probably owing to the fact that it is almost impossible to get the timber out of this area with present transportation facilities. The forests consist principally of spruce, balsam, banksian pine, red pine, tamarac, birch and poplar. The presence of tamarac in a thriving condition was a feature which impressed the writer most forcibly, inasmuch as in other regions in Ontario this valuable timber has been almost exterminated. In this area, however, it was seen in numerous places, the most thriving trees having been seen along the river between Loon lake and Little Vermilion lake. On the whole, the forest growth in the Hunter island area is thriving, but there are some places near the boundary where serious fires have occurred. Along Birch and Carp lakes, and for a short distance along Emerald lake, fire has destroyed most of the forest, while the chief part of the region between Saganaga and Gunflint lakes has also been entirely denuded of its forest growth by fire. There is, however, an abundance of good timber for mining operations throughout the region.

IRON PYRITES DEPOSITS IN SOUTHEASTERN ONTARIO*

By P. E. HOPKINS

Introduction and History

In speaking of the economic geology of southeastern Ontario, W. G. Miller and C. W. Knight[1] say:

> There occurs in southeastern Ontario a variety of minerals and rocks of economic value, probably as great as in any district of like size on the North American continent. Some of these deposits, including marble and trap, are inexhaustible. Others, including talc and iron pyrites, have proved to be of considerable economic importance. From time to time, during the last 50 years, the following minerals and rocks have been mined or quarried with varying success: Gold, iron pyrites, zinc blende, copper pyrites, galena, mispickel, magnetite, hematite, talc, actinolite, mica, marble, ophicalcite, feldspar, fluorite, apatite, corundum, graphite and sodalite. All of the economic materials, with the exception of fluorite, appear to be of pre-Cambrian age. The fluorite veins penetrate the Ordovician (Black River) limestone.

Accompanying that report was an article by the writer on the Queensboro Pyrite Area which includes one of the two working pyrite properties in southeastern Ontario.

In the present paper will be given a brief description[2] of all the known pyrite deposits in the area which may at some time possess an economic value, with fuller descriptions of the two working mines—The Canadian Sulphur Ore Co.'s mine near Queensboro, and the Nichols Chemical Co.'s property at Sulphide.

The earliest mining of iron pyrites in Ontario was done in 1868 on the Billings property near Brockville. The mines were closed down in 1879 under the assumption that they were exhausted. Many other pyrite deposits have been worked for gold, iron or copper at some time. The steady pyrite industry of the Province began in 1900 when ore from the Bannockburn mine was produced. Mines in Hastings county have been steady producers since that time. An acid-making plant has been in operation at Sulphide since 1907 by the Nichols Chemical Co. for the treatment of its ore at Sulphide. The company also buys the ore mined from other properties in the neighbourhood. Another plant for treating custom ore is operated by the Grasselli Chemical Co. at Hamilton. These two plants treat the bulk of the eastern Ontario production, the remainder being shipped to the United States.

Recently a large percentage of the production has been coming from the Vermilion Lake deposits[3] in northwestern Ontario, the ore being shipped to United

* Paper prepared for the Arizona meeting of the American Institute of Mining Engineers, September, 1916.

[1] The Pre-Cambrian Geology of Southeastern Ontario, Report, Ont. Bur. Mines, Vol. 22, Pt. II, 1914.

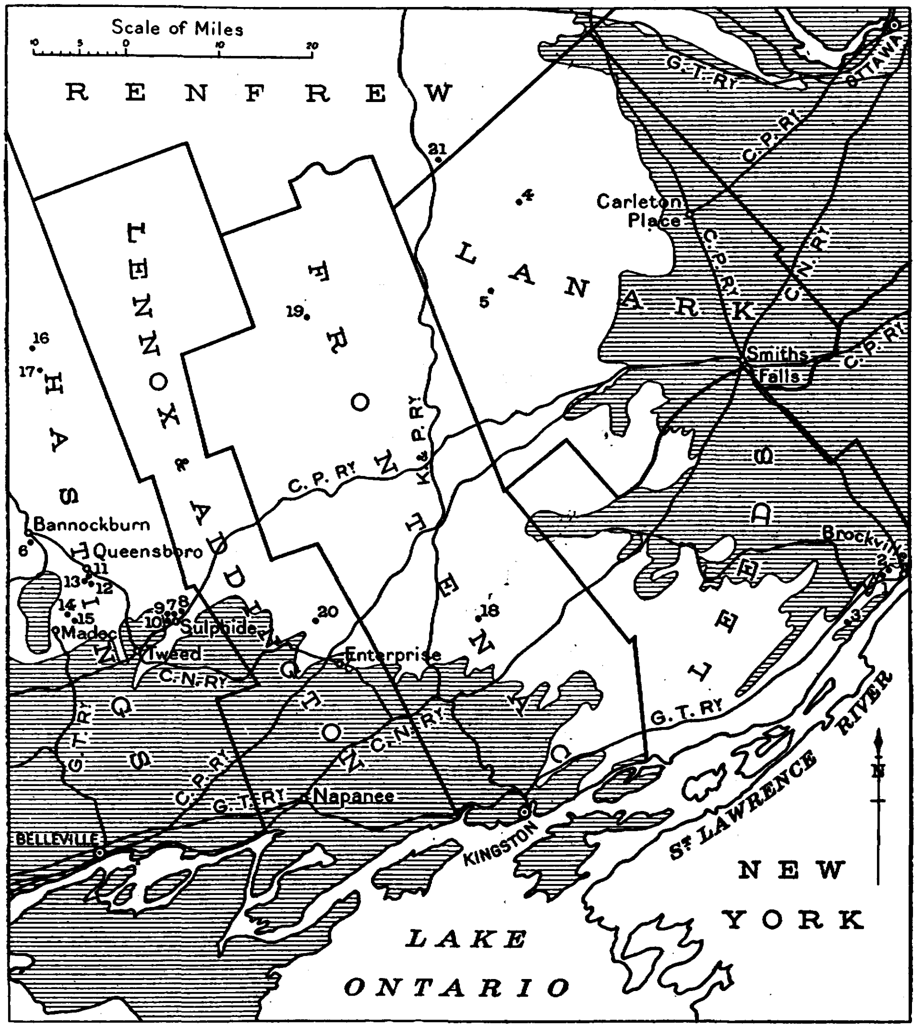
[2] The information regarding the various pyrite prospects in southeastern Ontario is summarized from E. L. Fraleck's comprehensive report on Iron Pyrites in Ontario, Report, Ont. Bur. Mines, Vol. 16, Pt. I, 1907, pp. 149-201.

[3] E. S. Moore: Vermilion Lake Pyrite Deposits, Report, Ont. Bur. Mines, Vol. 20, Pt. I (1911), pp. 199-213.

T. F. Sutherland: Northern Pyrites Company, Report, Ont. Bur. Mines, Vol. 24, Pt. I (1915), pp. 94-95.

States ports on the great lakes. Another property, the Goudreau lake deposits,[4] has been recently developed and expects to commence at once supplying large tonnages. The Helen mine,[5] operated by the Algoma Steel Corporation, produces some pyrite which is treated in its plant at Sault Ste. Marie.

The iron pyrites resources of Ontario are of considerable extent and value. In the last 15 years 538,755 tons, worth $1,438,122, have been produced, the



Map of a portion of southeastern Ontario. The hatched area is Paleozoic, and the numbers indicate the relative positions of the iron pyrites in the Pre-Cambrian.

greater part coming from southeastern Ontario. During the coming years there will undoubtedly be a steady increase in production. The war has had a stimulating effect on the demand of the United States for pyrite from Ontario.

[4] A. L. Parsons: Goudreau Pyrite Claims, Report, Ont. Bur. Mines, Vol. 24, Pt. I (1915), p. 211.

T. F. Sutherland: Madoc Mining Company, Report, Ont. Bur. Mines, Vol. 24, Pt. I (1915), p. 107.

[5] A. L. Parsons: Helen Mine, Report, Ont. Bur. Mines, Vol. 24, Pt. I (1915), pp. 202-205.

List Showing the Locations of Pyrite Deposits in Southeastern Ontario[6]

Brockville Section.

† 1. Brockville Chemical Co. (Billings property); lot 19, con. 2, Elizabethtown township.
† 2. Sloan prospect; lot 18, con. 2, Eliabethtown township.
3. Shipman prospect; about 6 miles west of the Billings (No. 1).

Lanark County.

† 4. McIlwraith mine; lot 5, con. 4, Darling township.
5. Ladore prospect; lot 19; con. 7, Dalhousie Township.

Hastings County.

‡† 6. Bannockburn (or Jarman) mine; lot 25, con. 6, Madoc township.
* 7. Hungerford mine (Nichols Chemical Co.); lot 23, con. 12, Hungerford township.
† 8. Canada mine (formerly Oliver Prospect); lot 26, con. 12, Hungerford township.
9. Hungerford Western Extension; parts of lots 21 and 22, con. 12, Hungerford township.
† 10. Ontario Sulphur Mines, Ltd.; northwest quarter of east half of lot 21, con. 12, Hungerford township.
† 11. Queensboro mine; lot 11, con. 11, Madoc township.
* 12. Canadian Sulphur Ore Co. (formerly Wellington prospect) N. ½ lot 9, con. 10, Madoc township.
† 13. Davis or Palmer prospect; lot 10, con. 10, Madoc township.
14. Farrell prospect; 2 miles northeast of Madoc village.
‡ 15. McKenty prospect; 2 miles east of Madoc village.
16. Little Salmon Lake deposit; lot 23, con. 7, Cashel township.
17. Gunter property; lot 23, con. 4, Cashel township.

Other Eastern Ontario Prospects.

18. Snooks prospect; lot 7, con. 14, Loughborough township, Frontenac Co.
19. Stalker prospect; lot 42, con. 6, Clarendon township, Frontenac Co.
20. Foley prospect; 5½ miles north of Enterprise Sta., Lennox, Addington Co.
21. Caldwell prospect; lot, 1, con.1, Blithfield township, Renfrew Co.

Brockville Section

The Brockville Chemical Co., No. 1,[7] began mining for pyrite on the Billings property in 1868. The ore occurred in a series of lenses conformable to the

* Mines now working (April, 1916) and shipping pyrites.
† Properties which have shipped pyrites.
‡ Properties which have shipped hematite or limonite.
[6] The number of each property refers to the corresponding number showing its position on the accompanying map.
[7] The numbers following mention of the pyrite properties refer to corresponding numbers showing their positions on the accompanying map.

lamination of a highly foliated pink granite gneiss. The lenses, which consist of pyrite and calcite in parallel lines, strike northeast and dip to the southeast. The richer shoots of ore were gouged out and no timbering was done. The main pit was sunk 250 ft. The ore was used for making acids in Brockville, the sulphuric and mixed acids being used at the fertilizer and dynamite works in and near Brockville. Operations of all kinds ceased in 1880. The evidence of the men who worked in the old pits is to the effect that they were never completely exhausted.

Sloan Prospect, No. 2.—A band of gossan strikes in a north-east direction across the property and dips to the southeast. The 20-ft. inclined shaft passes through 6 or 8 ft. of gossan. There is a width of 3 ft. of solid pyrites on the foot wall, the remainder of the shaft being in alternating bands of pyrite and crystallized calcite in equal amounts. Eighty tons of ore, running 40 per cent. sulphur, were shipped to Buffalo and Capelton.

The Buffalo-Brockville Mining Co. shipped a small tonnage from this lot during 1911 and 1912.

Shipman Prospect, No. 3.—The pyrite, which is much intermixed with pyrrhotite and country rock (gneiss), has been mined from an irregular pit 40 ft. long and 30 ft. wide.

Lanark County

McIlwraith Mine, No. 4.—The deposit, which is covered by 14 ft. of gossan, strikes north of east along a contact between diorite on the south and crystalline limestone on the north, and dips 60° to the south. It was first opened for gold. In 1899 and 1900 the shaft was deepened to 75 ft. and a 150-ft. tunnel run along the strike of the deposit, disclosing a length of over 90 ft. of clean high-grade pyrite inclosing lenses of quartz. A 12-ft. crosscut to the south did not pierce the width of the deposit. Three carloads of ore were shipped. Samples from the dump and tunnel, by E. L. Fraleck, gave 38.86 and 42.60 per cent. of sulphur respectively.

Ladore Prospect, No. 5.—A heavy fahlband strikes north of east along the contact of a coarse amphibolite and a fine-grained gray granite. The trenches and shallow pits expose a gossan in the form of bog iron ore, but pyrite in quantity was not located. The fahlband continues into the adjoining lot to the east along a contact of crystalline limestone and granite.

Bannockburn Mine, No. 6.—In 1898, the property was opened as an iron mine, 11 car loads of limonite, running about 38 per cent. in iron and low in sulphur, having been shipped. This ore was merely a gossan 8 to 15 ft. deep which capped iron pyrite deposits. The pyrites occurred as two lenses at right angles to each other, but conforming in strike and dip with the inclosing rock, a chloritic schist. Limestone covers the apex of the fold of the lenses. The south lens, which is 160 ft. long and 8 to 15 ft. wide, was mined to a depth of 275 ft. During the 6 years of operation about 580 tons of pyrite per month were shipped, all of which went to the General Chemical Co. at Buffalo. The ore did not fall off either in grade or quantity with depth, but, owing to the hazard of open-pit mining, operations were abandoned in August, 1906.

Hungerford Mine, No. 7.—This property was opened 40 years ago as a gold property, and a smelter was erected to extract gold from the barren pyrite. The Nichols Chemical Co.[8] re-opened the mine in June, 1903. Owing to some difficulty about the title, the mine was closed down in August, 1904, but operations were resumed in August, 1905, and have since been continuous. Since 1907 acid works have been in operation for the treatment of company ores, and other ores in the vicinity.

Passing through this property, and extending beyond, is a large fahlband striking 25° north of east and traceable for 2 miles. Level farm land to the south is underlain by garnetiferous crystalline schist cut by massive diorite, into which, 500 yd. north of the deposits, has been intruded a pink hornblende granite that rises above the country in a series of rugged hills, locally called the Bald Mountains. The granite has protected the deposits from denudation. The deposits are strung along the contact of the diorite and the schist, the strike of lenses, contact, fahlband, and schist being identical.

The pyrite occurs in three parallel deposits striking with the schist and dipping 60° to the south. The middle one, which does not outcrop on the surface, lies 85 ft. from the south vein and 45 ft. from the north deposit. The north deposit, upon which most of the work has been done, varies in width from 6 to 22 ft. It has been exploited to a length of 620 ft. and to a depth of 575 ft., and the ore still continues. The length as indicated on the surface is about 500 ft. There are now two shafts on the property and about 3,500 ft. of drifting has been done on the orebodies on the six levels. During 1915 work was confined to stoping on the north vein and drifting on the south vein.

The ore is coarsely granular and makes a large percentage of fines. The main impurity is calcite, although there is also some quartz present. A small quantity of pyrrhotite occasionally occurs, mainly in the north lode next the foot wall. The average percentage of run of mine ore is about 35 per cent., the fines being much higher.

The acid works have been successfully operated since their completion in July, 1907, and machinery has been installed at various times to increase the capacity and to make new acids. At present sulphuric, hydrochloric, nitric and mixed acids are made by the contact process and shipped in the company's tank cars to various parts of Ontario and Quebec.

Electric power supplied by the Seymour Power and Electric Co. is used throughout the mine and acid works.

The Canada Mine, No. 8, which was formerly the Oliver prospect, adjoins the mine operated by the Nichols Copper Co. on the east, and is located on the same fahlband. The lode strikes east and west and dips 50° to the south. During part of 1907, the Canadian Pyrites Co. sank an inclined shaft on the deposit to a depth

[8] W. H. Nichols, President, 25 Broad St., New York.

of 110 ft. and did some drifting on the 85-ft. level, together with some diamond drilling. The deposit varies from 4 to 7 ft. in width. The ore on the dump is pyrite with a little pyrite and pyrrhotite, which will grade upward of 40 per cent. in sulphur.

The Hungerford Western Extension, No. 9, was fairly well prospected in 1906 by means of surface trenches at regular intervals along the strike of the fahlband. The western lens had been exploited by surface trenches to a length of 500 ft., exhibiting, near the line between the lots, a width varying from 16 to 18 ft. of ore, which will grade from 42 to 44 per cent. sulphur. The only impurity consists of small included lenses of calcite.

The eastern lenses are presumably continuations of the Hungerford mine orebodies.

A gossan 40 ft. wide occurs on the south end of the property, but not enough work has been done to determine the extent of the deposit.

The Ontario Sulphur Mines, Limited,[9] *No. 10,* commenced work in March, 1908, and continued until the end of 1911, save for 2 months in the summer of 1910. The pyrite deposit on which work has been done is located about ½ mile west of the Hungerford mine. It appears to be a lens pitching towards the southeast. A shaft has been sunk 300 ft., with 225 ft. of drifting on the 100-ft. level and 250-ft. on the 200-ft. level. According to A. W. G. Wilson[10] "The total shipments from the property up to the first of May, 1911, have been 4,821 long tons of ore averaging 36½ per cent. sulphur." In one place the deposit is 30 ft. wide.

The Sulphide Chemical Co. operated the property from the spring of 1913 until the following November, during which time the mine was dewatered and considerable ore was raised and shipped.[11] No work has been done since.

The Queensboro Mine (Blakely), No. 11, up to the autumn of 1906 shipped 65 carloads of pyrites running about 45 per cent. sulphur. Mine operations ceased in 1908. The pyrite occurs as a series of lenses up to 15 and 20 ft. wide along the contact of a garnetiferous schist (Grenville in age) and an instrusive pink felsite (post-Hastings in age). The ore is dense, the only impurity being thin veinlets of quartz. Cutting a pyrite lens is a small quartz vein containing copper pyrites and argentiferous jamesonite. In another place some zinc blende is interbanded with the pyrite. The main shaft is 135 ft. deep with about 175 ft. of drifting on the 50- and 85-ft. levels.

The Canadian Sulphur Ore Co.'s Pyrites Mine,[12] *No. 12,* was discovered in 1906 by Stephen Wellington while prospecting for iron. Under the gossan, merchantable iron pyrites was discovered, from which a car load of iron pyrites was shipped

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[9] Formerly the Craig property.

[10] A. W. G. Wilson: Pyrites in Canada, Publication No. 167, Mines Branch, Ottawa (1912), p. 67.

[11] T. F. Sutherland: Report, Ont. Bur. Mines, Vol. 23, Pt. I, 1914, p. 174.

[12] Alex. Longwell, President, 410 Crown Office Building, Toronto. For a fuller description see The Queensboro Iron Pyrites Deposits, by P. E. Hopkins, Report, Ont. Bur. Mines, Vol. 22, Pt. II, 1913, pp. 89-104.

in 1908. Later, the Canadian Pyrites Syndicate bought the property, installed a small plant and shipped a few hundred tons of pyrite. In the spring of 1910 the property was handed over to the present company, which began shipping ore 3 months later, and has continued to the present. The mine is equipped to produce 100 tons of iron pyrites per day, yielding 40 per cent. of sulphur. Since Dec. 11, 1912, the mine has been run by electricity supplied by the Seymour Power Co. A branch line 2½ miles in length from the Bay of Quinte Railway near Queensboro to the mine was completed in 1913. The ore is shipped to the Nichols Chemical Co.'s acid plant at Sulphide, 11 miles southeast, and to the chemical companies at Hamilton and Detroit.

The pyrite is mined by underground and open-pit methods. The development work consists of three shafts and two open cuts, with some diamond-drill borings. Nos. 1 and 2 shafts, which are 75 and 100 ft. deep respectively, have been abandoned for some time. The work of late years has been confined to shaft No. 3, and the two open pits. The vertical shaft, No. 3, is 250 ft. deep with about 800 ft. of drifting on the 60-, 120-, and 200-ft. levels. The pyrite deposits are marked by gossan outcrops from 2 to 30 ft. in depth. Beneath are the pyrite deposits, which occur as lenses in contact with rusty schist to the south and white quartzite to the north (both Grenville in age) near an irregular post-Hastings intrusion of gray felsite. The strike of the deposits is slightly north of east, while the dip is almost vertical, inclining slightly to the south. Lenses vary in width up to 25 ft., but horses of country rock are frequently inclosed in the pyrites.

The ore is high grade, very little cobbing, if any, having to be done. Ores have been shipped running 40 to 48 per cent. sulphur.

The deposits are free from impurities such as arsenic, zinc, lead, copper and calcium. The pyrite burns satisfactorily, and is in good demand by sulphuric acid makers.

The Davis or Palmer Deposit, No. 13, is in the Grenville limestone. On the surface the pyrite is 2 ft. in width; 9 ft. down there is said to be a deposit 15 ft. wide. A few carloads of pyrites were shipped from a pit sunk on the property.

The Farrell Deposit, No. 14, lies in and conforms with the schist which strikes northwest. Test pits for a distance of 200 ft. show either gossan or pyrite. A shaft has been sunk to a depth of about 25 ft. A sample collected by E. L. Fraleck, representing an average of 75 per cent. of the dump (which consists of about 40 tons), yielded 40.64 per cent. of sulphur. The deposit maintains a uniform width of 5 ft., the only impurity being crystalline limestone.

The McKenty Prospect, No. 15, shipped hematite 40 years ago. A pit at one time 60 ft. deep has caved in. An examination of the cull dump reveals the fact that all large lumps of apparent hematite have, when broken, a core of pyrites. In E. L. Fraleck's opinion, this is one of many instances throughout eastern Ontario where hematite constitutes the gossan capping of a sulphide orebody.

The Little Salmon Lake Deposit, No. 16, occurs in a chlorite schist which strikes east and west, the main rock in the area being a white crystallized limestone, probably of Grenville age. A trench, 40 ft. long, uncovered pyrite 15 ft. in width. An average of 75 per cent. of the pyritiferous material yielded 38.83 per cent. of sulphur.

On the *Gunter Property, No. 17,* a shaft, 20 ft. deep, has been sunk on a deposit consisting of alternating bands of quartz and pyrite 5 ft. wide. A sample representing two-thirds of the dump yielded 39.50 per cent. of sulphur.

Snooks Prospect, No. 18.—A fahlband strikes northeast through a coarse, impure crystalline limestone, and can be traced across the adjoining lot 6 to Desert Lake. On the road allowance, 7 ft. of massive pyrite and 25 ft. of pyrite mixed with crystalline limestone were uncovered in obtaining material for the road.

On the *Stalker Prospect, No. 19,* is a well-defined fahlband, containing some hematite, and striking east and west. A small test pit has been sunk on a lens of pyrite which shows at that point a width of 6 ft.

The Foley Deposit, No. 20, occurs in an outlier of crystalline limestone surrounded on all sides at short distances by granite. The irregular deposit consists of small masses of pyrite and pyrrhotite in about equal proportions. The work consists of a pit, 80 ft. long, 40 ft. wide, and 10 to 15 ft. deep, sunk on pyrite and pyrrhotite in about equal proportions intermixed with pyroxene, calcite, mica and molybdenite.

The Caldwell Prospect,[13] *No. 21,* was opened in the fall of 1915 by Thomas B. Caldwell of Lanark. About 500 tons of ore have been mined, but the sulphur contents are not known.

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[13] See fuller description of property under Mines of Ontario.

A STUDY OF CERTAIN MINERALS FROM COBALT, ONTARIO

By

H. V. ELLSWORTH

Introduction

In presenting this paper on certain mineral associations of Cobalt, the writer believes that, considering the importance of this famous mining region, no apology is necessary for the somewhat detailed descriptions in which he has been tempted to indulge.

The geology of the Cobalt area has received a great deal of attention, naturally, and has been admirably described by W. G. Miller and his associates in the reports of the Ontario Bureau of Mines. To them also is to be credited most of the published mineralogical data relating to Cobalt. In the Nineteenth Report of the Ontario Bureau of Mines, Part II, was included a descriptive list of the minerals which were known from Cobalt at that time, together with remarks on their mode of occurrence, and a table in which the probable order of deposition of the chief minerals was indicated. The order of deposition was also worked out by Campbell and Knight[1, 2] from observations on polished surfaces by the metallographic method.

Early in 1914, at the suggestion of T. L. Walker, Professor of Mineralogy at the University of Toronto, the writer undertook an investigation of breithauptite ore from the Hudson Bay mine. The results of this investigation seemed to have a bearing on the question of isomorphous inter-growths and led to a study of other mineral associations from Cobalt. Dr. Walker very kindly allowed the writer the use of the numerous specimens from Cobalt in the collection of the Royal Ontario Museum of Mineralogy, and in this way the work gradually broadened in scope.

In the following pages no attempt has been made to deal exhaustively with all the common minerals of Cobalt. Only such associations have been studied as were interesting because of the minerals hitherto unidentified from Cobalt, because of rarity or unusual crystallization, or because of a possible bearing on questions of isomorphism or paragenesis. These investigations have added the following to the list of minerals from Cobalt: Löllingite, rammelsbergite, chalcocite and symplesite.[3]

The objects of the investigation may thus be summarized as follows:

1. Descriptive: Identification and crystallographic study of special minerals, rare, or new to Cobalt. Identification in the case of the complex ores of Cobalt usually involves—2.
2. (*a*) Chemical analysis and separation experiments.
   (*b*) Microscopic study of polished surfaces.
3. Study of structures having a bearing on isomorphism.
4. Order of deposition or paragenesis, as shown by study of microscopic structures.

[1] Microscopic examination of the Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming by W. Campbell and C. W. Knight, Ec. Geol., Sept.-Oct., 1906.

[2] The Paragenesis of the Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming, Eng. and Min. Jr., June 9th, 1906.

[3] For list of Cobalt minerals see Report Ont. Bur. Mines, Vol. XIX, Pt. II, p. 9.

Methods of Microscopic Examination and Separation

The preparation of polished sections of minerals for examination by the metallographic method has been treated in detail by Campbell and Knight.[4]

The use of acids or other corrosive re-agents for developing the structure of polished surfaces of metals or minerals probably originated in the study of meteoric iron, the so-called Widmanstätten figures having been described in 1808. Outside of its application to meteoric iron, but little use seems to have been made of this method in mineralogy until Baumhauer[5] in 1886, applied it to the study of crystals of smaltite-chloanthite, with extremely interesting results. Vollhardt[6] analyzed the crystals which had been examined by Baumhauer before and after treatment with hydrochloric acid and potassium chlorate, and found that the residue left after the acid treatment was considerably richer in arsenic than the original material. From this result he deduced the presence of skutterudite ($CoAs_3$) in the smaltite-chloanthite crystals.

The writer has applied similar methods to the study of microscopic intergrowths from Cobalt. If a polished surface of a complex ore, containing two or more minerals closely intergrown, say smaltite and chloanthite, which are quite indistinguishable by ordinary means, be slightly etched with acid, the two minerals become easily distinguishable owing to the different effect of the acid upon them. If the etching be continued for a longer time one mineral will finally be corroded much deeper than the other, which stands in relief. It occurred to the writer that this method might be used to liberate minerals from the minute inclusions which are so characteristic of minerals from Cobalt, and it has, in fact, been used with success in some instances (see Breithauptite, page 210).

This difference in the action of an acid on the two minerals is not due entirely to the difference in the rate of solution of the individual minerals taken separately in acid of a given concentration. Gottschalk and Buehler[7] have shown that there is a difference of potential between different natural minerals and that two minerals in contact act as a battery in oxidation experiments, the current flowing from the mineral of higher potential, which is protected from the action of the oxidizing agent, while the mineral of lower potential dissolves more rapidly. There are also of course, instances in which one of the minerals reacts with the acid to form an insoluble coating which protects it while the other mineral is being dissolved away. Such coatings on a mineral of lower potential may, in certain instances, cause a reversal of the normal action, so that the mineral of higher potential actually dissolves more rapidly.[8]

Palmer and Bastin[9] have recently advocated the use of silver sulphate solution to separate arsenides from sulpharsenides and sulphides, the sulphate being chosen because of the bearing of their experiments on silver enrichment. The writer has

[4] Loc. cit.

[5] Ueber die Structur und die mikroskopische Beschaffenheit von Speiskobalt und Chloanthit, von H. Baumhauer, Zeitschrift für Krystallographie 12, 18, 1887.

[6] Versuche über Speiskobalt—von G. Vollhardt, Zeitschrift für Krystallographie 14, 407, 1888.

[7] Oxidation of Sulphides—V. H. Gottschalk and H. A. Buehler—Ec. Geol., Vol. VII, No. 1, Jan., 1912.

[8] Breithauptite, page 210.

[9] Tetranickel Triarsenide, Its Capacity as a Silver Precipitant, Chase Palmer, Econ. Geol., Vol. IX, No. 7, Oct., 1914.

used silver nitrate solution with equal success, and this has the advantage that it can be made up in much stronger solutions than the sulphate, which is not very soluble. With the nitrate solution results are obtained in less time and with much smaller volumes of solutions.

It should be remembered, however, that all the foregoing methods are capable under favourable conditions of producing only a pure residue. The less soluble mineral is not entirely unaffected by acids or silver solutions and will also enter into solution to a certain extent, so that the resultant solution contains the constituents of both minerals. The residue, after sufficiently long action should, theoretically, be pure.

Methods of Chemical Analysis

In general, the writer has used the methods recommended by Treadwell, 1914 edition. As different methods do not always yield identical results, those used here may be summarized as below:

Arsenic—Usually determined by the Pearce method.[10] After fusion of the ore with a mixture of sodium carbonate and nitrate, the alkali arsenate is leached out and converted into silver arsenate which is titrated with ammonium sulphocyanate solution. If the solution to be titrated contains the same amount of silver as was used for standardizing the sulphocyanate solution, the results are very accurate.

Antimony—Weighed as Sb_2S_3 after heating in a current of carbon dioxide.

Bismuth—Weighed as sulphide or oxide. Separated from lead by basic nitrate method.

Copper—By electrolysis of sulphuric acid solution.

Iron—Separated from nickel and cobalt by one or more precipitations as basic acetate followed by precipitation as hydroxide from nitric acid solution and weighing as Fe_2O_3. The writer has found that if the hydroxide be precipitated along with finely macerated ashless filter paper as recommended by Washington,[11] there is no danger of the formation of magnetite on ignition and the results agree exactly with permanganate titrations.

Lead—Weighed as sulphate in Gooch crucible.

Mercury—Weighed as sulphide after reprecipitation.

Nickel and Cobalt—Determined together by electrolysis of ammonium sulphate solution, using a revolving cathode. Nickel separated and weighed as nickeldimethylglyoxime, cobalt by difference. In precipitating small amounts of nickel from large quantities of cobalt, a very large excess of the rather expensive dimethylglyoxime is required, in fact more than enough to combine with all the cobalt must be used in order to precipitate all the nickel. In such cases, the writer first precipitates the cobalt as tripotassium cobaltic nitrite, the nickel in the acetic acid filtrate is then readily precipitated by a relatively small amount of dimethylglyoxime.

Silver—As chloride.

Sulphur—Usually by fusion of the ore with alkali carbonate and nitrate, or with a mixture of sodium carbonate and sodium peroxide. Weighed as barium sulphate. The writer has not obtained quite as concordant results with the sodium

[10] Low—Technical Methods of Ore Analysis.
[11] The Chemical Analysis of Rocks—H. S. Washington.

peroxide method as with the old Fresenius method. All analyses, except where otherwise noted, have been made in duplicate.

Native Silver

The silver of Cobalt, as is well known, usually contains both antimony and mercury. It has been generally supposed that the mercury is alloyed with the silver as amalgam, and that the antimony is in the form of dyscrasite.

It was thought that a microscopic examination of analyzed specimens might throw some light on the manner in which the antimony is combined with the silver.

Five specimens were analyzed as below:

	Ag	Sb	Hg	S	Co or Ni	As	Insol.	Total
I	93.61	5.89	.35	trace	trace	....	....	99.85
II	95.39	3.31	trace	.63	trace	....	.60	99.93
III	99.56	.17	trace	trace	....	trace	....	99.73
IV	92.60	6.59	.34	trace	trace	....	.22	99.75
V	90.54	.79	3.08	trace	trace	....	5.50	99.91

I. Slab silver—1/8 to 1/4 inch thick, Buffalo mine.
II. do do Cobalt.
III. Thin leaf silver, Nova Scotia mine.
IV. Brittle moss-like silver, Cobalt.
V. Thin leaf silver from oxidized arsenate ore—Penn-Canadian mine. The 5.50 per cent. insoluble represents, chiefly, flakes of argentite which was separated approximately by using cold dilute nitric acid to dissolve the silver.

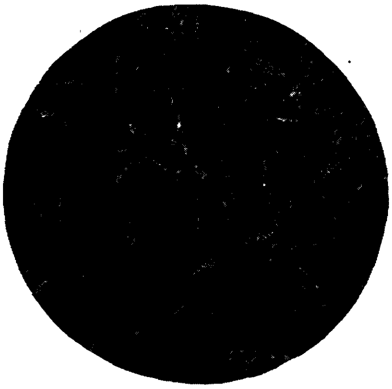


Fig. 1. Skeleton crystals of dyscrasite (?) in native silver, x 50.

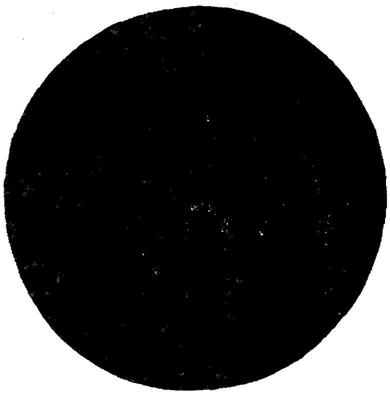


Fig. 2. Inclusions of argentite in native silver, x 50.

There is not enough antimony in any of these samples to form dyscrasite of theoretical composition and the question arises, does antimony combine chemically with silver in various proportions or is dyscrasite of theoretical composition alloyed or mixed with the silver. The stellate structure (Fig. 1) developed by etching a surface of silver, specimen No. 1, would furnish a partial answer to this question if we admit that these radiating structures represent skeleton crystals of dyscrasite set in a ground-mass of silver, as seems probable from the antimony content of this sample (5.89 per cent. Sb.)

The specimen of silver, No. III, contained but very little antimony and mercury and developed no noteworthy structure on etching, only a few small inclusions being noted. The homogeneous character of the etched surface agrees with its chemical purity.

In the preparation of the samples special care was taken to exclude all visible foreign adhering material. In spite of this all showed traces of sulphur and one, No. II, showed a notable quantity. The sulphur appears to be due to the presence of argentite as minute inclusions in the silver. Microscopic examination of a sur-

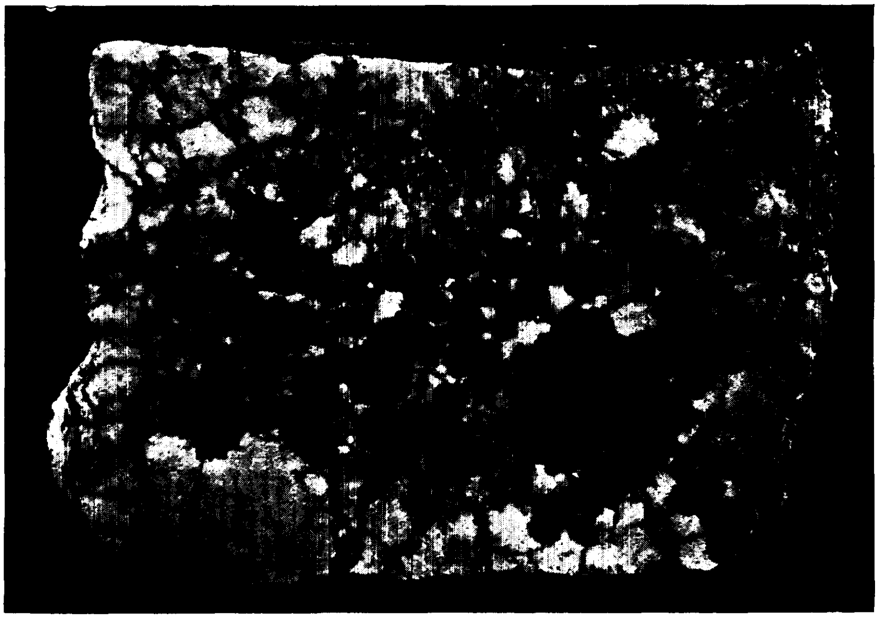


Fig. 3. Cross-section (natural size) of a rich silver vein, showing silver replacing arsenides and calcite.

face of No. II etched by nitric acid shows inclusions of a gray mineral which stands in relief and, therefore, must resist the acid better than silver (Fig. 2). This behaviour agrees with the known resistant character of argentite to cold dilute nitric acid.

There appears to be no relationship between the amounts of antimony and mercury in these analyses, but there can be no doubt whatever that the mercury is alloyed with the silver. Analyses of mineral samples in which silver is absent never show any trace of mercury and in this the writer's experience agrees with that of G. H. Clevenger of the Nipissing mill. Mr. Clevenger also shows that in the Cobalt ores he has analyzed the amount of mercury found is proportional to the silver content.[12]

[12] Note upon The Occurrence of Mercury on Cobalt Ores, by G. H. Clevenger, Econ. Geol., Vol. X, No. 8, December, 1915.

Paragenesis: Close examination of silver from Cobalt, in the writer's experience, always reveals the presence of more or less argentite, usually as thin amorphous coatings or scales attached to the surface of the silver. Thin coatings or patches of ruby silver are also common. Sometimes veinlets of argentite have a thin film of silver next the vein walls (Fig. 4). That the association of silver and argentite is very intimate is further shown by the presence of minute argentite inclusions in massive leaf silver (Fig. 2), as well as by the detection of traces of sulphur in several other samples. It is difficult to decide whether such structures are due to replacement or to more or less contemporaneous precipitation of both argentite and silver. At any rate the silver and argentite are later than the arsenide-sulpharsenide minerals since veinlets of silver may be seen cutting the latter (Fig. 3). Most of the silver fills in cleavage cracks and fractures or replaces calcite or arsenides. Fig. 3, a cross section of a typical very rich silver vein, illustrates well the replacement of arsenides by silver. In the picture both silver and

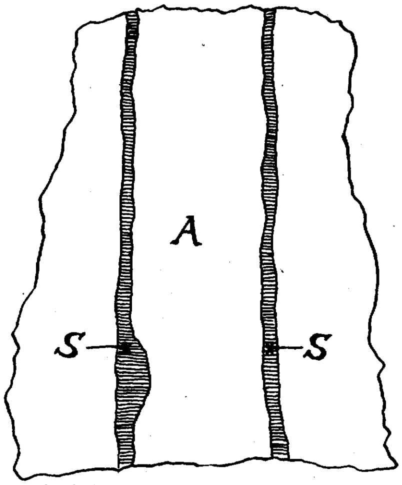


Fig. 4. Veinlet of argentite (*A*) with fibrous native silver (*S*) at the sides. The veinlet is about 2 mm. in width.

smaltite are dark, but the smaltite being harder has resisted buffing better and stands in relief. In the lower part of the picture native silver has almost completely replaced the arsenides, of which only a few fragments remain. In the upper part, the silver for the most part occupies the centre of the dendritic arsenide growths, and in some places can be seen connecting with veinlets in the calcite. There can be little doubt that in this case the arsenide minerals have been chiefly responsible for the precipitation of silver, and apparently the mineral which was originally in the centre of the dendritic growths was much more effective than the part that remains. This sort of structure might be expected to result from the reaction of cobalt-nickel arsenides on silver sulphate solution which has been demonstrated experimentally by Palmer and Bastin.[13] The writer's conception of the probable process is as follows:—The solutions from which the Cobalt ores were precipitated were at first very rich in arsenic, resulting in the precipitation of diarsenides, followed by arsenides. The arsenic content of the mother solution decreased as sul-

[13] Loc. cit.

phur became more prominent and sulpharsenides were also deposited. Finally the arsenic was practically all precipitated and the solution was essentially of a sulphate character. About this time came a slight movement, resulting in fracturing. The sulphate solution now carrying chiefly silver had an excellent opportunity to penetrate the fractured veins and come in contact with the arsenides which were dissolved while metallic silver and argentite were precipitated, resulting in replacement structures such as we have seen. No doubt the calcite also was concerned in the precipitation to an important degree. The dissolved arsenides were ultimately deposited elsewhere, resulting in structures in which the normal order of precipitation might appear to be reversed. Certain structures, the interpretation of which is very doubtful, do occur. Fig. 5 shows a beautiful dendritic growth of smaltite, with a very little niccolite, that is very suggestive of the tree-like crystallizations of silver. A few of these little tubes of smaltite are filled with silver, but calcite occupies the centre of most of them. There are also a few minute veinlets of native silver in the calcite.

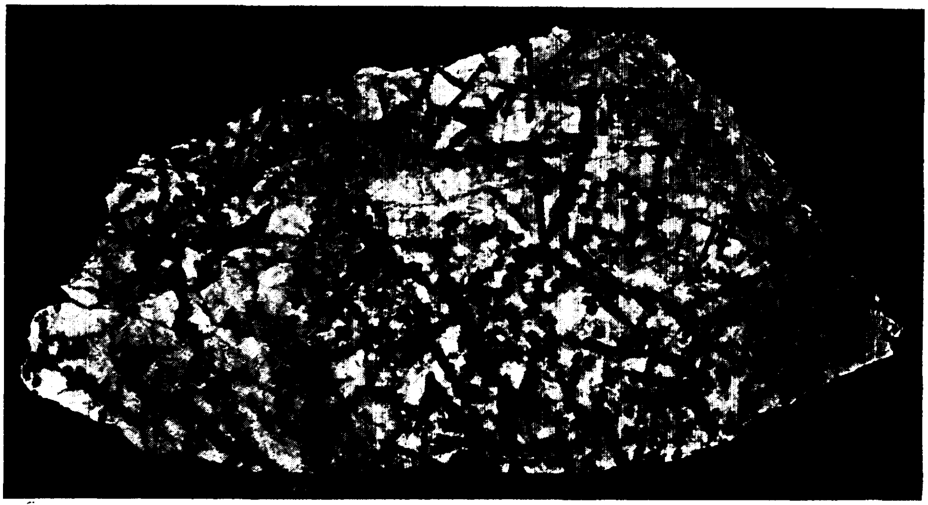


Fig. 5. Dendritic growths of smaltite, with native silver in calcite, reduced to three-quarters natural size.

Argentite Crystals, Casey-Cobalt Mine

A specimen from the Casey-Cobalt mine showed crystallized surfaces of argentite embedded in pure cleavable calcite. The argentite is closely associated with partially crystallized pyrite and these two minerals appear to have replaced or impregnated typical massive smaltite ore which makes up the rest of the specimen. In places, the argentite is intergrown with delicate filmy forms of native silver. On dissolving away the calcite with hydrochloric acid several well-developed, lustrous crystals of argentite were revealed. Examination of these crystals indicates that they occur in two distinct habits: 1. Simple, half-octahedrons attached vertically to the argentite mass, the plane of attachment corresponding to the direction of a cube face, and 2. Somewhat tabular forms which proved to be combinations of the rhombic dodecahedron, cube, icositetrahedron, trisoctahedron and tetrahexahedron (Fig. 6). These are also attached in a plane parallel to a cube face. A single crystal of the latter type about 1 x 1.5 x 1.5 mm. in size was found to have good faces suitable for measuring. Using the two-circle goniometer good signals were obtained for most of the faces, the only ones which are at all doubtful being the two faces belonging to the tetrahexahedron (510). These faces are small and the signals are faint and hazy. They are certainly in a zone with cube and dodecahedral faces. The best readings on the horizontal circle gave values for ρ of 77° 50′ and 79° 10′ for the two faces. These faces have been interpreted as belonging to the form (510) of the tetrahexahedron, a form which has not been recorded by Goldschmidt or Hintze as having been hitherto observed on argentite but which does occur on fluorite.[14] The theoretical value of ρ for (510) is 78° 41′. Faces belonging to the following forms have been observed on the crystal: c (100); d (110); q (211); u (221); and ε (510).

The drawing (Fig. 6) is intended to represent this crystal in its natural proportions, and shows only the faces actually present.

This is probably the first measurable crystallized argentite recorded from Canada.

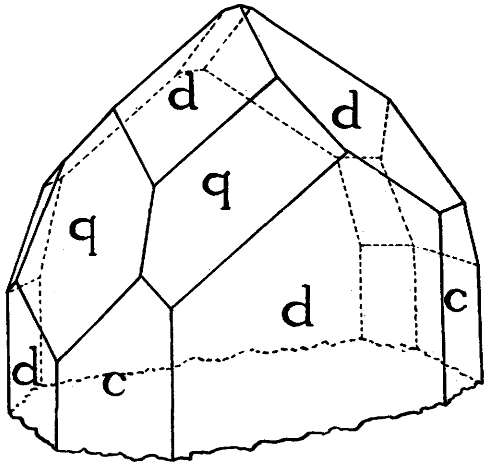


Fig. 6. Argentite, Casey-Cobalt mine.

Some of the partially crystallized argentite of this specimen was analyzed with the following results:

	Ag	S	Fe	Quartz	Sb (?)	Total
Per cent,	86.80	13.01	.08	.16	trace	100.05
Mol. Ratio	.8044	.4057	.0014	....	....	....
Argentite Ag_2S	.8044	.4029	....	....	....	....
Pyrite FeS_2	....	.0028	.0014	....	....	....

[14] Krystallographische Winkeltabellen—von. V. Goldschmidt.

The argentite is evidently very pure, the pyrite and quartz being merely accidental impurities.

A qualitative test of the pyrite shows that it also is practically pure if care be taken to obtain a sample free from adhering material.

One would be inclined to suspect from all the evidence that these two minerals were formed at a later period than the intimately mixed arsenide vein ore.

Argentite, O'Brien Mine

A specimen of argentite from the O'Brien mine attracted attention because of its peculiar iridescent tarnish resembling that of bornite, or perhaps more like the many-coloured tarnish which silver dishes assume after standing idle for some time in the laboratory. It was thought that this tarnish might indicate some variation in composition, and the mineral was accordingly analyzed. It proved to be ordinary argentite.

Ag	S	Sb or As	Cu	Co	Insol.	Total
86.91	12.86	trace	trace	trace	trace	99.77

This was the specimen from which crystals of polybasite were obtained. In a few places this argentite shows some evidence of a tendency to crystallize in forms which suggest rhombic rather than cubic symmetry. The argentite is associated with typical massive gray arsenide ore.

Galena Crystals, O'Brien Mine

Several large crystals of galena from the O'Brien mine are in the museum [14a] collection. They are rather remarkable because of their large size (up to 2.5 inches diameter), and because they are essentially octahedral in habit, cube faces when present being only slightly developed. The crystals are rough and have been more or less broken. Small grains and films of quartz can be seen along some of the broken cleavage surfaces, showing the same intimate association with quartz as was observed in the case of the very pure chalcocite from the Foster mine described on page 209.

Analysis of 1 gram samples failed to detect the presence of any impurity, except a small amount of iron.

	Per cent.				
Pb	86.56	÷	207.10	=	.4182
Fe	.05	÷	55.84	=	.0009
S	13.45	÷	32.07	=	.4195
Total	100.06				

The purity of this galena is remarkable when one remembers the usual complex character of Cobalt ores. It is not unlikely that several of the very pure minerals which have been encountered, such as galena, chalcocite, argentite, pyrite and chalcopyrite, which are usually associated with quartz and very pure calcite, belong to a later period of formation than the typical complex vein ores and may have been formed by solution and reprecipitation after the main period of mineralizing activity was finished.

[14a] Royal Ontario Museum, Toronto.

Chalcocite, Foster Mine

The specimen consists chiefly of white calcite through which runs a veinlet of white granular quartz. The chalcocite occurs as small patches, usually not over a quarter of an inch in diameter, very intimately associated with the quartz, which is later than the calcite.

Analyses of half gram samples showed no impurities except minute quartz grains, as below:

	Actual	Theoretical
Cu	79.58 per cent.	79.84 per cent.
S	20.10 " "	20.16 " "
Quartz	.34	
	100.02	100.00

The mineral is included here because it has not previously been reported from Cobalt, and further because of its unusual purity and freedom from intergrowths of other minerals.

Chalcocite in a disseminated condition may possibly be a constituent of certain of the complex ores which carry copper, but tetrahedrite and chalcopyrite appear to be much more common.

The character of the gangue is noteworthy, the calcite being a white, very cleavable variety encountered before in examining crystallized argentite specimens, and which seems to be quite different from the ordinary vein calcite, which is usually hard and dolomitic. This calcite is very easily soluble and is practically pure calcium carbonate. Minerals with which it is associated are more apt to be crystallized or unusually pure. It probably belongs to a late stage of deposition or it may be of a secondary character.

Breithauptite Association, Hudson Bay Mine

Within recent years the rather rare mineral breithauptite has been found in the silver-bearing veins of several of the Cobalt mines. Some time ago the Department of Mineralogy, University of Toronto, purchased from the Hudson Bay Mines, Ltd., a quantity of vein material in which this mineral appeared to be prominent. Since no analysis of breithauptite from this locality has been published up to the present, the writer, at the suggestion of T. L. Walker, undertook an investigation of the above material.

The constituent minerals, as will be seen later, proved to be breithauptite, niccolite, cobaltite and native silver, with calcite as the gangue material. In a typical polished hand-specimen, the purplish copper-coloured breithauptite is seen as rounded arborescent patches varying usually from one eighth to one inch along the greatest diameter. These breithauptite areas are always completely enclosed by a relatively narrow band of pale, copper-coloured niccolite, which in turn is fringed by an equally narrow border of gray cobaltite. The layer of cobaltite is sometimes so thin as to be almost indistinguishable to the naked eye. The intervening spaces are filled with white calcite. Finally, in some of the specimens, veinlets of native silver penetrate all the minerals previously mentioned.

Etching Methods for Breithauptite

In order to study in more detail the structure of breithauptite and other associated minerals, and their relation to each other, various etching re-agents were applied to polished surfaces, with the following results:

I. Strong nitric acid momentarily applied produces a very beautiful effect by darkening the breithauptite while leaving the niccolite bright and unaffected. The cobaltite shows up with a brightness intermediate between breithauptite and niccolite. With a somewhat longer application the breithauptite is strongly attacked with the formation of a white coating of the oxides of antimony. The niccolite is relatively little attacked and if the coating of oxides be removed from the breithauptite, it seems to stand in higher relief than the latter. If, however, the action is allowed to continue until a thick coating of oxides forms on the breithauptite, a point is reached when the niccolite begins to be rapidly dissolved and finally is etched deeper than the breithauptite.

It appears that in the latter case the oxides of antimony form a coating over the breithauptite which tends to protect the mineral beneath from the action of the acid, but since no coating forms on the niccolite it continues to dissolve and finally is etched deeper than the breithauptite.

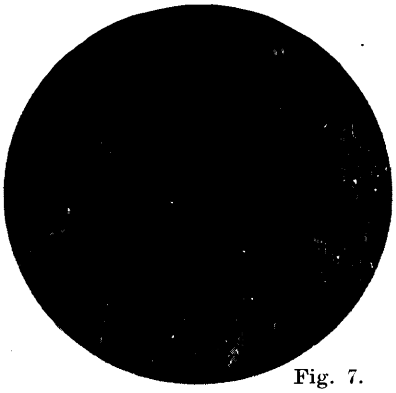


Fig. 7.

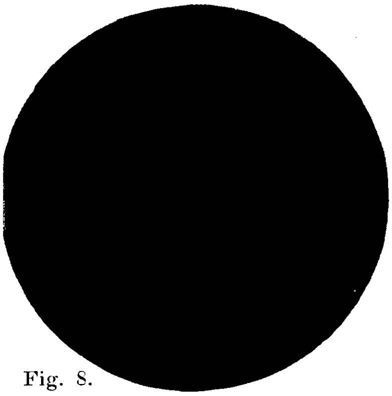


Fig. 8.

Fig. 7. The general structure of breithauptite as seen on a polished surface slightly etched with nitric acid. Magnification about 1½ diameters.

Fig. 8. Niccolite inclusions in bright relief in a ground mass of dark breithauptite. The darkest spots represent minute cavities in the breithauptite. (x 50).

The addition of tartaric acid to the nitric acid appears to prolong somewhat the time during which breithauptite is attacked with greater rapidity than niccolite. By repeatedly removing the specimen from the acid as soon as a moderately thick coating of oxides has formed and freeing the breithauptite surface of oxide by brushing and treatment with hydrofluoric acid, the breithauptite may be removed, without much affecting the niccolite. This observation suggested a method which is described later of removing breithauptite inclusions from niccolite.

II. Aqua regia attacks strongly both breithauptite and niccolite which dissolves to a clear solution. The cobaltite appears to be scarcely acted upon so long as the other minerals are present and hence stands in the highest relief after etching. By continuing this etching process until the breithauptite and niccolite have been entirely dissolved away, the cobaltite can thus be obtained as a residue free from both breithauptite and niccolite.

III. Hot dilute nitric acid (1-4) dissolves away the niccolite leaving breithauptite standing in relief and practically unaltered. The cobaltite is not perceptibly attacked but crumbles away as the supporting niccolite is dissolved and collects as a residue along with some breithauptite powder at the bottom of the dish. Since, as will be seen later, there are no cobaltite inclusions in the breithauptite itself we can thus eliminate both niccolite and cobaltite from the breithauptite.

Various other re-agents gave negative results or were so slow in action as to be valueless. Hydrochloric and sulphuric acids, strong or dilute, hot or cold, have but little effect. Hydrofluoric acid, though useless as an etching re-agent, proved useful in clearing away the oxides from etched surfaces.

Microstructure and Order of Deposition of the Breithauptite and Associated Minerals

The use of the etching methods outlined above produced surfaces in which the individual minerals by their differences in colour and relief could be very easily and clearly distinguished under the microscope or even with a hand lens.

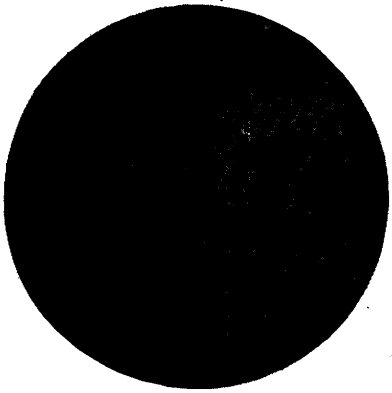


Fig. 9.

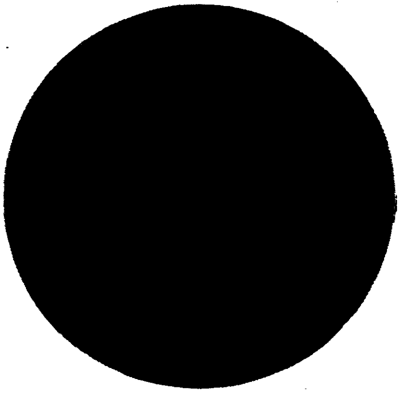


Fig. 10.

Fig. 9. The end of an arborescent area of breithauptite with characteristic niccolite inclusions is seen surrounded by a bright band of niccolite which on its outer edge is fringed by light gray cobaltite. Outside the cobaltite is a black band where calcite has been deeply etched, with two included dark gray areas at the top and bottom which represent calcite or perhaps a dolomitic calcite, since it is less deeply etched than that next the cobaltite. To the left is a small light gray area which represents the fringing cobaltite of another arborescent mass.

Fig. 10. Represents the same structure as Fig. 9, i.e., calcite filling the space between two closely arborescent masses, except that the envelope of niccolite is thicker and the cobaltite thinner than before. It should be noted that the vein-like appearance is very deceptive, suggesting that the breithauptite had been deposited massive, had subsequently been fractured, and in the cracks thus formed, niccolite, cobaltite and calcite had been deposited in order, as in a ribbon vein. This, however, is not the case. None of these minerals in reality penetrates the breithauptite, and fracturing did not occur until calcite had been deposited. The structure is due entirely to the closely arborescent form of the breithauptite, upon which the niccolite and cobaltite were precipitated. (x 70).

In all the specimens examined the same general relationship was found to hold; i.e., the aborescent breithauptite is entirely surrounded by a layer of niccolite which in turn bears a thin coating of cobaltite. On dissolving out the calcite which fills the intervening spaces, the outer surface of the cobaltite next the calcite is often seen to be crystallized in the form of brilliant cubes. In the specimens richest in breithauptite the layer of niccolite and cobaltite are relatively very narrow, typically not over one millimetre thick and often very much less, with arborescent breithauptite closely set and with little intervening calcite. Other specimens show relatively small patches of breithauptite surrounded by a ground mass of niccolite as though the breithauptite had been the nuclei around which comparatively large quantities of niccolite had precipitated. The specimens richest in cobaltite are characterized generally by rather small and scattered breithauptite areas with calcite more prominent. When native silver occurs it appears to fill cracks which penetrate all the minerals just mentioned.

Micro-structure of Breithauptite.—After etching with nitric acid the breithauptite appears as a dark porous massive surface containing numerous minute irregular inclusions of niccolite which stand in bright relief (Fig. 8). The breithauptite areas with their coating of niccolite and cobaltite and the calcite filling in the spaces between this arborescent complex may be seen in Figures 9, 10 and 11. No inclusions of any mineral other than niccolite were observed in the breithauptite,

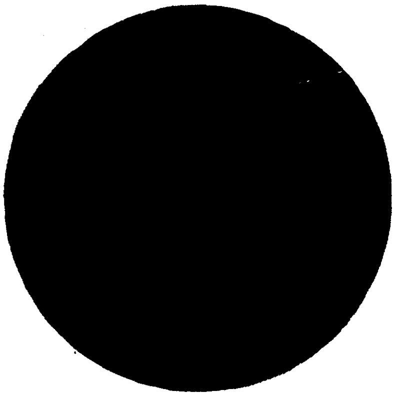


Fig. 11. The same structure as shown in Fig. 9. A few dark breithauptite inclusions in the niccolite may be noted. As before, the black vein-like band represents deeply etched calcite. (x 50).

which with this exception appears to be quite uniform and pure. Neither breithauptite nor niccolite exhibit any evidence of crystal form or structure. These structures suggest a simultaneous precipitation of breithauptite and minor quantities of niccolite as the first of the minerals to be deposited.

Micro-structure of the Niccolite.—The niccolite, which occurs as a narrow coating on the breithauptite appears to be quite pure, and has the closely granular appearance typical of a pure metal or mineral. In the more massive areas it contains inclusions of breithauptite which here also tend to be arborescent and appear to have been the nuclei around which the niccolite was deposited (Fig. 12). It also contains inclusions of cobaltite (Fig. 13). From the structures seen in Figs. 9, 10 and 11 the niccolite seems to have come down in maximum quantity after the breithauptite had been entirely precipitated.

Micro-structure of the Cobaltite.—This mineral occurs as a thin coating on the niccolite (Figs. 9, 10 and 11). It appears to have an extremely fine granular structure and may at times contain a few small inclusions of niccolite. The surface next the calcite is sometimes crystallized in cubes as previously mentioned. From its position as the outer layer of the arborescent masses it appears to be the last formed of the nickel-cobalt minerals.

Calcite fills in the spaces between the arborescent masses of breithauptite, niccolite and cobaltite, and hence is next in order of deposition after cobaltite. It appears to be the ordinary white variety with good cleavage in places and effervesces readily with cold dilute hydrochloric acid. Some portions are more dolomitic, however, as may be seen by reference to Fig. 9, where the calcite next the cobaltite has been etched deeper than the central parts. A few small grains of quartz occur with the calcite. Minute slender prisms of ruby silver were seen embedded in the calcite between the nickel-cobalt minerals. They were too small for measurement or analysis.

Veinlets of native silver fill irregular cracks that at times penetrate all the nickel-cobalt minerals as well as the calcite (Figs. 14, 15). Occasionally silver may be seen filling cleavage cracks in the calcite, a good example of which is shown in

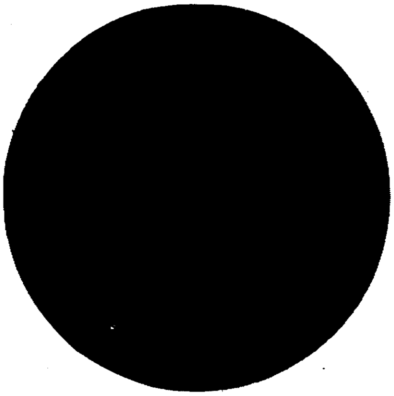


Fig. 12.

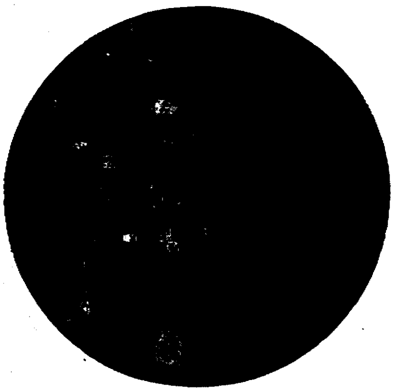


Fig. 13.

Fig. 12. Two skeleton-like areas of light-coloured breithauptite set in a dark ground mass of porous niccolite. (x 50).
Fig. 13. Cubes of cobaltite in bright relief included in a ground mass of dark, somewhat porous niccolite. The darkest spots represent cavities in the niccolite. (x 50).

Fig. 16. These structures would seem to indicate that subsequent to the deposition of calcite there was a slight movement which caused more or less fracturing in all the minerals and developed cleavage cracks in the calcite. In these fractures and cleavage cracks the native silver was deposited.

Summary: From the structural evidence, it appears that breithauptite was the first mineral deposited accompanied by relatively small amounts of niccolite as microscopic included grains. After the precipitation of breithauptite had ceased the niccolite continued to come down and formed a thin layer over the arborescent breithauptite. On the niccolite was deposited a thin coating of cobaltite with the outer surfaces partly crystallized. Thus both niccolite and cobaltite were moulded upon the breithauptite. The deposition of the nickel-cobalt minerals then ceased and the spaces between the arborescent masses were filled with calcite. Then came a period of movement with a slight fracturing of the minerals, and finally native silver was deposited in the cracks thus formed.

The order of succession of the minerals studied would seem to indicate broadly three periods of deposition as follows:—

I. Period of deposition of nickel and cobalt minerals, the nickel minerals being first.
   1. Breithauptite with minor amounts of niccolite as inclusions.
   2. Niccolite.
   3. Cobaltite.

II. Calcite with perhaps a little ruby silver. Period of slight movement and fracturing.

III. Native silver.

Separation of the Minerals for Analysis

It became evident from microscopic examinations after etching that the nickel and cobalt minerals were so intimately associated as to render of doubtful value any analysis of merely hand-selected material. The separation of the minute niccolite inclusions from the breithauptite and of the breithauptite and cobaltite inclu-

Fig. 14.

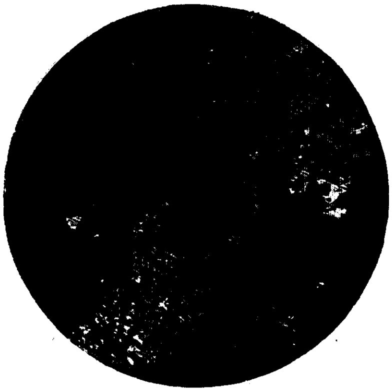


Fig. 15.

Fig. 14. A veinlet of scratched native silver is shown cutting through two masses of the nickel-cobalt minerals and the calcite which fills the space between them, proving conclusively that it was the last mineral deposited. The light granular mineral in high relief is niccolite, the dark spots intermingled with the niccolite represent breithauptite. Cobaltite, as usual, fringes the niccolite as the fine-grained, light gray mineral next the black calcite. Some of the best examples of this structure were too large to photograph. (x 60).

Fig. 15. Another example of a silver veinlet cutting the light-coloured nickel cobalt minerals at the top and bottom, and dark calcite to the right and left. (x 60).

sions from the niccolite was manifestly impossible by any mechanical means. In this connection the following paragraph from Campbell and Knight is here particularly applicable:

> From the above (a photomicrograph showing microscopic inclusions in smaltite) it is seen how an apparently homogeneous mineral varies from the centre to the outside and also contains other minerals as impurities so finely distributed through it that complete mechanical separation would be impossible. We can also understand how in this way analyses would vary as recorded by Dana.[15]

An attempted separation by means of the electro-magnetic concentrator proved unsuccessful, and since mechanical separation was out of the question, it occurred

[15] Microscopic examinations of the Cobalt-Nickel arsenides and Silver deposits of Temiskaming—Economic Geology, September-October, 1906.

to the writer that a separation might be effected by the prolonged application of the etching methods previously outlined.

The behaviour of a mineral with acids when intimately associated with another mineral is sometimes not the same as when it alone is treated under similar conditions with the same acids. An instance of this is recorded by V. Goldschmidt and A. L. Parsons as follows:

> By treatment with dilute hydrochloric acid the calcite can be dissolved out without the goethite being in the least attacked, so long as the least trace of the calcite is present.[16]

This fact was also noticed by the writer in the case of the association of minerals under discussion. It was found, for example, that aqua regia rapidly dissolves breithauptite and niccolite, leaving the cobaltite apparently quite unattacked so long as breithauptite or niccolite is present, but as soon as the two former minerals have disappeared, the cobaltite is at once vigorously attacked and quickly dissolved. Thus the cobaltite can be completely separated from the breithauptite and niccolite.

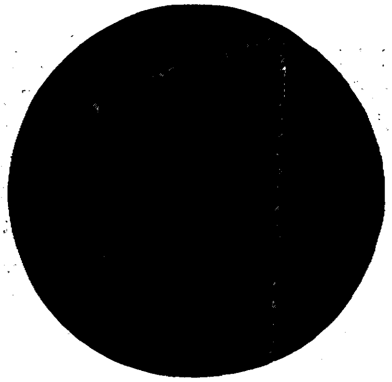


Fig. 16. White native silver filling cleavage cracks in dark calcite. This structure terminates an irregular, much thicker vein, the end of which is seen at the lower right-hand corner.

Similarly, though both niccolite and breithauptite alone are violently attacked by concentrated nitric acid, yet when the two minerals together are acted on by this acid the niccolite is relatively little attacked so long as a clean surface of breithauptite is present. Under the conditions described under etching methods, this process thus affords a means of freeing niccolite of breithauptite inclusions but not of cobaltite, which resists nitric acid so long as breithauptite or niccolite is present. Cobaltite, when alone, however, is readily attacked and quickly dissolved by nitric acid.

Finally, hot dilute nitric acid (1-4) dissolves away the niccolite leaving breithauptite practically unaltered, so that in this way we can free the breithauptite from niccolite inclusions. Here, again, when the niccolite has almost or quite disappeared, the solubility of the breithauptite in the dilute nitric acid is apparently much increased.

The details of the application of these methods are described below.

[16] Über Goethit von V. Goldschmidt und A. L. Parsons—Zeitschrift für Krystallographie usw. XLVII. Band, 3 Heft.

Isolation of Breithauptite.—A specimen containing as little niccolite and cobaltite as possible and with relatively large and pure-looking areas of breithauptite was selected and sawn into slices about an eighth of an inch thick. These slices were then treated with hot dilute nitric acid (1-4) until the outside coating of niccolite had been dissolved away and the slices presented the appearance of arborescent skeletons of breithauptite. The cobaltite falls off as the supporting niccolite is dissolved, leaving the breithauptite free of all impurities except the microscopic niccolite inclusions still contained in the interior. These thin branching pieces of breithauptite were then broken up by hand and inspected for freedom from niccolite and cobaltite. In this way about seven grams of breithauptite were obtained which apparently were entirely free of cobaltite and free of all but microscopic inclusions of niccolite. The specific gravity of this sample was 8.14 at 20° C. The arsenic content was 5.83 per cent. These selected pieces were then broken to 100 mesh and again treated with dilute nitric acid until the breithauptite began to be noticeably attacked as shown by the formation of the white antimony oxide. The breithauptite in the form of fine grains of size considerably less than 100 mesh was then rinsed and treated with dilute hydrofluoric acid to clear off any oxidised material, rinsed again and dried with alcohol at 120° C. Under the microscope the rounded grains thus obtained appeared to be of good colour, lustrous and apparently unchanged by the acid, though the sample in bulk was slightly darker than the original massive material. No cobaltite was visible. The specific gravity of the sample of about three grams was 8.23 at 20° C, but allowance must be made for the finely divided condition of the sample which results in slightly too high a figure for the specific gravity.[17] This material was then analyzed with the following results:—

Ni	Co	Fe	Sb	As	S	Total
32.09	.59	.04	66.62	.58	nil	99.92

It may be noted that the amount of nickel found is relatively a little low. This may be due to loss in analysis or to a slight surface oxidation of the breithauptite by the acid by which the bases are subtracted leaving a film of antimony oxide on the grains. As to the chemical constitution of the breithauptite, it seems probable that the cobalt and iron present replace some of the nickel since there is no microscopic evidence of the presence of cobaltite, while the absence of sulphur is a further confirmation. As to what extent arsenic actually replaces antimony, it is difficult to decide. The remainder of the material, after the analysis was subjected to further treatment with dilute nitric acid, was analyzed and the arsenic re-determined and found to be 0.47 per cent., which indicates that some niccolite was still present. This exhausted the supply of material. It is probable, however, that isomorphous arsenic, if present, amounts to less than 0.47 per cent.

The above analysis shows that the breithauptite is individually quite pure; in fact, this is nearer a theoretical analysis than any given by Hintze or Dana. It also

[17] Day, Allen and Iddings—The Isomorphism and Thermal Properties of the Feldspars. Pages 56, 57.

demonstrates that the chemical separation was in a large measure successful though for lack of material the niccolite was probably not entirely eliminated.

The following results were obtained on material from the same specimen:—

1. Hand-picked grains between 20 and 40 mesh selected for purity:—arsenic content = 11.23 per cent.

2. Grains with outer coating of niccolite removed by dilute nitric acid but still containing microscopic niccolite inclusions in the interior:—arsenic content = 5.83 per cent.

3. Material reduced to 100 mesh and again treated with dilute nitric acid:—arsenic content = 0.47 per cent.

The fact that this breithauptite though apparently pure and homogeneous to the naked eye contains nevertheless over five per cent. of arsenic, as microscopic niccolite inclusions is evidence of the importance of a microscopic examination of minerals which are to be submitted to analysis, since it may settle the question as to whether the presence of certain elements is due to isomorphous replacements or to admixture with another mineral in which they are contained.

Isolation of Niccolite.—One of the largest, purest specimens containing relatively little breithauptite was sawn into slices about one sixteenth of an inch thick which were treated with concentrated nitric acid containing tartaric acid as previously described under etching methods. When all the breithauptite that could be reached by the acid had been removed, the pieces were broken successively to 20, 40, 60, 80 and 100 mesh and retreated after each sizing. In this way it was hoped that the breithauptite inclusions would be eliminated. The sample was finally treated with hydrofluoric acid to clear off oxides, rinsed and dried at 120° C. Under the microscope the grains appeared bright, clean and of good colour. The sample, however, still contained brilliant cubes of cobaltite which apparently had scarcely been effected by the acid.

Considerable experimenting had previously been done with a view to finding some re-agent which would dissolve the cobaltite without affecting the niccolite or breithauptite, but all these attempts proved unsuccessful. There is, therefore, no means of determining absolutely whether any of the nickel is replaced by cobalt in this niccolite. Analysis of the sample thus prepared yielded the following results:—

Ni	Co	Fe	As	Sb	S	Total
40.64	2.04	trace	50.78	4.95	1.47	99.88

Specific gravity of the sample at 20° C = 7.66.

The remainder of the sample after analysis was re-treated with acid and the final determination yielded 3.81 per cent, of antimony. From the result it would appear that the material analyzed still contained breithauptite, and the amount of possible replacing antimony is thus reduced to less than 3,81 per cent., though it seems likely that most of this represents breithauptite.

Since sulphur is present in excess of the amount required to combine with the cobalt to form cobaltite, we must assume the presence of isomorphous sulphur to the extent of 0.37 per cent., if we consider all the cobalt to exist as cobaltite of theoretical composition.

Here again in the case of niccolite is demonstrated the usefulness of a microscopic examination. We know definitely that any antimony in excess of 3.81 per cent. exists as breithauptite, and also that a large proportion of the cobalt is present in the form of cobaltite.

A determination of antimony is 20-40 mesh grains of niccolite from the same specimen, carefully selected by hand and in which no breithauptite was visible to the naked eye yielded 17.76 per cent. Had there been no microscopic examination this would probably have been reported as an arite with the above percentage of antimony replacing arsenic. Thus it is possible that certain so-called arites may be in reality relatively pure niccolite containing minute inclusions of breithauptite. Similarly a sample of breithauptite containing a high percentage of very minute niccolite inclusions might also be reported as arite, though the enclosing breithauptite itself might be almost of theoretical purity. In this way an entirely fictitious series of arites containing any proportion of arsenic and antimony might be obtained.

Isolation of Cobaltite.—Examination of the hand specimens showed that those in which the calcite gangue was relatively prominent with the breithauptite as rather small and scattered areas, were richest in cobaltite. Such a specimen was selected, reduced to 40 mesh and after the calcite had been dissolved out was treated with aqua regia. In this way the breithauptite and niccolite were dissolved away, leaving the cobaltite as a relatively very small amount of finely divided residue. As previously noted, the cobaltite is apparently scarcely acted on until the breithauptite and niccolite have disappeared. It was found that the cobalt residue contained no nickel, so that the very delicate dimethylglyoxime test could be used to ascertain when all breithauptite and niccolite had been removed. When fresh quantities of the aqua regia solvent, therefore, no longer reacted for nickel, the separation was complete and the residue was washed, dried and examined under the microscope. The whole amount readily passed the 100 mesh. It was seen to consist partly of material without crystal form, derived, no doubt, from the layer coating the niccolite, and partly of very perfect cubic crystals which still retained their sharp edges and corners and brilliant metallic lustre. Accompanying the cobaltite were grains of yellow, rose-coloured, white and colourless quartz derived from the calcite gangue, and a few minute particles of silver. In order to get rid of the quartz grains the residue was treated with hydrofluoric acid until they were all dissolved. This was followed by dilute nitric acid to dissolve the silver.

In this way about three grams of apparently pure and in part crystallized material were obtained. The sample had a specific gravity of 6.35 at 20° C.

Analysis of this material dried at 120° C. yielded the following result:—

CO	Ni	Fe	As	S	Ag	Total
34.83	nil	.63	46.97	.04	17.48	99.95

From the above analysis and its cubic crystallization the mineral appears to be cobaltite, which has the theoretical composition: Co. 35.5, As. 35.2, and S. 19.3 per cent. The small amount of silver present was doubtless due to the escape of particles of native silver not affected by the nitric acid.

It will be noted that the arsenic is in excess of the theoretical percentage, while the sulphur falls below. This may result from replacement of sulphur by arsenic or may be due to the presence of small quantities of skutterudite, $CoAs_3$. The somewhat high specific gravity of the sample rather favours the latter explanation. To settle this point absolutely would require a relatively large sample of the cobaltite residue, which would necessitate the destruction of several pounds of the original specimens. There would then still remain the difficult problem of isolating the supposed skutterudite from the cobaltite.

However, the fact remains that cobaltite is, in any case the important constituent of the material analyzed. Further, it is remarkably pure as compared with most of the analyses given by Hintze and Dana. Iron is present in very small amount, and the entire absence of nickel as shown by the dimethylglyoxime test on one gram of material is especially noteworthy, since from its close association with niccolite and breithauptite it might be expected to contain nickel replacing cobalt.

General Conclusions Regarding Breithauptite and Associated Minerals

The methods of chemical separation adopted as a result of observation of the relative etching effects of various acids have proven successful except in the case of cobaltite inclusions in niccolite.

That the three minerals, breithauptite, niccolite and cobaltite, though so very closely associated as to suggest simultaneous precipitation, especially in the case of breithauptite and niccolite (Fig. 8), nevertheless individually possess almost their respective theoretical compositions with but very little possible replacement by isomorphous elements, would indicate the possibility of the wide variation in some mineral analyses being due more to admixture with other minerals than to actual replacement with isomorphous elements.

Smaltite and Chloanthite Crystals, Foster Mine

A specimen of what appeared to be very pure smaltite from the Foster mine showed good crystals embedded in a hard dolomitic gangue. The crystals are slightly distorted cubes with small octahedral and still smaller rhombic dodecahedral faces. Some of the cubes reach a size of 5 millimetres.

It was thought that it would be interesting to see if these crystals were intergrowths like those described by Baumhauer, and analyzed by Vollhardt. One of the cubes was cut through the centre and polished parallel to a cubic face. After etching with acid it was seen to be made up of two different materials which were intergrown as shown in Fig. 17. On further etching at least two other components could be recognized but these were present only in very small amount. The massive part of the specimen was also etched and showed the same two prominent materials (Fig. 18) together with small quantities of others not identified. On prolonged etching the inner part of the growths was corroded deeper than the outer later part and relatively much nickel passed into solution, so that the central areas are probably essentially chloanthite. There are also extremely minute inclusions in the chloanthite which can be seen only with a high power.

A single analysis was made on crystals with the following results:

Co	Ni	Fe	Cu	As	S	Total
13.81	11.35	1.21	.96	71.61	.75	99.69

A sample of the more massive, but partially crystallized material was prepared in order to try some separation experiments. This sample on analysis yielded the following results:

Co	Ni	Fe	Cu	As	S	Total
12.16	14.14	2.10	.40	66.87	4.13	99.80

Co: Ni: Fe = 5.79 : 6.73 : 1

Theoretical composition of smaltite—Co 28.12 and As 71.88 per cent.
" " of chloanthite—Ni 28.12 and As 71.88 per cent.

Fig. 17.

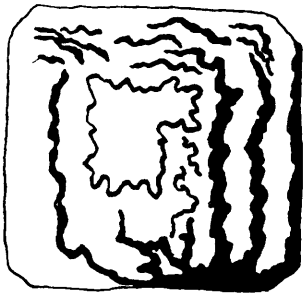


Fig. 18.

Fig. 17. Intergrowth of smaltite and chloanthite in a crystal about 2 millimetres in diameter (x 50).
Fig. 18. Sketch showing major features of smaltite-cloanthite intergrowth in a crystal 2 mm. in diameter as seen under the low power.

It is evident that both the crystals and the more massive material consist of about equal parts of smaltite and chloanthite.

A sample after prolonged treatment with hydrochloric acid and potassium chlorate, yielded a residue from which the following amounts were obtained:—

Co = .0868 g, Ni = .0064 g, Fe = .0098 g or
Co : Ni : Fe = 8.857 : 0.65 : 1

It is evident that this residue was nearly pure smaltite.

Another sample was agitated with successive quantities of silver nitrate solution and the solutions thus obtained were analyzed.

First solution yielded Co = .0068 g, Ni = .0393 g, Fe = .0018 g or
Co: Ni: Fe = 3.77: 21.83: 1

Second solution yielded Co = .0409 g, Ni = .0222 g, Fe = .0080 or
Co : Ni : Fe = 5.11 : 2.77 : 1
Third solution yielded Co = .0686 g, Ni = .0173 g, Fe = .0113 g or
Co : Ni : Fe = 6.07 : 1.53 : 1

These experiments serve to show that silver nitrate solution acts more readily on chloanthite than on smaltite, but as a separation method the large amount of silver precipitated is a disadvantage as it tends to retard the action of the solution, which becomes very slow as the amount of silver increases.

The results obtained seem to indicate that a smaltite residue containing little or no nickel might be obtained by sufficiently prolonged application of suitable separation methods.

Paragenesis—Considering first of all, the intergrowths which occur as good crystals, it seems probable that the crystals grew continuously from a mother solution which contained the elements of both smaltite and chloanthite, and that both these minerals were being precipitated as the crystals grew. The absence of definite concentric or zonal structure renders it unnecessary to suppose that the crystals were formed by overgrowth due to sharp changes in the cobalt and nickel content of the solution. A study of the massive part, however, seems to indicate that chloanthite was formed in greatest quantity during the early stages. The chloanthite areas are not pure but contain minute inclusions which are probably smaltite, and are bordered by smaltite. Apparently chloanthite was predominantly precipitated at first, and smaltite slightly later, but the two periods overlap.

Summary—The crystals examined are not homogeneous mixed crystals of cobalt-nickel diarsenide, but are intergrowths of about equal parts of smaltite and chloanthite, which appear to have been precipitated together. Chloanthite is doubtless much more common at Cobalt than has been supposed as a constituent of massive smaltite ore, and in the aggregate may be responsible for a greater part of the nickel content of Cobalt ores than the more conspicuous niccolite.

Cobaltite Crystals, Columbus Claim

The crystals which have been found at this mine are probably not surpassed in perfection of development by those of any other known locality. They are essentially octahedral in habit, with relatively small cube faces. A small percentage have the cube and octahedron about equally developed but in the great majority the octahedron predominates.

One of the crystals—an octahedron with small cube faces—measures 7 mm. between cube faces.

These crystals have been analyzed by J. S. De Lury[18] and found to contain notable amounts of iron and nickel. Remembering the slight solubility of cobaltite relative to the more common arsenides, which was displayed in the separation of minute cobaltite crystals from niccolite and breithauptite and also bearing in mind the very small capacity of this mineral for precipitating silver from silver sulphate solutions, noted by Palmer and Bastin,[19] the writer decided to subject

[18] Cobaltite Occurring in Northern Ontario, Canada, by Justin S. De Lury—American Journal of Science, Vol. XXI, April, 1906.

[19] Metallic Minerals as precipitants of silver and gold, Economic Geology, Vol. 8, No. 2, March, 1913.

samples of this cobaltite to the action of such re-agents as might be expected to act more rapidly on any iron or nickel minerals that may be present as microscopic inclusions.

A preliminary microscopic study of etched surfaces of these crystals revealed numerous inclusions which it was thought might be sufficient in amount to account for the iron and nickel found in the analysis. For instance, a very perfect crystal which showed no evidence whatever of inclusions, externally, was cut through the centre parallel to a cubic face. In this case inclusions of at least two different minerals were observed. On being strongly etched with concentrated hydrochloric acid and potassium chlorate, one kind of inclusion is strongly attacked while another kind appears to be even more resistant than the cobaltite itself (Fig. 19). Some of the

Fig. 19. Inclusions of gersdorffite (?), light, in relief, in ground mass of a cobaltite crystal. Another sort of inclusion has been deeply corroded and is represented by the black line crossing the picture.

inclusions occur as wandering lines which can scarcely be fractures, since in some cases, they have a roughly concentric arrangement. On the other hand, unmistakable mineral-filled fractures are present in some of the other crystals. The inclusions that appear to be more resistant than the cobaltite are scattered throughout the cobaltite groundmass in irregular grains which remain bright and unattacked, even when the cobaltite has been roughened and the more soluble inclusions deeply corroded by the strong acid.

The structure suggests that most of the inclusions were formed at the same time as the cobaltite and that there is good ground for believing that the iron and nickel found by analysis are due to mineral inclusions rather than to isomorphous replacement of cobalt by nickel and iron.

A sample of about 5 or 6 grams of crystals, free from adhering matter was selected, ground to 200 mesh and analyzed, with results as in No. 1.

	Co	Ni	Fe	As	S	Total
I	28.11	3.07	4.76	44.61	19.57	100.12
II	28.28	3.12	4.40	44.82	19.20	99.82
III	28.64	3.06	4.11	44.77	19.34	99.92
Theoretical.	35.41	....	....	45.26	19.33	100.00

The powder left after analysis No. 1, was digested for two or three days at room temperature with concentrated hydrochloric acid, a little potassium chlorate being added from time to time. The residue was then washed, dried and a sample analyzed, which gave the results under No. II. What remained was digested with silver nitrate solution for a week. Only a very little metallic silver was precipitated, which was removed with dilute nitric acid. The final residue gave the results under No. III. In the analyses, Co, Ni, Fe, and S were determined only once, the arsenic by titrations of two aliquot portions of the same sample.

The chief results of interest are:

1. The regular increase in the amount of cobalt found, with corresponding decrease in the percentage of iron.

2. The fact that the nickel percentage remains practically the same, or perhaps even increases slightly. This result, considered along with the observation of inclusions which appear to resist corrosion better even than cobaltite, appears to point to the conclusion that there is some inert nickel mineral present, intergrown with the cobaltite. It is not unlikely that this mineral is gersdorffite—NiAsS. The progressive decrease in the iron found tends to confirm the suspicion that the iron is present as a mineral rather than in molecular combination replacing cobalt.

Summary—All the evidence—microscopic and analytical—confirms the conclusion that in the case of these cobaltite crystals, the iron and nickel found by analysis can be accounted for by the presence of microscopically visible inclusions of other minerals in the crystals.

There is reason to believe that these included minerals are, for the most part, not later infiltrations or replacements, but are intergrowths with cobaltite, being formed from the same solution at the same time.

Löllingite, Kerr Lake Mine

The specimen in which this mineral was identified is a cross-section of a portion of a calcite vein. One side was originally in contact with the vein wall and contains small angular fragments of decomposed country rock (Figs. 20 and 21).

The vein shows white calcite of two generations (A) and (B), of which (A) appears to be the later, since the base of the löllingite growths (L) rests on (B) and their partially crystallized terminations are embedded in (A). The calcite (B) has a slightly bluish tinge and is readily distinguishable from (A) which is

Fig. 20. Löllingite specimen (natural size).

almost pure white. The löllingite shows a marked fibrous structure with the fibres somewhat radiating, but in a general way normal to the vein walls. Extremely minute fractures filled with calcite traverse the löllingite masses.

On dissolving away the calcite with hydrochloric acid, the löllingite, which is not attacked so long as a little calcite remains, is obtained as radiating fibrous

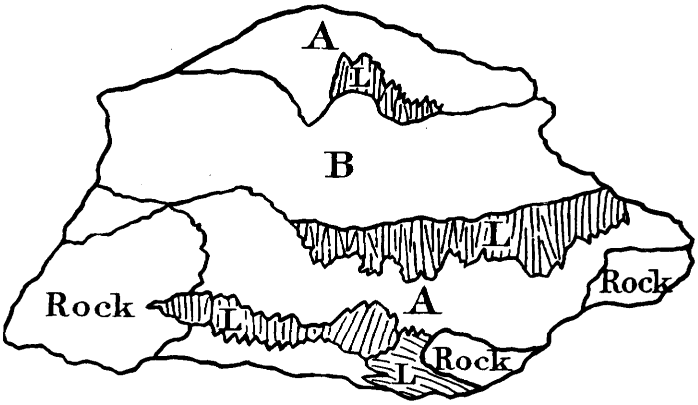


Fig. 21. Diagram of löllingite specimen (natural size).

botryoidal masses. The surface which was embedded in calcite (A) has a velvety appearance and reflects light from very numerous minute sparkling points, which under a microscope are seen to be crystal faces.

Using a binocular microscope, the surface appears to be made up of very small terminated crystals showing minute faces. An attempt to remove some of these for measurement proved fruitless. A few small crystals of arsenopyrite up to .5 mm. diameter are embedded in or attached to the surface.

Examination of polished surfaces etched by acid (Fig. 22) indicates that certain parts are more readily attacked than others, and that the material is far from homogeneous. After a rather severe etching one set of fibres stands in sufficient relief to be repolished by lightly rubbing on fine emery paper, while another constituent is so deeply corroded that it is not affected by moderate rubbing. In fact, three different minerals can be distinguished with certainty, and there are indications of a fourth. The two most important constituents, as will be seen from the analysis, are löllingite ($FeAs_2$) and cobalt diarsenide. The latter, because of the high specific gravity and the fibrous character of the intergrowth, is probably the rhombic form, safflorite. The arsenopyrite previously noted seems to be most abundant toward the outer portions of the growths.

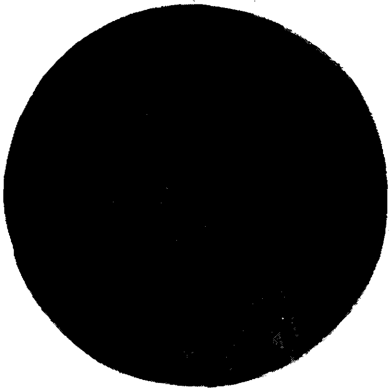


Fig. 22. Löllingite surface strongly etched, showing three constituents. Two are bright and stand in relief. The third is deeply etched and appears black in the picture. (x 50).

Analysis—At first only a small sample of about two grams was selected which yielded the following results:

	Fe	Co	Cu	As	S	Sb	Ni	Total
Per cent.	22.18	5.62	.41	70.84	.82	trace	absent	99.87
Mol. Ratio	.3972	.0979	.0064	.9448	.0256	....	....	....
Arsenopyrite Fe As S	.0256	....	....	.0256	.0256	....	....	....
Safflorite Co As_2	....	.0979	....	.1958	....	....	....	....
Löllingite Fe As_2	.3617	....	....	.7234	....	....	....	....
Excess	.0099	....	....	....	....	....	....	....

For convenience, the calculations have been made on the assumption that löllingite, safflorite and arsenopyrite of theoretical composition are present. The sulphur has all been calculated as arsenopyrite, but, as will be seen later, there is reason to believe that some of it should be assigned to the copper.

Another sample of about 7 grams was selected with a view to trying some of the separation methods used in other instances. The specific gravity of the sample before grinding was 7.300 at 15.5° C. This sample on analysis gave the following results:

	Fe	Co	Cu	As	S	Sb	Ni	Total
Per cent.	23.60	5.94	.38	69.08	.96	trace	absent	99.96
Mol. Ratio	.4227	.1007	.0059	.9212	.0299	....	....	....
Arsenopyrite (Fe As S)	.0299	....	....	.0299	.0299	....	....	....
Safflorite ($Co\ As_2$)	....	.1007	....	.2014	....	....	....	....
Löllingite ($Fe\ As_2$)	.3449	....	....	.6899	....	....	....	....
Excess	.0479	....	....	....	....	....	....	....

Fe : Co = 1 : 0.251

Compared with the first analysis, this one shows that the mass varies somewhat in composition from place to place, thus confirming the conclusions arrived at by microscopic examination, that the material is an intergrowth of distinct minerals.

As only a small amount of material was available the separation experiments were carried out on about 5 or 6 grams. Only iron and cobalt were determined.

Exp. 1. Concentrated hydrochloric acid with a little potassium chlorate on 250 mesh powder. The filtrate contained relatively much copper.

.0226g Fe and .0054g Co, or Fe: Co = 1: 0.237.

Exp. 2. Silver nitrate solution on 250 mesh powder, filtrate contained .0307 g Fe and .0075 g Co or Fe: Co = 1: 0.244.

Exp. 3. Nitric acid (1 : 1) on 250 mesh powder, filtrate contained .0852 g Fe and .0163 g Co or Fe: Co = 1: 0.191. This treatment was continued and the final residue yielded .1363 g Fe and .0635 g Co or Fe: Co = 1: 0.267.

These experiments for lack of sufficient material could not be carried far enough to obtain definite separations and their value is also lessened because sulphur was not determined, as at that time the arsenopyrite had not been recognized, and it was thought that löllingite and safflorite were the only important variables, whereas, there are certainly three, and possibly five, minerals present. There seems to be, however, no great difference in the solubility of the minerals when in the form of a fine powder, except that the copper mineral, whatever it may be, seems to be more readily attacked than the others. This probably is because the minerals, being closely related chemically and crystallographically, have only small differences in solubility and potential. Furthermore, when finely powdered, the electrical contact between the mineral protected and the protecting mineral is not so good as in the case of a polished surface, and isolated particles of the protected mineral which do not have some of the protecting mineral attached to them will readily dissolve.

Paragenesis—In a complex intergrowth of this sort it is impossible to separate different periods of precipitation. The growth of the various minerals has been, not in bands parallel to the direction of the vein, nor in concentric layers as we might expect if the mother solution varied in composition from time to time, but in a fibrous aggregate approximately normal to the vein wall and containing the individual minerals side by side. Apparently all the mineral constituents were being formed continuously during the whole period of precipitation, though the percentage of arsenopyrite appears to have increased toward the last. A rather slow, contemporaneous precipitation of the different minerals from a solution of fairly constant composition appears to be the most reasonable explanation of the formation of such an intergrowth.

Summary—There is good reason to credit the cobalt found in the analysis to safflorite. Arsenopyrite crystals were identified by blow-pipe tests and hence the sulphur may be assigned, in part at least, to arsenopyrite. The copper comes off in greatest quantity at first in separation experiments, and probably is present as an easily soluble compound with sulphur. The chief mineral constituent is löllingite.

In short, the material examined appears to be an extremely intimate intergrowth of several minerals closely related, chemically and crystallographically. It is not a single homogeneous mineral containing isomorphous replacing elements in molecular combination. On the other hand it has not been proved that the individual mineral components themselves are not subject to molecular replacement by isomorphous elements.

Arsenopyrite Crystals, O'Brien Mine

Crystals of arsenopyrite from Cobalt have been described and illustrated in Part II. of the Nineteenth Report of the Ontario Bureau of Mines.

The writer in dissolving away the calcite from some of the so-called glaucodot of the O'Brien mine found a residue of detached crystals up to 2.5 mm. across, which it was thought might be glaucodot, but which analysis proved to be arsenopyrite.

The crystals are of a habit which is rather unusual for arsenopyrite, the base being most prominent, followed in order by the prism ∞ (110), and small domes 01 (011) and 10 (101). The base gives multiple reflections and probably consists really of almost infinitely flat pyramids or domes. The drawing (Fig. 23) represents the type habit and characteristic development of the faces. The faces, especially the domes 01, $0\bar{1}$ are usually corroded, and only two crystals were found to give fairly good reflections. Besides the forms mentioned, which were definitely determined, there also occur corroded traces of the brachypinacoid and of a pyramid in the zone of the prism ∞. One crystal gave very poor readings for a prism which seems to be $\infty \frac{7}{3}$.

An analysis of the crystals yielded the following results:

	Fe	Bi	Co	As	S	Total
Per cent.	34.53	.79	.09	44.34	20.22	99.97

The analysis proves that these crystals are not glaucodot. The presence of bismuth is unusual, though it has been reported in two out of eighty-one analyses of arsenopyrite recorded by Hintze. When examined under a microscope, however, the crystals are seen to be non-homogeneous, which probably accounts for the corrosive effect of the acid on them, as pure arsenopyrite is not much affected by hydrochloric acid.

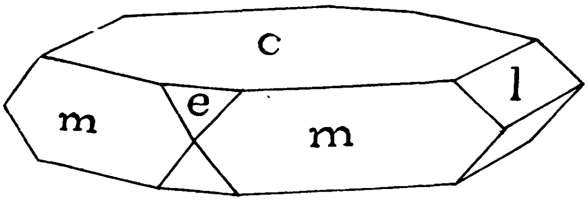


Fig. 23. Arsenopyrite crystal, O'Brien mine.

The finding of arsenopyrite as isolated crystals embedded in calcite and as crystals attached to the arsenide complex, shows that the main arsenopyrite precipitation was later than the main arsenide precipitation, though for a time both were probably being formed together. Bismuth also, in other instances, seems to come later than the period of maximum arsenide deposition, so that its presence here is not remarkable.

Arsenopyrite has been identified in a number of specimens from Cobalt and is probably present in relatively small quantity in most of the complex ore. When intergrown with massive cobalt-nickel diarsenide ore, it cannot be readily detected, except by examining etched surfaces.

Rammelsbergite, University Mine

This specimen at first glance appeared to consist chiefly of very pure niccolite bordered by a band of smaltite from a quarter to a half inch wide, in typical dolomitic vein calcite. On closer examination the supposed smaltite, which analysis shows to be really rammelsbergite, is seen to have the fibrous structure and prismatic cleavage which one associates with the rhombic cobalt-nickel arsenides.

Microscopic observation of etched surfaces shows that the rammelsbergite which is immediately in contact with the niccolite is crystallized, the numerous long, prismatic crystals extending into the niccolite (Fig. 25), and thus proving that the niccolite is the younger of the two.

The niccolite also contains detached crystals of rammelsbergite (Fig. 26) which, in some instances, have been fractured across and the fractures filled with niccolite. The rammelsbergite mass itself is not entirely pure as it contains small inclusions of niccolite which appear to have been precipitated at the same time, though in very much smaller quantity. The niccolite also contains inclusions of what appears to be breithauptite and possibly of cobaltite, though the latter cannot be identified with certainty because of the nearly square cross-sections of the rammelsbergite crystals, which simulate the cubic crystals of cobaltite.

An analysis of the rammelsbergite yielded the following results:

	Ni	Co	Fe	As	S	Sb	Total
Per cent.	27.84	1.80	trace	67.32	2.03	.83	99.82

Specific gravity at 20°C = 7.157.
Theoretical composition of rammelsbergite, Ni = 28.12 per cent., As = 71.88 per cent.

The analysis indicates that the material is essentially nickel diarsenide. The slight excess of nickel and cobalt over the theoretical percentage is no doubt due

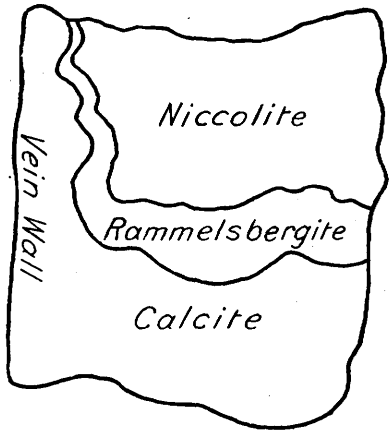


Fig. 24.

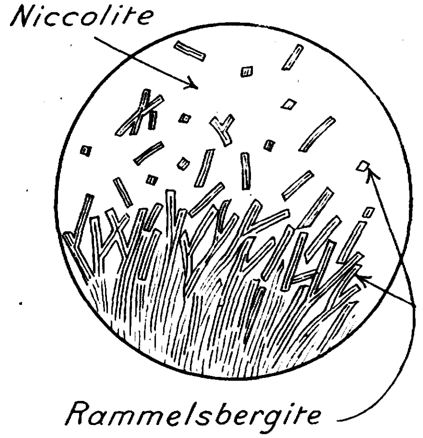


Fig. 25.

Fig. 24. Diagram of rammelsbergite specimen, natural size.
Fig. 25. Drawing of crystallized rammelsbergite at the contact with niccolite, as seen under the microscope.

to the presence of some niccolite, and the antimony is probably in the form of breithauptite associated with the niccolite. The rôle of the sulphur and cobalt is doubtful as cobaltite was not identified with certainty. The long prismatic crystals seen projecting into the niccolite together with the high specific gravity and the well-marked cleavage prove the mineral is the rhombic form—rammelsbergite.

Paragenesis—The fact that the rammelsbergite in contact with the niccolite is crystallized, with the crystals embedded in the niccolite would indicate that the niccolite is the later of the two. Such crystallized surfaces may often be seen in banded veins or vugs in which the growth has undoubtedly been from the walls inwards. The small inclusions of niccolite which occur in the rammelsbergite are probably due to simultaneous precipitation of a small amount of niccolite during the formation of the rammelsbergite. The composition of the mother solution which at first precipitated rammelsbergite with a little niccolite, must have altered in such a way that the amount of niccolite formed was increased until only a small amount of rammelsbergite was being precipitated along with the niccolite. At a point about a quarter inch from the edge of the massive part of the rammelsbergite, only scattered, isolated crystals can be seen in the niccolite, which appears to the naked eye to be very pure.

That the structure just described could be due to replacement of either mineral by the other, appears to be improbable. If niccolite replaced rammelsbergite the crystals would have suffered more severely. They are, on the contrary, very perfect and entirely uncorroded. If rammelsbergite be supposed to have replaced niccolite one would have difficulty in explaining the presence of perfect, isolated crystals of rammelsbergite embedded in niccolite at considerable distances from the main rammelsbergite mass.

The relationship between rammelsbergite and niccolite thus appears to support the theory which will be developed later, of the general order of precipitation at Cobalt, i.e., diarsenides first, followed by monarsenides, these by sulpharsenides, and finally sulphides and disulphides, with native silver.

Fig. 26. Long prismatic crystals of rammelsbergite in niccolite.

Glaucodot, O'Brien Mine

Glaucodot has been mentioned as occurring at Cobalt, but its presence has not been proved[20]. Having examined a large quantity of the material from the O'Brien mine, which has long been supposed to contain glaucodot, the writer is satisfied that the complexity of the material is such that the presence of glaucodot cannot be confirmed. The reasons for this opinion will appear later.

On dissolving away the calcite from some of this material, numerous small tabular crystals up to 2 mm. in diameter were obtained. It was thought that these might be glaucodot. They were measured on the two circle goniometer, but, while the signals were not very good, the readings indicated that the mineral might be either arsenopyrite or glaucodot. They were then analyzed and found to be arsenopyrite, containing .09 per cent. of cobalt. Another lot of crystals of different habit proved to be arsenopyrite also.

The massive material was then examined by etching a number of polished surfaces, and it proved to be a very complex intergrowth of five or six different minerals, often in a very finely divided condition. Some of the larger structures can be seen with a hand lens, but the microscope shows that the whole is a mixture of grains,

[20] Pt. II, 19th Report, Ont. Bur. Mines, p. 22.

often of extremely small size, sometimes cencentrically arranged (Fig. 27), sometimes irregularly distributed like the grains in a section of granite. The main constituents appear to be smaltite, arsenopyrite and pyrite with small amounts of what appears to be niccolite or breithauptite—perhaps both. On treating a fragment with hydrochloric acid till the arsenides are partly dissolved, a thin network of native silver is revealed.

A sample of the mass was analyzed with the following results:

	Ag	Co + small amount of Ni	Fe	Bi	Cu	As	S	Quartz	Total	Sb
Per cent	2.12	$\frac{17.34}{58.97}=.2941$	$\frac{10.28}{55.84}=.1799$	.95	.09	$\frac{60.77}{74.96}=.8106$	$\frac{8.08}{32.07}=.2520$	.12	100.22	.47

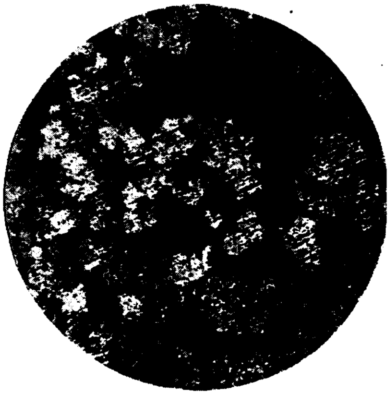


Fig. 27.

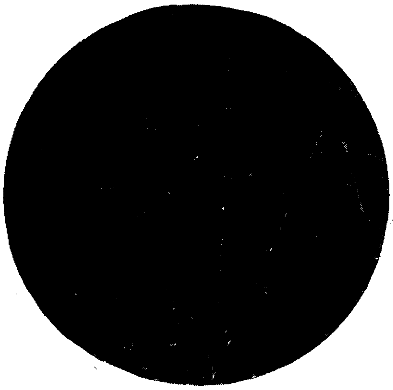


Fig. 28.

Fig. 27. Concentric structure, representing an intergrowth of several different arsenides. The black central part is more or less square in outline, suggesting a cube of smaltite or chloanthite.

Fig. 28. Matildite inclusions (dark), in light ground mass of galena.

This material serves very well as an example of the extreme microscopic complexity of much of the Cobalt ore. There appears to be no evidence, however, which would lead to the supposition that glaucodot is one of the constituent minerals.

After examining a considerable quantity of the massive material microscopically, another sample, which was apparently purer than the first lot, was selected and analyzed, with results as below:

	Co	Fe	Ni	As	S	Cu, Bi, Ag and Sb	Total
Per cent.	$\frac{17.22}{58.97}=.2920$	$\frac{10.79}{55.84}=.1933$	$\frac{1.80}{58.68}=.0307$	$\frac{63.14}{74.96}=.8422$	$\frac{6.75}{32.07}=.2105$	trace	99.70

The ratios here are much the same as in the first analysis, but smaller amounts of copper, bismuth and antimony are present. There is no evidence that glaucodot is one of the constituents.

Summary—The material is a complex microscopic intergrowth of several minerals, which are so intimately mixed that they cannot be definitely assigned to different periods of precipitation though the arsenopyrite, pyrite and chalcopyrite were formed chiefly at the last. Cobalt diarsenide (smaltite or safflorite) and arsenopyrite with less pyrite or marcasite are the predominant minerals of the complex. Several others such as niccolite, löllingite, breithauptite are indicated by etching tests and analysis. Native silver and probably native bismuth and chalcopyrite are present in small amounts. There appears to be no reason to suppose that glaucodot is one of the constituents, knowing as we do that arsenopyrite and pyrite are present.

Here, again, all the facts point to slow simultaneous precipitation of several minerals from a solution which varied but slowly in composition, the sulpharsenides and sulphides predominating during the last stages of the deposition.

Matildite-Galena intergrowth, O'Brien Mine

The specimen examined was a small mass of galena in which certain areas were remarkable because of their whiter colour and brighter lustre, and also because of a disturbance of the normal cubic cleavage which in such parts assumes a distorted, roughly rhombohedral form. Microscopic examination of an etched surface (Fig. 28) shows that this last material is an intergrowth of two distinct minerals, of which the ground mass is galena and the included mineral, as shown by the accompanying analysis, is matildite.

	Pb	Bi	Ag	S	Sb	Fe	Total
Per cent.	54.35	20.26	10.11	14.68	.45	.20	100.05
Mol. Ratio.	.2624	.0974	.0937	.4580	.0037	.0036	....
Galena PbS	.2624	....	....	.2624	....	....	....
Matildite $AgBiS_2$	....	.0937	.0937	.1874	....	....	....
Excess	....	.0037	....	.0080	.0037	.0036	....

Specific gravity at 21° C = 7.201.

The somewhat inexact ratios shown by the analysis may be due partly to the difficulties of the chemical separations. The rôle of the iron and antimony found is doubtful. It is evident, however, that the material is essentially an intergrowth of galena and matildite in the approximate proportion of: Galena 62.76, and Matildite, 36.50 per cent.

Paragenesis.—The specimen described was a small mass of the material associated only with galena and traces of calcite, so that it was impossible to ascertain the relationship of matildite to the common minerals of Cobalt.

Microscopic examination of etched surfaces shows that the intergrowth is of a very intimate and uniform character. Any section taken at random, throughout the mass, shows the same characteristic structure. There is no arrangement of the matildite particles along cleavage lines or cracks in the galena as might be expected if the structure were due to metasomatic replacement of galena by matildite. That the perfect cleavage of galena persists in the intergrowth, though in a slightly distorted form, and the very fact that the cleavage is distorted so that it is no longer exactly cubic, along with the isolated, discontinuous character of the matildite inclusions, seems to the writer to be evidence as conclusive as can be expected of the simultaneous precipitation of the matildite and galena.

Further, in all occurrences of matildite recorded by Dana and Hintze from widely separated regions of the world, this mineral has been intimately associated with galena. All the analyses on record show a lead content, varying from 2.58 to 8.00 per cent., and in every case the lead has been reported by the analyst as galena. There are many examples of such pairs of minerals which very often occur as intergrowths, even when in crystals, as in the case of smaltite and chloanthite. Such intergrowths can hardly be explained in any other way than by supposing that the two constituent minerals were being formed continuously during the period of crystallization.

The fact that matildite from such widely separated localities as Peru, Colorado, Japan and Ontario is always very intimately associated with galena is rather remarkable, and would seem to have some special significance.

Proustite from Cobalt, Ont., O'Brien Mine (?)

Crystals of proustite, supposedly from the O'Brien mine, have been described in detail by A. L. Parsons of the University of Toronto, and were analyzed by the writer. The following extracts from the article[21] referred to may be quoted:

> The crystals for the most part are less than two millimetres in length and very few exceed a millimetre in diameter. They are light ruby-red in colour and exceedingly brilliant, and casual inspection suggested that they were proustite. As this mineral had not been described from the Cobalt region, it seemed desirable to confirm this supposition by chemical analysis and crystallographic measurement.
>
> The material for analysis was obtained by floating the crystals from a large quantity of fine material which had broken away from the larger specimens. In this operation it was found that certain impurities accompanied the proustite, so that the final separation was made by means of a brush and lens. It was observed that many of the crystals still had a trace of what appeared to be smaltite attached to one end, but with the material at hand it did not appear feasible to remove the last trace of impurity.
>
> It was also observed that in some instances the crystals were somewhat dark for proustite, and in most cases these were discarded, but the small amount of antimony found in the analysis would indicate that a little pyrargyrite is mingled with the proustite.
>
> The analysis yielded the following results:

	Ag	As	S	Sb	Fe	Co (with trace of Ni)	Insol. in HNO_3	Total
Per cent.	64.12	15.90	19.28	.08	.25	.12	.38	100.13

> The percentages for silver, arsenic, sulphur and iron are the averages of two determinations for each. The determinations for antimony and insoluble were made only once, while the cobalt-nickel determination was obtained by combining the cobalt-nickel contents of two analyses.

[21] Proustite from Cobalt, Ont., by A. L. Parsons, in Mineralogical Magazine, Vol. XVII—No. 82—April, 1916.

If we assume that the iron is combined with sulphur in the form of pyrite and the cobalt with arsenic in the form of smaltite, the recalculation gives a nearly pure proustite with a small excess of arsenic as follows:

Element	Ag	As	S	Sb	Fe	Co
Per cent.	64.12	15.90	19.28	.08	.25	.12
Mol. Ratio	.5943	.2120	.6013	.0007	.0045	.0020
Pyrite	....	....	.0090	....	.0045	....
Smaltite	....	.0040	....	....	....	.0020
Proustite	.5922	.1974	.5922	....	....	....
Pyrargyrite	.0021	....	.0021	.0007	....	....
Arsenic excess	....	.0106	Deficiency of S = .0020	....	....	....

Converting these ratios into percentages the following result is obtained:

	Proustite	Pyrargyrite	Smaltite	Pyrite	Arsenic excess	Insol.	Total
Per cent.	97.69	.39	.42	.53	.79	.38	100.19
						Less S added	.06
							100.13

Owing to an error in calculating the molecular ratio for antimony in the original paper, the percentages of the mineral constituents given here differ slightly from those tabulated in the paper by Mr. Parsons.

Polybasite Crystals, O'Brien Mine

Polybasite has long been supposed to be present in the Cobalt ores, but hitherto has not been positively identified by crystallographic measurements or chemical analysis.

Several years ago M. T. Culbert, of the O'Brien mine, presented to the museum of the University of Toronto, a specimen of argentite, showing a few minute crystals, which he believed to be polybasite, because of the triangular striations to be seen on some of the faces.

The writer examined this specimen with a view to extracting crystals for measurement. The minute, brilliant, thin tabular crystals, reaching a maximum diameter of perhaps two millimetres, are always firmly attached to the argentite, either by the large basal pinacoid or by one side, and had to be very carefully cut away. Finally, about ten crystals, together with some broken material, were obtained. These were examined on the goniometer and all showed the same characteristic habit, but only one, which was about one millimetre in diameter, gave fairly good reflections. This one was measured as accurately as possible. The best readings for the side faces gave values of 59° 46′, 60° 05′ and 59° 10′ for the outer angles between these faces, which agree closely with the values given by Penfield (60°02′) and Goldschmidt (60°01′) for the prism *m*: *m*. The base, as nearly as could be ascertained, was at 90° to the side faces. The vicinal faces, indicated in the drawing (Fig. 29), gave a continuous hazy band of light in which no definite points could be observed, from about 16° to about 44° from the base. This crystal had been attached by one side, and the lower half of the crystal showed exactly the same arrangement of vicinal faces as the upper, but because of the fragile nature of the crystal, no attempt was made to measure the vicinal faces on the lower half. The side faces which correspond to the prism m (110) are slightly concave, causing distortion of the signals, and a fracture parallel to the base divides the crystal

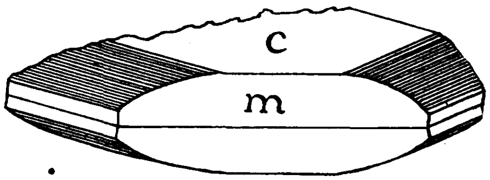


Fig. 29. Polybasite, O'Brien mine.

symmetrically into two equal parts, thus displaying perfect basal cleavage. This fracture was doubtless developed by cutting the argentite from around the crystal. Considered along with the re-entrant character of the prism faces, it suggests a twinning parallel to the base.

Polybasite has been considered by different authors to be either rhombic or monoclinic with twinning plane m, and probably also with a twinning like the micas, parallel to the base. Penfield, who is responsible for much of the later work on polybasite, considers it monoclinic, on both crystallographic and optical grounds.

Using the high power of the microscope, small, very thin particles of these crystals appear translucent and of a bright cherry red colour. This character distinguishes polybasite from the corresponding arsenic compound—pearceite, which is said to be "opaque even in the thinnest splinters."[22] The crystals are very brittle and rather soft. H = 2.5 to 3. Colour and streak black, lustre metallic, cleavage basal.

In order to further confirm the identification of these crystals as polybasite, the broken fragments obtained in trying to remove the crystals from the argentite were combined with those crystals which had proved useless for measurement and about 20 milligrams of powder was thus collected for analysis. Weighings were made only to the usual four places of decimals on a good balance and the analysis was necessarily at the same time both qualitative and quantitative, so that no great accuracy was attained. The results, however, confirm the decision, reached by means of crystallographic methods, that the mineral is polybasite.

[22] Hintze—Handbuch der Mineralogie.

Analysis of polybasite crystals:

	Ag	Cu	Sb	S	Total
Per cent.	74 to 75	2	6+	12+	95
Theoretical $Ag_9\,Sb\,S_6$	75.67	....	9.34	14.99	100.00

Reviewing all the evidence it is found that these crystals agree in form, physical properties, and chemical composition with the mineral polybasite $(Ag,Cu)_9SbS_6$, which is thus definitely established as a Cobalt mineral.

It was thought that the argentite to which the polybasite crystals were attached might show an admixture with massive polybasite, especially as certain spots showed an unusual brilliant, superficial tarnish like bornite. An analysis (page 208), however, yielded no more than traces of antimony and copper as impurities, so that there is no evidence to show that massive polybasite is present in quantity.

Pink Carbonate

An oxidized arsenide specimen from the O'Brien mine showed velvety coatings, one to two millimetres thick, consisting of very delicate needle-like crystal growths. On some parts of the specimen this coating was pure white, on others, a beautiful peach blossom pink. It was thought that the pink material might be roselite and it was accordingly analyzed.

Fe	2.33	per cent.	=	4.83	per cent.	$Fe\,CO_3$
Co	0.80	"	=	1.35	"	$Co\,CO_3$
Ca O	51.13	"	=	91.53	"	$Ca\,CO_3$
Mg	.64	"	=	2.21	"	$Mg\,CO_3$
		Total......		99.92		

The material is evidently merely calcium carbonate with small amounts of iron and cobalt which give the colour. From optical tests and habit of growth it appears to be arragonite rather than calcite.

Symplesite, Penn-Canadian Mine

This material was examined because it was thought it might contain cobalt oxides such as heterogenite or heubachite which have been supposed to be present in some of the oxidized Cobalt ores.

The specimen represents weathered, oxidized ore such as was obtained at the surface in opening up the Cobalt veins. It consists of earthy masses of bluish black oxidized material, held together by spongy native silver or dyscrasite. In some spots a dirty pink colour indicates the presence of impure erythrite.

Under the microscope, the earthy material is seen to consist for the most part of grains which, when thin, are translucent to transparent, yellowish in colour and doubly refracting. Along with these are other opaque grains which are chiefly native silver or dyscrasite, and argentite.

Chemical Properties—The earthy part is readily soluble in five per cent. hydrochloric acid, and no unoxidized arsenides were detected in the residue. The insoluble part consists chiefly of native silver or dyscrasite, and argentite, with small grains of quartz. The argentite is not attacked by hydrochloric acid of this concentration, and no sulphur is found in the filtrate, showing that all the sulphur obtained in the analysis is to be assigned to argentite. Qualitative tests show that the iron is practically all in the ferrous condition, though a very small amount of ferric iron was detected. On treating with strong hydrochloric acid no chlorine is evolved, showing that the cobalt and nickel are also in the lower state of oxidation. Water-soluble arsenic trioxide was not detected, neither by long standing (three weeks) with occasional shaking, at room temperature, nor by boiling for an hour or more.

Preparation of Samples—The material was gently rubbed in an agate mortar and two portions were separated for analysis.

1. Arsenate Part: The powder which passed a 250 mesh sieve. This was chiefly arsenates with particles of native silver or dyscrasite and argentite. The hope that the very fine sieve would eliminate most of the native silver proved to be unjustified because of the brittleness of the so-called silver which may be judged by the fact that the analysis indicates the presence of about 18 per cent. in this sample, all of which of course, had passed through the fine sieve along with the arsenates, after only moderate rubbing. The brittle character of the silver would lead one to suspect that it was really dyscrasite.

2. Silver Part: This constitutes the coarser, less brittle portions left behind on the sieve. These were freed from adhering arsenates by dilute hydrochloric acid, rinsed with ammonia to remove any silver chloride and then washed to get rid of small particles of argentite.

These two samples were analyzed with the following results:

Analysis of the arsenate part:

Element	Per cent.	Mol. Ratio	Argentite Ag_2S	Native Silver. Dyscrasite and Amalgam	Symplesite $Fe_3As_2O_8 \cdot 8H_2O$	Erythrite $Co_3As_2O_8 \cdot 8H_2O$	Annabergite $Ni_3As_2O_8 \cdot 8H_2O$	$R_3As_2O_8 \cdot 8H_2O$ R=Cu, Ca, Mg, Al
Ag	28.11	.2605	.1066	.1539	....	....	....	....
S	1.71	.0533	.0533	....	....	....	....	....
Sb	.79	.0066	....	.0066	....	....	....	....
Hg	.64	.0032	....	.0032	....	....	....	....
FeO	7.71	.1074	....	....	.1074	....	....	....
CoO	6.31	.0842	....	....	....	.0842	....	....
NiO	1.74	.0233	....	....	....	....	.0233	....
CuO	2.42	.0304	....	....	....	....	....	.0304
As_2O_5	24.60	.1070	....	....	.0358	.0281	.0078	.0301
Sb_2O_5	1.55	.0048	....	....	....	....	....	....
*H_2O	13.64	.7577	....	....	.2864	.2245	.0622	.2512
CaO	2.58	.0460	....	....	....	....	....	.0460
MgO	.72	.0638	....	....	....	....	....	.0638
†CO_2	(2.81)	.0638	....	....	....	....	....	....
‡CO_2	.73	....	....	....	....	....	....	....
Al_2O_3	.30	....	....	....	....	....	....	....
Quartz	4.45	....	....	....	....	....	....	....
	(100.08)							
	98.00							

* Direct determination of total water. H_2O at 100°C not determined.
† Equivalent to CaO and MgO found.
‡ Actually found. One determination.

Analysis of silver part:

	Ag	Hg	Sb	Argentite Insol.	S	Total
Per cent.	90.54	3.08	.79	5.50	trace	99.91

The arsenate sample could not be dried at 100° C. as it loses water, at first rapidly, then slowly, but continuously at that temperature. One gram heated for a half day at 100° C. lost 4.87 per cent.; one gram heated another half day, .22 per cent.; one gram heated another half day, .14 per cent. After allowing this dried sample to stand in the open for three days it had regained its original weight. In order to secure uniform sampling, the material, without previous heating, was all weighed out at one time into gram quantities and kept in clamped watch-glasses till required.

The duplicate analysis of the arsenate part gave closely concordant results, but there is some uncertainty as to the way in which some of the actual analytical results should be recalculated, and certain assumptions have been made which may not be altogether justifiable. For example, the total antimony found has been divided into two portions as Sb, and Sb_2O_5. The amount of antimony found in the silver part has been tabulated as such in the arsenate part, assuming it to be in the form of dyscrasite, but it is not improbable that the silver which was mixed with the arsenates was richer in antimony than the coarser, more ductile sample analyzed as part 2, and, therefore, a larger proportion of the total antimony should really be deducted to make dyscrasite. An attempt was made to analyze the silver mixed with the arsenates by extracting the arsenates with dilute hydrochloric acid, but the silver was in such a finely divided condition that even the dilute acid changed it almost completely to the chloride while mercury and antimony passed into solution. A titration with permanganate of a sulphuric acid solution of the arsenates made in an atmosphere of carbon dioxide gave almost exactly the same results for iron as the gravimetric determination. Carbon dioxide is believed to be present in much smaller amount than would be required to combine with the CaO and MgO found. The single carbon dioxide determination on about 2 grams of material could not be expected to give results of great accuracy, but the quantity found confirms the suspicion that the lime and magnesia are not present entirely as carbonates. When the material is treated in a small test-tube with strong hydrochloric acid, a slight evolution of gas can be detected with a hand lens, but would not be noticed by the naked eye. In fact, the presence of carbonates was not suspected until analysis revealed calcium and magnesium in the mixture. Calcium and magnesium are often found in considerable quantity in the arsenates of this series and no doubt in this case, also, are chiefly in the form of arsenates.

Mineral Constituents.—From the foregoing chemical data the mineral composition of the mixture has been calculated as indicated in the table. All the sulphur is combined with silver to form argentite. Mercury and the amount of antimony found in the silver part (2) are associated with the rest of the silver as dycrasite and amalgam. It may be noted that the amount of mercury relative to silver is approximately the same in both analyses, but is a little higher in the more brittle silver of the arsenate part.

In arsenate part Ag: Hg = 16.61: 64
In silver part Ag: Hg = 90.54: 3.08

Since the iron is in the ferrous condition it has been calculated as symplesite, the iron arsenate corresponding to erythrite and annabergite. Symplesite has not been recognized hitherto in Cobalt ores, though it might be expected to occur. Cobaltous and nickelous oxides are calculated to erythrite and annabergite respectively.

So far there can be little doubt that the calculation represents the true mineral composition. There are, however, many arsenates of copper, while calcium and magnesium arsenates are known, and these elements may also replace cobalt or nickel in erythrite and annabergite, according to analyses recorded by Dana. If a compound $R_3As_2O_8$. 8 H_2O (R= Ca, Mg, Cu Al) analogous to erythrite be calculated for the lime, magnesia and copper oxide found then small amounts of arsenic and antimony pentoxides remain uncombined and a little more water than was found in the analysis is required. Certain of the copper, calcium, and magnesium arsenates, however, contain less water and more arsenic than the assumed compound and some of these may be present. The excess of arsenic would also be explained if a small amount of native arsenic were present. If so, it must be in a very finely divided condition and would be difficult to detect.

The percentages of the different minerals so far as they may be definitely calculated are given below:

	Argentite	Native Silver with Sb and Hg	Symplesite	Erythrite	Annabergite	Arsenates of Cu, Ca, Mg, etc.	Quartz	Total
Per cent.	13.21	18.04	21.09	20.60	4.65	about 18.00	4.44	100.03

Earthy Scorodite and Erythrite, Temiskaming and Hudson Bay Mine

The erythrite of Cobalt occurs usually as earthy incrustations on oxidized smaltite, crystallized material being rather uncommon. A sample of the earthy material of yellowish pink colour from the Temiskaming and Hudson Bay mine was examined for free arsenic trioxide and incidentally was found to contain a relatively large amount of ferric iron. This appeared to indicate the presence of scorodite, so the sample was analyzed with results as below:

	Fe_2O_3	CoO	NiO	As_2O_5	H_2O (total)	CuO	As_2O_3 (Sol. in H_2O)	Insol.	CaO	S	Total
Per cent.	8.73	21.43	3.95	38.45	24.22	small am'u't	trace	2.90	trace	trace	99.68
Atomic Ratio	.0547	.2859	.0529	.1673	1.346	....	....	....	....	....	....
Scorodite $Fe_2O_3 \cdot As_2O_5 \cdot H_2O$	.0547	....	....	.0547	.2188	....	....	....	....	....	....
Erythrite $Co_3As_2O_8+8H_2O$	....	.2859	....	.0953	.7624	....	....	....	....	....	....
Annabergite $Ni_3As_2O_8+8H_2O$	....	....	.0529	.0176	.1408	....	....	....	....	....	....
Excess	....	....	....	.0003	.224	....	....	....	....	....	....

On gently rubbing the material to a powder, the yellowish tint became more prominent and when some of the larger lumps were broken open, yellow spots were visible which were found to be chiefly ferric arsenate. The copper appears to be associated with the scorodite. Only a trace of water-soluble arsenic trioxide was obtained after treating the material with water for three weeks at room temperature. The total water obtained in the analysis probably includes more or less merely hygroscopic water, and perhaps, may also represent a slight loss of arsenic acid. The arsenic determinations were made on separate portions. Qualitative tests show that the iron is all in the ferric condition. The analytical results thus indicate that an important amount of scorodite is present in this earthy arsenate material.

On Isomorphism as Displayed by Certain Minerals from Cobalt

Analyses of even the most carefully selected samples of apparently pure, simple minerals from Cobalt such as, say, niccolite or smaltite, have, in the writer's experience, invariably revealed the presence of so-called isomorphous replacing elements, e.g., Fe Co, Sb and S in niccolite, Ni, Fe and S in smaltite. Such an experience is, moreover, not at all unusual, as witness the numerous similar analyses in any handbook on mineralogy. It has been usual with most mineralogists to regard such foreign elements as replacing in a molecular way a corresponding amount of the elements essential to the pure mineral. The writer, in examining polished surfaces of such minerals after etching with acid, has always found inclusions of one or more different minerals present which might easily account for the foreign elements found by analysis. As has been seen in the case of cobaltite and smaltite, even the most perfect crystals may contain considerable amounts of foreign minerals either as inclusions or intergrowths. Such inclusions are very likely to be a mineral or minerals similar in crystal symmetry and analogous in chemical composition to the including mineral, e.g., the inclusions of niccolite in breithauptite (Fig. 8), or the smaltite-chloanthite intergrowth (Fig. 17). This is not always the case, however, examples of the latter type of intergrowth are furnished by inclusions of cobaltite (cubic) in niccolite (hexagonal), Fig. 13, and rammelsbergite (rhombic) in niccolite, Fig. 26. The former type of associations appears to be mixtures or intergrowths of more or less related, or isomorphous individual minerals, rather than homogeneous molecular mixtures.

Most of our knowledge of isomorphism rests on the data of chemical laboratory experiments. Nernst [23] refers to isomorphous mixing as "the capacity of two crytallized substances for uniting to form a homogeneous mixed crystal." Retgers [24] speaks of "the property of forming solid molecular mixtures." The chemist takes special precautions in order to obtain homogeneous mixed crystals. Retgers recommends in making mixed crystals, that "in order to obtain a product as homogeneous as possible, it is best to use a large quantity of solution and to study only the crystals which separate first."

In nature, however, these ideal conditions are probably seldom realized, and in the case of the arsenides and sulpharsenides of Cobalt, at least, the result is oftener a very intimate mixture or intergrowth of the two isomorphous substances than a true homogeneous molecular mixture, even when good crystals are formed. The etching methods described in the introduction enable us to distinguish very definitely the different components of such a mixture. The separation experiments performed on certain of these mixtures, e.g., niccolite-breithauptite, smaltite-chloanthite, seem to show that the individual components may be precipitated side by side as minute particles in extremely intimate microscopic mixtures or intergrowths and still retain their chemical identity and purity. There is this difficulty, however, with such etching separations, that only the residue may be expected to be pure and homogeneous, and if such a pure residue is obtained, it does not prove that some of the material which dissolved was not a homogeneous molecular mixture. It seems certain, however, that in most of the mixtures examined by the author, the amount of material which may represent true isomorphous molecular mixtures must be small compared to the amount which exists as pure chemical individuals.

Whether special conditions of precipitation were responsible for this character of the Cobalt minerals or whether it is a general characteristic of the arsenide and sulpharsenide groups of minerals, is a problem for the future. Baumhauer[25] and Vollhard[25] were the first to show that crystals of smaltite or chloanthite (from European localities) were really intergrowths, the different parts of which varied in composition. The writer suspects that such intergrowths are general among the minerals of these groups and that true molecular isomorphous replacements or mixed crystals are correspondingly rare.

[23] W. Nernst—Theoretical Chemistry.
[24] Idem, page 109.
[25] Loc. Cit.

It appears to the writer that such structures as the smaltite-chloanthite and the niccolite-breithauptite intergrowths afford some evidence of the degree of isomorphism exhibited by the minerals concerned, granting, of course, that these structures have resulted from practically simultaneous precipitation of the constituents from the same mother solution. The term isomorphism, of course, implies more or less complete identity of crystal symmetry. In this sense, these minerals are isomorphous. The property of mutual overgrowth is possessed by substances which have not the slightest chemical or crystallographic similarity and has accordingly been rejected by Retgers as conclusive evidence of isomorphism. Accepting complete miscibility or the property of forming homogeneous mixed crystals in all proportions as the most decisive criterion of pure isomorphism, as advocated by Retgers, we are led to the conclusion that the minerals with which we have been dealing, such as niccolite-breithauptite, smaltite-chloanthite, probably do not form molecular mixtures in every proportion and, therefore, do not exhibit the highest degree of isomorphism, in spite of their similar crystal form and analogous chemical composition. The same holds true for the cobaltite crystals with their gersdorffite (?) inclusions.

Following the classification of miscibility according to Retgers, these minerals appear to display limited miscibility of a sort.

Order of Deposition of Cobalt Minerals

The writer has not been concerned primarily with the study of the paragenesis of Cobalt minerals, but the apparent order of formation has been indicated for the associations which have come under his observation. For a complete study of this question very complete data would be necessary and final conclusions are probably

Fig. 30. Diagram of portion of vein from Silver Bar mine, natural size, showing order of deposition. The shaded part represents smaltite-chloanthite intergrowth with chloanthite in the centre of dendritic growths. The hatched part is later niccolite and the white is calcite.

not justified by a microscopic study of isolated specimens alone. As the writer's conclusions, however, agree in the main with those of W. G. Miller and C. W. Knight, they are here summarized.

From the numerous extremely intimate intergrowths which have been observed among the Cobalt minerals, e.g., smaltite-chloanthite, niccolite-breithauptite, etc., it is believed that certain of these minerals were precipitated in greater or less quantity at the same time. The structures observed appear to indicate that the mineralizing solutions at first were relatively very rich in arsenic and during this time intergrowths of diarsenides-smaltite and chloanthite—were chiefly precipitated. The arsenic content of the solutions gradually diminished and monarsenides-niccolite and breithauptite—were for a time predominately deposited. The arsenic continued to decrease in amount and sulphur became prominent, so that sulpharsenides, such as cobaltite and arsenopyrite, were deposited. Finally, the arsenic in solution was reduced to a very small quantity, and calcite was deposited. A period of fracturing ensued and the solution which may now have been of either a sulphate or carbonate character circulated through the fractured veins. From this solution native silver and argentite were precipitated by the action of arsenides and calcite, resulting in such silver replacement structures as we have seen (Fig. 30).

It is believed that the process of deposition of the various arsenides and sulpharsenides was more or less continuous, and that, though a period of maximum deposition for any one of these minerals may be distinguished, there is, nevertheless, no sharp dividing line between the different periods.

The apparent order of deposition from the writer's observations may be indicated in tabular form as follows:

I. Arsenides and Sulpharsenides	1. Diarsenides	$Ni\,As_2$ $Co\,As_2$
	2. Monarsenides	$NiSb$ $NiAs$
	3. Sulpharsenides	$Co\,As\,S$ $Fe\,As\,S$

II. Calcite, followed by fracturing.

III. Native silver and argentite, native bismuth, sulphides and sulpho-salts.

IV. Decomposition products—arsenates of cobalt, nickel, iron, copper, and calcium.

In conclusion, the writer wishes to thank T. L. Walker, Professor of Mineralogy at the University of Toronto, not only for much kindly advice and encouragement, but also for the original suggestion which initiated this work.

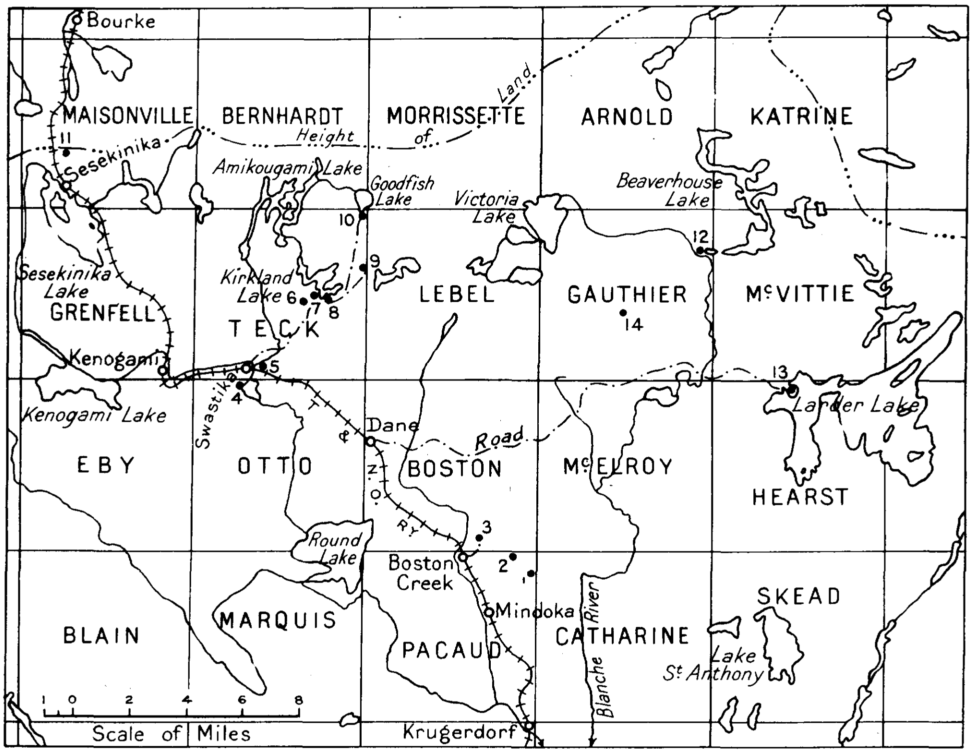
BOSTON CREEK GOLD AREA

By

A. G. BURROWS and P. E. HOPKINS

Introduction

That part of Boston, Pacaud, McElroy and Catharine townships in the vicinity of Boston Creek is spoken of herein as the Boston Creek gold area. The region is situated in the district of Timiskaming, about 45 miles northwesterly from Cobalt, and is traversed by the Timiskaming and Northern Ontario railway. Boston Creek station, mileage 153.5, is approximately in latitude 48° north and longitude 80° west. By rail, Boston Creek station is 382 miles north of Toronto.



Sketch map showing the locations of some of the gold properties mentioned in the reports on Boston Creek and Goodfish Lake areas:

1. Miller-Independence
2. McRae
3. R. A. P. Mining Co.
4. Swastika
5. Lucky Cross
6. Kirkland Lake Mines
7. Teck-Hughes
8. Lake Shore
9. Tough-Oakes
10. La Belle Kirkland
11. Smith-La Bine
12. La Mine D'Or Huronia
13. Goldfields, Limited
14. Elstone-Dunkin Mines, Ltd.

Claims were staked for gold in this area in 1906 and 1907 during the days of the Larder Lake gold rush. Again in 1913, during the activity at Kirkland lake twelve miles to the northwest, many claims were re-staked and some work was done on them. Since May, 1915, John Papassimakes has had a number of men at work on what is known as the Kenzie vein, on claims L 3665 and L 5163, in the south central part of Boston township. The promising development work on the Kenzie vein attracted many prospectors to the area, and several other gold discoveries were made in the four townships. Considerable prospecting, particularly on the surface, was done during 1915, but as yet no bullion has been shipped.

A railway station has been erected near the crossing of Boston creek, around which has grown a small settlement.

Part of the Boston Creek area was included in the map[1] of the Kirkland Lake and Swastika gold areas. During September and October, 1915, the writers examined about 70 square miles, including Pacaud and parts of Boston, McElroy and Catharine townships. Owing to the lateness of the season and the extremely wet weather, a part of the area was examined only in a general way. A coloured geological map[2] of this area, showing the main rock outcrops on a scale of three-quarters of a mile to the inch, accompanies the report.

Boston Creek station, T. & N. O. railway, showing hotel on the right, and the stream valley and railway bridge on the left. *May, 1916.*

Early Exploration of the Area

The first exploration was by Walter McOuat[3] who in 1872 made a reconnaissance survey of the Blanche river from lake Timiskaming to Round lake.

W. G. Miller,[4] Provincial Geologist, in 1900 described a portion of the area. In his report the geology along the Blanche in McElroy and Catharine townships

[1] Map No. 23 a, accompanying Part II, Vol. XXIV, Rep. Ont. Bur. Mines, 1914.

[2] Map No. 25 d, Ont. Bur. Mines.

[3] Report on an Examination of the Country between Lakes Timiskaming and Abitibi, Report of Progress, Geol. Sur. Can., pp. 112-135, 1872-73.

[4] Lake Timiskaming to the Height of Land, 11th Report, Ont. Bur. Mines, 1902, pp. 214-230.

is described. He also mentions prospecting for gold on a 4 or 5-foot quartz vein in the hill west of the lower end of a portage which is now shown in lot 9, concession III, Catharine township.

In 1904, after the discovery of Cobalt, W. A. Parks[5] of the University of Toronto made a geological survey of this portion of the country. Parks remarks that the high hills along the Blanche, in the township of Catharine, are well worth prospecting for gold.

In 1908 and 1909, M. E. Wilson examined the Larder Lake gold area, which is located to the east of Boston creek. The geological map accompanying his report[6] joins the east side of the Boston Creek sheet.

Topography

The area in general has an elevation varying from 700 to 1,050 feet above sea level. Boston Creek station has an elevation of 920 feet. While the difference in elevation is seldom more than 200 feet, the country is somewhat rugged and broken, particularly in the vicinity of Boston Creek station and along the north branch of the Blanche river in McElroy and Catharine townships.

The country is situated south of the continental divide, and is drained by two branches of the Blanche river and their tributaries, which flow southward into lake Timiskaming.

The magnetic declination is about 8 to 9 degrees west of north.

General Geology

The rocks are all pre-Cambrian in age, the nearest younger formation being an exposure of Niagara limestone about ten miles to the south in lot 10, concession IV, Evanturel township. The rocks of the area may be classified as follows:

PLEISTOCENE	
Glacial and recent:—	Boulder clay, sand and gravel.
PRE-CAMBRIAN	
Keweenawan:—	Quartz diabase dikes.
(INTRUSIVE CONTACT)	
Algoman:—	Feldspar porphyry and quartz porphyry, hornblende and biotite granite, and syenite.
(INTRUSIVE CONTACT)	
Timiskamian (?):—	Conglomerate, greywacké and slate.
(UNCONFORMITY?)	
Keewatin:—	Grey schist (volcanic fragmental rocks and iron formation). Ellipsoidal, amygdaloidal and spherulitic lavas, agglomerate, tuff, iron formation, serpentine, diabase and felsite. (These rocks are in part altered to hornblende and chlorite schists.)

[5] The Geology of a District from Lake Timiskaming Northward. Summary Report of the Geol. Sur. Can., pp. 198-225, 1904.

[6] Geology and Economic Resources of Larder Lake District, Mem. No. 17-E, Geol. Sur. Can., 1912.

Keewatin

The Keewatin rocks have the widest distribution, and are important since they contain gold-bearing veins. They consist chiefly of greenstones with some volcanic fragmental rocks and iron formation. A band of clastic sediments is mapped as grey schist. The original constituents are so entirely altered that many exposures may be spoken of as serpentine, hornblende and chlorite rocks. Cutting the greenstones is a felsitic rock which may be post-Keewatin in age.

Greenstones: The greenstones are fine-grained, and consist of altered basic volcanics which are sometimes schistose, but more often massive. They commonly show the amygdaloidal and ellipsoidal structure, and more rarely the spherulitic, indicating their volcanic origin. The spherulitic structure, which is rare in basic rocks, has not been noted before in this section of Ontario. What may be the spherulitic structure in greenstone was reported on the north shore of Doig lake in the northwest corner of Lebel township.[7] A similar structure was also seen under the microscope in an acid rock, a rhyolite, from lot 6, concession III, Beatty township.[8] In this area, spherulitic greenstones are beautifully developed on a bare hill on claim L 1878, Boston township. The varioles, which are rounded and white-weathering, vary in size from minute pea-like form to those about two inches in diameter, and constitute a large part of the rock. Under the microscope the varioles consist of coarse radiating flakes of chlorite, feldspar, epidote and probably quartz in a fine groundmass of the same material, and actinolite. Throughout the whole rock are pyrrhotite grains and numerous black ferruginous specks. The rock is probably an altered basalt.

The pillow lava flows constitute the main portion of the greenstone. They are interbedded with much non-pillow greenstones, which have a diabasic texture at times, and some tuff, agglomerate and slate which point to a subaqueous origin. The nearly complete alteration of the greenstones, with the retention of their original ellipsoidal structure, is, according to Leith and Van Hise, due to a metasomatic rather than a dynamic change. Under the microscope the original minerals in the greenstones are hornblende, quartz, magnetite and plagioclase, the altered plagioclase laths suggesting a basaltic or diabasic texture. The secondary minerals are calcite, hornblende, chlorite, sericite and quartz. The altered greenstone in places may be spoken of as hornblende or chlorite schist.

Volcanic fragmental rocks: Tuff and agglomerate are prominent, particularly in the northwest corner of Catharine township. They are, in places, interbedded with the basic volcanics. They are somewhat similar to the grey schists described below, but are too much intermingled with the greenstones to map separately.

Iron formation: Iron formation, consisting of interbanded silica, black slate and magnetite, occurs in the greenstone in the north part of Boston township. The iron range has been described in detail by W. G. Miller[9] and by the writers.[10]

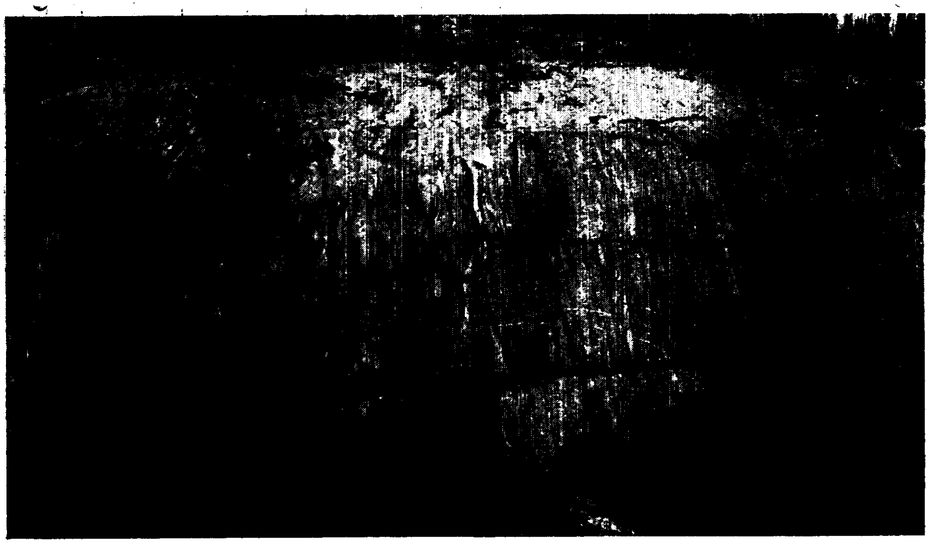
[7] Kirkland Lake and Swastika Gold Area, by A. G. Burrows and P. E. Hopkins. Report, Ont. Bur. Mines, Vol. 23, Pt. 2, 1914, p. 4.

[8] Beatty-Munro Gold Area, by P. E. Hopkins. Report, Ont. Bur. Mines, Vol. 24, Pt. 1 1915, p. 176.

[9] Boston Township Iron Ranges, 14th Rep., Ont. Bur. Mines.

[10] Kirkland Lake and Swastika Gold Areas, 23rd Rep., Pt. II, Ont. Bur. Mines.

Keewatin volcanic fragmental, intruded by narrow reddish feldspar porphyry dikes, southeast of Boston Creek station.



Volcanic fragmental rock, one-quarter of a mile east of Boston Creek station.

Serpentine: The trail on claim L 4902, Boston township, passes over an exposure of serpentine. A thin section of the rock was examined microscopically and found to consist of about 60 per cent. of serpentine and 40 per cent. of calcite. Numerous magnetite grains and a little pyrite are scattered through the rock.

Grey schist: A belt of banded, greyish-green schist resembling an altered sediment has been differentiated on the map. The series, which occurs on the periphery of a granite and syenite mass, is about one mile in width and ten miles in length, passing in a semi-circular shape from lot 12, concession II, Catharine, through Boston Creek station to Round lake. The rocks may be best seen in the vicinity of Boston Creek station, where deep railway cuts have been made. The schist approaches a vertical attitude with a strike parallel to the periphery of the granite. A great portion of the series consists of narrow alternating bands of rusty carbonate (including some magnetite and pyrite bands) and slate. Ash rocks, with bomb-like inclusions, are common. Some thin sections represent greywacké and quartzite, while one is clearly an altered porphyry. The whole series is greatly metamorphosed by the large granite mass, and is cut by narrow porphyry, lamprophyre and other dikes. In the vicinity of Round lake much altered diabase and green chloritic dikes are intruded into the banded schist. At mileage 153 on the Timiskaming and Northern Ontario railway two or three narrow bands of pyrite occur in the grey schist. The series was probably laid down conformably with the Keewatin pillow lavas.

Felsite: In the southwest part of McElroy township, and running northwestward across Boston township, are small areas of a white-weathering, felsitic-looking rock which may be post-Keewatin in age. Owing to the complex manner in which the felsite or rhyolite and greenstones have been intermingled, it would be difficult to map the outcrops on a small scale map. The word "felsite" is written on the map across the main areas. The rock is fine-grained, grey, green or pink in colour, and resembles chert. Under the microscope one-half the thin section is seen to consist of phenocrysts, which are rather small, and uniform in size. The phenocrysts consist of albite, partly altered to sericite, an occasional quartz grain, and some hornblende and chlorite masses. The fine-grained groundmass is dominantly quartz, with feldspar, chlorite, sericite, epidote and numerous grains of magnetite and pyrite. Narrow quartz veins are sometimes present in the rock.

Timiskamian

A few small, isolated patches of conglomerate schist, slate and greywacké, standing in a vertical attitude, occur along the Larder Lake road in Boston and McElroy townships. The rocks are similar to the sediments classed as Timiskamian on the map of the Kirkland Lake and Swastika gold areas. The pebbles of the conglomerate, which are elliptical in outline, consist largely of greenstone and felsite and some Iron formation. A grey magnesian limestone occurs both as pebbles and matrix in the conglomerate in McElroy township about a mile east of the three-mile post on the west boundary.

Algoman

These rocks include batholith and stocks of granite and syenite, and dikes of feldspar porphyry, quartz porphyry and lamprophyre. They are massive, fresh-looking, and are probably Algoman in age, since similar granite in Boston and Lebel townships to the north was found cutting the Timiskamian series.

Granite and Syenite: A batholith of red, biotite granite occupies nearly all of Pacaud township, and extends to the south and west beyond the township boundaries. In the southwest part of the township garnets are present, while in other parts the granite may be said to change into a quartz syenite. The rock is massive, except near the contact with the Keewatin, where it occasionally takes on a gneissoid structure. Near the contact with the greenstone, just south of mileage 153, the granite is intruded by numerous parallel felsitic dikes which give the rock a banded structure. It is cut by quartz veins, and by pegmatite and other dikes representing various differentiation facies of the magma. The rock in the south part of lot 9, concession VI, Pacaud, is a light grey, medium

Granite, with fragments of Keewatin greenstone, and narrow dikes (apophyses of the granite) cutting the granite and fragments of greenstone on Authier claim, Boston township.

grained, biotite granite. Under the microscope microcline is seen showing the gridiron structure, albite partly altered to sericite, biotite altered partly to hornblende and chlorite, quartz and calcite.

A reddish syenite outcrops in the west part of Boston township, being part of the large syenite boss-like mass occupying most of Otto township.

A small stock of reddish biotite and hornblende granite intrudes the greenstones in McElroy township. Gold and a telluride have been found in this granite in a pegmatitic quartz vein which is probably a part of the granite magma.

Other small, irregular, granitic dikes cut the greenstones and felsitic rocks. Gold was seen in quartz veins in these small granite dikes on claim L 5165 and L 5133, Boston township.

Feldspar Porphyry: Numerous intrusions of massive red and grey feldspar porphyry occur over the whole area. They appear as narrow dikes up to thirty feet or more in width, and probably represent apophyses from the granite masses. The phenocrysts usually consist of albite, often showing a zonal structure, an occasional rounded quartz grain, and blades of biotite in a microcrystalline groundmass of quartz, feldspar, chlorite and calcite. Fine grains of magnetite and pyrite, and crystals of apatite are often present. A feldspar porphyry on claim L 2000, Boston township, and in other parts of that vicinity, contains white feldspar phenocrysts up to one inch across, which show beautiful zonal structure in the hand specimen. Some porphyry dikes in the southwest part of Boston township contain many prominent quartz phenocrysts, and thus resemble the quartz porphyry at Porcupine. In other parts the rock may be called a felsite. The acid dikes are usually cut by minute veinlets of quartz, some of which carry gold. Small, irregular fragments of red feldspar porphyry are also, at times, present in auriferous quartz veins.

Lamprophyre: A few narrow lamprophyre dikes cut the greenstones and grey schist, but these are too small to map. They may be seen on the south part of lot 3, concession VI, Pacaud township, and at about mileage 154.3 along the railway. In the Kirkland Lake area the lamprophyre cuts the Timiskaming sediments, but is older than the feldspar porphyry. A lamprophyre dike that intrudes the Algoman granite can be observed in a rock-cut about half a mile north of Mindoka.

Keweenawan

Quartz diabase dikes are rare in this area; however, they were noted cutting the greenstones and Timiskamian (?) sediments. To the northwest, in Teck township, the diabase was seen to cut the red feldspar porphyry. These dikes are classed as Keweenawan, since they are fresh-looking and resemble the diabase at Cobalt. A thin section of a sample taken immediately south of M.R. 15, Boston township, shows labradorite laths, partly altered to saussurite and sericite, augite partly altered to hornblende and chlorite with a little quartz, biotite, magnetite and intergrowths of quartz and feldspar.

Glacial and Recent

The region has been heavily glaciated, the ice having moved in a general S. 20° E. direction, astronomic.

The area lies at the northern edge of a tract of farming land, which extends from Haileybury to Round lake, and is covered in places with stratified clays, sand and gravels. At Boston Creek station one can see the vertical section of a morainic deposit which has been cut into by Boston creek. The central part of McElroy township to the east of the Blanche river is one vast area of sand, representing probably large terminal moraines and outwash plains.

Economic Products

Gold

Gold, the chief mineral sought for in the area at the present time, occurs usually native, but occasionally combined with tellurium in quartz veins and veinlets in the Keewatin greenstone and later intrusions of granite and porphyry. The veins, which have a varying strike and dip, are well mineralized with varying quantities of pyrite and molybdenite, and sometimes with chalcopyrite, galena, specular hematite, bismuthinite, gold and a telluride. The gangue consists largely of quartz of several generations, with considerable calcite and chlorite. The gold is found along the dark streaks of chlorite and calcite.

There are various types of gold deposits, viz.:

(*a*) Fissure quartz veins in the greenstone and porphyry, with well-defined walls. Examples, Miller-Independence, McRae and Authier.

(*b*) Replacement veins. The country rock, including altered greenstone and porphyry, has been brecciated and partly replaced by vein-forming solutions of quartz of several generations, and by calcite and other carbonates. Example, the Kenzie vein on the R. A. P. property.

(*c*) A stockwork in granite and porphyry. Examples, Charest claim (McElroy township), Authier (L 4737) and Papassimakes (L 5133).

The chief deposits will be described later in the report when dealing with the gold claims.

Pyrite

Pyrite occurs in two narrow bands, and disseminated through the grey schist at mileage 153 on the railway in Pacaud township. About 100 feet east of the 153-mile post, two shallow pits were sunk several years ago, and at present one can see a little pyrite on the dumps, but the deposit "in place" is covered with débris. In the deep railway-cut there are two bands of pyrite 10 and 20 inches wide respectively which will carry about 35 per cent. of sulphur; samples from each band were found to contain no gold values. The deposits did not appear to be large enough to work, although wider ore bodies might be revealed by further trenching. Iron pyrites is used in the manufacture of sulphuric acid.

Copper

Several calcite veins with some quartz, and carrying copper pyrites, occur in the vicinity of the Blanche river in the south part of McElroy township. The Jean Petit copper property, W.R. 97, in this vicinity, has been referred to by W. G. Miller and W. A. Parks. Considerable work has been done on the calcite veins, but as far as known no copper has been shipped. It is reported that gold and silver values occur with the copper.

The Dane Mining Company has done considerable prospecting and shipped some copper ore from Teck and Lebel, adjacent townships to the north and northwest.

Iron

The isolated exposures of iron formation along the Larder Lake road in Boston township represent the southern portion of the Boston township iron range. The formation consists of interbanded silica and magnetite, with some black slate. Numerous shallow test pits were sunk in 1902, but the iron proved to be too low grade to be workable at that time. The iron formation is, in places, intruded by quartz veins, some of which carry gold.

Building Stone

The red and grey granite and syenite along portions of the railway in Pacaud township is serviceable for building purposes. The fine station at Matheson is constructed of stone taken from along the railway immediately to the north and south of Mindoka.

Timber and Agriculture

In general the trees are small, and consist of spruce, jack pine, poplar, birch and cedar. A few white pine, three and one-half feet in diameter, to the southeast of Smith lake, have escaped an old fire which swept most of the area. Large charred stubs of pine in various parts of the area are relics of the same fire. Other parts have been recently burned.

Many farms have been located on the scattered clay areas of Pacaud township, while the greater part of the remaining area is unsuitable for agriculture by reason of rock, sand or swamp.

Water Powers

No hydro-electric power is used as yet in the area, mining being in the early prospecting stage.

The transmission line of the Long Lake Power Company runs from Charlton along the west side of the area and furnishes energy to the Tough-Oakes mine at Kirkland lake.

K. Farah, of Englehart, has applied for a waterpower on the northwest branch of the Blanche river in lot 12, concession IV, Pacaud township. On August 12th, 1914, the discharge of the river at this point was 350 cubic feet per second. The 61-foot falls is expected to develop 405 horsepower. Immediately to the north in concession V, is a 36-foot falls which could be utilized to develop an additional 240 horse power.

Messrs. Hotchkin and Grover of Haileybury expect to develop a minimum of 2,000 horse power at High falls on the north branch of the Blanche river in lot 11, concession IV, Marter township, where a total operating head of 138 feet is avilable. The discharge of the river on May 6th 1915 was 552 cubic feet per second. The transmission line would follow approximately the railway to Boston creek and Kirkland lake.

It is the intention of the Northern Ontario Light and Power Company to extend their lines during 1916 from Cobalt to serve both Boston creek and Kirkland lake.

Origin of the Gold Deposits

As pointed out by W. G. Miller and C. W. Knight in a paper called "Metallogenetic Epochs in the Pre-Cambrian of Ontario,"[11] most of the gold deposits of Ontario belong to the Algoman epoch. The gold deposits of Boston creek supply another example of gold being derived from acid intrusives of Algoman age. The granite, syenite and feldspar porphyry exposed in this area by erosion are probably different facies of a plutonic rock which underlies the whole area. The gold generally occurs near these acid rocks. The presence of a number of gold-

[11] Rep., Ont. Bur. Mines, Vol. XXIV, Part I, 1915, pp. 243-248.

bearing veins along the contact of the intrusive porphyry and older rocks at Boston creek, as in many other parts of central Canada, and the frequent occurrence of auriferous quartz veinlets in the porphyry and granite, suggest the relationship between the intrusives and the veins. The relationship is more clearly shown in this area by the occurrence of gold in a pegmatitic vein in the granite on the Charest claim, McElroy township.

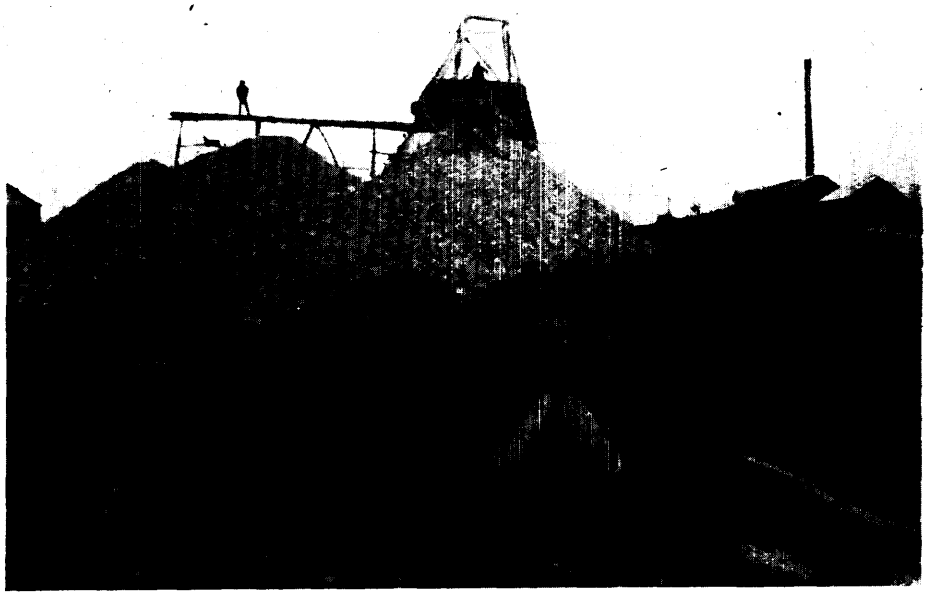
The deposits are in part due to the replacement of the country rock by mineral solution.

Some minerals which characterize deposits that are formed at high temperatures are found in the veins at Boston creek. Actinolite was noted in a thin section of material from the Kenzie vein, and specularite has been frequently observed in other veins. Other minerals formed at high temperature, such as pyroxene, apatite and tourmaline, have not been noted. It is probable that the deposits were formed at great depth, but not at extremely high temperature.

Description of the Gold Prospects

R. A. P. Mining Company

The R. A. P. Prospecting, Developing and Mining Syndicate owns a number of mining claims in the area, the principal ones being L 3665 and L 5163 in the south central part of Boston township. Some work was done on these claims



Shaft and power plant, R. A. P. Mining Co. *May, 1916.*

in 1914 by the La Rose Mining Company. Since May, 1915, Mr. John Papassimakes has had a number of men engaged in opening what is known as the "Kenzie" vein, which occurs in a massive pillow lava. The vein, which has been stripped for about 400 feet, strikes 30 degrees north of east, astronomic, and dips from 60 to 70 degrees to the south. It varies from several inches up to five feet in width, with good breaking walls on either side. Spectacular gold showings were obtained from a 28-foot shaft on the western end of the vein and finely disseminated gold can be seen in many samples on the dump.

When the property was visited in May 1916, the easterly inclined shaft had reached a depth of 135 feet, and 230 feet of drifting on the vein had been done on the 100-foot level. Development has shown the ore to occur in shoots in the vein. The vein material consists of quartz of several generations, silicified rock, reddish calcite, and brecciated and partly replaced masses of reddish feldspar porphyry. The occurrence of feldspar porphyry in various parts of the workings suggests that originally the greenstone was intruded by a narrow feldspar porphyry dike, that at a later period was greatly brecciated, and impregnated with vein-forming solutions which carried the gold and other minerals. The gold occurs with a very fine-grained greenish quartz, which has the character of a replacement deposit, while the green colour is due to minute inclusions of chlorite. Iron pyrites is finely disseminated in the vein, and copper pyrites, molybdenite and galena occur in minor quantity.

Thin sections of the ore show the gold to be closely associated with the sulphides in chlorite and calcite seams near the foot wall part of the vein, where there is a narrow band of fine grained greenish quartz. Certain sections of the vein run as high as $25 or $30 in gold to the ton across five feet.

The property is equipped with a small plant, including a 60 h.p. boiler, 2-drill compressor and hoist.

On the east side of claim L 2631, which lies immediately northeast of that on which the main shaft is sunk, there is an irregular band of mineralized schist with quartz, about one foot wide, which contains visible gold. The showing occurs where the greenstone is intruded by a dike of feldspar porphyry, and near the contact.

About one mile to the northeast, on claim L 5165, there is a red medium grained mica granite intruding the Keewatin. Cutting the granite are several narrow white quartz veins, some of which carry molybdenite and a few specks of native gold.

Currie

The Currie unsurveyed claim, L 5037, is situated about one-half mile northeast of the R. A. P. property in Boston township. In the west and northwest parts of the claim are rusty schist bands heavily mineralized with iron pyrites, and cut by quartz stringers. No visible gold could be seen in place, but gold colours can be panned from the sulphides. A grab sample showing cubes of pyrite gave $2.40 in gold to the ton, while samples across two feet and three feet seven inches gave $1.60 and 60 cents respectively in gold to the ton. Some trenching has been done.

Miller-Independence

This property is situated on the south half of lot 1 in the sixth concession of Pacaud. Gold was discovered on the lot by a prospector, Mr. Joseph McDonough, in July 1915. The vein has been traced on the property for about 600 feet in an east and west direction, and for several hundred feet easterly into Catharine township. It is narrow, averaging about a foot in width, and has a low dip to the north, usually about 20° or less, at one place being almost horizontal. The vein material is milky white quartz, and the mineralization is more or less concentrated toward the foot wall side of the vein. Telluride, copper pyrites, pyrite, specular iron ore and galena are observed in the quartz. Native gold occurs frequently with the telluride and other minerals in a net-like arrangement in the quartz along the foot wall. There are probably several tellurides, but so far only one, a bismuth telluride, containing some selenium, has been recognized. This telluride of a brilliant grey colour appears to occur abundantly with the gold.

The country rock is mainly fine-grained pillow lava, associated with which is a coarsely grained basic rock of a hornblendic type. Along the vein there is a dike of grey feldspar porphyry which at two places is two feet wide on the hanging

Power plant and mill at Miller-Independence property. *May, 1916.*

wall side of the vein. The porphyry was also observed on the foot wall side. It contains much calcite and other carbonates, as well as disseminated iron pyrites, and is cut by veinlets of quartz.

The vein has been prospected by means of a number of trenches and pits, from which some high-grade ore has been bagged. A shaft was being sunk to the north of the vein. The property is equipped with a small plant, including boiler, compressor, hoist, and a Nissen stamp mill; and a small oil flotation plant was being constructed.

McRae

The McRae claim is the northeast quarter of the north half of lot 2, concession VI, Pacaud township. The vein has a general magnetic north and south strike, with a dip of about 45° to the east. Fine gold can be seen in a number of places, particularly on the hanging wall part of the milky white quartz vein, which is about one foot in width.

Small steam plant on McRae property. *May, _916.*

Gold bearing quartz vein, dipping 20° N. The man is standing on the hanging wall side of vein, while the foot wall is shown in the foreground, Connell-McDonough claim, Catharine township.

The country rock is pillow lava and massive greenstone showing a diabasic texture, while the wall rock is considerably altered in places next the vein. A shaft is being sunk on the vein to the 100-foot level. Exposed in the shaft, the vein has a somewhat banded structure, showing streaks of dark quartz, with considerable iron pyrite, some films of molybdenite, and dark grey calcite.

The property was being prospected by the Crown Reserve Mining Company in May 1916.

Connell-McDonough

This property is the south half of lot 12, concession VI, Catharine township. The vein on the Miller-Independence which is being prospected can be traced easterly to the Connell-McDonough claim, where there has been considerable trenching along the strike of the vein. Native gold can be observed at several places along the foot wall of the vein.

Cullen-Renaud

This group of claims is situated in the northeast corner of Pacaud township. Native gold has been reported to occur in several veins which outcrop on the surface. The veins which outcrop on the McRae and Miller-Independence properties, if continued to depth on their indicated dips, would pass into this property at some depth.

Prospector at his discovery of native gold in veinlets in the granite, Authier claim, southeast part of Boston township.

Authier-Charlebois

Mining claims L 4737 and L 5025 are situated in the southeast part of Boston township, just to the north of the McRae property. The quartz veins in the greenstone are similar to the McRae vein, being narrow and dipping about

45° N. Native gold has been discovered in some of them, along with pyrite and a grey mineral bismuthinite.

Toward the north part of the property is a small area of fine-grained mica granite which intrudes the greenstone. At one place near the contact there is a quartz vein one foot wide in the granite, on which a shallow pit has been sunk. Molybdenite, pyrite and bismuthinite are disseminated in parts of the quartz vein, and visible gold was reported to have been seen. A sample across eleven inches, taken a few feet from the pit, gave $4.80 in gold. Northwest of this discovery, beyond a ravine, the granite is intersected by numerous quartz veinlets, some of which are several inches wide. In some of the narrow joint-like cracks native gold was observed, along with a grey mineral which gave reactions for tellurium and bismuth and is probably tetradymite. There is also considerable iron pyrites in the granite along some of the veinlets.

Charest

The Charest unsurveyed claim, L 5305, is situated in the southwest quarter of McElroy township. As shown on the map, the claim is on a small stock of massive, coarse-grained, flesh-coloured hornblende and biotite granite. A quartz vein averaging about one inch in width, and 300 feet long, strikes 30 degrees north of west across the granite. Considerable fine gold, pyrite, chalcopyrite, and a grey mineral which proved to be a telluride, were noticed in different parts of the vein. A few pieces of quartz from the vein gave, on assay, $8.80 in gold to the ton. Other veins on the property contain molybdenite and specular hematite. Some of the veins contain coarse feldspar and are pegmatitic in character, while many of the narrow veins represent the filling of joint cracks. The occurrence of gold in the pegmatitic vein is important, since it strongly points to the formation of the gold-bearing quartz veins following the pegmatitic veins and representing part of the granite intrusion.

Conclusion and Acknowledgments

The geology and mineralogy of the Boston Creek area is, in a general way, similar to that of the adjoining Swastika, Kirkland Lake and Larder Lake areas. Gold is known to be widely distributed over all the areas. No bullion has, as yet, been shipped from Boston creek. The Tough-Oakes, Swastika, Lucky Cross, La Mine D'Or Huronia and Goldfields Limited properties, which are from 12 to 15 miles from Boston Creek station, have from 1912 to the end of 1915, yielded gold valued at $779,715. Most of this production was from the Tough-Oakes mine. In Boston creek the prospecting, as yet, has been largely confined to the surface, the deepest shaft being 135 feet (May, 1916). Prospecting is aided by the excellent transportation facilities. In prospecting the area it seems a good rule to trench in the old rocks near the porphyry dikes and small granite areas.

In conclusion, the writers wish to express their indebtedness to several of the men in charge of mining and prospecting operations, particularly to J. Papassimakes of the R. A. P. property. The assays were made and some minerals identified by W. K. McNeill and T. E. Rothwell, of the Provincial Assay Office. The accompanying map was drawn by P. A. Jackson.

GOODFISH LAKE GOLD AREA

By

A. G. BURROWS and P. E. HOPKINS

Introduction

Goodfish lake, 1,025 feet above sea level, is situated two miles northeast of Kirkland lake in the Larder Lake Mining Division, near the intersections of the four townships, Teck, Bernhardt, Morrisette and Lebel. The area is three miles south of the height of land which separates the Hudson Bay and St. Lawrence River waters. Hills seldom rise more than 100 feet above the adjacent valleys. A wagon road nine miles in length connects Goodfish lake with Swastika, a station on the Timiskaming and Northern Ontario railway, 390 miles north of Toronto.

Gold was first found on the Costello claim, L 2194, in the summer of 1912, shortly after the discovery of gold on the Tough-Oakes mine, two and one-half miles to the south. Reference is made to gold on the Costello claim in the report on the Kirkland Lake and Swastika gold areas,[1] and part of the geology is included on the coloured map accompanying that report.

During 1915 considerable prospecting was done around the lake on the Costello, Martin, Brennan, Gibson, Potvin, Papassimakes and other claims. All have ceased work at present (April, 1916,) except the La Belle Kirkland mines, who are continuing with underground mining on the Gibson-Potvin claims in the northeast corner of Teck township.

Geology

Keewatin

The Keewatin is the oldest and most dominant of the rocks, which are all pre-Cambrian in age. The Keewatin rocks consist of pillow and amygdaloidal lavas (meta basalts) and altered diabases in about equal volume. Some of the rocks are quite massive, while others are very schistose and rusty, striking easterly and dipping vertically. The original constituents are largely altered, mainly to calcite, chlorite and sericite, and often the rock is so greatly metamorphosed that there is no clue to its original nature. The fine-grained greenstone on the southwest corner of the Costello claim, L 2194, Morrisette township, shows under the microscope rounded and angular quartz grains, some with corroded edges, in a groundmass of calcite, chlorite, sericite, altered feldspar, leucoxene and apatite. This rock is identical to the rock which shows large "eyes" of quartz and occurs with the pillow lava flows in Porcupine, and is probably a more acid rock than basalt.

Quartz-Feldspar Porphyry

Cutting these older rocks are dikes, stocks and flow-like masses of granite porphyry (quartz-feldspar porphyry or rhyolite porphyry). The porphyry has a grey colour, and a whitish weathering surface in which white quartz phenocrysts

[1] Ont. Bur. Mines, Vol. XXIII, Pt. 2, 1914, p. 31.

a quarter of an inch across are quite conspicuous. Under the microscope the rock is holocrystalline. The phenocrysts consist of about 5 to 10 per cent. of quartz and 50 per cent. of albite-oligoclase partly altered to sericite. The groundmass is felsitic, consisting of sericite, plagioclase, quartz, chlorite, pyrite and iron oxide. The porphyry is somewhat schistose, and is similar to certain porphyries described in Porcupine and many other parts of northern Ontario.

In the Kirkland Lake and Swastika report[2] the quartz-feldspar porphyry was classed as Keewatin on account of the fact that a conglomerate, on the north shore of Gami lake, classed as "Timiskaming," was found to contain fragments of quartz-feldspar porphyry quite similar to the porphyry which occurs near at hand "in place." There is a possibility that this small isolated area of conglomerate is of later age than "Timiskaming," in which case the quartz-feldspar porphyry might be of Algoman age, similar to the feldspar porphyry around the Tough-Oakes mine.

The age of the quartz porphyries in northern Ontario is usually difficult to determine, that is, whether of Keewatin or later age. They may be in part connected with the acid flows interbedded with the Keewatin pillow lavas, or they may be of Laurentian age. In any case some porphyries seem to have yielded most of the acid pebbles for the Timiskaming conglomerates.

Timiskamian Series

The conglomerate and slate in the southeast corner of the accompanying map is the northern extremity of a large volume of Timiskamian sediments which have been described fully in the report on the Kirkland Lake and Swastika gold areas.[3] The sediments were laid down unconformably on the eroded Keewatin surface. An unconformity can be seen on claim L 2796, where the overlying conglomerate contains fragments of the amygdaloidal basalt and diabase similar to the underlying Keewatin.

Economic Geology

The rocks of the area are mostly massive and schistose greenstones, cut by small irregular masses of schistose quartz-feldspar porphyry. Gold, the chief mineral sought for, occurs in narrow quartz veins and replacement deposits along the contact of porphyry with other rocks. The veins or stringers are generally an inch or less in thickness, but there may be a series of them forming a lode deposit. Often two or three parallel slip planes coated with quartz and a thin film of molybdenite may form the ore body. The large amounts of molybdenite and pyrite give the deposits a dark and rusty appearance. Visible gold, in a state of fine division, occurs in many parts of the area. A telluride has been reported to occur in Morrissette township, but no such mineral has been identified in the laboratory of the Bureau of Mines. Calcite and other carbonates occur with the quartz.

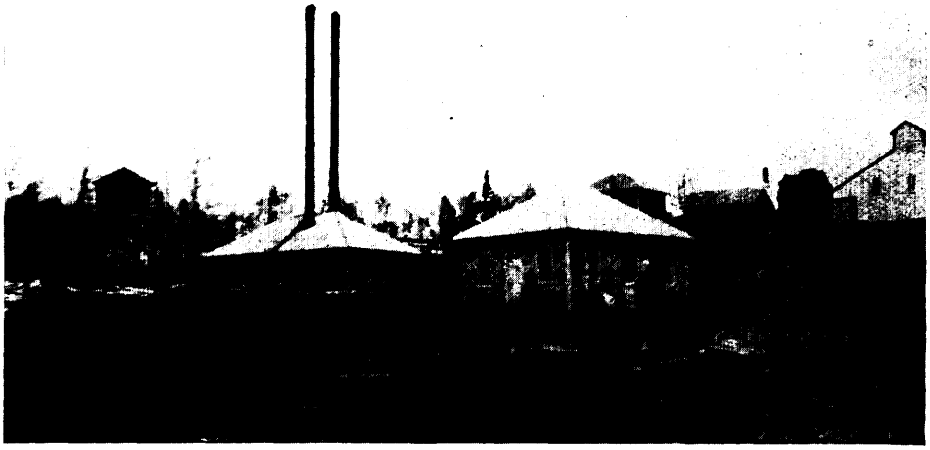
The quartz-feldspar porphyry appears in some way to have influenced the gold deposition as similar porphyries have done in Porcupine; and it seems also to have been the source of the gold-bearing solutions. If the porphyry is the source of the ores and is pre-Timiskamian in age, then the gold deposition of

[2] Ont. Bur. Mines, Vol. XXIII, Pt. 2, 1914, p. 10. [3] Ibid, pp. 9 and 10.

Goodfish lake is of an older type (Keewatin or Laurentian) than the Kirkland Lake gold-telluride deposits, which are clearly connected with the Algoman intrusions of feldspar porphyry.

The cessation of work by many properties would suggest that many of the deposits are low grade. La Belle Kirkland Mines, the only property being worked (May 1916) has blocked out considerable ore.

La Belle Kirkland: La Belle Kirkland Mines Limited is operating a group of claims to the south of Goodfish lake. Of these claims the most important is L 1751, on which the company had sunk a shaft to the 300-foot level (May, 1916). The ore deposit occurs along the contact of quartz porphyry and basalt. The porphyry lies to the north, and forms the hanging wall of the deposit, which occurs in the altered basalt. The shaft, which inclines 60° N. for 80 feet, and



La Belle Kirkland Mines, showing a large erratic of basalt on the right.
May, 1916.

70° N. below this level, is on the dip of the ore body, which is also approximately the angle of contact of the porphyry and basalt. The basalt near the contact is greatly altered to a greyish rock high in silica, calcite and other carbonates. The altered rock has the following composition: silica, 46.94 per cent.; ferric oxide, 5.60; ferrous oxide, 5.16; alumina, 13.94; lime, 9.31; magnesia, 1.19; soda, 2.12; potash, 2.48; water, 2.15; carbon dioxide, 11.43. In this altered basalt area there are streaks or bands of blackish material which form the higher grade portion of the deposit. These streaks contain films of molybdenite, to which the dark colour is due, and abundant iron pyrite, quartz and calcite, while visible gold is occasionally seen. A dark band near the foot wall was persistent in the shaft, while other bands toward the hanging wall are more lenticular, but have similar characteristics to the foot-wall streak. The silicified material between the streaks or bands carries low values in gold, but the values obtained in the high-grade streaks, which vary from a part of an inch to a foot in width, have indicated that the deposit is workable over a considerable width. The management is at present continuing the sinking of the shaft and drifting and cross-cutting at several levels to determine the size of the ore body.

The narrow high-grade streaks or bands are reported to carry from \$20 to \$150 per ton in gold, while a probable value of from \$15 to \$18 per ton is given for a width of 7 feet to 10 feet, for some of the ore.

The deposit is evidently a replacement of the basalt near the contact with the porphyry. There is no evidence of the filling of open fissures with milky white quartz. Slickensides surfaces in the material of the streaks indicate some faulting along the dip of the deposit.

The equipment consists of two 60 h.p. Robb-Mumford boilers, a 4-drill compressor, and hoist. Timber from the company's properties is at present used for fuel. Frank Loring is manager, and Ernest Loring superintendent of the mine.

Costello: Gold was found on the Costello claim, L 2194 and L 2202, Morrissette township, in 1912. The dominant rock is a Keewatin greenstone, which has been intruded by small irregular masses of a quartz-feldspar porphyry. The basalt has been greatly altered to rusty-weathering carbonate. The gold occurs in rusty quartz and calcite veinlets, which are more or less irregularly distributed in a mineralized zone as shown on the map. Considerable trenching has been done transverse to the strike, which shows the gold-bearing zone to extend for 400 yards or more. A shaft was sunk in 1915 on the west part of the zone, and while some gold was found near the surface, the work was discontinued. The property is owned by the Goodfish Lake Mines, Limited.

Martin (L 2233): This claim is situated north of the Costello (L 2194). A gold-bearing zone occurs along the contact of the quartz-feldspar porphyry and the basalt. It dips about 65° N. and strikes N. 30° E., and has been traced by trenching to the Brennan claim, which lies to the east. On the line between the claims the vein four inches in width is exposed, while along the contact the porphyry and schist are greatly stained by iron oxide, an alteration product of iron pyrites. An inclined shaft was sunk on the Martin claim to a depth of 20 feet, but at the time of the visit was filled with water. It is reported, however, that the south wall of the shaft showed a mineralization over widths of four to six feet, several narrow irregular quartz veins being exposed with promising assays in gold, while the north wall of the shaft showed neither so much quartz nor such good values.

Brennan (L. 2603): An inclined shaft 18 feet in depth was sunk on this claim. The shaft is probably on the extension of the vein which occurs on the Martin. The vein material between the porphyry and basalt has a width in one place of 15 inches, and consists of quartz, calcite, molybdenite and pyrite.

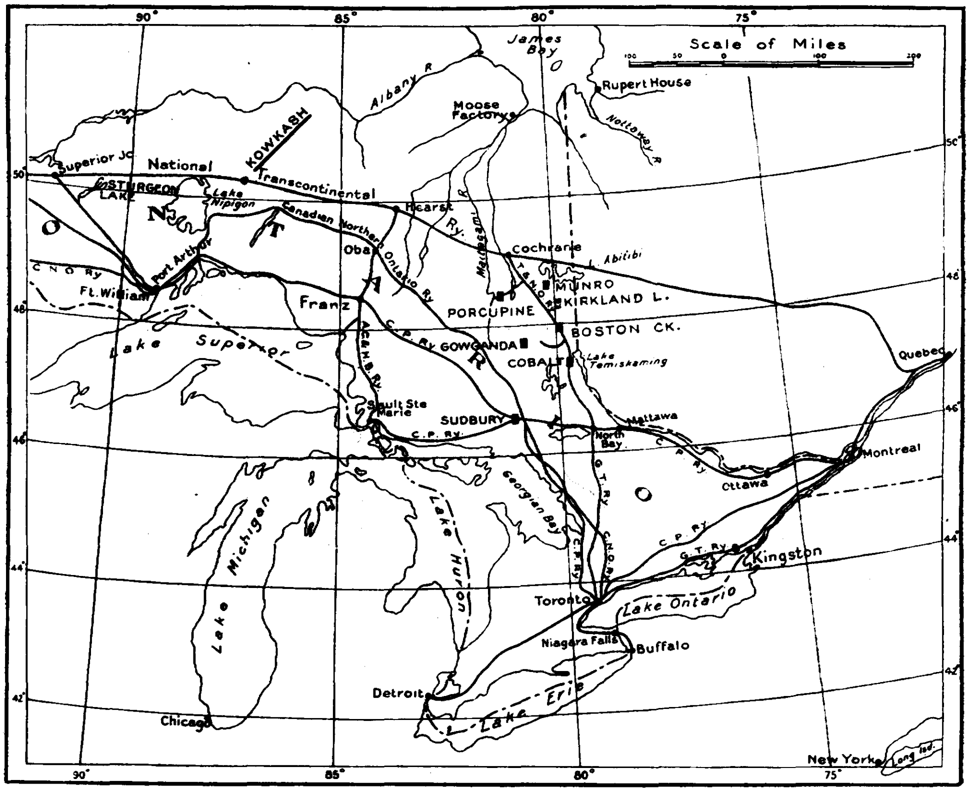
Brennan-Bowes Group: During the fall of 1915 the Dominion Reduction Company had a working option on a group of claims immediately to the east of the Costello group. A large amount of trenching was done across contacts of porphyry and basalt, while two shafts were sunk to a moderate depth at supposedly favourable locations. A shaft on claim L 2614 is on the contact of the porphyry and basalt, with the basalt forming the north or hanging wall. This condition is the opposite to that at the La Belle Kirkland mine, where the prophyry forms the north or hanging wall. Low gold values were obtained in the vein material from this shaft, but these were not sufficient to indicate a workable deposit.

KOWKASH GOLD AREA

By P. E. HOPKINS

Introduction

In accordance with instructions received from Thos. W. Gibson, Deputy Minister of Mines, the writer left Toronto on September 6th, 1915, and spent six days in making a preliminary investigation of the recent gold discovery near Kowkash, a station 297 miles west of Cochrane on the National Transcontinental railway. A preliminary report[1] was published in the Canadian Mining Journal, Toronto, and a map[2] of part of Thunder Bay district showing the Kowkash gold



Sketch map showing the position of Kowkash relative to other mineral areas in northern Ontario.

area accompanied Part I, Volume 24, Report of the Ontario Bureau of Mines, 1915. The writer revisited the area in the latter part of October, 1915, and spent another six days in examining the geology and all the known discoveries. The Kawashkagama river below Johnson creek, part of O'Sullivan lake, and the greater part of the route along the railway between Johnson creek and Robinson lake, 25 miles west, were examined. Accompanying this report is a map of the area on a scale of four miles to the inch showing the topography, geology and location of the prospects.

[1] Kowkash Gold Area by P. E. Hopkins, Can. Min. Jour. Oct. 1, 1915, pp. 583-4.
[2] Map No. 24c, Ontario Bureau of Mines.

Location

The Kowkash gold area is situated in the central part of the district of Thunder Bay, Ontario, northeast of Lake Nipigon, and is traversed by the National Transcontinental railway. Kowkash station is 297 miles west of Cochrane at about latitude 50° 15′ north and longitude 87° 15′ west.

Early Exploration and History

A spectacular gold find was made by E. W. King Dodds on August 21, 1915, on claim T.B. 2424, nine miles northwest of Kowkash, near Howard falls, on the river Kawa-kash-kagama, which signifies "sparkling water". This name has been shortened to Kawashkagama by the Geographic Board. The railway station called "Kowkash"—an abbreviation or corruption of Kawashkagama—has given its name to this area. The region has so recently been opened up by the National Transcontinental railway that the geological reports have been for the most part of a preliminary character and confined to the more important canoe routes.

Kowkash station, National Transcontinental railway, September, 1915.

That part of the Kawashkagama river near the gold find is described by Robert Bell, in the annual report of the Geological Survey of Canada for 1870-1, p, 342; also, by party number 5 in the report on the Exploration of Northern Ontario, issued by the Ontario Department of Crown Lands, in the year 1900, p. 156. In the latter report, E. V. Neelands, geologist, blazed the way for the prospector when he stated:

> Huronian [Keewatin] rocks, mainly chlorite and other soft green schists, occur in the Kawa-kash-kagama river for about four miles below the Wawong portage to the northern limit of exploration [Howard falls]. . . . The most promising district is the country on the Kawa-kash-kagama river below the Wawong portage. Here Huronian [Keewatin] exposures are numerous, mostly chlorite and other soft green schists. Several samples from small quartz veins in this district showed traces of gold, and it might be that careful prospecting in this district would be rewarded.

W. J. Wilson of the Geological Survey of Canada also made a geological reconnaissance survey[3] of part of this area in 1903-4, and his map[4] accompanying the report, which shows the water routes and geology, was very useful to the early prospectors. Robert Bell,[5] W. A. Parks,[6] A. H. A. Robinson[7] and others have described the canoe routes and geology on the western part of the accompanying map.

Up to the present time little attention has been given the Kowkash area by gold seekers, but part of the region was well known to some who prospected for iron on the Onaman iron range along Johnson creek. The iron first attracted the attention of the prospector in 1904, when engineers began the survey of the National Transcontinental railway through this area. R. Flaherty prospected on the range for two seasons, 1906-7, for the United States Steel Corporation, during which time much stripping and three diamond drill holes were sunk. However, the banded red jasper and magnetite and hematite proved to be of too low grade to be workable at that time. E. S. Moore[8] who spent part of two seasons in examining the range gives a detailed report on the geology and topography of this area.

From an economic point of view, gold is the chief interest in the region, at present.

Prospectors at the crossing of Johnson creek and National Transcontinental railway, September, 1915.

E. W. King Dodds made his discovery while walking over the rocky hill below Howard falls, which had been burned clean of moss and trees on the previous day. The news of the rich find caused a rush of about four hundred prospectors to the neighborhood, and 75 or 100 claims were staked within three weeks.

At the time of the writer's second visit at the end of October, no further discoveries had been made in the vicinity of the original find, around which centred

[3] Geological Reconnaissance of a portion of Algoma and Thunder Bay Districts, Geol. Surv. of Can., 1909, pp. 1-45.

[4] Map No. 964, scale 8 miles to inch. Geol. Surv. of Can., 2nd Edition, 1911.

[5] Geol. Surv. of Can., 1866-69, p. 344.

[6] Geol. Surv. of Can., 1901, Vol. XIV, pp. 105-109. A: Vol. XV, 1902, pp. 213-222.

[7] Report of party No. 6, on Survey and Exploration of Northern Ontario. Department of Crown Lands, 1900, pp. 162-172.

[8] Ont. Bur. Mines, Vol. XVII, 1908, pp. 170-189; Vol. XVIII, 1909, pp. 196-253.

the early staking. This was the magnet, however, that drew the prospectors to the locality, resulting in newer finds farther to the south and west. Two gold discoveries have been made farther up the Kawashkagama river, about three miles north of Kowkash station, on the Richardson and Dawson claims. Gold and a telluride have also been found on the Devanney claim near Tashota, 22 miles west of Kowkash, towards the western side of the Keewatin area. In the latter region as much staking has gone on as around the Dodds property. Gold values were obtained near Redmond station at mileage 54.3, from a quartz vein on O'Sullivan lake and other places. Mile posts are marked on telegraph poles along the line of railway west from Grant, a divisional point.

Over 1,000 claims have been staked mainly around Tashota, adjacent to the Dodds discovery, and in the vicinity of the railway between Kowkash and Tashota stations. Nearly 500 claims were recorded at the Port Arthur office up to November 11th, 1915. At the end of October there were about 100 prospectors still in the area.

Topography

The country has an average elevation of about 1,000 feet above sea level with no great variations in level. There is not a difference of more than about 150 feet between the highest hills and lowest valleys. The most prominent hill seen lies about four miles southwest of O'Sullivan lake.

The continental divide, separating the waters of the great lakes from those of Hudson bay, runs in a tortuous course through the region; but nowhere is it conspicuous as a ridge. A large swamp with streams emerging from either side often forms the watershed. A boss of red granite, three miles wide occurs at the divide, altitude 1,118 feet, at Redmond. Towards the northwest of the sheet is Summit lake, a shallow, muddy lake, three miles long by one mile wide, which discharges water both ways, the stream flowing northward towards the Albany being nearly as large as the southern outlet. The country northeast of the height of land is drained largely by the Kawashkagama river, a branch of the Albany.

The average magnetic declination for the area embraced by Map 25a is about one degree west of north.

Following is a brief resumé of the geology and a description of the several gold prospects.

General Geology

The Kowkash area presents pre-Cambrian rocks similar to those found elsewhere in northern Ontario. They are dominantly of Keewatin age, with some Timiskaming sediments and later intrusions of feldspar porphyry, granite and diabase. The younger formations can be separated when the area is mapped in detail. The above rocks cover an area of 600 or more square miles, which is worthy of further prospecting. Surrounding this region are rocks of Laurentian, Keweenawan and Paleozoic age.

Keewatin

The Keewatin consists chiefly of massive fine-grained chlorite and hornblende rocks which are in places altered to schists, and which have a nearly vertical dip. Among these rocks are altered diabase, altered basalt showing pillow or ellipsoidal structure, agglomerate and rusty carbonate, so much altered that microscopic examinations are unsatisfactory.

A considerable amount of Iron formation occurs on the Onaman iron range, the location of which is taken from E. S. Moore's map.

Cutting the greenstones and closely associated with the Iron formation are narrow dike-like masses and flows of quartz-porphyry or rhyolite. Exposures may be seen at many places, chiefly around O'Sullivan lake, Howard falls, Onaman iron range and Tashota station. The porphyry contains numerous white quartz phenocrysts, the size of peas, and some feldspar phenocrysts, in a fine-grained, greyish-white groundmass. The porphyry also contains some quartz stringers, is schistose in places and resembles the quartz porphyry at Porcupine,[9] Goodfish lake[10] and Big Duck lake[11] (north of Schreiber). A sample from the Dodds' claim which was examined microscopically showed large, rounded, angular and broken quartz grains, and albite phenocrysts, partly altered to sericite. The crystalline groundmass consists of quartz, feldspar, sericite, calcite and a little chlorite. E. S. Moore noted tourmaline in the rhyolite-porphyry from near Castor lake.

On the Kawashkagama river at the last portage into O'Sullivan lake is an actinolite rock, below which are numerous serpentine exposures.

Laurentian ?

Granite and gneiss, possibly of Laurentian age, are shown on the map, but these may include some granites of later age. Much of the gneiss is similar to the Laurentian gneiss in other parts of the pre-Cambrian shield. A. W. G. Wilson[12] notes that the acidic schistose rocks in the Summit-Marshall lake region occupy a very doubtful position between undoubtedly Keewatin and undoubtedly Laurentian.

Timiskamian

Conglomerates and slates apparently similar to the Timiskamian sediments in Porcupine and Kirkland lake are found about two miles below Howard falls and one chain from the west bank of the Kawashkagama river. They strike north 65° east and dip vertically. The pebbles of the conglomerate are rounded and drawn out, and consist of chert, quartz-porphyry, amygdaloidal basalt and granite-gneiss. The conglomerate is separated on the north by a few feet of drift from a large volume of pillow lava. Slates standing vertically can be seen at mileages 50.7, 51.7, 53.6 and elsewhere in the area. E. S. Moore has mapped a few exposures of tuff and conglomerate with the Keewatin.

Algoman ?

Cutting these older rocks are fresh-looking massive granite areas, probably of Algoman age. A grey granite can be seen at the water tank at Tashota station, which under the microscope shows quartz, albite, microcline and biotite. A large boss of red granite three miles wide forms the height of land, altitude 1,118 feet, at Redmond. It contains microcline showing the gridiron structure, albite with zonal structure, quartz and biotite partly altered to chlorite. Some of the quartz porphyries may be of Algoman age, apophyses from the larger granite masses. The feldspar porphyries are rare. A narrow dike was noticed cutting the iron formation at mileage 56.3 along the railway.

[9] See Vol. 24, Pt. III, Ont. Bur. Mines, 1915.
[10] See Vol. 23, Pt. II, Ont. Bur. Mines, 1914.
[11] See Vol. 24, Pt. 1, Ont. Bur. Mines, 1915, pp. 9-13.
[12] Geology of Nipigon Basin, Ontario, Memoir No. 1, Geol. Surv. of Can., 1910, p. 50.

Keweenawan

Quartz diabase dikes occur in many parts of the area. Exposures may be seen at mileages 50.3, 50.5, and 56.7 west of Grant station. Large exposures of diabase and gabbro occur south of Tashota, and also about 300 yards north of the Dodds gold find. The only reason for placing these rocks in the Keweenawan is that they are similar in every respect to the Keweenawan diabase at Cobalt and in the Nipigon region. W. J. Wilson notes that the diabase is common in both the granites and schists and does not contain olivine.

Large areas of diabase occur around Lake Nipigon.[13] The occurrence of silver associated with the diabase at Silver islet and Silver mountain, 150 miles to the southwest, suggests the advisability of prospecting these diabase areas for silver.

Glacial and Recent

The region has been heavily glaciated, the ice movement having been from the northeast over the height of land in a general south-55°-west direction.

The area lies near the western edge of the northern Ontario clay belt, which has an extent of about 25 million acres, and is covered in places with stratified

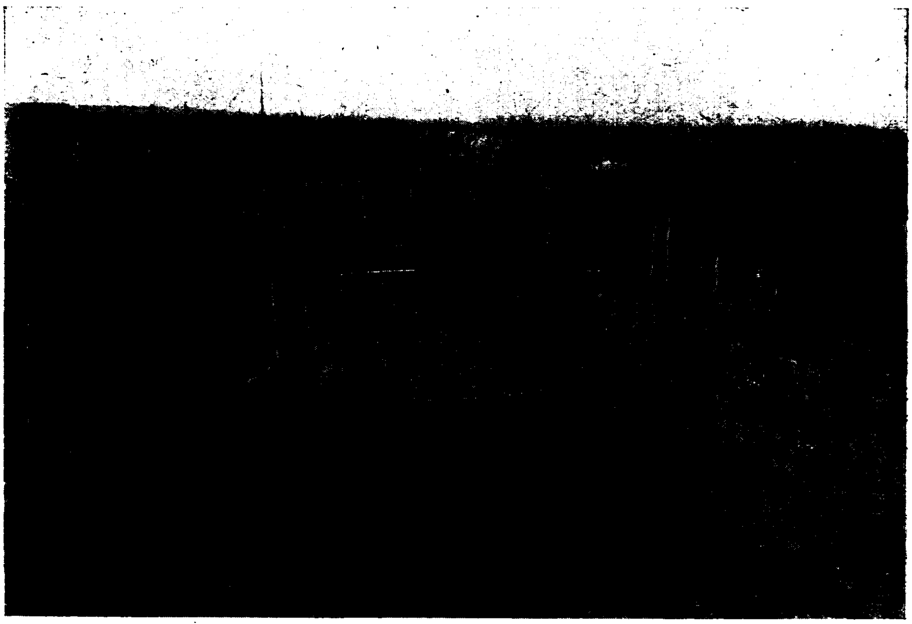


Photo by E. S. Moore.

Kettle lakes in terminal moraines near Johnson creek, south of Kowkash station.

clays, sands, gravels and coarse boulders. South of Kowkash station near the railway are numerous terminal morainic hills which contain many kettle lakes. Kowkash station is built on an outwash plain formed from an ice sheet.

Economic Geology

At present gold is the chief mineral sought for in the area, but there was considerable prospecting for iron in earlier years.

[13] See geological map No. 8A, scale 4 miles to the inch, accompanying Memoir No. 1, Geol. Surv. of Can., 1910.

Iron

The iron occurs on the Onaman iron range, which was examined in detail by E. S. Moore in 1907 and 1908. He found the iron formation to occur in two bands, called the northern and southern ranges, the former extending for nine miles and the latter three miles in an east and west direction. The formation is composed largely of red jasper, often well banded, and magnetite. There are considerable deposits of these minerals, but they are interbanded with much slate and some greywacké.

Gold

Quartz veins carrying gold values in parts of the area have been known for some time, particularly from the Cross-Summit lake area. A. H. A. Robinson, in 1900, obtained an assay return of 80 cents per ton from a vein on the west shore of Summit lake. Another sample on the Lily river, two miles from Summit lake yielded $2.80 of gold per ton.[14] W. A. Parks reports an assay value of $1 per ton in gold from a sample from Cross lake.[15] In 1900 E. V. Neelands obtained traces

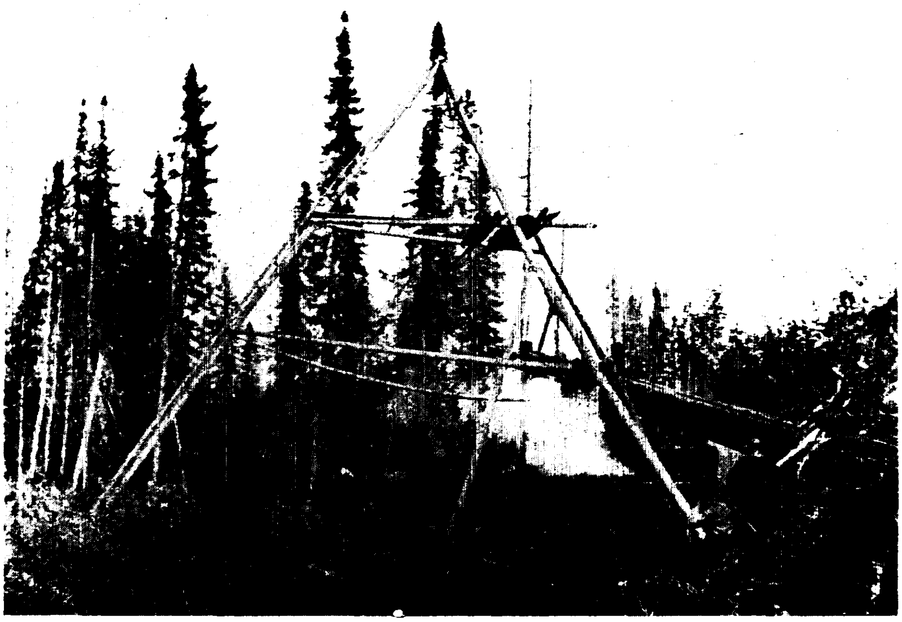


Photo by E. S. Moore.

Flaherty's diamond drill prospecting for iron, Onaman iron range.

of gold from several samples collected along the Kawashkagama river above Howard falls.

Dodds' find in 1915 led to others, particulars of which are given below. The prospectors are still busily engaged in the region but enough prospecting has not yet been done to prove the prospects.

Other Minerals

A boulder of pyrite, about three feet across, was reported from a point about two miles northwest of Paska station.

[14] Survey and Exploration of Northern Ontario, Dept. of Crown Lands, Ont., 1900, p. 165.

[15] Geology and Natural Resources of the Northeastern Nipigon District, Geol. Surv. of Can., M.S. Report, 1902, p. 60.

A few specks of native copper were seen in quartz veins near the Tashota gravel pit.

No silver was present in the several samples which were assayed.

Other Resources

The trees are mostly second growth and consist of small spruce, poplar, balm of gilead, pine, birch and cedar, along the rivers occasionally attaining a diameter of two feet. On the whole, these are suitable for pulpwood and locally for ties, posts and small timber. Large areas have been recently burned. The east boundary of the Nipigon forest reserve, which is not surveyed, is approximately shown on the map.

Small tracts of the country are suitable for agricultural purposes.

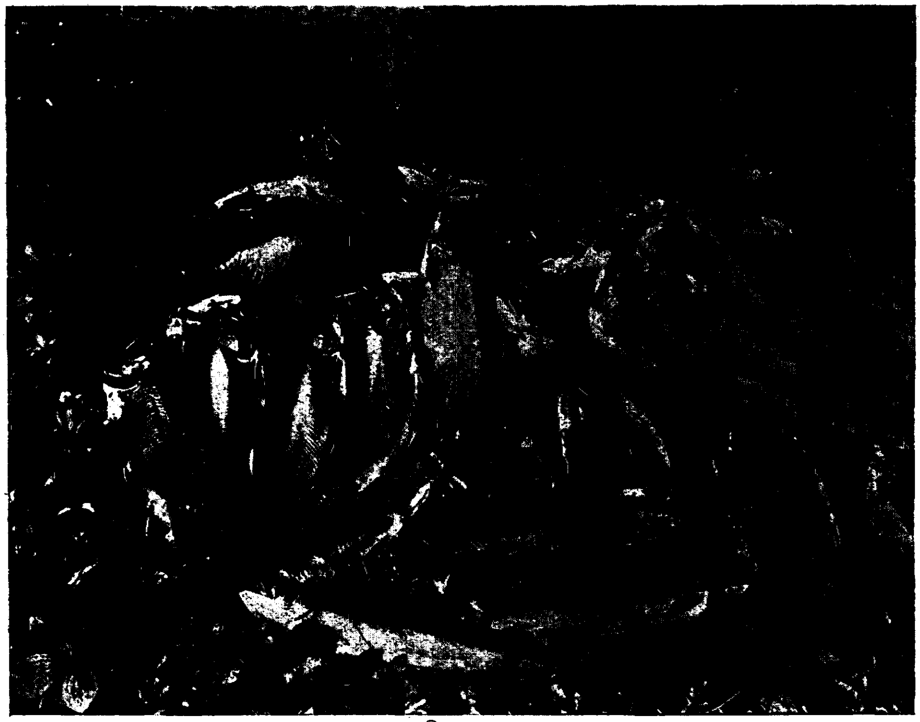


Photo by W. J. Wilson.

Speckled trout 16" to 20" long; Albany river waters, Kowkash region.

Whitefish, pickerel, pike, suckers and brook trout are plentiful in these waters. The rapids on the Kawashkagama river and the numerous brooks entering the river are famed for their speckled trout, some of which are two feet in length.

Many small undeveloped water powers occur on the rivers. Howard falls on the Kawashkagama river would make an excellent water power. The 19-foot fall here is caused by a hornblende-chlorite ridge through which the river cuts, making a narrow canyon-like gorge fourteen chains long. W. J. Wilson notes that the gorge is from twenty to thirty feet deep, and the water descends in steps and slides varying from one to five feet.

Description of Gold Claims

The main properties visited are described as follows:

Dodds

The original gold find which caused the rush to the area was made on the Dodds' claim, T.B. 2424, about three-quarters of a mile east of Howard falls, on the Kawashkagama river. The quartz vein strikes 10° south of east and dips 75° to the north, thus conforming in strike and dip with the country rock. On the surface, the vein which is one to five inches wide, averages three inches in width. The quartz is somewhat glassy in appearance and largely free from sulphides. An abundance of free gold occurred for four or five feet along the hanging wall part of the vein. On the north side of the vein is a rusty schist band, six inches wide

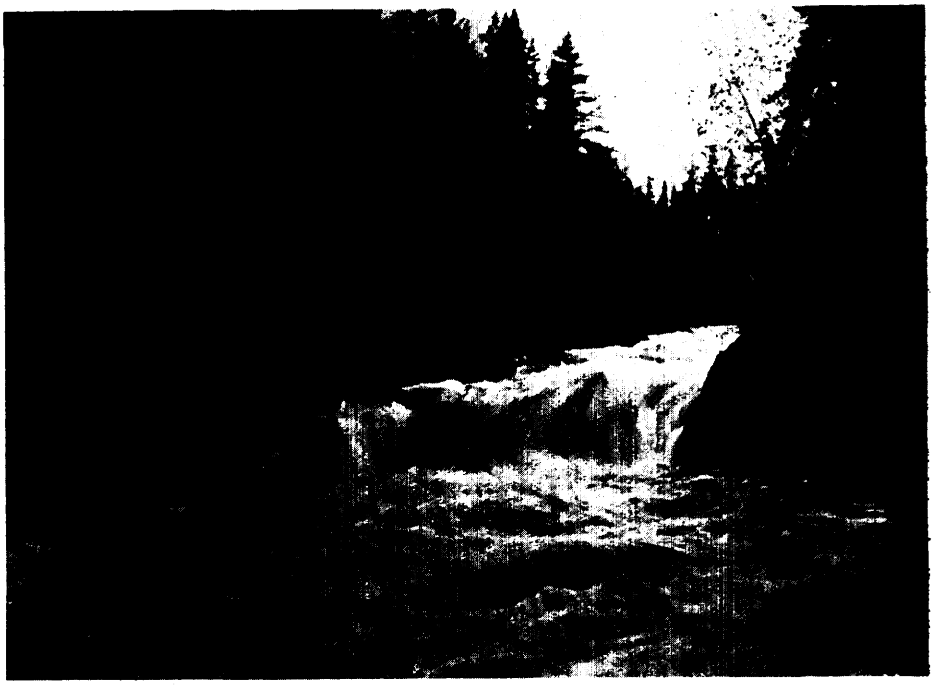


Photo by W. J. Wilson.
Howard falls, Kawashkagama (Kowkash) river.

which is heavily impregnated with iron pyrites. The wall rock is pillow lava (meta-basalt) altered in places to schist. Numerous quartz porphyry dikes up to thirty feet wide occur on the claim.

The claim was optioned by T. B. Caldwell, of Lanark, Ontario, and Messrs. Fraser and Orn. On October 23rd the vein had been stripped for 100 feet, exposing two specks of gold towards the western end, and a 14-foot pit had been sunk. In sinking, the showing of free gold disappeared in a few feet. At the bottom of the shaft the vein is two inches wide with a foot of pyritous schist on the foot wall, but no gold was visible. A channel sample across twelve inches of the pyritous schist from the bottom of the shaft gave an assay $2 in gold. Work was suspended early in November. It is reported that arrangements have been made to sink a 150-foot shaft.

Richardson—Loudon—Ogilvie

During the first week in October, 1915, gold was found on Claim T.B. 2599, near the first rapids on the Kawashkagama river below the junction of Johnson creek. The quartz vein is narrow, averaging about two inches in width over a length of 200 feet. The vein strikes south 85° east and dips about 70° to the south. The rock is Keewatin pillow lava, and near the vein is a biotite granite dike 6 feet wide. Coarse gold could be seen in 6 or 7 places along the vein, and pyrite is also present. Rock outcrops in this vicinity are scarce, but further trenching may reveal larger auriferous quartz veins.

Dawson

About two miles northwest of the Richardson claim across sand plains and intervening swamps is the Dawson claim, T.B. 2620, where gold was reported to have been found about October 22nd, 1915. The quartz vein strikes north and south for 400 feet and dips about 60° to the east. The vein is lenticular and will average about one foot in width. Chalcopyrite, pyrite and chalcocite are disseminated throughout the rusty quartz. The country rock is a massive, green, altered Keewatin diabase.

Devanney

On account of obtaining visible gold and high assays from the Devanney claim, near Tashota, 22 miles west of Kowkash station, as much staking has gone on around Tashota as around the Dodds' property.

The Devanney claim, T.B. 2650, lies about one and a quarter miles north of Tashota station on the northwest shore of Tashota lake. The vein strikes south 60° east and dips from 50° to 70° to the southwest. The vein is lenticular varying from a few inches up to four feet in width, and having an average width of a foot or more. It can be traced intermittently for about 600 feet. The quartz is milky, in places rusty, and contains a little fine gold, a telluride in considerable amount, also pyrite and pyrrhotite. A polished surface of the ore shows that there are probably three tellurides present. Three pieces of quartz containing a small amount of the tellurium mineral gave $27.60 in gold to the ton. The wall rock is a Keewatin greenstone consisting of chlorite, calcite and quartz. Quartz porphyry dikes occur on the claim and in the vicinity. The little trenching that has been done shows the prospect to be an interesting one.

McFarlane-Manion

At mileage 54.3 west of Grant, or four miles east of Redmond on the north side of the track on claim T.B. 2722, is a quartz-calcite vein, two to ten feet wide in a Keewatin greenstone which is said to extend across several claims in an east-west direction. Mr. McFarlane has sunk a pit 11 feet deep on the vein where it strikes south 70° east and dips 70° to the north. A one-half inch vein of galena occurs near the foot wall. Chipped samples for assay taken in three sections with a moil and hammer across the vein at the bottom of the pit gave as follows:

No. 1. 1½ ft. hanging wall part of vein, gold none; silver none.

No. 2. 3½ ft. centre of vein, gold $1.20; silver none.

No. 3. 1½ in. foot wall part of vein, containing galena, gold $6.00; silver none.

Conclusions

The Kowkash area, comprising 600 or more square miles, is similar geologically to other northern Ontario Keewatin areas, for instance, Porcupine. In these schistose rocks quartz veins are plentiful. Gold, at this early stage, is known to be widely distributed. The Dodds vein contained a small rich pocket of ore, and the Devanney vein carries a telluride in addition to gold. Enough work has not been done to prove that the gold occurs in paying quantities. Prospecting is somewhat difficult in places on account of the heavy overburden, while other parts are rocky and burned. The transportation facilities are excellent on account of the railway and splendid waterways. The area is worthy of thorough prospecting, which it undoubtedly will receive during the coming summer. Besides gold, the prospector should be on the lookout for iron ore and pyrite.

In concluding, the writer wishes to express his thanks to W. R. Rogers, topographer, and P. A. Jackson, for the preparation and production of the map.

The assays were made by W. K. McNeill and T. E. Rothwell of the Provincial Assay Office.

End of Part I.

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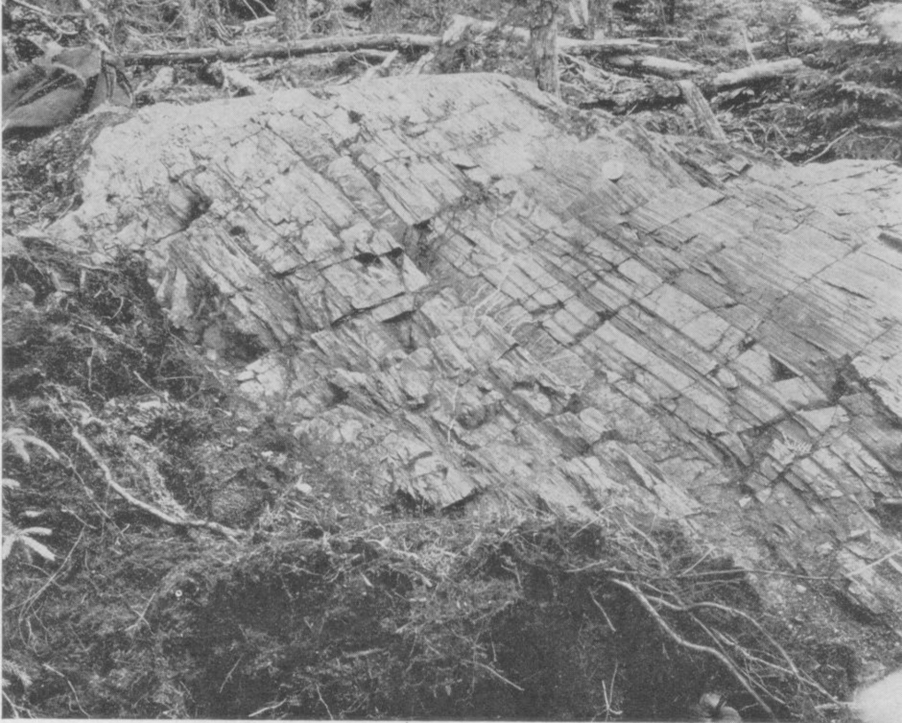
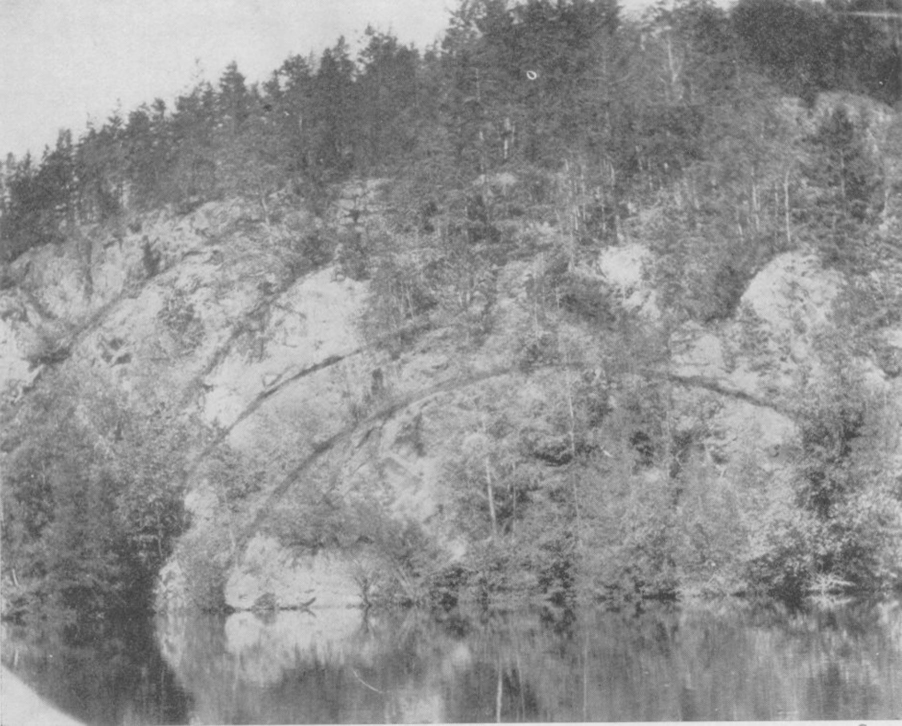
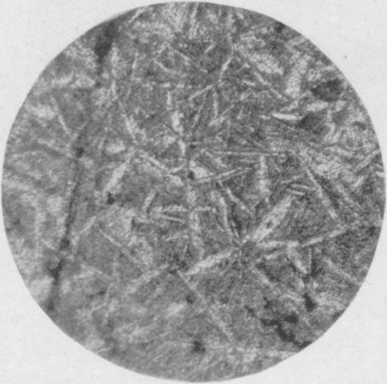
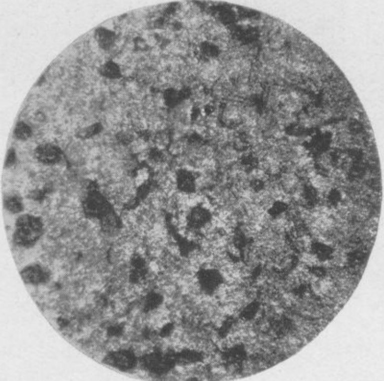
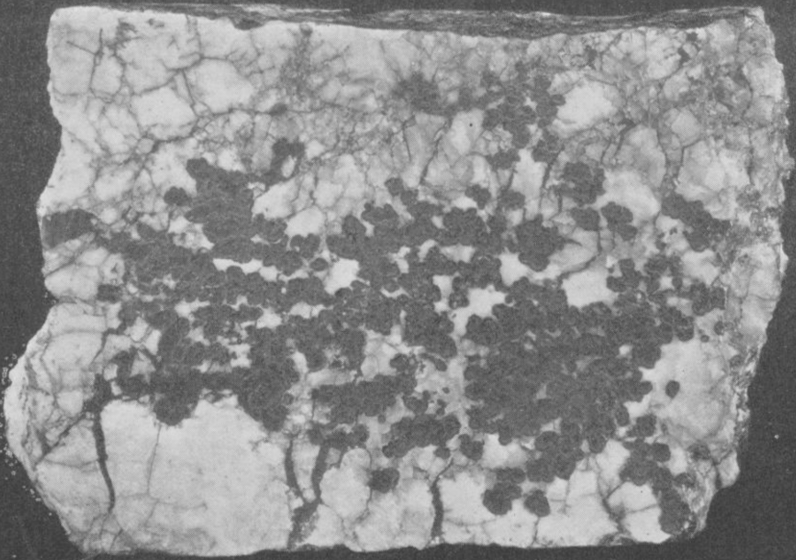
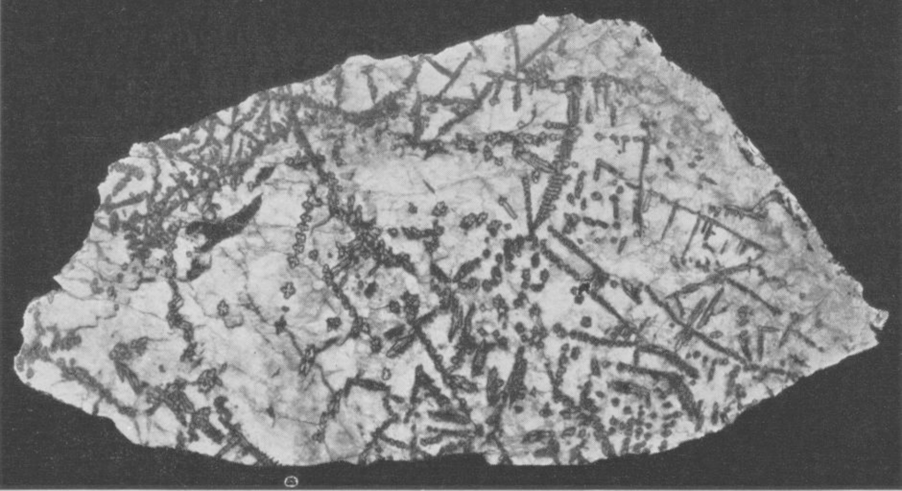












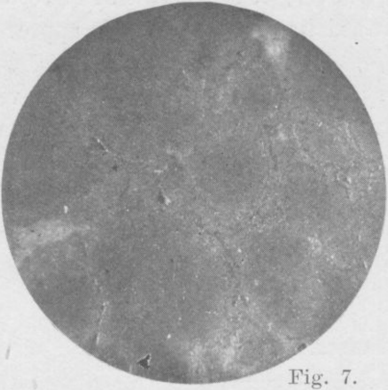


Fig. 7.

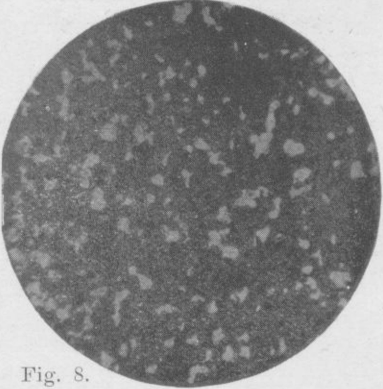
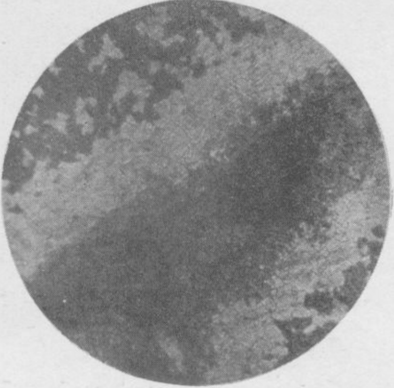
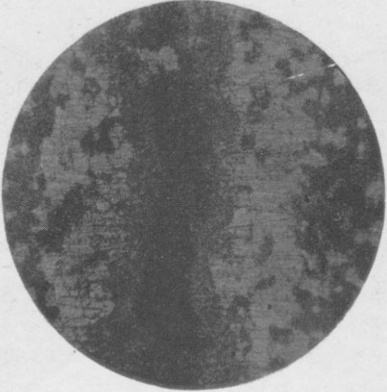
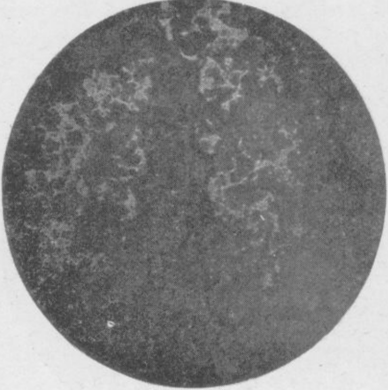
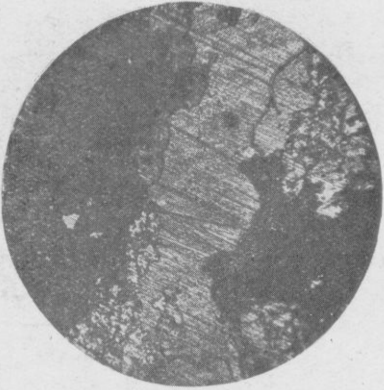


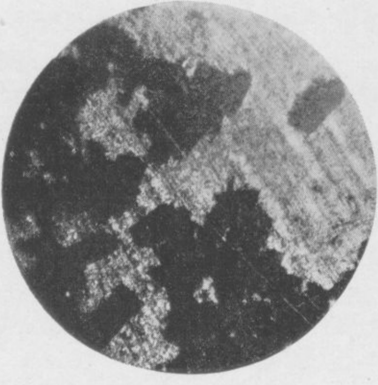
Fig. 8.

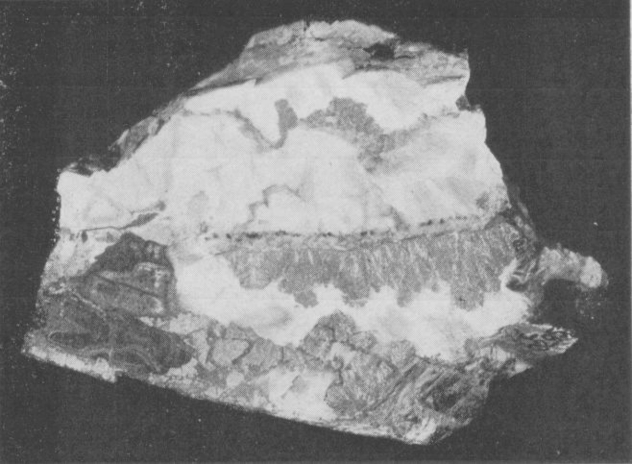


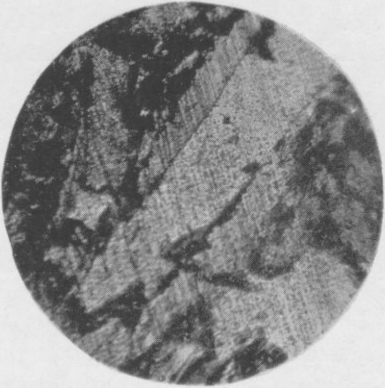


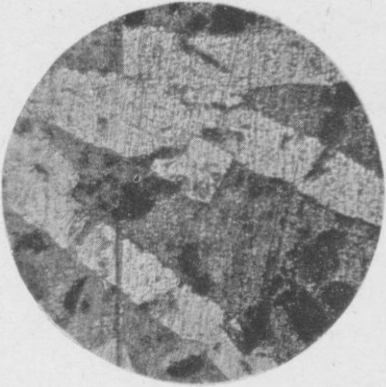


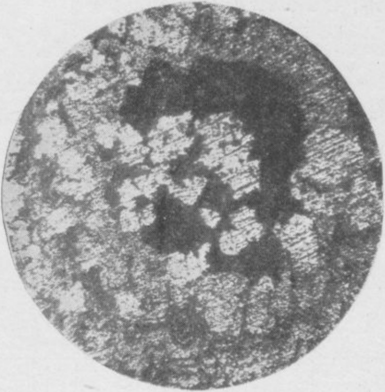


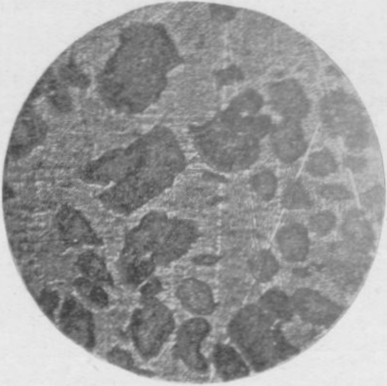


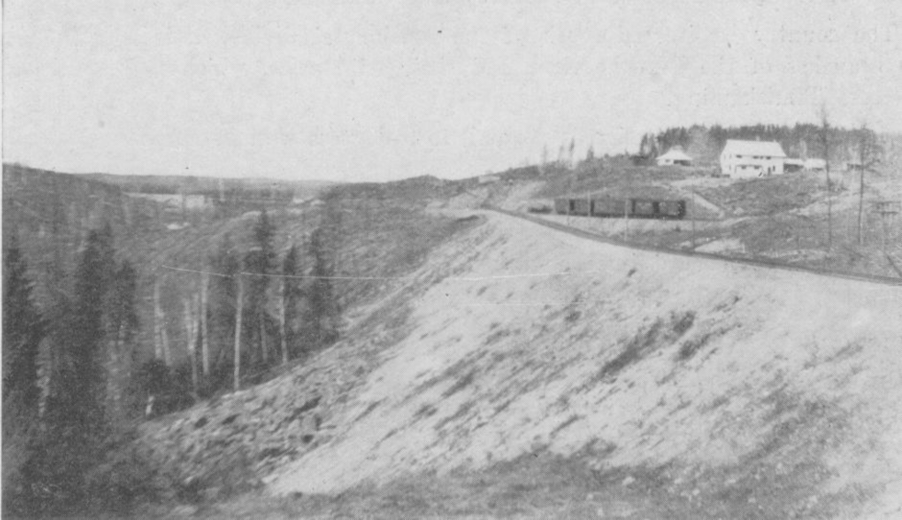













KOWKASH