SIXTEENTH ANNUAL REPORT

OF THE

BUREAU OF MINES, 1907.

VOL. XVI. PART I.

CONTENTS

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO.

TORONTO:
Printed and Published by L. K. CAMERON, Printer to the King's Most Excellent Majesty
1907

CONTENTS

ILLUSTRATIONS

Map

LETTER OF TRANSMISSION

To His Honor William Mortimer Clark, &c., &c., &c.,

Lieutenant-Governor of the Province of Ontario.

Sir,—I have the honor to transmit herewith for presentation to the Legislative Assembly the Sixteenth Annual Report of the Bureau of Mines.

I have the honor to be, Sir,
Your obedient servant,

F. Cochrane,
Minister of Lands, Forests and Mines.

Department of Lands, Forests and Mines,
Toronto, 20th March, 1907.

INTRODUCTORY LETTER

TO THE HONORABLE FRANK COCHRANE,
Minister of Lands, Forests and Mines.

SIR,—I beg to submit herewith to be presented to His Honor the Lieutenant-Governor the Sixteenth Annual Report of the Bureau of Mines, which consists of two Parts. Part I gives a statistical review of the mining industry of the Province for the year 1906, and describes the operation and results of the means adopted by the Bureau for the promotion of the industry, namely, the Government Diamond Drills, the Provincial Assay Office, and the Summer Mining Classes. A brief statement is made covering the principal amendments to the mining laws made by the Mines Act, 1906, and the boundaries are given in detail of the several Mining Divisions which have been established under that Act. Part I also contains the report of Mr. E. T. Corkill, Inspector of Mines, on the Mines of Ontario, and the following articles; two on the Iron Ranges East of Lake Nipigon, by Dr. A. P. Coleman and Mr. E. S. Moore respectively; Oil and Gas in Kent county, by Mr. C. W. Knight; Iron Pyrites in Ontario, by Mr. E. L. Fraleck; and the Larder Lake District, by Mr. R. W. Brock. All of these articles are the outcome of personal investigation on the ground by their writers, and will, it is believed, be found of interest and value.

Part II consists of the Report of Prof. W. G. Miller, Provincial Geologist, on the Cobalt silver area, first published as Part II of the Fourteenth Report, and now enlarged and revised to date. Accompanying this Report is a geological map of the Cobalt district on a scale of 400 feet to an inch, on which are shown the various working mines and prospects in the silver-cobalt field.

The present Report is the first since the changes in the status of the Bureau of Mines made by the Mines Act, 1906. The Bureau, instead of as formerly being an annex of the Department of Lands, Forests and Mines, is now an integral portion of the Department, and is brought more directly under the supervision of the Minister, the head of the Bureau being termed the Deputy Minister of Mines, instead of Director of the Bureau of Mines. These changes, being largely administrative in their nature, do not affect the functions of the Bureau or alter the scope of its operations, and this being the case, it has been thought inadvisable to make any change in the numbering or title of the Annual Report, or to make any break in the continuity of the series, which might possibly have the effect of introducing confusion.

I have the honor to be, Sir,
Your obedient servant,

THOS. W. GIBSON,
Deputy Minister.

OFFICE OF THE BUREAU OF MINES.
TORONTO, 20th March, 1907.

REPORT OF
THE BUREAU OF MINES
1907

Vol. XVI. **Part 1.**

Statistical Review

By Thos. W. Gibson, Deputy Minister of Mines

The output of the mines and mineral works of Ontario for the calendar year 1906 had a total value of $22,388,383, computed at the selling prices of the products at the mines or works, and not taking into account the additional values induced by subsequent refining or treatment. Compared with the production of 1905, up to that time considerably the largest on record, the yield for 1906 shows an increase of $4,534,087, or about 25 per cent. In view of the large step in advance taken in 1905, this result cannot be considered as other than satisfactory. A period of expansion has set in in the mining industry of the Province, and it may confidently be expected that still higher figures, both as to quantities and values, will be reached in the near future. The larger aggregate of value for 1906, as compared with that for 1905 is partly due to an increase in prices, which is somewhat general throughout the list of products, and in some cases quite marked in character; but for the greater part the excess is due to increased production, especially in the metallic schedule.

Following is a summary table of the production, showing also the number of employees and the wages paid for labor:

Table I.—Mineral Production, 1906

Product.	Quantity.	Value.	Employees.	Wages.
Metallic:		$		$
Gold .... ounces	3,926	66,193	244	152,011
Silver .... "	5,433,984	3,689,286	1,057	581,253
Cobalt .... tons	321	80,704		
Nickel .... "	10,936	3,839,419	1,632	1,246,793
Copper .... "	6,032	960,813		
Platinum metals .... ounces	314	5,652		
Lead .... tons	1,100	93,500	50	17,000
Iron ore .... "	128,049	301,032	204	125,391
Pig iron .... "	275,558	4,554,247	1,095 (a)	576,206 (a)
Zinc ore .... "	400	6,000	16	12,000
	....	13,596,846	4,298	2,710,654
Less value Ontario iron ore (101,569 tons) smelted into pig iron	....	243,766	....	....
Net metallic production	....	13,353,080	4,298	2,710,654
Non-metallic:				
Arsenic .... tons	1,440	15,858	(b)	(b)
Brick, common .... No.	300,000,000	2,157,000	3,342	1,050,055
Tile, drain .... "	17,700,000	252,500		
Brick, pressed .... "	39,860,000	337,795	358	133,604
" paving .... "	3,000,000	45,000		
Building and crushed stone	....	660,000	1,200	480,000
Calcium carbide .... tons	2,626	162,780	80	38,981
Cement, Portland .... bbl.	1,598,815	2,381,014	1,035	562,085
" natural rock .... "	8,453	6,000	27	2,694
Corundum .... tons	2,914	262,448	235	160,354
Feldspar .... "	20,773	43,849	89	40,807
Graphite .... "	1,772	15,000	41	12,000
Gypsum .... "	3,265	6,605	17	3,234

(a) Includes steel making. (b) Included in silver and cobalt.

Table I.—Continued.

Product.	Quantity.	Value.	Employees.	Wages.
		$		$
Iron pyrites.......tons	11,090	40,583	128	57,580
Lime.......bush.	2,885,000	496,785	450	151,000
Mica.......tons	355	69,041	147	48,221
Natural gas.......	....	533,446	108	64,968
Peat fuel.......tons	300	900	5	900
Petroleum.......imp. gal.	19,928,322	761,546 (c)	496 (d)	308,986 (d)
Pottery.......	....	65,000	60	17,000
Quartz.......tons	48,376	65,765	56	38,930
Salt.......“	50,414	367 738	151	69,153
Sewer pipe.......	....	279,620	213	94,768
Sodalite.......cu. feet	200	6,000	6	1,0[illegible]4
Talc.......tons	1,235	3,030	9	1,300
Non-metallic production.......	....	9,035,303	8,253	3,337,674
Add net metallic “	....	13,353,080	4,298	2,710,654
Total.......	....	22,388,383	12,551	6,048,328
Totals for 1905.......	....	17,854,296	11,151	5,082,653

(c) Value crude, not including Dominion Government bounty. (d) In petroleum refining works.

Comparing the foregoing table with the one given in last year's Report, the principal changes are seen to be in respect of the following items:

Product.	1905	1906	Change	
Metallic:	$	$		$
Silver.......	1,372,877	3,689,286	I.	2,316,409
Nickel.......	3,354,934	3,839,419	I.	484,485
Copper.......	688,993	960,813	I.	271,820
Lead.......	9,000	93,500	I.	84,500
Iron Ore.......	227,909	301,032	I.	73,123
Pig Iron.......	3,909,527	4,554,247	I.	644,720
Non-metallic:				
Brick, common.......	1,937,500	2,157,000	I.	219,500
Brick, pressed.......	234,000	337,795	I.	103,795
Cement, Portland.......	1,783,451	2,381,014	I.	597,563
Corundum.......	152,464	262,448	I.	109,984
Natural Gas.......	316,476	533,446	I.	216,970
Petroleum.......	898,545	761,546	D.	136,999

The causes leading to the above and other minor changes in value will be touched upon under appropriate headings in the subsequent pages.

It was pointed out in last year's Report[1] that the method of computing values was a highly important feature in the compilation of statistics, and that in this respect the mineral industries of Ontario had suffered in comparison with those of some of the other Provinces of the Dominion, by reason of the widely different bases adopted in valuing the mineral products. In presenting the statistics of this Province from year to year, the products have been appraised at the prices placed upon them for selling purposes at the point of production, be this mine, quarry, well or furnace; while in the case of some of the other Provinces the valuation was at the prices for which the metals or other substances would sell in some recognized market in the refined or finished form. Take an example. The copper contained in the nickel-cobalt mattes produced in the Sudbury district are valued in Table 1 of this Report at a trifle under 8 cents per pound, while in the Report of the Minister of Mines for British Columbia for 1905, when copper was worth much less than in 1906, the metal in the ore and matte, etc., is valued at 15.5 cents per pound, and in the "Mineral Production of Canada, 1906," issued by the Geological Survey of Canada, it is reckoned as being worth 19.278 cents per pound.

[1] Rep. Bur. Min. Vol. XV. Part 1, p. 2.

At the latter figure the copper raised in this Province last year was worth $2,325,698, instead of $960,813, as shown in Table 1. The same is true of nickel. The yield of this metal produced in Ontario is valued in the present Report at $3,839,419, or at the rate of 17.5 cents per pound; practically the same quantity is given by the Geological Survey Department, but it is valued at $8,948,834, or 41.64 cents per pound.

There are arguments both for and against both systems of valuation, and those in favor of the one employed by the Bureau of Mines have seemed conclusive. But it is apparent that comparisons founded on premises so divergent are likely to be misleading, and in order that no injustice may be done the mineral industries of Ontario, the figures presented in Table 1 have been recast according to the method employed by the Mines Department of British Columbia and the Geological Survey of Canada. (See Table II). It is much to be desired that some common system of statistics should be adopted by the Governments of the Dominion and the various Provinces, since official schedules dealing with the same kind of facts, in manner so diverse, cannot but be confusing.

Table II.—Mineral Production 1906; Value Refined Products

Product.		Quantity	Price	Value
Metallic:				$
Gold	oz.	3,926	$16.86 per oz.	66,193
Silver	"	5,433,984	67.892 cts. per oz.	3,689,286
Cobalt	tons	321	$2.25 per lb.	1,836,389
Nickel	"	10,936	41.64 cts. per lb.	9,107,500
Copper	"	6,032	19.278 " "	2,325,500
Platinum Metals	oz.	314	$18.00 per oz.	5,632
Lead	tons.	1,100	5.657 cts. per lb.	124,454
Iron Ore	"	128,049	$2.35 per ton.	301,032
Pig Iron	"	275,558	$16.49 " "	4,554,247
Steel	"	167,026	$25.15 " "	4,202,278
Zinc Ore	"	400	$15.00 " "	6,000
				26,218,511
Deduct value Ontario ores melted into pig iron			$ 243,766	
do value pig iron converted into steel			2,849,105	
				3,092,871
				23,125,640
Non-Metallic:				
Petroleum products per Table XVI. (p. 24)				2,506,177
Other products as per Table I				8,273,757
Gross production				$33,905,574

While both the metallic and non-metallic schedules shared in the increased production of 1906, it will be seen that, as in 1905, the metallic list has shown proportionately the larger increase, and this, too, after excluding the item steel, which has perhaps only a doubtful claim to be included in the table. The excess of metallic production last year over that for 1905 was $3,152,070, or an increase of 30 per cent. The output of metals and their ores for the first time exceeded that of non-metalliferous substances in 1905; in 1906 the former was to the latter as 1.5 is to 1. For the reason that the non-metallic list comprises many materials whose production, though capable of almost indefinite expansion, is yet strictly dependent upon the domestic demand, such as brick, stone, lime, salt, etc., while the metals are largely exported, the prospect is that the metal-producing branches of the industry will continue to grow more rapidly than those concerned with the non-metalliferous substances. It would be a mistake, however, to suppose that the latter are not making substantial progress. As a matter of fact, the aggregate value of the non-metallic products in 1906 was $1,382,017 greater than in 1905, an advance of 18 per cent. The only falling off of any moment shown on either list was in the case of crude petroleum, which was lower in value in 1906 than in 1905 by $136,999.

Table III covers a period of five years and shows the value of the various mineral products in each year both metallic and non-metallic. The increase during the term covered by the Table was 67 per cent.

Table III.—Mineral Production, 1902 to 1906

Product.	1902	1903	1904	1905	1906
Metallic:	$	$	$	$	$
Gold	229,828	188,036	40,000	99,885	66,193
Silver	58,000	8,949	111,887	1,372,877	3,689,286
Platinum	....	....	10,452	} 28,116	5,652
Palladium	....	....	18,564		
Cobalt	....	....	36,620	100,000	80,704
Copper	680,283	716,726	297,126	688,993	960,813
Nickel	2,210,961	2,499,068	1,516,747	3,351,934	3,839,419
Iron Ore	518,445	450,099	108,068	227,909	301,032
Pig Iron	1,683,051	1 491,696	1,811,664	3,909,527	4,554,247
Steel	1,610,031	304,580	1,188,349	3,321,884	....
Lead Ore	....	....	11,000	....	....
Pig Lead	....	1,500	2,500	9,000	93,500
Molybdenite	400	1,275	....	....	....
Zinc Ore	11,500	17,000	3,700	....	6,000
	7,002,499	5,678,929	5,321,677	13,113,125	13,596,846
Less value Ontario iron ore smelted into pig iron, and pig iron converted into steel	745,000	436,354	250,000	2,912,115	(*a*) 243,766
Net metallic production	6,257,499	5,242,575	4,906,667	10,201,010	13,353,080
Non-Metallic:					
Actinolite	6,150	1,650	102	....	....
Arsenic	48,000	15,420	903	2,693	15,858
Brick, common	1,411,000	1,561,700	1,430,000	1,937,500	2,157,000
Brick, paving	42,000	45,288	55,450	54,000	45,000
Brick, pressed	144,171	218,550	226,750	234,000	337,795
Building and Crushed Stone	1,020,000	845,000	700,000	700,000	660,000
Carbide of Calcium	89,420	144,000	152,295	156,755	162,780
Cement, natural rock	50,795	69,319	65,250	10,402	6,000
Cement, Portland	916,221	1,182,799	1,239,971	1,783,451	2,381,014
Corundum	83,871	87,600	150,645	152,464	262,448
Feldspar	12,875	20,046	21,966	29,968	43,849
Graphite	17,868	20,636	4,700	9,825	15,000
Gypsum	19,149	7,910	10,674	4,118	6,605
Iron Pyrites	14,933	21,693	43,716	21,885	40,583
Lime	617,000	520,000	406,800	424,700	496,785
Mica	102,500	102,205	37,847	50,446	69,041
Natural Gas	199,238	196,535	253,524	316,476	533,446
Peat Fuel	....	3,300	2,400	1,200	900
Petroleum Products	1,431,054	1,586,674	904,437	898,545	761,546
Pottery	171,325	160,000	100,000	60,0 0	65,000
Quartz	....	....	....	....	65,765
Salt	344,620	388,097	362,621	356,783	367,738
Sewer Pipe	191,965	199,971	283,000	225,835	279,620
Sodalite	....	....	....	....	6,000
Talc	930	2 625	2,919	2,240	3,030
Tile, drain	199,000	227,000	210,000	220,000	252,500
Total non-metallic production	7,134,135	7,628,018	6,665,970	7,653,286	9,035,303
Add metallic production	6,257,499	5,242,575	4,906,677	10,201,010	13,353,080
Total production	13,391,634	12,870,593	11,572,647	17,854 296	22,388,383

(*a*) Iron Ore only.

Gold

The gold mines of the Province were for the most part idle and unproductive during 1906. According to the returns made to the Bureau, some 3,926 ounces of bullion were obtained from the following properties, St. Anthony Reef, Laurentian, Sultana, Shakespeare, Olympia, Rush Bay, Golden Horn and Craig; a small amount was also recovered from the Bessemer mattes made from the nickel-copper ores raised by the Canadian Copper Company. The total value of the gold production was $66,193, a somewhat smaller yield than that for the year previous.

Gold was found in 1906 on the shores of Larder lake, which lies some distance northeast of lake Temiskaming and near the Quebec boundary line, and the many prospectors who were attracted by reports of the discoveries staked out a large number of claims, mostly during the winter of 1906-07. The rock formations of the region were not well-known in detail, but as the geologists of the Bureau were all employed in other fields, examination of the district had to be postponed until the present year. A brief sketch and geological map, the work of Mr. R. W. Brock, are given in the present volume, and it is hoped to print a fuller account and more complete map in the Seventeenth Report.

Table IV.—Gold Mining, 1902 to 1906

Schedule.	1902	1903	1904	1905	1906
Mines worked........................Number	20	19	12	13	14
Ore treated........................ tons	48,544	32,347	....	17,510	11,791
Gold product........................ ounces	13,625	10,383	2,285	5,541	3,926
Gold value........................ $	229,828	188,036	40,000	99,885	66,193
Men above ground..................Number	341	243	100	175	147
Men below ground..................Number	385	250	130	134	97
Wages paid.......... .... $	343,984	245,490	133,000	175.818	152,011

Silver

The discovery of the Cobalt silver camp was one of the most significant events in the story of the mining industry of Ontario. The region was not a remote one, being close to the shores of lake Temiskaming whose waters were known to the voyageurs of two centuries ago, and was in later times for years the scene of active lumbering operations, yet its mineral riches, though in many places lying actually on the surface, remained undiscovered until accidentally stumbled upon in the summer or fall of 1903.[2] Nothing was known of the existence of silver nearer than at the Wright mine on the Quebec side of lake Temiskaming, where the ore is argentiferous galena, a mineral not at all characteristic of the veins of Cobalt; and as for cobalt, though detected by Sterry Hunt at the Wallace mine on the shore of lake Huron fifty-five years before, it appeared to be taken for granted by mineralogists that the association of this mineral with the nickel-copper ores of Sudbury, which was speedily ascertained when the latter began to be worked, was a sufficient realization of Hunt's suggestion that other deposits might hopefully be looked for. The fact that one of the richest silver districts in America had been found, came to the general public and even to mining men, fairly familiar with conditions in Ontario, with as much surprise as if the announcement had been made of the discovery of workable diamond fields in the same locality; in the

[2] The first discovery seems to have been made by James H. McKinley and Ernest J. Darragh, described as "lumbermen and prospectors," who on 14th August 1903 made a joint application to the Department of Crown Lands for a location situated "about 600 feet southeasterly from the ninth mile, say between stations 54 and 64, south from New Liskeard, of the Temiskaming and Northern Ontario Railway line as now located and graded." The application was not accompanied by the required affidavit showing discovery of mineral, but this was supplied on 6th October, and gave the date of discovery as the 7th August previous, the find consisting of rock ascertained by assay to contain "a goodly percentage of free or native silver." According to the papers, McKinley and Darragh were joint discoverers. The location was surveyed by W. J. Blair, O.L.S. as J.B. 1, containing 32 acres. Subsequently, four acres of the bed of Cobalt (then known as Long) lake in front of J. B. 1, and the mining rights of the road allowance between these two parcels, containing two acres, were granted. The discovery on J B. 1 was developed into the well-known McKinley-Darragh mine, now owned and operated by the McKinley-Darragh-Savage Mining Company.

While silver appears to have been the first mineral of value actually discovered in Cobalt, the active history of the camp begins with the finding of niccolite (kupfer-nickel) on what is now the La Rose mine, perhaps the most famous of all the Cobalt deposits. Fred La Rose, a blacksmith employed in construction work on the T. & N. O. railway, then being graded, when not engaged in sharpening "steel" for the rock-men, was accustomed to poke about the rocks in the neighborhood of his smithy. In doing so he uncovered some pinkish material and a little digging disclosed samples of a heavy copper-colored mineral, which in reality was niccolite, hitherto found in Ontario only in minute quantity, and known practically in this Province to mineralogists only. La Rose applied to the Department on 29th September 1903 for a location described as being opposite station 113 on the T. & N. O railway about 1,300 feet from Long lake at the mouth of Rock creek about one mile from the south boundary of the township of Bucke. The date of the discovery is given in the affidavit as 15th September 1903 The claim was afterwards surveyed by John Shaw O. L. S. as J. S. 14, containing 37 acres, being a 40-acre tract less the right of way of the T. & N. O. Railway which crosses the western half of the parcel almost diagonally. La Rose's affidavit (which is signed Fred "Rose") describes his discovery as of one of copper, which was not an unnatural mistake under the circumstances, especially as La Rose was not a prospector, and knew nothing whatever about minerals. Neil A. King, a fire ranger on the T. & N. O. line subsequently (on 8th October 1903) filed a claim for 160 acres, being "80 acres south of lot 8 first range township of Bucke, also 80 acres south of lot 9 first range" of said township, a description which included the La Rose parcel. King dated his discovery on 16th May 1903, also describing the mineral found as "copper ore." A hotly contested dispute between La Rose and King—or their assignees—followed, which was decided in favor of La Rose. The latter and his associates had at first entirely failed to recognize the native silver which lay blackened by exposure in plates and nuggets on the surface of the vein, both in place and in the form of boulders. These were pointed out to them by Prof. Miller, Provincial Geologist, who visited and examined the veins in the early part of November 1903. Mr. Miller's reports really made known these remarkable discoveries to the public.

latter case the incredulity would perhaps not have been so great, since the idea had already been exploited that the diamonds found in the drift of some of the States southwest of the great lakes had their origin in the region south of Hudson Bay.

But the chief significance of the discovery lay in the disclosure which it made of the possibilities latent in the northern parts of the Province, and the impetus which it gave to prospecting. The formations in which the cobalt veins were found are widespread, and there appears no reason why other areas equally rich may not exist elsewhere. Naturally the immediate neighborhood of the valuable discoveries was the first to be examined for other deposits, and after the course of prospecting had given what seemed to be fairly definite bounds to the rich area of eastern Coleman and the southern fringe of Bucke, explorers began to go farther afield. Following up the Montreal river, whose noble flow makes a rarely equalled route for canoe travel, the conglomerate and diabase stretches lying on both sides were looked over, and in the fall of 1906, it was reported that good finds of native silver and cobalt ore had been made in at least two localities, one by a prospector named Thomas Saville in lot one in the fifth concession of the township of James, a short distance east of the Montreal river, and about 35 miles up the stream from the Temiskaming and Northern Ontario railway crossing at Latchford, and the other by the White brothers on Anvil lake, north of Lady Evelyn lake, through which the waters of the northern part of lake Temagami find their way to the Montreal river. The latter locality is within the limits of the Temagami Forest Reserve. Not much could be done by way of development before snow fell, or while it lay upon the ground, but during the winter Prof. W. G. Miller, the Provincial Geologist, visited the region and brought back samples of smaltite containing free silver, which were quite as rich as many from the Cobalt region and greatly resembled them. The thick mantle of snow which covered the ground effectually prevented anything like extensive geological investigations, but Mr. Miller's impression was that there was a considerable development of diabase in the Anvil lake region with areas of quartzite, conditions which probably obtained also in the township of James. The Bureau proposes to have these discoveries examined and the surrounding districts thoroughly explored as soon as the snow leaves the ground in the spring of 1907, and hopes to publish a report and geological map describing them in the Seventeenth Report. Meantime some thousands of claims have been staked out in the neighborhood of both finds, many of them doubtless of the kind which has come to be known as the "snowshoe" variety. But there is every prospect of the Montreal river region being thoroughly prospected during the season of 1907, and it is quite possible that a field or fields resembling the Cobalt one may as a result be opened up.

The producing mines of the Cobalt camp in 1906 were the following: Nipissing, LaRose, Coniagas,[3] Kerr Lake (Jacobs), Drummond, Buffalo, O'Brien, University, Trethewey, Cobalt Silver Queen, Right-of-Way, McKinley-Darragh-Savage, Foster, Temiscaming and Hudson Bay and Nova Scotia. A small quantity of ore was also taken from the Violet. Outside of the Cobalt region the only sources of silver were the West End Silver Mountain mine, west of Port Arthur, operated by the Hanson Consolidated Mining and Milling Company, and the Bessemer mattes refined for the Canadian Copper Company at the Orford works, New Jersey. The total production of silver was 5,433,984 ounces, worth $3,689,286, of which the Cobalt mines yielded 5,401,766 ounces.

The Provincial Mine

The opening up of a mine and the carrying on of mining operations on a commercial scale have not heretofore been regarded as coming within the customary scope of Governmental duties, and the Province of Ontario can certainly claim to have led the way in this respect in the Dominion of Canada, if not in North America. When the rich silver finds were made in the Cobalt region, the Department of Crown Lands refused to grant locations for mining purposes on what is generally known as the Gillies

[3] Co (Cobalt) Ni (Nickel) Ag (Silver) As (Arsenic) = Co-ni-ag-as, a name suggested by Prof. Miller.

timber limit, a tract of country lying on both sides of the Montreal river about 100 square miles in extent, the reason being that it contained a large quantity of green pine, the owners of which were apprehensive lest fire should be introduced if prospecting and mining were permitted on the limit. The northern apex of this tract penetrated like a wedge into the township of Coleman to a short distance south of Cobalt lake, and was therefore geographically within the favorable area for the occurrence of minerals. As a matter of fact, a small portion of the extreme end of this apex had been included in a grant to one of the early applicants for mining lands, the then owner of the limit having given his consent, and on this portion a workable deposit of silver ore had been found. It was not an unnatural suggestion that the mineralized portion of the Gillies limit should be prospected and worked on government account, and in the early and excited days of the Cobalt camp, rumors were rife regarding the great riches of the

Provincial Silver Mine

Gillies limit. The Legislature approved of the proposal and granted the necessary funds. Work began in the spring of 1906 under the direction of Prof. Miller, Provincial Geologist, whose first efforts were directed towards a study of the geology and to delimiting the favorable ground. The next step was to thoroughly prospect the promising areas with the view of locating actual veins, it having speedily been found that the reports of wonderful discoveries were largely, if not altogether unfounded. Those familiar with the Cobalt camp know what prospecting there means, and particularly what is involved in testing a tract of land thickly covered with soil. Trenches have to be sunk to bed rock through many feet of clay, gravel and boulders, and every inch of bed rock uncovered must be scrutinized with care lest the narrow cracks which occasionally contain so much richness be overlooked. Intelligent and systematic search, stimulated by the offer of a bonus of $150 per inch in width for the discovery of rich silver-bearing veins, was rewarded by the finding on 19th July 1906 of a fine seven-inch vein carrying smaltite and niccolite, accompanied by a profusion of native silver partly in sheets and nuggets, and partly disseminated in smaller particles throughout the vein matter. The actual discoverers were Messrs. Thor Brown and G. R. McLaren, two mining students who had both had experience in prospecting, and whose reward amounted to $1,050.

A shaft has been sunk in the country rock about 10 feet away from the vein, the work down to 75 feet being by contract, and thence to 120 feet by day labor. At 75 feet a cross-cut connects the shaft with the vein, on which a drift has been run to the northeast 110 feet and southwest 75 feet. The vein continues strong, rich and of full width as far as exposed.

A shafthouse 40 feet in height has been erected, and an ore house 20 by 20 feet built about 100 feet northwest of the shaft. In the power house, 34 by 50 feet, one 100-h.p. Jenckes return tubular boiler, the high pressure half of a B-3 Rand drill compressor capable of developing 450 cubic feet of air per minute, one 7 by 10-inch double cylinder Jenckes hoist, and one feed-water pump, have been installed. At Cart lake, which is 450 feet distant, a duplex Worthington pump has been placed for supplying water to the boiler. In the mine itself are one Cameron sinking pump, two No. 42 Rand drills, and two 2¾-inch Mac drills. The camp buildings consist of office 18 by 22 feet, bunk house 20 by 50, dining room 20 by 40, and blacksmith shop 12 by 15 feet. In addition, there is sufficient pipe for carrying air into the mine and keeping the latter free from water, etc.

The vein has been stripped for about 100 feet in length. On another vein adjoining the Morrison property, west of the railway track, a shaft has been sunk 50 feet deep, at which depth some 35 feet of drifting has been done.

A spur of the T. & N. O. Railway from Cobalt to Kerr lake is under construction, which will pass close to the Provincial mine and provide good facilities for shipping.

Like many of the other mines of the district the Provincial mine was hampered and progress was rendered slow by the delays experienced in procuring machinery from the makers. Contracts given on the understanding that delivery was to be made in so many weeks were not filled until the lapse of as many months. Labor conditions, too, have been unfavorable during the summer of 1907, and it was found impracticable to run a night shift because of the proximity of the sleeping camp to the railway cuts, blasts from which on several occasions sent stones through the roofs. Doubtless, however, the mine will be in position to make shipments of ore as soon as it can be hauled out over the snow.

The following table summarizes the output of the Cobalt camp since it was opened up:

Table V.—Production of Cobalt Mines, 1904-1906

Year.	Ore shipped.	Nickel.		Cobalt.		Arsenic.		Silver.		Total value.
	Tons.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Ounces.	Value.	
			$		$		$		$	$
1904	158	14	3.467	16	19,960	72	903	206,875	111,887	136,217
1905	2,144	75	10,000	118	100,000	549	2.693	2,451.356	1,360,503	1,473,196
1906	5,335	160	....	321	80,704	1,440	15,858	5,401,766	3,667,551	3,764,113
Total	7,637	249	13,467	455	200,664	2,061	19,454	8,059,997	5,139,941	5,373,526

The average value of the ore shipped during the three years was $704 per ton. For the first year, when only very rich material left the camp, the ore averaged $862 per ton; in 1905, when a large quantity of low-grade gravel was included in the shipments, it fell to $687 per ton; while in 1906 the average went up to $705 per ton, practically identical with the average for the whole period. A considerable proportion of the consignments last year was also of second or third class quality, but on the other hand there were many carloads of unusual richness. The percentage of low grade ore will in 1907 probably show an increase, but concentration plants which are now being installed at some of the mines will enable much of this grade of material to be treated in the camp. The minimum limit of ore which can be profitably shipped is about 100 ounces of silver per ton, and owing to the fact that in many of the mines free silver in films and thin sheets is found extending from the veins into the walls for a considerable distance, the quantity of concentrating rock or ore will no doubt in the aggregate prove to be large.

Table VI sets forth the course of silver mining in the Province for the last five years; in examining it the fact should be borne in mind that in 1903 the Lake Superior mines ceased work, and in 1904 those of Cobalt began. The difference between the figures for 1902-3 and for 1904-6 is sufficiently striking.

Table VI.—Silver Mining, 1902 to 1906

Schedule.	1902.	1903.	1904.	1905.	1906.
Ore raised....tons	6,250	3,400	158	3,144	9,456
Ore stamped.... "	6,250	3,360	....	....	1,500
Ore shipped.... "	....	....	158	2,144	5,335
Silver product.... oz.	96,666	16,688	206,875	2,473,452	5,433,984
Value of silver....$	58,000	8,949	111,887	1,372,577	3,689,286
Men above ground....No.	25	12	29	289	471
Men under " .... "	25	20	28	186	586
Wages paid....$	36,000	8,000	12,300	191,582	581,253

It will be observed from the statistics in the foregoing tables that the cobalt, nickel and arsenic contents of the Cobalt ores are at present of very little value to the mine-owners. As a matter of fact, they are of so little importance to them that in most cases no assays are made for anything but silver, everything else being regarded as waste. The sole exception is cobalt, which in the silver-bearing ores is paid for if in excess of 6 per cent.; in non-silver ores, of which there are some veins, it brings 60 cents per pound when the ore runs over 16 per cent. cobalt, lower percentages being settled for nearly in proportion. These rates are paid by manufacturers of cobalt oxide in Great Britain, who advance 75 per cent. of the value upon shipment, and settle for the balance on umpire assay in Britain. Nickel and arsenic bring practically no return to the sellers of ore, the figures of value set opposite the latter being for the refined white arsenic produced at the Copper Cliff reduction works, where about 1,000 tons of ore from Cobalt were treated during the year.[4]

[4] The principal purchasers of ore produced in the mines of Cobalt are the American Smelting and Refining Company, Perth Amboy, N.J., the Balbach Smelting and Refining Company, Newark, N.J., and the Orford Copper Company, Copper Cliff, Ont. The Anglo-French Nickel Syndicate, Swansea, Wales, are buyers of silver-free cobalt ore. Under date of 26th April, 1907, the American Smelting and Refining Company notified ore sellers that its terms for purchasing ore would thereafter be as follows:

"Silver: Pay for 94 per cent. of the silver contents at the New York quotation as given by Messrs. Handy and Harman to Western Telegraph Co. on the thirtieth day after agreement of assays.

"Working charge: On ores containing less than 300 ounces per ton, $10 per ton of 2,000 lbs. dry weight. On ores assaying 300 ounces or over and under 1,000 ounces per ton, $9. On ores assaying 1,000 ounces or over, and under 1,500 ounces, $8. On ores assaying 1,500 ounces or over, $25.

"Arsenic: Should arsenic be contained in excess of 5 per cent., an addition to the working charge will be made at the rate of 50 cents per dry ton for each per cent. of arsenic in excess of 5 per cent.

"Insoluble matter: An addition to the working charge will be made at the rate of 7 cents per dry ton for each per cent. of insoluble matter in excess of iron.

"Payments of net proceeds of shipments will be made on the thirtieth day after date of agreement of assays."

Shipments of ore to be accepted by the company only under regular contract for some stated period.

The Orford Copper Company's schedule for ores purchased to be treated at the reduction works, Copper Cliff, is as follows:

Payment for 94	per cent. of silver	per ton (2,000 lbs.) carrying	4,000 oz.	silver and over.
93	do	do	1,200	do
92	do	do	800	do
90	do	do	500	do
85	do	do	300	do
80	do	do	150	do

$30	per ton of ore (2,000 lbs.)	containing	12	per cent. cobalt	and over.
20	do	do	8	do	do
10	do	do	6	do	do

No payment for other metals than cobalt and silver, and ores containing more nickel than cobalt are not wanted.

Under such circumstances, it is impossible to obtain exact figures of the production of cobalt, nickel and arsenic, and those given in the foregoing tables are approximate. A very large number of assays of car lots of Cobalt ores have been made by Messrs. Ledoux and Company of New York, upon whose certificate practically all of the ore is bought and sold, and in an address to the Canadian Mining Institute in March, 1907, Dr. A. R. Ledoux states that 394 such assays showed the ore to contain on an average 5.99 per cent. of cobalt, 3.66 per cent. of nickel and 27.12 per cent. of arsenic.[5] The percentages adopted for the purpose of the tables given in this Report are cobalt 6, nickel 3, arsenic 27.

Of the several plants for the treatment of Cobalt ores, one reached completion in 1906, namely the works erected by the Canadian Copper Company at Copper Cliff. Some 998 tons of ore were here treated during the year, a considerable proportion of the silver and arsenic being recovered and the remainder shipped as speiss to the International Nickel Company's works in New Jersey for further treatment. The reduction plant at North Bay put up by the Montreal Reduction and Smelting Company, Limited, was reported completed or nearly so in the spring of 1907, but has not yet been put in operation, while the works of the North American Cobalt Refining Company, Limited, in which the Peake process experimented with at Hamilton was to have been installed, have not as yet been erected at Thorold, the site fixed upon. At Deloro in Hastings county, the gold-arsenic extraction plant formerly operated by Canadian Goldfields has been acquired by the Deloro Mining and Reduction Company, Limited, which is now refitting it with machinery required for the Kirkpatrick-Kirkegaard process, with a view of treating ores from the Cobalt camp. A fourth plant is in course of construction at Sturgeon Falls by the North Ontario Reduction and Refining Company, Limited, and a fifth is projected at Cobalt itself by Mr. Henry H. Muggley and others. There is no doubt that the metallurgical process involved in the complete separation of the four valuable ingredients of the Cobalt ores, namely silver, cobalt, nickel and arsenic, presents a good many difficulties, but there is no occasion to doubt that these difficulties will yield to skill and ingenuity, and that ere long these refractory ores will be satisfactorily treated within the boundaries of the Province.

Dividend-paying Mines

That legitimate mining operations in the Cobalt field are remunerative may be seen from the table given on the next page of the dividend-paying mines. In nearly every instance too, a large first profit was reaped before the mine was sold to the company operating it. In fact, a large proportion of the money made in Cobalt has gone to the original prospectors or their immediate successors who purchased the properties and did enough work on them to show their value. A remarkable case is that of the Temiscaming and Hudson Bay Mining Company. This was a local concern organized to exploit some iron deposits before the discoveries at Cobalt were made. In the spring of 1904 after the richness of the silver veins found in the previous autumn had been made known, the company located a number of claims close to the first discoveries. On one of these was developed the Cobalt Silver Queen Mine, which was sold to the company of that name. Subsequently, on another claim—the northeast part of lot 6 concession 6 Coleman—a rich vein was exposed which the company is now working. The original paid up capital of this company, $8,110, has been returned in dividends 92 times over, most of this being the proceeds of the sale of the Silver Queen. The shares of $1 per value have sold up to $190. Such successes, coupled with the fortunes made by private individuals, could not fail to have the effect of drawing marked attention to the camp.

Following is the table showing dividends paid up to 30th June, 1907:

[5] According to Dr. Ledoux the richest carload assayed by him contained 7,402 ounces of silver per ton, the next in order 6,909 ounces per ton and the next 6,413. Several others followed closely. From another source it is learned that in 1907 one carload consignment of 18 tons averaged 7,091 ounces, and another of 12 tons 6,208 ounces.

DIVIDENDS PAID BY COBALT SILVER MINES.

Name of Company.	Date of Incorporation.	Amount of Capital Stock Authorized	Amount of Capital Stock Issued.	Par Value of Share.	Total Dividends and Bonuses declared up to 31st December, 1906.	Dividends and bonuses declared in 1907.	When last dividend or bonus declared.	Rate of last dividend per cent.	Rate of last bonus per cent.
		$	$	$	$	$			
The Buffalo Mines, Limited	May 10, '06	1,000,000	900,000	1	27,000	81,000 00	July 10, '07	3	
The Coniagas Mines, Limited	Nov. 27, '06	4,000,000	4,000,000	5	none	200,000 00	June 17, '07	2	1
Cobalt Silver Queen, Limited	April 6, '07	1,500,000	1,500,000	1	none	120,000 00	Jan. 15, '07	8	
Foster Cobalt Mining Company, Limited.	Feb. 14, '06	1,000,000	900,000	1	45,000	none	Dec. 15, '06	5	
McKinley - Darragh - Savage Mines of Cobalt, Limited	April 17, '06	2,500,000	2,200,000	1	none	44,000 00	Jan. 21, '07	2	
The Nipissing Mining Company, Limited	Dec. 16, '04	250,000	250,000	100	950,000	400,000 00	June 20, '07	80	53½
The Right of Way Mining Company, Limited	July 13, '06	500,000	499,518	1	none	34,923 40	Mar. 5, '07	7	
Temiscaming and Hudson Bay Mining Company, Limited	July 29, '03	25,000	8,110	1	746,120	none	Nov. 14, '06	4,500	
Trethewey Silver Cobalt Mine, Limited	May 30, '06	1,000,000	945,450	1	37,818	37,818 00	Mar. 31, '07	4	
					$1,805,938	$917,741 40			

The foregoing table does not include several companies or concerns which are practically close corporations, and whose stock or properties are owned or controlled by a few individuals in each case. Under this category fall the La Rose Mining Company, the Kerr Lake Mining Company, Drummond Mines, Limited, and the O'Brien mine. Adding the profits divided among the shareholders of these companies or owners of the mines to the total of dividends and bonuses paid out as above, the net returns from the active mines of the Cobalt camp will be found to be little if any less than four millions of dollars up to the end of the first six months of 1907.

The Cobalt Boom

A word or two was said[6] in last year's Report as to the then impending "boom" in the stocks of Cobalt mining companies. The prediction was amply verified, but no warning would have sufficed to stem the tide of speculation which was then steadily rising. To follow the progress of a mining "boom" is to take a course in the study of psychology. News comes of a rich discovery; almost immediately the ground, good, bad or indifferent, surrounding the find is staked out as mining claims; a languid public is roused to interest by tales of sudden wealth; exaggerated reports of the richness of the district appear in the press; a host of joint stock companies is formed on lands of very doubtful value, but as near as possible to a known mine; shares in these companies are loudly advertised, and the public, whose appetite has by this time become whetted, buys readily. The supply of such stocks being inexhaustible, there is little or no chance for prices to go up, and when the disappointed purchasers come to look for profits or returns, they find, in some cases, a variety of excuses, in many nothing whatever. The really valuable properties are either not offered to the public at all, or if offered are for the most part capitalized too highly. In these for a time the speculative fever may send up the price of shares, but the height is quickly reached and a reaction sets in during which everybody wants to sell and none to buy. The stocks of non-operating companies become unsaleable, and those of legitimate concerns drop to something like their real value. The public is "shaken out" and loads with objurgations the mining industry, losing sight of the fact that the real causes of the loss were its own cupidity and the unscrupulousness of promoters.

This is the story of many mining camps in America, and this is what happened at Cobalt in 1906. In the fall of that year when speculation was at its height the withdrawal of the Guggenheims of New York from an option to purchase a heavy interest in the Nipissing mine precipitated a break in the stock market, from which it has not yet recovered. Though the losses were heavy, it is probable that the "slump" was a blessing in disguise, for had the excitement continued it would have become more general, and the loss when it came, with the consequent demoralization, would have been even more widespread. These recurring periods of excitement do much to hinder the development of mining as a business, and to discredit it in the eyes of people with money looking for safe and remunerative investments.

The map of the Cobalt mining area which accompanied Prof. Miller's Report, the second edition of which, consisting of 10,000 copies, was published last year, was again revised, and republished with some corrections and additions in the spring of 1907. A contoured map of the camp on a scale of 400 feet to an inch with the geology brought down to include the latest developments, is in course of preparation and will be published as soon as completed. It is the work of Prof. Miller and Mr. C. W. Knight, Assistant Geologist.

Nickel

The output of the nickel mines of the Province, 10,936 tons, was the largest yet recorded, being 1,433 tons in excess of the production of 1905, which was the greatest up to that time. Of this 160 tons was derived from the silver-cobalt mines of the Cobalt district, in which nickel occurs in the mineral niccolite, or nickelite, the remainder being from the nickeliferous pyrrhotite mines of Sudbury.

The producing companies in the Sudbury district are the Canadian Copper Company and the Mond Nickel Company. The former raised 219,220 tons of ore from the Creighton mine, and 70,515 tons from Copper Cliff No. 2. The ore extracted by the Mond Company came entirely from Victoria mine No. 1.

[6] Rep. Bur. Min. Vol. XV. Part I, p. 10.

The works of both of these companies are thoroughly well equipped, and furnish excellent examples both of mining and smelting practice. The ore is first roasted in open-air heaps to expel the sulphur and then smelted into matte, which is treated in Bessemer converters and raised in metallic contents of nickel and copper to about 80 per cent. In this form it is shipped for final separation of the metals by the Canadian Copper Company to Constable Hook, New Jersey, and by the Mond Nickel Company to Clydach, Wales. The number of workmen employed in the nickel-copper mines and works in 1906 was 1,417, and the amount of money paid out in wages was the large sum of $1,117,420. The nickel mining industry continues to play, as it has long played, a highly effective part in the development of that part of northern Ontario in which it has its seat.

Following are particulars of the nickel-copper industry for 1906 and the four preceding years:

Table VII.—Nickel-Copper Mining 1902 to 1906

Schedule.		1902.	1903.	1904.	1905.	1906.
Ore raised	tons	269,538	152,940	203,388	284,090	343,814
Ore smelted	"	233,388	220,937	102,844	257,745	340,059
Ordinary matte produced	"	24,691	30,416	19,123	....	....
High grade matte produced	"	13,332	14,419	6,926	(a) 17,388	(a) 20,364
Nickel contents	"	5,945	6,998	4,743	9,503	10,776
Copper contents	"	4 066	4,005	2,163	4,525	5,260
Value of Nickel	$	2,210,961	2,499,068	1,516,747	3,354 934	3,839,419
Value of Copper	"	616,763	583,646	297,126	688,993	806,413
Wages paid	"	835,050	746,147	570,901	833,822	1,117,420
Men employed	No.	1,445	1,277	1,063	1,176	1,417

(a) Bessemer matte.

In 1906 26,741 cords of wood valued at $61,571, were used, principally in roasting the green ore, and 59,868 tons of coke, worth $380,732 for smelting the ore. The nickel contents of the ore smelted last year, as estimated on the quantity of Bessemer matte produced, and making no allowance for loss in roasting or smelting, were 3.16 per cent., and copper 1.54 per cent.

Table No. VII does not cover the nickel contained in the Cobalt mines. The total nickel product in 1906 is shown by the following figures:

District.	Ore.	Quantity ore. Tons.	Nickel. Tons.	Nickel contents per cent.
Sudbury	Nickel-copper	340,059	10,776	3.16
Cobalt	Nickel and cobalt arsenides and silver	5,335	160	3.00
Total		345,395	10,936	

Copper

The nickel-copper mines are still the great source of the copper produced in Ontario, but the sulphide mines of the north shore of lake Huron, which do not carry nickel, are growing in output and importance. Seven mines—the Hermina, Bruce, Superior, Dean Lake and Massey Station, north of lake Huron, the Tip-top, west of Port Arthur, and Medina or Eldorado in Hastings county—raised a total of 18,836 tons of ore, estimated to contain about 772 tons of copper, or a little over 4 per cent.

The Copper Mining and Smelting Company of Ontario, Limited, a company formed in London, England, took over the old Bruce mines property in 1905, and after unwatering the workings, which are quite extensive, began drilling with two machines in August, 1906. At the close of the year they had six at work, and intended to increase the number as they opened up new ground. The Superior Copper Company operated their mine of the same name north of Sault Ste. Marie for the whole of the year, and now propose to put in an extensive plant for concentrating the ore and also for smelting purposes. About half a mile from the village of Eldorado, in the County of Hastings, occurs a deposit of copper sulphide which was at first worked as an iron mine, the upper portion having been oxidized into hematite and the copper and sulphur leached out by atmospheric action and water. After a considerable quantity of iron ore had been removed, copper pyrites began to be encountered in increasing quantity, and diamond drill boring revealed the fact that the iron was merely a surface deposit, copper being the chief mineral of value below. A smelter has been erected at this mine.

In past Reports statistics of the non-nickeliferous or purely copper mines have been included in those of nickel-copper mines, but the figures are now sufficiently important to warrant their being presented separately:

Non-Nickeliferous Copper Mines 1906

Ore raised	tons	18,836
Estimated copper in do.	"	772
Value of do.	$	154,400
Ore smelted	tons	2,660
Matte produced	"	117
Value of do.	$	24,576
Wages paid	$	129,373
Workmen employed	No.	215

Iron Ore

Of iron ore the output in 1906 was 128,049 tons valued at the mine at $301,032, as compared with 211,597 tons worth $227,909 in 1905. The bulk of the ore was hematite from the Helen mine in Michipicoten, the remainder being magnetite from the Radnor mine near Eganville, owned by the Canada Iron Furnace Company, and the Mineral Range Company's mines near L'Amable in the county of Hastings. The last named company have been developing their properties for several years past under the management of Mr. H. C. Farnum, and are now in a position to ship a considerable tonnage of ore per day, a spur line having been built to connect the mines with the Central Ontario railway. Engagements have been made to fill orders for the blast furnaces at Midland and Sault Ste. Marie, the ore being of desirable quality.

The magnetite deposits in Hutton township, north of Sudbury, have been under development for some time, and are very promising both as regards the extent and character of the ore. The branch of the Canadian Northern railway from Sudbury to Moose Mountain has been nearly completed and shipments of ore will no doubt be made during the season of 1907. In Ogelbay, Norton and Company's handbook of Lake Superior Iron Ores, Cleveland, 1907, the following analysis is given of consignments of Moose Mountain ore:

	Per cent.
Iron	54.06
Phosphorus	.097
Silica	12.94
Manganese	.019
Alumina	1.18
Lime	3.51
Magnesia	3.07
Sulphur	.010
Titanium	None
Moisture	2.60

The guarantee of metallic iron contents is given as 54 per cent., the ore being in its natural condition.

Iron ore has been found in the township of Wisner, north of Sudbury, and the deposits at Burwash lake in the Temagami Forest Reserve, east of Moose Mountain, have been under exploration by the diamond drill. The drilling is being done by Messrs. Mackenzie and Mann.

It has long been known that the Iron formation characteristic of northern and northwestern Ontario attains a considerable development in the unsurveyed territory east of lake Nepigon, and last year an examination of that region was undertaken by Dr. A. P. Coleman, assisted by Mr. E. S. Moore. The results of their labors are set forth in the present volume under the title "Iron Ranges East of Lake Nepigon." The work not having been completed, it is proposed to continue it during the field season of 1907. For the same reason it has been thought better to postpone publication of the geological map which accompanied the report of Messrs. Coleman and Moore until the field work has been more fully covered.

Table IX sets out the iron ore production of the Province during the five years beginning with 1902:

Table IX.—Iron Ore Production, 1902 to 1906

Schedule.	1902.	1903.	1904.	1905.	1906.
Ore shipped.....tons	359,288	208,154	53,253	211,597	128,049
Value of ore shipped.....$	518,445	450,099	108,068	227,909	301,032
n employed.....No.	388	324	191	278	204
Wages paid.....$	228,534	166,457	84,673	161,153	125,391

Pig Iron and Steel

There were produced in the blast furnaces of Ontario during the year 1906, 275,558 tons of pig iron valued at $4,554,247, as compared with 256,704 tons worth $3,909.527 in 1905. The number of furnaces in operation remained the same, namely, five, situated at Hamilton, Deseronto, Midland and Sault Ste. Marie. The Province's capacity for pig iron production in undergoing enlargement, as the blast furnace at Port Arthur in which it is proposed to smelt the output of the Atik-okan mines was nearly completed at the end of the year, and early in 1907 the construction of a new furnace by the Hamilton Steel and Iron Works at Hamilton was well under way. This furnace was being erected by Frank C. Roberts and Company of Philadelphia. The measurement of the stack was 85 feet high by 22 feet 6 inches in diameter, and the new furnace will enable the company to increase its pig iron product by 110,000 gross tons per annum. It is expected to go into operation in July or August, 1907. In addition the company are erecting a fourth open-hearth steel furnace under the supervision of Alex. Laughlin and Company of Pittsburg, which when completed will nearly double their production of steel bars. The production of steel in the Province was as shown in the table below. Of the pig iron, output 49,907 net tons were used by the Hamilton Steel and Iron Company in the production of steel ingots and castings, while the whole product of the Algoma Steel Company at Sault Ste. Marie was converted into steel rails. The latter company are installing a plant for the production of openhearth steel, their present works being for the Bessemer process.

Following are details of the operation and production of the blast furnaces and steel works in 1906:

Ontario ore smelted.....	tons	101,569
Foreign " "	"	396,463
Scale and mill cinder.....	"	24,282
Limestone for flux.....	"	153,702
Coke for fuel.....	"	304,676
Value of do.....	$	1,589,941
Charcoal for fuel.....	bush.	811,926
Value of do.....	$	32,477
Pig iron product.....	tons	275,558
Value of do.....	$	4,554,247
Steel product.....	tons	167,026
Value of do.....	$	4,202,278
Workmen employed.....	No.	1,095
Wages paid.....	$	576,206

It will be seen that of the total quantity of ore charged into the blast furnaces last year only 101,569 tons, or some 20 per cent. was of domestic origin, the remainder being imported from the United States. Several reasons have operated in favor of the use of iron ores from south of the line. One is the enormous and constant movement of ore cargoes from lake Superior ports to eastern furnaces, which enables supplies of ore of any desired kind to be easily obtained at current prices, and another is the fact that there are very few iron mines in Ontario in a position to maintain shipments of ore on any considerable scale. The former advantage can be freely availed of by Ontario furnace men because of the absence of any import duty on ore brought from the United States, Canadian fiscal arrangements being such as to impose no such obstacle to the use of foreign ores as the U. S. tariff, for instance, with its impost of 40 cents per gross ton, places on Canadian ores. The Helen mine has for years been the chief source of iron ore within the limits of the Province which could be drawn upon by blast furnaces here, but this paucity of supply is likely to disappear in large degree at an early date, with the opening up of the Moose Mountain and Mineral Range mines. It must be remembered, too, that all ores are not suitable for all purposes. Hence, although a large proportion of the Ontario ore produced which comes from the Helen mine is exported to the United States, the practical effect is that it is exchanged there for other ores better suited for the manufacture of steel rails by the Bessemer process as carried on by the Algoma Commercial Company at Sault Ste. Marie.

Particulars with regard to the operations of the pig iron and steel making industry for the last five years are as follows:

Table X.—Production Iron and Steel, 1902 to 1906

Schedule.	1902.	1903.	1904.	1905.	1906.
Ontario ore smelted.....tons	92,883	48,092	50,423	61,960	101,569
Foreign ore smelted..... "	94,079	103,137	173,182	383,459	396,463
Limestone for flux..... "	58,885	49,426	61,566	121,052	153,702
Coke..... "	111,390	96,540	135,108	262,415	304,676
Charcoal.....bush.	968,623	932,630	1,821,270	3,387,869	811,926
Pig iron.....tons	112,687	87,004	127,845	256,704	275,558
Value of pig iron..... $	1,683,051	1,491,696	1,811,664	3,909,527	4,654,247
Steel.....tons	68,802	15,229	51,002	138,387	167,026
Value of steel..... $	1,610,031	304,580	1,188,349	3,321,884	4,202,278

Lead

Pig lead was produced last year to the extent of 1,100 tons, the ore being extracted from the mines of the Stanley Smelting Works and smelted at the Company's furnace at Bannockburn, Hastings county. The quantity of ore raised was 1,950 tons and the quantity smelted 1,600 tons, the pig product having a value of $93,500. The capacity of the Stanley Smelting works is about seven tons of pig lead per day.

Zinc Ore

Some 400 tons of zinc ore were raised during the year from the Olden zinc mine in the county of Hastings, worth $6,000.

Building Materials

That building operations were actively carried on during the past year is clear from the returns made of the production of materials used for construction purposes. The larger cities and towns have nearly all experienced a shortage of dwelling houses, and the higher scale of rentals has had the natural result of bringing about the erection of a very large number of new houses; this, too, in the face of the steadily increasing cost of building. The demand for building materials for railway construction and other public improvements has also been very considerable.

The output of common brick, according to returns to the Bureau, was 300 million worth $2,157,000, as compared with 250 million valued at $1,937,500 in 1905. Pressed brick rose from 26,000,000 worth $234,000 in 1905 to 39,860,000 worth $337,795 in 1906. The brick yards in and around Toronto have for several years had difficulty in meeting the demand, and prices in that market have increased in consequence. Taking the Province as a whole, however, there has been a slight fall in the average price of bricks as compared with 1905, the value having gone back practically to the level of 1904. The tendency to higher prices for bricks has been manifest for a series of years, as the following figures show, 1906 being the first year in which this tendency has been suspended.

Year.	Price per M.
1901	$5 73
1902	6 41
1903	6 78
1904	7 15
1905	7 75
1906	7 19

The advancing prices have beyond doubt been due to the increasing cost of labor, fuel and plant, as the raw material is of comparatively little monetary value, and exists in enormous—it may be said, inexhaustible—quantities distributed over the whole of the Province.

Other clay products were pressed and paving brick, pottery and sewer pipe, which were made in about the usual quantity. An exception ought perhaps to be made in the case of pottery, the domestic manufacture of which does not seem to be flourishing. The causes for this lack of progress appear to be severe competition from imported goods, and the scarcity of suitable clay for the finer articles. The glacial deposits of Ontario are rarely pure enough or sufficiently uniform in composition to furnish clay of the requisite composition for any but the common varieties of pottery. There are three factories for the production of sewer pipe, namely those of the Toronto and Hamilton Sewer Pipe Company at Hamilton, the Ontario Sewer Pipe Company at Mimico, and the Dominion Sewer Pipe Company at Swansea. The first named plant was burned down in April, 1906, but new buildings were erected and the works again put in operation about the beginning of December.

The output of stone for builders' use remained at about the same level as in former years, and was supplemented by a very considerable production of crushed stone for road-making and fluxing purposes. The rapidly growing use of Portland cement which is now employed so extensively for foundations, bridges and even whole structures, has undoubtedly interfered with the development of the quarrying industry in Ontario, as well as in other places. The Province is well supplied with the raw material for this industry, and admirably situated for carrying it on to advantage, especially with our neighbours to the south, by reason of cheap water transportation. Nevertheless, it is a fact that the limestones, granites and marbles of eastern Ontario, the dolomites, sandstones and limestones of southeastern Ontario, and the traps, granites and sandstones of the north, have not yet begun to play that part in the economic life of the Province of which they are capable. In part this may be due to adverse tariffs, but perhaps also in part to other causes of a nature likely to disappear before skill, enterprise and capital.

The quantity of lime turned out by the kilns of Ontario in 1906 was 2,885,000 bushels, as against 3,100,000 bushels in 1905. Returns show a decided advance in price, the average value per bushel in 1906 being 17.2 cents, as compared with 13.7 cents in 1905.

Cement

Very few departments of the mineral industry can exhibit so remarkable a record of steady and rapid growth as the manufacture of Portland cement. Beginning in 1891, the production has increased from 2,033 barrels valued at $5,082, to 1,598,815 barrels in 1906 worth $2,381,014, and the number of manufactories has risen from one to twelve. The raw materials, marl and clay, are abundant, and the demand for cement has been, and still is, very active. In consequence of this demand, the increase in production has been accompanied by an advance in price, the average cost per barrel at the factory having risen from $1.42 in 1905 to $1.48 in 1906. It seems in every way likely that the production and sale of cement will show a corresponding increase in 1907.

The cement plants which were in operation during 1906 were the following: Raven Lake Portland Cement Company, Raven Lake; Imperial Cement Company, Owen Sound; Belleville Portland Cement Company, Point Ann; Lakefield Portland Cement Company, Lakefield; Canadian Portland Cement Company, Marlbank; National Portland Cement Company, Durham; Grey and Bruce Portland Cement Company, Brookholm; Owen Sound Portland Cement Company, Shallow Lake; Ontario Portland Cement Company, Blue Lake; Sun Portland Cement Company, Owen Sound; Western Ontario Portland Cement Company, Atwood; Hanover Portland Cement Company, Hanover. Two plants, those of the Colonial Portland Cement Company, Wiarton, and the Superior Portland Cement Company, Orangeville, had not been completed at the close of the year.

Nearly all of the Portland cement manufactories hitherto established in Ontario have made use of marl as one of the ingredients, but there is a tendency towards substitution of solid limestone, where this can be obtained of suitable composition, as it is believed the cost of production can in this way be lessened. The limestone beds at Point Ann on the Bay of Quinte are utilized by the Belleville Portland Cement Company, but all the other plants in the list given above use marl.

The manufacture of natural rock cement, on the other hand, has exhibited a decidedly downward tendency of late years, and from the returns of 1906 appears to be on the point of extinction. In 1901 there were made 138,628 barrels valued at $107,625, while in 1905 three factories produced 14,741 barrels worth $10,402, and the same number of plants turned out in 1906 only 8,453 barrels, valued at $6,000. Nearly the whole of this output was from one factory, the other two having practically suspended operations. The reason assigned for this state of affairs by the manufacturers is the general preference shown by builders and the public generally for Portland cement. Doubtless this preference is due to some extent at least to the more uniform composition, and hence more satisfactory results, of Portland cement as compared with the natural rock article. For a variety of uses, however, where homogeneity is not essential, the latter is quite as useful and considerably cheaper. It is therefore matter for regret that its manufacture appears to be coming to an end.

Table XI.—Production of Cement, 1891 to 1906

Year.	Natural Rock.		Portland.		Total.	
	Bbl.	Value. $	Bbl.	Value. $	Bbl.	Value. $
1891	46,178	39,419	2,033	5,082	48'211	44,501
1892	54,155	38,580	20,247	47,417	74,402	85,997
1893	74,353	63,567	31,924	63,848	106,277	127,415
1894	55,328	48,774	30,580	61,060	85,903	109,834
1895	55,219	45,145	58,699	114,332	113,918	159.477
1896	60,705	44,100	77,760	138,230	138,465	182,330
1897	84,670	76,123	96,825	170,302	181,495	246,425
1898	91,528	74,222	153,348	302,096	244,876	376,318
1899	139,487	117,039	222,550	444,228	362,037	561,266
1900	125,428	99,994	306,726	598,021	432,154	698,015
1901	138,628	107,625	350,660	563,255	489,288	670,880
1902	77,300	50,795	522,899	916,221	609,199	967,016
1903	89,549	69,319	695,260	1,182,799	784,809	1,252,118
1904	85,000	65,250	880,871	1,239,971	965,871	1,305,221
1905	14,741	10,402	1,254,360	1,783,451	1,269,101	1,793,853
1906	8,453	6,000	1,598,815	2,381,014	1,607,268	2,387,014
Totals	1,200,717	956,354	6,303,557	10,011,326	7,513,274	10,967,680

Corundum

There were produced from the corundum mines of Renfrew and Hastings counties in 1906, 2,914 tons of grain corundum valued at $262,448. This is a decided increase over 1905 when the output was 1,681 tons valued at $152,464. The operating companies are the Canada Corundum Company and the Ashland Emery and Corundum Company. The mines and concentration plant of the former are at Craigmont in the county of Renfrew, and of the latter at Burgess Mines, Hastings county. Most of the production of 1906 is to be credited to the Canada Corundum Company.

Table XII gives particulars of the corundum industry during the last five years:

Table XII.—Production of Corundum, 1902 to 1906

Schedule.	1902.	1903.	1904.	1905.	1906.
Corundum produced.............................tons	1,137	1,119	1,665	1,681	2,914
Value of product.................................$	83,871	87,600	150,645	152,464	262,448
Workmen ....No.	95	186	202	216	235
Wages paid ....$	34,674	106,332	139,548	109,128	160,354

Feldspar

The quarrying of feldspar for use in the manufacture of pottery, enamelled ware, etc., is developing into an industry of some importance. It has its seat in the county of Frontenac on the Kingston and Pembroke railway. The rock is blasted out on the open-work system, and is shipped to Ohio and New Jersey for use as above. The producing companies last year were the Kingston Feldspar and Mining Company, the Kingston Mining and Development Company, and the Verona Mining Company. The quantity of feldspar raised during the year was 20,378 tons valued at $43,849; 89 workmen were employed, to whom wages were paid amounting to $40,807.

Hitherto all the feldspar exported has come from the above locality, principally from the neighborhood of Verona, but large deposits of apparently available rock have recently been found in the township of South Canonto, in the same county, which are being developed.

Table XIII gives statistics of feldspar production for the last five years:

Table XIII.—Production of Feldspar, 1902 to 1906

Schedule.	1902.	1903.	1904.	1905.	1906.
Feldspar raised ....tons	8,776	15,296	10,983	12,234	20,373
Value of product.................................$	12,875	20,046	21,966	29,968	43,849
Workmen employed.............................No.	66	51	34	52	89
Wages paid ....$	10,250	14,089	16,300	19,200	40,807

Iron Pyrites

There was an increased production of iron pyrites in 1906 as compared with 1905, the output being 11,090 tons worth $40,583, while in 1905 it was 7,325 tons valued at $21,885. The producing companies were the American Madoc Mining Company, which has two mines, one near Bannockburn and the other near Tweed; the British American Company, whose mine is near Queensboro; the Northland Mining Company, which has begun mining on a deposit at Rib lake on the Temiskaming and Northern Ontario railway, and the Lake Superior Power Company. The last named Company raised a quantity of the pyrite found in the Helen iron mine, where its associations with the iron ore of that mine have attracted the attention of geologists.[7]

The element sulphur is widely distributed throughout the mineral-bearing rocks of Ontario; indeed it may be said to be present in one form or other in most, if not all, of the metallic deposits hitherto worked. From the nickeliferous pyrrhotites of the Sudbury region, which are worked so extensively for their nickel and copper contents, thousands of tons of sulphur are expelled every year as sulphurous fumes into the open air; the copper ores of Ontario are wholly sulphides, with the exception of the native copper found on the northern and eastern shores of lake Superior; in the auriferous quartz veins of the northwestern part of the Province, iron pyrites usually occurs more or less abundantly and generally carries part of the gold values; sulphur is of course an essential constituent of the mispickel deposits of Hastings county and northeastern Ontario, of the galena of Frontenac and Hastings, and the zincblende of eastern Ontario and the Port Arthur region; it is a minor constituent of the cobalt and nickel arsenides of Cobalt and enters into combination with the silver of those deposits to form argentite, the same being true of the silver ores of lake Superior; and as disseminated pyrite it occasionally contaminates the iron ores of eastern and northern Ontario. In chemical union with calcium it constitutes the gypsum beds of the Grand river and the James bay slope, and even in the petroleum of southwestern Ontario it makes its presence known and requires to be eliminated in refining. In most of these minerals sulphur is a deleterious, or at the best a redundant ingredient, although in some, as in the nickel-copper ores of Sudbury, it can be utilized in the process of reduction as a source of heat, and from none of them by present methods of treatment can this substance, so useful when isolated, be economically extracted. But when united with iron as iron pyrites, or FeS_2, the sulphur can by roasting be dissociated from the iron and recovered by one or other of the two processes now chiefly employed in the manufacture of sulphuric acid. The use of this acid lies at the foundation of a very large part of the chemical industry, and as investigation of the mineral resources of this Province proceeds, it becomes apparent that in Ontario we have widely distributed very large supplies of the raw material out of which sulphuric acid is made, the possession of which makes possible the establishment and successful prosecution of many diverse and important manufactures. Under instructions of the Bureau of Mines, Mr. E. L. Fraleck, M.E., undertook an examination of the various known pyrites deposits of the Province, and his report under the heading "Iron Pyrites in Ontario" in the present volume will be read with interest.

Table XIV presents statistics of the iron pyrites industry for five years past.

Table XIV.—Production of Iron Pyrites, 1902 to 1906

Schedule.	1902.	1903.	1904.	1905.	1906.
Pyrites raised .... tons	4,371	7,469	13,451	7,325	11,090
Value of do. .... $	14,993	21,693	43,716	21,885	40,583
Workmen employed .... No.	45	39	60	68	128
Wages paid .... $	6,585	16,327	22,875	27,690	57,580

Mica

The production of mica in this Province is now largely in the hands of large operators, of whom the General Electric Company is chief. Under the name of the Loughborough Mining Company, Limited, this company raised large quantities of mica

[7] A. P. Coleman and A. B. Willmott in 11th Rep. Bur. Min., p. 170; A. P. Coleman in 15th Rep. Bur. Min., p. 188; W. G. Miller in 12th Rep. Bur. Min., p. 103, etc. See also E. L. Fraleck's description of the deposit in "Iron Pyrites in Ontario" in the present volume.

from the Lacey mine near Sydenham, and also from its properties near Perth. Other producers were the Financial Development Company (Martha mine), Kent Bros., Kingston, (Bedford township), J. W. Trousdale, (Gould lake), James Richardson Sons, Kingston, (Richardson mine), and W. L. McLaren, Perth, (North Burgess township). The production was returned as 355 tons of rough-cobbed mica, worth $69,041. Most, if not all, of this was of the amber variety.

Canadian mica, whether from the mines of Ontario or Quebec, has a good reputation for flexibility, freedom from stains, etc., and has been introduced into the markets of Great Britain with some success. In European markets, however, it has a strong competitor in Indian mica, and trial shipments made to France have not met with favor, being composed of pieces too small in size, and accompanied by terms of payment, etc., not acceptable to French buyers. At present the mica mined in Ontario goes mainly to the United States.

Salt

From the salt wells of the Province 50,414 tons of salt were raised in 1906, having a value of $367,738. This is a falling off in quantity but an increase in value as compared with the output of 1905, when the quantity produced was 60,415 tons worth $356,783. The bulk of the salt made in Ontario comes from the wells of the Canadian Salt Company, Windsor; the other producers in 1906 were the Exeter Salt Company, Exeter; Gray, Young and Sparling, Limited, Wingham; R. & J. Ransford, Clinton and Stapleton; Ontario People's Salt and Soda Company, Kincardine; and the Parkhill Salt Company, Parkhill. The number of hands employed in the raising and manufacture of salt was 213, to whom $94,768 was paid in wages.

Table XV gives statistics of the salt industry for five years ending with 1906.

Table XV.—Production of Salt, 1902 to 1906

Schedule.	1902.	1903.	1904.	1905.	1906.
Salt produced ....tons	62,011	58,274	55,877	60,415	50,414
Value of salt produced .... $	344,620	388,097	362,621	356,783	367,738
Workmen employed .... No.	198	208	183	148	151
Wages paid .... $	76,154	87,995	84,682	68,580	69,153

Petroleum

The oil fields of Lambton and Kent counties continue to furnish the whole of the oil produced in Ontario, and practically the whole of the oil produced in Canada. It is only natural that during the forty years and more for which the oil fields of Petrolea and Oil Springs have been yielding oil, there should be a diminution in the rate of production. Formerly, the whole of the oil came from the Corniferous formation, and it would seem that these reservoirs are showing symptoms of gradual depletion; but latterly, more deep-seated strata have proven to be oil-bearing, and wells in the Guelph, Medina and Clinton formations are now yielding largely and promise to counteract the lessening flow of the older fields. In the township of Tilbury East a new field, apparently of considerable extent, and a smaller pool in the township of Romney, were brought in last year, particulars of which are given elsewhere in this Report. The yield of crude in 1906 was 19,928,322 Imperial gallons valued at $761,546, as compared with 22,131,658 Imperial gallons worth $898,545 in 1905. The decrease in considerable, but the quantity is greater than in any year since 1902 save 1905. The value of the oil as given does not include the bounty of one and one-half cents per Imperial gallon paid by the Dominion government. There can be little doubt that this bounty acts as a stimulus to the production of crude oil in this Province. For purposes of this bounty all crude oil produced in this or any other Province is required to be reported to the Department of Trade and Commerce, Ottawa, to whom the Bureau is indebted for courteously furnishing the figures of production. The only other source of crude oil in Canada is New Brunswick, from which an output of 13,035 gallons was reported last year. A slightly different estimate of production in Ontario is made by the Imperial Oil Company of Sarnia, whose sources of information are unquestionably good. This company places the output at 585,328 barrels, or 20,486,483 gallons, and credits it by districts as follows:

	Bbl.
Dutton	18,596
Leamington	35,957
Wheatley	775
Bothwell	43,836
Richardson (Chatham)	1,376
Thamesville	1,584
Moore Township	53,029
Oil Springs	68,099
East Tilbury	115,400
Pelee Island	378
Petrolea	246,292
Total	585,328

The highest price which crude oil reached during the year was $1.38 per barrel on the 25th April, and the year closed at the lowest figure, $1.30 per barrel. The average price, not including the Dominion bounty of 52½ cents, was $1.3375 per barrel.

The crude oil produced by Ontario wells is not now sufficient to meet the requirements of the home market, or equal to the capacity of Ontario refineries, of which there are two—the Imperial Oil Company works at Sarnia, and the Canadian Oil Refining Company's plant at Petrolea. The removal of the duty of two cents per gallon formerly imposed on imported crude permits the refiners to make free use of American oil, and of the total quantity of oil distilled during the year, namely 36,134,349 gallons, 16,679,544 gallons, or 46 per cent. was imported from the United States. In 1905 the proportion of imported crude distilled was only 34 per cent.

The article entitled "Oil and Gas in Kent" in this Report, by Mr. C. W. Knight, presents data regarding recent developments in this new field.

Table XVI gives statistics of the crude oil and petroleum products for 1906, and comparative figures for the four preceding years:

Table XVI.—Petroleum and Petroleum Products, 1902 to 1906

Schedule.		1902.	1903.	1904.	1905.	1906.
Crude produced	Imp. gal.	18,185,592	16,640,338	17,237,220	22,131,658	19,928,322
Crude distilled	"	15,630,592	14,464,248	22,805,109	33,821,998	36,134,349
Value crude produced	$	940,104	1,024,597	904,437	898,545	761,546
Value distilled products	"	1,298,961	1,451,756	1,670,805	2,196,678	2,506,177
Illuminating oil	Imp. gal.	7,720,866	7,096,073	11,461,435	16,433,588	16,125,450
Lubricating oil	"	2,765,677	2,614,313	2,683,281	3,402,977	4,351,818
Benzine and naphtha	"	902,847	832,153	1,488,503	2,827,971	3,497,954
Gas and fuel oils and tar	"	2,157,039	1,968,172	1,962,752	5,788,351	5,961,834
Paraffin wax and candles	lb.	2,433,[illegible]27	2,673,806	2,272,511	4,077,610	5,011,467
Workmen employed	No.	323	291	406	469	496
Wages paid	$	169,398	165,700	229,955	280,701	308,986

Natural Gas

The output from the natural gas wells of the Province in 1906 showed a marked increase over that for 1905, the value of the product being $533,446 as against $316,476. This result is largely due to the development of the Haldimand county field, in which the Dominion Natural Gas Company is the largest producer. In the Welland county field the Provincial Natural Gas and Fuel Company and the Mutual Natural Gas

Company are the chief operators. From its wells in Welland the Provincial Company pipes a large part of the product to Buffalo, N. Y., and supplies as well several towns and villages in Ontario. The Dominion Company in the Haldimand field sends gas to Hamilton, Dundas, Brantford, Galt, Paris and a number of other places. In the county of Essex the Leamington Oil Company obtains a sufficient supply for the wants of the inhabitants of that town. Some of the oil wells sunk in the new Tilbury and Romney fields yield a good deal of gas.

Table XVII shows the course of the natural gas industry during the past five years.

Table XVII.—Natural Gas Production, 1902 to 1906

Schedule.		1902.	1903.	1904.	1905.	1906.
Value gas produced	$	199,238	196,535	253,324	316,476	533,446
Producing wells	No.	169	210	176	273	332
Producing wells sunk	"	18	20	36	58	77
Non-producing wells sunk	"	13	12	13	5	14
Delivery pipe	miles	369	312	231	461	550
Workmen employed	No.	107	138	98	130	108
Wages paid	$	55,618	79,945	53,674	88,865	64,968

Of the producing wells 225 were in the Welland county field, and 104 in the Haldimand county field.

Minor Products

Arsenic is at present not being mined for itself, but is a by-product of the Cobalt ores. It is estimated that some 1,440 tons of arsenic were contained in the shipments made from that camp during the year. Of this some 200 tons were recovered as merchantable white arsenic at the Copper Cliff reduction works, where about 1,000 tons of silver-cobalt ore were treated. The remainder was exported either in the ore shipped from Cobalt, or in the speiss resulting from the Copper Cliff process.

The reduction plant formerly operating at Deloro on the mispickel ores of Hastings county has been idle for several years, but has been acquired by the Deloro Mining and Reduction Company, and will, it is expected, shortly be treating the product of the Hastings mines as well as those of the Cobalt camp, for the extraction of the arsenic and the other constituents of value.

At the present time the arsenic contents of the Cobalt ores are valueless to the mine owners, the buyers of ore refusing to pay for them.

Calcium carbide for use in the production of acetylene gas was made at the Ottawa and Merritton factories to the extent of 2,626 tons, valued at $162,780. There were 80 men employed in the two establishments, who were paid in wages $38,981.

At the graphite properties owned by the Globe Refining Company near Port Elmsley and the Ontario Graphite Company in Brougham township (Black Diamond mine) 1,772 tons of crude graphite were produced, valued at $15,000. The industry gave employment to 41 men, who received $12,000 in wages.

There were mined 3,265 tons of crude gypsum from the deposits along the Grand river, the output having a value of $3,265. By the Alabastine Company of Paris the raw material is worked up into a variety of useful commodities such as wall plasters, alabastine, etc. The use of gypsum as a fertilizer does not seem to be increasing.

Of peat fuel some 400 tons only were manufactured during the year, the product being a fuel for special purposes made by Alex. Dobson of Beaverton. The difficulties of climate and treatment in the way of producing a thoroughly satisfactory and economic fuel from the peat bogs of the Province have been formidable enough to discourage not a few of the inventors and experimenters who have taken the task in hand. There can be little doubt, however, that a solution of this important problem will ultimately be found.

Two new minerals find a place in the list of production for 1906, namely, quartz and sodalite. The former, principally for flux and converter linings, was raised to the extent of 48,376 tons valued at $65,765 by the Canadian Copper Company and Algoma Commercial Company. Some 200 cubic feet of sodalite was taken out of the quarries of the Princess Quarries Company near Bancroft, Hastings county. The stone is of a beautiful blue color, and is highly esteemed for interior decorative work.

Some 1,235 tons of talc were mined from a property near Madoc and exported to the United States. The value at the pit's mouth was $3,030.

Mining Revenue

Following is a statement of the moneys received for the sale and lease of Crown lands for mining purposes during 1906:

District.	Sales.			Leases.			Totals.		
	No.	Ac.	Amount. $	No.	Ac.	Amount. $	No.	Ac.	Amount. $
Rainy River	16	950	2,176	40	4,024	4,024	56	4,974	6,200
Thunder Bay	5	964	1,977	14	2,319	2,319	19	3,283	4,296
Algoma	10	924	2,327	17	2,468	2,468	27	3,392	4,795
Nipissing	59	1,599	4,581	14	954	914	73	2,553	5,495
Elsewhere	7	440	927	33	3,619	3,452	40	4,059	4,379
Total	97	4,877	11,988	118	13,384	13,177	215	18,261	25,165

The above table has reference only to lands sold and leased within the year. The gross receipts on account of lands disposed of for mining purposes in 1906 and previously, was $118,244 for sales and $46,620 for leases. In addition to this, there were receipts for miner's licenses, recording fees, etc., $70,256, and for mining royalties $15,000.

Tabulated, the moneys received from mining sources were as follows:

Sales	$118,244
Leases	46.621
Miners' licenses and fees	70,256
Royalties	15,000
Total	$250,121

The system of leasing mining lands, first introduced in 1891, was abolished by the amendments to the mining laws made in 1906, except as regards lands in the Forest Reserves, but the right was reserved to applicants to obtain such leases where applications were pending at the time the law was changed. In a number of cases, owing to the lands being heavily covered with timber, or for other reasons, applications before the Department could not be completed. Some of these were carried to a conclusion before the close of the year, and are included in the above Table. The law of 1891 required the lessee or patentee of mining lands to expend a certain amount of money per acre within a given time in development work, in default of which his grant was subject to forfeiture. The law of 1906 reversed this, and required an applicant after staking and recording his claim to perform 240 days' work upon it, after which he is entitled, subject to other provisions of the law, to obtain a grant from the Crown free from any further working conditions.

One of the changes introduced into the mining laws in 1906 was a provision making it necessary for a prospector to hold a miner's license before having the right to stake out mining claims on lands belonging to the Crown. These licenses expire annually on the 31st of March, and were issued on payment of a fee of ten dollars each. By an amendment passed in the session of 1907 this fee was reduced to five dollars, and to three dollars for a license issued after the 1st of October. Fees for recording mining claims, transfers, etc., were also provided for, and from these sources, which may be called current revenue, a very considerable sum was received last year, amounting as shown in the foregoing table, to $70,256. Mining companies are also required to hold a miner's license, the fee for which is based on the amount of capital stock. Owing to the activity of prospecting and claim staking which is likely to continue throughout 1907 and probably longer, receipts from this source for the coming year will probably show a considerable increase.

Another source of revenue, which appears in the accounts of the Province for the first time is royalties, from which $15,000 was derived in 1906. This sum was not the result of a general levy on minerals or on any specified kind of minerals, as royalties were done away with in 1900, but was received on shipments of silver-cobalt ore from the O'Brien silver-cobalt mine, in which the Government of Ontario holds an interest. It will be remembered that a suit was instituted by the Attorney-General of the Province to test the validity of certain grants of land in the township of Coleman made on the strength of affidavits of discovery whose truthfulness there was afterwards reason to doubt. The litigation was settled by a consent judgment, the effect of which was to award twenty-five per cent. of the proceeds of the mine to the Province, less a certain proportion of expenses for handling the ore above ground, transporting, etc. The mine was left in possession of the owners, but was charged with the payment of this royalty. Under the terms of the agreement payment is to be made quarterly based on the shipments of the previous three months. The only ore on which the royalty accrued due during 1906 was a carload which had been shipped in 1905, the proceeds of which amounted to upwards of $65,000. As the mine is a valuable one and is now to be actively worked, the Provincial treasury will no doubt benefit largely by reason of these royalties.

Mining Companies

The schedule given below shows the mining companies incorporated under the laws of Ontario and also companies of foreign incorporation licensed to do business in this Province, during 1906. Of the former, 263 concerns were organized with a nominal capital aggregating $184,677,000, and of the latter, 18 received licenses having a united capital of $12,536,000. The increase of companies as compared with 1905 was very marked, the numbers being 263 and 99, and aggregate capital $184,677,000 and $27,509,000 respectively. The larger part of the increase, as will be seen by looking over the list, was due to the great activity in exploiting the silver-cobalt field.

Mining Companies Incorporated, 1906

Name of Company.	Head Office.	Date of Incorporation.	Capital. $
Abitibi and Cobalt Mining Company, Limited	Sault Ste. Marie	March 10, 1906	2,500,000
Algoma Custom Smelting and Refining Company, Limited	Sault Ste. Marie	November 28, 1906	250,000
Amalgamated Cobalt Mines, Limited	Toronto	June 23, 1906	1,000,000
Anima-Nipissing Silver Mines, Limited	Cobalt	November 22, 1906	300.000
Anthony Blum Gold Mines, Limited	Toronto	November 28, 1906	100,000
Argentite Mining and Smelting Company, Limited	Toronto	April 24, 1906	2.000,000
Atlantic Oil Company, Limited	Toronto	June 30, 1906	2,000,000
Banner Cobalt Mining Company, Limited	Windsor	December 19, 1906	
Barnard-Argue-Roth-Stearns Oil and Gas Company, Limited	Chatham	October 3, 1906	400,000
Baxter Oil Company, Limited	Thamesville	October 26, 1906	50,000
Beaver Silver Cobalt Mining Company, Limited	New Liskeard	April 24, 1906	500,000
Becktels, Limited	Waterloo	November 30, 1906	75.000
Ben Allen Portland Cement Company, Limited	Owen Sound	February 14, 1906	500,000

Mining Companies Incorporated 1906.—Continued

Name of Company.	Head Office.	Date of Incorporation.	Capital. $
Bonanza Reef Extension, Limited	Toronto	December 14, 1906	100,000
Boston Mines, Limited	Toronto	July 26, 1906	50,000
Burrough Larder Lake Gold Mining Company, Limited	New Liskeard	December 5, 1906.	500,000
Calumet Cobalt Mining Company, Limited	Haileybury	November 24, 1906	500,000
Campbell-Crawford Cobalt Silver Mining Company, Limited	Cobalt	December 12, 1906	1,000,000
Canada Minerals, Limited	Toronto	September 26, 1906	100,000
Canada and United States Oil and Gas Company, Limited	Chatham	October 12, 1906	30,000
Casey Cobalt Silver Mining Company, Limited	Haileybury	December 19, 1906	100,000
Cobalt-American Development Company, Limited	Toronto	March 16, 1906	600,000
Cobalt Annex Silver Mines, Limited	Haileybury	November 16, 1906	500,000
Cobalt Bullion Mines, Limited	Haileybury	December 7, 1906.	1,000,000
Cobalt Chief Silver Mining Company, Limited	Toronto	November 28, 1906	3,000,000
Cobalt Consolidated Mines, Limited	Cobalt	March 16, 1906	2,500,000
Cobalt Diamond Drilling and Development Company, Limited	Toronto	September 26, 1906	100,000
Cobalt and Hudson Bay Development Company, Limited	Haileybury	April 6, 1906	100,000
Cobalt Lake Mining Company, Limited	Toronto	December 22, 1906	5,000,000
Cobalt Merger, Limited	Toronto	November 28, 1906	3,000,000
Cobalt Mines Syndicate, Limited	Toronto	December 28, 1906	100,000
Cobalt Monarch Mining Company, Limited	Toronto	November 24, 1906	500,000
Cobalt Native Silver Mining Company, Limited	Haileybury	November 7, 1906.	500,000
Cobalt and New Ontario Prospectors, Developers and Investors, Limited	Toronto	November 16, 1906	500,000
Cobalt North-Ontario Mining Company, Limited	Haileybury	January 31, 1906	40,000
Cobalt Nugget Silver, Limited	Haileybury	April 28, 1906	40,000
Cobalt Silver Queen, Limited	Cobalt	April 6, 1906	1,500,000
Cobalt Silver Ores, Limited	Toronto	November 16, 1906	1,000,000
Cobalt Silver Prince, Limited	Cobalt	November 16, 1906	1,000,000
Cobalt Smiley Mining Company, Limited	Toronto	November 16, 1906	40,000
Cobalt Townsite Mining Company, Limited	North Bay	April 9, 1906	100,000
Cobalt Union Mines, Limited	Toronto	November 16, 1906	1,000,000
Coin Silver Mining Company, Limited	Windsor	November 21, 1906	300,000
Coleman and Quebec Mining Company, Limited	Ottawa	November 28, 1906	1,000,000
Dardanelles (Larder Lake) Gold Mines, Limited	Toronto	December 19, 1906	250,000
Davis Silver Cobalt Mines, Limited	Toronto	December 5, 1906.	2,000,000
Deep Rock Cobalt Silver Mines, Limited	Toronto	December 21, 1905	1,000,000
Detroit and Algoma Silver Mining Company, Limited	Windsor	August 15, 1906	100,000
Duluth Cobalt Mining Company, Limited	Haileybury	December 28, 1906	500,000
Edward Cobalt Mines, Limited	Toronto	November 16, 1906	100,000
Empress Cobalt Silver Mining Company, Limited	Toronto	November 9, 1906.	500,000
Erie Cobalt Silver Mining Company, Limited	Toronto	May 28, 1906	1,000,000
Floyd Silver Mines, Limited	Toronto	March 13, 1906	2,000,000
Foster Cobalt Mining Company, Limited	Toronto	February 14, 1906.	1,000,000
Forest Reserve Mining Company, Limited	Toronto	November 16, 1906	100,000
Freeda Larder Lake Gold Mining Company, Limited	Toronto	December 21, 1906	500,000
Gallagher Iron Mining Company, Limited	Sault Ste. Marie	June 13, 1906	500,000
Giant Silver Nugget Mines, Limited	Haileybury	June 13, 1906	500,000
Glen Lake Mining Company, Limited	Toronto	April 24, 1906	500,000
Golden Park Mining Company, Limited	Windsor	October 12, 1906	100,000
Gordon Benson Cobalt Mining Company, Limited	Toronto	October 3, 1906	300,000
Great Lakes Portland Cement Company, Limited	Toronto	June 13, 1906	1,000,000
Green-Meehan Mining Company, Limited	Toronto	October 24, 1906	2,500,000
Hanson Consolidated Mining and Milling Company, Limited	Toronto	April 11, 1906	1,500,000
Harris-Maxwell Gold Mining Company, Limited	Toronto	November 30, 1906	50,000
Hudson Bay Extended, Limited	Toronto	April 17, 1906	100,000
Huron Oil Producers, Limited	Petrolea	March 10, 1906	60,000
Imperial Cobalt Silver Mines Company, Limited	Toronto	November 16, 1906	1,000,000
Independence Cobalt Silver Mines Company, Limited	Toronto	December 28, 1906	1,000,000
Iroquois Cobalt Silver Mining Company, Limited	Haileybury	May 3, 1906	100,000
Keewatin Silver Cobalt Mining Company, Limited	Toronto	December 5, 1906.	1,000,000
Kennedy Cobalt, Limited	Toronto	December 21, 1906	1,000,000
King Cobalt Mining Company, Limited	Toronto	January 24, 1906	300,000
Latchford Silver Mining Company, Limited	Toronto	November 21, 1906	100,000
Larder Lake Gold Mining Company, Limited	Haileybury	October 17, 1906	500,000
Lehigh Portland Cement Company, Limited	Township of Thurlow	September 19, 1906	1,000,000
Little Nipissing Silver Cobalt Mining Company, Limited	Toronto	November 2, 1906.	650,000
Maple City Oil and Gas Company, Limited	Chatham	July 26, 1906	40,000
Mining Development and Securities Company, Limited	Toronto	April 20, 1906	150,000
Montreal Cobalt Mining Company, Limited	Toronto	March 14, 1906	500,000
New York and Canadian Mining Company, Limited	Toronto	January 5, 1906	40,000
New York and Ontario Oil and Gas Company, Limited	Chatham	October 12, 1906	30,000
Nipissing Copper and Silver Company, Limited	Toronto	December 14, 1906	3,500,000
North Bay Brick and Tile Company, Limited	North Bay	July 16, 1906	50,000
North Cobalt Mining Company, Limited	Cobalt	November 7, 1906.	50,000
Northland Mining Company, Limited	London	December 5, 1906.	250,000
North Ontario Reduction and Refining Company, Limited	Toronto	June 13, 1906	500,000
North Range Nickel and Iron Mining Company, Limited	Sudbury	May 12, 1906	1,000,000
Nova Scotia Silver Cobalt Mining Company, Limited	Toronto	November 9, 1906.	2,000,000
Ontario Quebec Cobalt Mining Company, Limited	Toronto	December 28, 1906	1,000,000
Ore Contracting Company, Limited	Bessemer	November 7, 1906.	40,000
Peerless Larder Lake Mines, Limited	Toronto	December 5, 1906.	1,000,000
Penn Cobalt Mining Company, Limited	Toronto	December 19, 1906	500,000

Mining Companies Incorporated 1906.—Continued

Name of Company.	Head Office.	Date of Incorporation.	Capital. $
Pennsylvania Cobalt Silver Mines, Limited	Toronto	December 21, 1906	1,000,000
Peterson Lake Silver Cobalt Mining Company, Limited	Toronto	April 11, 1906	3,000,000
Rochester Mining Company, Limited	Toronto	August 21, 1906	40,000
St. Anthony Cobalt Mining Company, Limited	Haileybury	December 5, 1906	100,000
Sasagenaga Mining Company, Limited	Cobalt	June 8, 1906	250,000
Silverhorn Mining Company, Limited	Toronto	April 6, 1906	50,000
Silver Horse Shoe Cobalt Mining Company, Limited	Toronto	December 28, 1906	40,000
Silver Ledge, Limited	Toronto	April 24, 1906	20,000
Silver Wonder Mining Company, Limited	Toronto	April 24, 1906	300,000
Sombra Oil and Gas Company, Limited	Chatham	November 7, 1906	40,000
Standard Cobalt Mines, Limited	Toronto	December 19, 1905	2,000,000
Star Silver Cobalt Mining Company, Limited	Toronto	April 11, 1906	2,000,000
Stellar Silver Cobalt Corporation, Limited	Sudbury	November 28, 1906	1,000,000
The Abitibi Mining and Development Company, Limited	Finch	January 12, 1906	100,000
The Albert Mining Company, Limited	Toronto	May 12, 1906	375,000
The Alder Street Natural Gas Company, of Dunnville, Limited	Dunnville	December 12, 1906	20,000
The Amalgamated Oil Company of Canada, Limited	London	June 4, 1906	1,000,000
The Amalgamated Petroleum Producers, Limited	Belleville	April 20, 1906	40,000
The American Cobalt Mines, Limited	Toronto	February 15, 1906	1,000,000
The American Silver King Mining Company, Limited	Haileybury	May 30, 1906	1,000,000
The Bailey Mining Company, Limited	Windsor	August 15, 1906	5,000,000
The Barron Brick Company, Limited	Toronto	September 19, 1906	500,000
The Big Six Silver Cobalt Mines, Limited	Cobalt	December 12, 1906	1,750,000
The British American Oil Company, Limited	Toronto	October 17, 1906	200,000
The British American Silver Company, Limited	Toronto	August 24, 1906	50,000
The Brooks Hudson Silver Mining Company, Limited	New Liskeard	November 30, 1906	500,000
The Brussels Oil Company, Limited	Brussels	April 4, 1906	100,000
The Bucke Silver and Cobalt Mining Company, Limited	Ottawa	December 19, 1906	300,000
The Buffalo Mines, Limited	Toronto	April 27, 1906	1,000,000
The Canadian Cobalt and Silver Mining Company, Limited	Ottawa	January 19, 1906	250,000
The Canadian Cobalt Corporation, Limited	Toronto	November 28, 1906	1,000,000
The Canadian General Industrial and Development Company, Limited	Chatham	November 30, 1906	150,000
The Capital Cobalt Mining Company, Limited	Ottawa	December 5, 1906	250,000
The Central Oil and Gas Company, Limited	Toronto	March 6, 1906	40,000
The Century Silver Mining Company, Limited	Toronto	December 14, 1906	1,000,000
The Cheapside Natural Gas and Oil Company, Limited	Cheapside	January 19, 1906	10,000
The City of Cobalt Mining Company, Limited	Cobalt	October 5, 1906	500,000
The Clarks Standard Developing Company, Limited	New Liskeard	January 19, 1906	40,000
The Clear Lake Mining Company, Limited	Toronto	May 16, 1906	650,000
The Cleveland Cobalt Silver Mines, Limited	Toronto	October 12, 1906	1,000,000
The Cobalt and Larder Lake Gold Mining Company, Limited	New Liskeard	December 19, 1906	300,000
The Cobalt Central Silver Mining Company, Limited	New Liskeard	April 24, 1906	500,000
The Cobalt Chartered Company, Limited	Haileybury	April 27, 1906	350,000
The Cobalt Contract Silver Mines Company, Limited	Toronto	May 16, 1906	300,000
The Cobalt Ore Sampling Company, Limited	Cobalt	December 28, 1906	100,000
The Cobalt Portage Mines, Limited	Toronto	October 26, 1906	1,000,000
The Cobalt, Silver and Copper Mining Company, Limited	Sault Ste. Marie	February 23, 1906	500,000
The Cobalt Smelting and Refining Company, Limited	Toronto	May 18, 1906	250,000
The Colonial Mining Company, Limited	Cobalt	October 19, 1906	100,000
The Columbus Cobalt Silver Company, Limited	Toronto	April 24, 1906	450,000
The Commercial Brick Company, Limited	Toronto	July 18, 1906	50,000
The Coniagas Mines, Limited	St. Catharines	November 24, 1906	4,000,000
The Croesus Mining Company, Limited	Ottawa	January 19, 1906	500,000
The Crown Mining Company, Limited	Leamington	January 26, 1906	1,000,000
The Cuyahoga Silver Cobalt Mines, Limited	Toronto	November 24, 1906	1,000,000
The Detroit and Cobalt Development Company, Limited	Windsor	April 17, 1906	25,000
The Dominion Cobalt Mining and Development Company, Limited	Cobalt	May 3, 1906	450,000
The Douglas Mining Co., Limited	Toronto	November 16, 1906	500,000
The Dufferin Cobalt Silver Mining Company, Limited	Ottawa	November 30, 1906	1,000,000
The Dunnville Gas Development Company, Limited	Dunnville	May 12, 1906	40,000
The Dwyer Mining Company, Limited	Toronto	January 5, 1906	100,000
The Erie Natural Gas Company, Limited	Dunnville	October 17, 1906	40,000
The Esperanza-Cobalt Mines Company, Limited	Windsor	November 21, 1906	1,000,000
The Eureka Silver Mining Company, Limited	New Liskeard	April 24, 1906	100,000
The Exploration Company of Canada, Limited	Toronto	November 7, 1906	100,000
The Findlay Mining Company, Limited	Windsor	April 24, 1906	20,000
The Florence Mining Company, Limited	Toronto	March 21, 1906	100,000
The German Canadian Smelting and Refining Company, Limited	Toronto	July 6, 1906	1,000,000
The Gillies Silver Mining Company, Limited	Haileybury	April 9, 1906	500,000
The Gilpin Cobalt Silver Mining Company, Limited	Toronto	April 24, 1906	500,000
The Gold and Silver Mountain Mining Company, Limited	Cobalt	December 5, 1906	1,000,000
The Golden Reed Mining Company, Limited	Sault Ste. Marie	August 31, 1906	1,200,000
The Green Rock Mining Company, Limited	Sault Ste. Marie	April 24, 1906	600,000
The Heathcock Mining Company, Limited	Dresden	October 12, 1906	100,000
The Hudson Cobalt Mining Company, Limited	Barrie	June 27, 1906	300,000
The Hunter Cobalt Silver Mining Company, Limited	Ottawa	November 21, 1906	1,000,000
The Huronian Cobalt Silver Mining Company, Limited	Cobalt	August 21, 1906	500,000
The International Cobalt and Silver Mining Company, Limited	Sault Ste. Marie	September 19, 1906	500,000

Mining Companies Incorporated 1906.—Continued

Name of Company,	Head Office.	Date of Incorporation.	Capital. $
The Interprovincial Mining Company, Limited	Haileybury	August 31, 1906	1,500,000
The Jessie Fraser Copper Mining Company, Limited	Niagara Falls	January 26, 1906	250,000
The Jury Copper Mines, Limited	Sault Ste. Marie	December 5, 1906	1,000,000
The Kerr Lake Lawson Mining Company, Limited	Cobalt	November 16, 1906	1,500,000
The Lake Abitibi Gold Mining Company, Limited	Toronto	December 19, 1906	200,000
The Lawson Cobalt Silver Mining Company, Limited	Eganville	May 12, 1906	500,000
The Lorrain Mining Company, Limited	Toronto	November 7, 1906	400,000
The Lumsden Mining Company, Limited	Toronto	December 14, 1906	1,000,000
The McKinley-Darragh-Savage Mines of Cobalt, Limited	Toronto	April 17, 1906	2,500,000
The Manhattan Cobalt Mining Company, Limited	Toronto	November 2, 1906	100,000
The Manufacturers Natural Gas Company, Limited	Hamilton	June 13, 1906	200,000
The Mining and Lands Development Company Limited	Toronto	April 17, 1906	40,000
The Montreal River Silver Syndicate, Limited	Toronto	April 24, 1906	200,000
The Nancy Helen Mines, Limited	Cobalt	October 3, 1906	500,000
The National Cobalt Silver Mining Company, Limited	Ottawa	December 21, 1906	1,000,000
The National Mining and Development Company, Limited	New Liskeard	August 24, 1906	40,000
The Nepigon Mines Company, Limited	Toronto	December 5, 1906	5,000,000
The New System Brick Company, Limited	Brantford	January 17, 1906	50,000
The New York Cobalt Silver Mines, Limited	Toronto	October 26, 1906	1,000,000
The North American Cobalt Refining Company, Limited	Hamilton	February 28, 1906	1,000,000
The Northern Ontario Consolidated Copper Company, Limited	Sault Ste. Marie	October 17, 1906	1,500,000
The Northern Ontario Copper Mining Company, Limited	Sault Ste. Marie	January 17, 1906	500,000
The Norwalk Mining Company, Limited	Sault Ste. Marie	March 2, 1906	300,000
The Ohio Cobalt Mining Company, Limited	Haileybury	May 3, 1906	60,000
The Old Chap Mining Company, Limited	Cobalt	November 16, 1906	1,000,000
The Ontario Nickel Company, Limited	Worthington	October 5, 1906	1,000,000
The Ontario Oil and Refining Company, Limited	Chatham	August 31, 1906	100,000
The Ontario Sewer Pipe Company, Limited	Toronto	January 12, 1906	300,000
The Ottawa Cobalt Silver Mining Company, Limited	Ottawa	September 19, 1906	250,000
The Owen Sound Brick Company, Limited	Owen Sound	March 30, 1906	40,000
The Pontiac and Nipissing Exploration Company, Limited	New Liskeard	December 19, 1906	1,000,000
The Port Arthur Sand Lime Brick Company, Limited	Port Arthur	March 28, 1906	60,000
The Progress Cobalt Silver Mining Company, Limited	Cobalt	September 19, 1906	500,000
The Queen City Mining and Development Company, Limited	Toronto	February 28, 1906	150,000
The Red Rock Silver Mining Company, Limited	Haileybury	March 2, 1906	1,000,000
The Renfrew Brick and Tile Manufacturing Company, Limited	Renfrew	June 22, 1906	20,000
The Right of Way Mining Company, Limited	Ottawa	July 13, 1906	500,000
The Rochester-Cobalt Mines, Limited	Cobalt	October 26, 1906	1,000,000
The Ross Cobalt Silver Mines Company, Limited	Cobalt	November 21, 1906	1,500,000
The Ruby Silver Mining and Development Company, Limited	Hamilton	November 9, 1906	500,000
The Russell Brick and Tile Company, Limited	Russell	December 19, 1906	100,000
The St. Paul Cobalt Mining Company Limited,	Cobalt	November 28, 1906	600,000
The Savage Mine of Cobalt, Limited	Toronto	February 14, 1906	500,000
The Shakespeare Development Company, Limited	Sault Ste. Marie	March 14, 1906	300,000
The Sharpe Lake Cobalt Silver Mining Company, Limited	Ottawa	December 28, 1906	1,000,000
The Silverado Cobalt Mines, Limited	Cobalt	December 7, 1906	1,500,000
The Silver Bell Mining Company, Limited	North Bay	April 6, 1906	250,000
The Silver City Mining Company, Limited	Toronto	March 21, 1906	350,000
The Silver Cliff Mining Company, Limited	Ottawa	April 17, 1906	2,000,000
The Silver Crown Mining Company, Limited	North Bay	May 3, 1906	500,000
The Silverland Development Company, Limited	Toronto	March 26, 1906	1,000,000
The Silver Leaf Mining Company, Limited	Toronto	February 14, 1906	5,000,000
The Silver Lion Mining and Development Company, Limited	Cobalt	October 5, 1906	500,000
The Silver Star Mining Company, Limited	New Liskeard	February 19, 1906	40,000
The Soo Cobalt Mining Company, Limited	Cobalt	May 18, 1906	50,000
The South American Petroleum Company, Limited	Toronto	January 10, 1906	1,000,000
The Southern Belle Cobalt Silver Mining Company, Limited	Cobalt	November 24, 1906	1,000,000
The Steep Rock Development Company, Limited	Fort Frances	April 6, 1906	150,000
The Sudbury Cobalt Mining Company, Limited	Sudbury	April 27, 1906	300,000
Tarentorus Mining Company, Limited	Sault Ste. Marie	March 2, 1906	700,000
Temagami Iron Mining Company, Limited	Toronto	February 28, 1906	40,000
Temiskaming Hematite Iron Company, Limited	Toronto	January 17, 1906	150,000
Temiskaming Sterling Mining Company, Limited	Milberta	September 14, 1906	42,000
The Temagami Silver Mining Company, Limited	Sturgeon Falls	November 16, 1906	2,500,000
The Temiskaming Mining Company, Limited	Toronto	April 6, 1906	40,000
The Terra Cotta Pressed Brick Company, Limited	Toronto	February 21, 1906	60,000
The Terrill Cobalt Mining Company, Limited	Sault Ste. Marie	December 27, 1905	100,000
The Thorold Natural Gas Company, Limited	Toronto	December 22, 1905	40,000
The Trout Lake Cobalt Mining Company of Montreal, Limited	Ottawa	December 10, 1906	3,000,000
The Twin Lake Mining Company, Limited	New Liskeard	August 24, 1906	500,000
The Two Lakes Copper Mining Company, Limited	Sowerby	October 12, 1906	500,000
The University Mines, Limited	Toronto	May 3, 1906	1,000,000
The Violet Mining Company, Limited	Toronto	August 3, 1906	250,000
The Wabi Cobalt Silver Mining Company, Limited	Cobalt	June 27, 1906	500,000
The Waterloo Mining Company, Limited	Berlin	October 12, 1906	200,000
The Wendigo Progressive Mining and Development Company, Limited	New Liskeard	December 27, 1905	40,000
The Wet Process Reduction Company, Limited	Toronto	October 12, 1906	1,000,000
The White Lily Mining and Milling Company, Limited	Fort William	December 21, 1906	1,000,000

Mining Companies Incorporated, 1906.—Continued

Name of Company.	Head Office.	Date of Incorporation,	Capital. $
The Williams Copper Mining Company, Limited	Toronto	September 7, 1906	100,000
The Williamson-Marks Mines, Limited	Toronto	February 21, 1906.	300,000
The Youngstown-Cobalt Silver Mining Company, Limited	Cobalt	December 28, 1906	1,000,000
Trethewey Silver Cobalt Mine, Limited	Toronto	May 30, 1906	1,000,000
United Mines of Cobalt, Limited	Toronto	September 5, 1906	1,000,000
United Silver Company, Limited	Cobalt	October 26, 1906	1,000,000
United States Cobalt Company, Limited	Toronto	December 7, 1906	3,000,000
Vermilion River Ore Company, Limited	Toronto	December 20, 1905	80,000
Victoria Silver Cobalt Mines, Limited	Toronto	November 2, 1906	1,000,000
Wainfleet Natural Gas Company, Limited	Port Colborne	January 17, 1906	100,000
Watts Mines, Limited	Toronto	October 12, 1906	1,000,000
Wendigon Silver and Copper Mining Company, Limited	Windsor	May 16, 1906	400,000
Wolst-Rees Cobalt Silver Mining Company, Limited	Windsor	May 7, 1906	250,000
Wonderland Silver Mining Company, Limited	Windsor	March 21 1906	250,000
Wright Silver Mining Company, Limited	Toronto	August 15, 1906	200,000
Zone Consolidated Oil Company, Limited	Thamesville	December 28, 1906	40,000

Mining Companies Licensed, 1906

Name of Company.	Head Office.	Date of Incorporation.	Capital. $
Acme Oil Company	Leamington	February 2, 1906	1,000,000
Amalgamated Silver Mines Company	Port Arthur	October 12, 1906	1,000,000
Arbor Oil Company	Chatham	December 28, 1906	50,000
Arizona Cobalt Silver Company	Toronto	May 28, 1906	1,000,000
Chicago Cobalt-Silver Mining Company, Limited	Toronto	December 10, 1906	500,000
Commonwealth Jewel Oil Company	East Tilbury	September 7, 1906	40,000
Kerry Mining Company	Woodstock	September 26, 1906	5,000
Lake Huron Company	Ottawa	August 15, 1906	100,000
Manitou Mines Company, Limited	Wabigoon	June 6, 1906	40,000
Northern Pyrites Company	Toronto	August 21, 1906	100,000
Olympia Gold Mining Company, Limited	Toronto	October 26, 1906	40,000
Stanley Smelting Works	Bannockburn	December 5, 1906.	40,000
The Braddock Development Company, Limited	Michipicoten River	August 24, 1906	5,000
The Can-Amer Mining and Developing Company	Niagara Falls	October 12, 1906	500,000
The Consolidated Mining and Smelting Company of Canada, Limited	Toronto	April 17, 1906	5,500,000
The Ontario Oil and Gas Company	Chatham	December 12, 1906	15,000
Verona Mining Company	Kingston	July 18, 1906	1,000
Western Oil and Coal Consolidated	Toronto	November 16, 1906	100,000

Diamond Drills

The Sullivan "S" diamond drill was placed at the disposal of Mr. S. D. Maddin in August 1906 to prospect the north part of the southwest quarter of lot 2 in the fifth concession of Coleman township. On this location one hole was put down to a depth of 123 feet, mainly, as reported by manager E. K. Roche, in diabase. The gross cost of the boring was $598.96, or $4.87 per foot; the net cost, after debiting 35 per cent. of the expense to the Department as provided by the Regulations, was $389.30, or $3.17 per foot. The gross cost of diamonds was $210.80, or per foot $1.71.

In September the "S" drill was removed to the south half of the northwest quarter of the north half of lot 3 in the sixth concession of Coleman township, where drilling operations were to be carried on for Mr. R. H. C. Browne and associates under the supervision of Mr. S. D. Maddin. The ground proved difficult drilling. A heavy covering of drift overlay the rock, and after penetrating gravel, clay and hard pan to a depth of 51 feet and blasting numerous boulders, a bed of loose broken rocks was encountered through which it was impossible to force the casing pipe, especially as the bore hole was found to be going down on the dip of the rock instead of against it. This hole was thereupon abandoned and prospect number 2 was with considerable difficulty put down to a depth of 166 feet, solid conglomerate being encountered at 66 feet. Loose ground was met with at 68 feet and at successive depths until the hole bottomed in broken ground, the rock being conglomerate throughout.

The total cost was $2,584.91, or per foot of drilling $11.91, the net cost $1,680.19 or $7.74 per foot. The gross cost of diamonds was $605.33, or $2.19 per foot for the depth bored.

The expense of this operation was very greatly increased by the difficulty in reaching the solid ledge.

Mining Accidents

There were 11 men killed in mining accidents in 1906, two more than in 1905. Five men were seriously, and eleven others slightly injured, the total number of casualties being 25, involving 27 men. The causes of the fatalities were as follows: caught in slack of descending cable, 2; electric shock, 1; explosion of furnace, 1; falling down shaft, 2; run over by locomotive, 1; fall of timber in stope, 1; fall of car down shaft, 1; caught by descending cage, 1; unexpected explosion of dynamite, 1. Five of the men who were killed received their injuries above ground, and six below ground.

Algoma Steel Company

William Ault, employed as coke car man in the blast furnace department of the Algoma Steel Company's works at Sault Ste. Marie was killed on 10th January 1906, by an explosion which occurred in No. 2 furnace. A heavy slip took place in the latter causing the top to blow off, and a piece of flying material struck Ault on the head, killing him almost instantly. Coroner Dr. J. McLurg held an inquest on the evening of January 12th, the verdict of the jury being one of accidental death in accordance with the foregoing facts, and stating that no blame was attached to any one. Ault was 250 feet away from the furnace attending to his ordinary duties when the explosion took place. The superintendent, Mr. Sweetzer, had examined the furnace at 10.29 a.m., finding the temperature and pressure normal. At 10.30 a.m., one minute later, the explosion occurred. The coroner's theory is that an arch was formed in the stack by the charge failing to descend properly, and that the space beneath was filled with gas at a high pressure. When the arch suddenly gave way the gas could not find sufficient escape by the safety door, and hence relieved the pressure by expelling the upper part of the furnace outwards.

Helen Iron Mine

A number of minor accidents were reported to the Bureau during the year, the particulars of which are given in the table. Three fatalities occurred. On August 15th one of the drill men at the Helen mine, named Ed. Powers, met his death by falling through No. 2 shaft from the second to the third level. No inquest was held, as the manager of the mine stated it would have been impossible to keep the body the four days necessary for the coroner to reach the scene of the accident from Sault Ste. Marie. From the acoount of the fatality given by the superintendent of the mine it would appear that blame does not attach to anyone.

On 17th September the head pump-man, James Newell, met his death. Newell had entered the cage at the surface to go to the third level, but when he reached the latter he signalled to be hoisted to the second; while rising to the latter an empty car was actually pushed by the lander, Contardo, into the shaft. The car fell on the cage, crushing through the protection roof. Newell received the blow on the back of his head, the impact breaking in his skull and knocking his body out of the cage into the sump beneath, where it was found by grappling. Coroner McLurg held an inquest, the verdict of the jury being to the effect that the accident had been caused by the carelessness of lander Contardo and chute tender Redmond.

The third fatal accident was that which caused the death of Jani Walli, a Finlander who sat down to rest on the "divider," at the landing place on the fourth level, while coming up the shaft at noon, 22nd November. Part of his body projected into the shaft, and the cage descending caught him in the back and crushed him so severely that he died next day. The statements of the men who were on the platform at the time with Walli show that they had left work before the noon hour had arrived, and were waiting on the platform for the whistle to blow. They were aware that the cage was being used in the shaft, and it would seem that the unfortunate man placed himself in a position of great danger without thought of the possible consequences.

Canadian Copper Company

An electrician named H. E. Jackson, employed by the above company at Copper Cliff, met his death on 12th January 1906. He was connecting lights in the switch board room of the new power house, and attempting to cut a charged wire was instantly killed. Everything possible was done in the hope of reviving the unfortunate man, but without avail. The coroner was notified, and decided that an inquest was unnecessary.

On 20th June a Finlander laborer named Rusta Stanros (or Stenaras) while attempting to get on the foot-board of a locomotive which was backing up after having been connected with two cars loaded with rock, missed his footing, fell on the rails and was immediately killed. At the company's request Coroner Oliver held an inquest. The jury returned a verdict of death through misadventure.

In the course of making some alterations in the hoisting apparatus at No. 2 mine, two Finlanders named Matti Vaysi (also written Warri) and Frank Salo, the former a trammer and the latter a drill runner, were killed under the following circumstances: The hoist cable, a wire rope one inch in diameter, 425 feet long, and weighing one and a half pounds per foot, was taken up for part of the way, the "slack" being drawn out through a side door in the covering of the skipway at the collar of the shaft; this left 350 or 400 feet of cable dangling in the shaft below, the upper portion being clamped at the knuckle of the shaft, as it was thought, quite securely. Suddenly and without warning that part of the rope hanging in the shaft began running through the clamp that was holding it, and the jerk of the rope knocked down several men, throwing Vaysi and Salo forward on the skip tracks with great force. They both received injuries from which they died in the hospital, the former after six hours and the latter after twenty-four hours. Coroner Oliver decided that an inquest was required, and accordingly a jury was empanelled, which after hearing the evidence, rendered the following verdict: "We, the jury, find that Matti Vaysi and Frank Salo came to their death through an accident, the clamp giving way and the cable slipping through and throwing them on the skip track." The cable was covered with grease, and no doubt the weight of the rope overcame the pressure of the clamp, but the jury's verdict did not place censure upon any one.

Bannockburn Pyrites Mine

While riding in a bucket at the Bannockburn pyrites mine, the property of the American Madoc Mining Company, on 3rd April, Peter Jarvis, underground shift boss, fell down the shaft seventy or seventy-five feet and was instantly killed. A jury was empanelled by Dr. W. S. Harper of Madoc, coroner, and an investigation held, at which Mr. E. T. Corkill, Inspector of Mines, was present. The evidence showed that deceased and four other men were ascending in the bucket, when the latter got outside the guard rail, and Jarvis was precipitated down the shaft. Another of the men also fell, but about 20 feet down was stopped by a timber. The others caught the ladder when the bucket struck and came to the surface. The miners knew it was against the regulations to ride in the bucket, and had read the notice at the shaft top forbidding the practice. Notwithstanding this, the ladderways, though in good condition, were but little used in coming up out of the mine, the prevailing custom being to ride up in the bucket. The verdict of the jury was that the company was not responsible for the death of deceased, as he himself being underground foreman should have lived up to and enforced the rules of the company, which as well as the provisions of the Mines Act, prohibit the use of the bucket for raising or lowering men.

Nipissing Mine

Ankusti Polvi, a Finlander who had previously worked at Copper Cliff, was fatally injured on 6th August by the falling of a timber at what is known as ledge number six, Nipissing silver mine. The accident took place at 5.30, and Polvi was taken to the hospital at Cobalt, where he died at 10.30, from fracture of the skull. Dr. H. R. Codd of Haileybury, coroner, was notified, but after investigating the circumstances, concluded an inquest was unnecessary. The stull which fell and caused Polvi's death had been in position for eight or nine months and had at various times sustained great weight. Deceased had just fired a round of machine holes, and it is supposed a heavy stone must have struck the stull, loosening it and leaving it in position to fall.

O'Brien Silver Mine

A piece of rock fell out of an over-loaded ore bucket in the O'Brien mine on 23rd August, and struck a miner named William Dymer on the head, injuring him somewhat seriously. He was taken to St. Michael's hospital at Toronto, where he was treated for his injuries, a portion of the skull being removed. He was able to leave the hospital in about three weeks, to all appearances perfectly well.

Mitchell Prospect

At the Mitchell silver prospect near Haileybury on 24th November, Joseph Couture, drill runner and shift boss, suffered a compound fracture of the leg by being struck while descending the shaft in the bucket, the blow being inflicted by an empty car which fell down after him. Vibration of the machinery or a strong south wind, or both together, are said to have started the car from its place on the track towards the mouth of the shaft. On 7th December he was reported progressing favorably towards recovery.

Kerr Lake Silver Mine

Two miners named respectively Geo. Rush and E. Girouard, on 4th December drilled into a "missed hole" in the Kerr Lake (Jacobs) mine, exploding the remnant of the old charge and severely injuring the men. Rush died of his wounds the following day, and an inquest was held by Dr. Codd of Haileybury. The jury found the occurrence to be entirely accidental, and exonerated all persons other than deceased from blame. Girouard, the other injured man, was sent to Montreal for treatment, and in the end lost the sight of both eyes.

Victoria Mines

On 11th December Eugene Orassi, an Italian, employed by the Mond Nickel Company, was injured about the head and face by an explosion while placing a charge of dynamite in a bed of roasted ore. The injury was chiefly to the sight of one eye. The ore that was being blasted had been cooled off by snow and cold water. The explosion took place while tamping the cap.

Another employee, named Louis Kasskulton, was badly burned on the legs and arms December 21st by the explosion of a pot of slag while dumping it on the ground. He was taken to the hospital in Sudbury, and the doctor reported that although his life was not in danger, he would be laid up for some weeks.

A table is appended giving a summary of the accidents, their nature, causes, etc.

Table of Mining Accidents, 1906

No.	Date.	Mine or Works.	Name of Injured Person.	Result of injury. Slight.	Serious.	Fatal.	Above ground.	Below ground.	Nature of Injury.	Cause of accident.
1.	Jan. 12	Canadian Copper Co.	H. E. Jackson	....	....	1	1	....	Killed instantly	Electric shock.
2.	" 13	Algoma Steel Co	William Ault.	....	....	1	1	....	"	Explosion of furnace.
3.	Feb. 6	Helen iron mine	Guiseppe Vignuda	1	....	....	...	1	Leg and knee hurt	Fall of ore.
4.	" 9	" "	Alex. Koskela	1	....	....	....	1	Bruised	Fell down rise.
5.	April 3	American Madoc Mining Co.	Peter Jarvis.	....	....	1	....	1	Killed instantly	Fell down shaft.
6.	June 6	Helen iron mine	Thomas Shea	1	....	....	1	....	Fingers crushed	Caught in winch gear.
7.	" 10	" "	James Newell	1	....	....	1	....	Bone in hand broken	Caught in machinery.
8.	" 20	Canadian Copper Co	Kusta Stanros	....	....	1	1	....	Killed instantly	Run over by locomotive.
9.	" 26	Helen iron mine	James Keenan	1	....	....	1	....	Fracture of toe	Fall of piece of iron.
10.	July 24	" "	John Ojanperei	1	....	....	....	1	Injured in face and eyes	Explosion of powder.
11.	Aug. 6	Nipissing silver mine	Anhusti Polvi	....	....	1	....	1	Died in five hours	Fall of timber in mine.
12.	" 15	Helen iron mine	Ed. Powers	....	....	1	....	1	Killed instantly	Fell down shaft.
13.	" 23	O'Brien silver mine	William Dymer	....	1	....	....	1	Head injured	Fall of piece of ore.
14.	Sept. 13	Helen iron mine	Mytro Tohorsky	1	....	....	....	1	Back hurt	"
15.	" 17	Helen pyrites mine	James Newell	....	....	1	....	1	Killed instantly	Fall of car down shaft.
16.	" 26	Helen iron mine	Sam. R. Hanna	1	....	....	....	1	Hand pierced	Candlestick ran through hand.
17.	Nov. 8	" "	Alfred Kelly	1	....	....	....	1	Bruised	Fell down raise.
18.	" 17	" "	Patrick Nevilles	1	....	....	....	1	Hands and eyes injured	Premature explosion of dynamite.
19.	" 22	" "	John Walli	....	....	1	....	1	Body crushod	Caught by descending cage.
20.	" 24	Mitchell silver prospect	Joseph Couture	....	1	....	....	1	Compound fracture of leg	Fall of car down shaft.
21.	" 29	Helen Iron mine	Victor Sunnel	1	....	....	....	1	Head and wrist hurt	Struck by door suddenly forced open.
22.	Dec. 3	Canadian Copper Co.	Matti Vaysi (or Warri)	....	....	1	1	....	Killed instantly	Caught in slack of descending cable.
			Frank Salo	....	....	1	1	....	"	
23.	" 4	Kerr Lake Mining Co.	Geo. Rush	....	....	1	....	1	Died next day	Drilled into unexploded dynamite.
			E. Girouard	....	1	....	....	1	Loss of eyesight	
24.	" 11	Victoria Mines	Eugene Orassi	....	1	....	1	....	Head and face injured	Explosion of dynamite in roasted ore.
25.	" 21	Victoria Mines	Louis Kasskulton	....	1	....	1	....	Arms and legs burned	Explosion of slag.
		Total casualties		11	5	11	10	17		

The Mining Divisions

The amendments to the Mines Act in 1906 have worked a radical change in the method of administering the mining lands of the Crown. Formerly, all applications for such lands were made direct to the Department of Crown Lands (now the Department of Lands, Forests and Mines), at Toronto, where they were passed upon and dealt with. Delays were found inevitably connected with correspondence carried on at a distance, arising sometimes from misunderstanding or ignorance of the law, sometimes from lack of precision or carefulness in describing the lands applied for, and sometimes from other causes; and in times of "boom" or excitement caused by discovery of promising or valuable mineral deposits, the difficulties attendant upon this method of transacting business were aggravated. By providing for the parcelling out of the mineral regions of the Province into Mining Divisions and placing each Division in charge of an officer who should live on the spot, receive applications and deal with them so far as possible definitely without reference to the Department at Toronto, it was hoped to inaugurate a system which would be of great convenience to the public at large, and especially to prospectors and others interested in the taking up of Crown lands for mining purposes. Mining Divisions, it may be said, were not new to the Act of 1906, authority for their establishment having been first included in the law of 1868, and having remained there ever since. This feature, however, had been but little availed of. An exception was the creation of the Michipicoten Mining Division in 1898, following upon the discoveries of gold and iron there shortly before. The Temiskaming Mining Division set apart in April 1905 was established under the provisions of the Mines Act as it then was, and the facilities thus afforded for the speedy dealing with applications for mining lands during the excitement consequent upon the rich finds of silver and cobalt in the township of Coleman, indicated that a localized, rather than a centralized, method of administration was suited to the needs of the case.

This principle of decentralization was extended by the amendments of 1906, and Mining Recorder's offices have been established at Sudbury, Sault Ste. Marie, Port Arthur, Kenora, Parry Sound, Larder Lake and Latchford, in addition to those already in existence at Haileybury and Cobalt. A list of these Divisions with the date of the Order in Council establishing them, and the name and address of the Recorder in charge is here appended:

List of Mining Divisions

Mining Divisions.	Date of Order-in-Council.	Name of Recorder.	Address.
Temiskaming	5th April, 1905	George T. Smith	Haileybury.
Coleman	14th May, 1906	T. A. McArthur	Cobalt.
Sudbury	28th May, 1906	F. F. Lemieux	Sudbury.
Sault Ste. Marie	28th May, 1906	S. T. Bowker	Sault Ste. Marie.
Port Arthur	28th May, 1906	J. W. Morgan	Port Arthur.
Kenora	28th May, 1906	C. W. Belyea	Kenora.
Fort Frances	28th May, 1906	Deputy Minister of Mines	Toronto.
Parry Sound	26th September, 1906	H. F. McQuire	Parry Sound.
Larder Lake	15th May, 1907	J. A. Hough	Larder Lake.
Montreal River	8th May, 1907	A. Macphail	Latchford.
Temagami Forest Reserve	20th June, 1906	Deputy Minister of Mines	Toronto.
Mississiaga Forest Reserve	23rd June, 1906	do do	Do.

Temiskaming

The Temiskaming Mining Division was the first to be created, and for a considerable time all the claims staked out in the Cobalt area were recorded at the head office of the Division at Haileybury.

Its original boundaries were as follows:

Commencing at a point on the west shore of lake Temiskaming, in the District of Nipissing, where the same is intersected by the line between concessions numbers three and four in the township of Lorrain, half a mile south of Old Fort Temiskaming; thence following along the shore of said lake northwesterly and northeasterly to where the same is interesected by the inter-provincial boundary between the Provinces of Ontario and Quebec; thence due north astronomically along said boundary seventy miles more or less to where the same is intersected by the southerly shore of Upper Lake Abitibi; thence westerly, northerly and northwesterly along the southern and western shores of Upper Lake Abitibi and Lower Lake Abitibi to an iron post one and one-quarter inches in diameter planted alongside a black ash post six inches square on the west shore of Lower Lake Abitibi, about eight miles north of the outlet of said lake, which post was planted in 1904 by Ontario Land Surveyor William Galbraith on his base line run in that year, and marked "XLII M;" thence due west astronomically along said base line to the northeast angle of the township of Moody; thence due west astronomically along the north boundaries of the townships of Moody, Wesley, Edwards, Aurora, Newmarket and Mann, a distance of forty-two miles nine chains and fifty links, more or less, to the one hundred and fiftieth mile post on the boundary between the districts of Nipissing and Algoma, as run by Ontario Land Surveyor Alexander Niven; thence due south astronomically along said district boundary, being the west boundaries of the townships of Mann, Little, Evelyn, Matheson, Cody, Carman and Langmuir to the southwest angle of the township of Langmuir, a distance of forty-two miles; thence due east astronomically along the south boundaries of the townships of Langmuir, Blackstock and Timmins, a distance of fifteen miles, more or less, to the portage on the canoe route between the Great Northern Bend on the Montreal river and Night Hawk lake; thence southerly along said portage route south to the Great Northern Bend on the Montreal river; thence southeasterly along the easterly bank of the Montreal river, and along the east shore of the lake expansions thereon to where the same is intersected by the southerly limit of lot number eleven in the third concession of the township of Coleman; thence north fifty-five degrees and thirty-five minutes east astronomically along the southern boundary of the township of Coleman, a distance of two hundred and fifty chains, more or less to the northeast angle of the Booth and Lumsden timber-berth; thence southeasterly along the east boundary of said timber berth to where the same is intersected by the line between the third and fourth concessions of the township of Lorrain; thence due east astronomically along said concession line a distance of five miles, more or less, to the water's edge of lake Temiskaming, or place of beginning.

Out of the foregoing territory the Coleman Special Mining Division and the Larder Lake Mining Division have been set apart as separate Divisions, as described below.

Reports up to the 31st December 1906 which have been received from Mining Recorders follow the descriptions of the several Divisions.

Coleman

The township of Coleman, within whose limits is comprised the greater part of what has come to be known as the Cobalt silver field, was for purposes of the Mines Act detached from the Temiskaming Mining Division, of which it had formerly been part, and constituted a separate Mining Division by Order in Council of 30th October, 1905. One effect of this separation was to reduce the size of mining claims in Coleman to 20 acres, the area in ordinary Divisions being 40 acres, or 20 chains square. For some time the affairs of both Mining Divisions were under the sole charge of Mr. George T. Smith, Haileybury, Recorder of the Temiskaming Division, but with the view of affording greater local facilities for the transaction of the business arising in this very active mining camp, a separate office for Coleman was opened at Cobalt. and Mr. T. A. McArthur appointed Assistant Recorder in charge, July 27. 1906.

Mr. McArthur, Mining Recorder, writes:

"I beg to make a brief report as follows:

"Office opened, 21st September, 1906.

"Miners' Licenses issued, 249.

"Number of applications for mining claims received and recorded, 154.

"Number of applications for working Permits received and recorded, 166.

"Total fees collected and remitted, $3,975.50.

"The shipping mines are in almost every case increasing their monthly output.

"A very considerable amount of prospecting and development work has been done in the southeast quarter of the township, as a result of which several shipping properties have been opened up in concessions three and four, southeast of Kerr lake. Blind veins have been discovered in this section of the township at a depth of 50 and 75 feet.

"The western, or Portage Bay, portion of the township has developed several properties which promise to be numbered among the shippers at an early date. Lots 15, 16 and 17 in the fifth concession, and lot 15 in the sixth concession are showing up well, and give every evidence of adding to the list of shipping mines.

"The opening of the recording office at Cobalt has been a great convenience to prospectors in the matter of filing claims and doing other business which comes within the jurisdiction of this office."

Sudbury

The Sudbury Mining Division includes the following territory:

Commencing at the junction of the Mattawan river with the Ottawa river, near the town of Mattawa, thence westerly along the southerly boundary of the townships of Mattawan, Olrig, Phelps and Widdifield to lake Nipissing, thence across lake Nipissing in a direct line to the Chaudiere Falls at the outlet of said lake; thence down the French river, following the channel, forming the boundary between the Districts of Nipissing and Parry Sound to lake Huron; thence along the north shore of lake Huron to the southeast corner of the township of Long; thence due north astronomically, along the eastern boundary of the townships of Long, McGivern and townships Nos. 155, 156, and 157, a distance of twenty-nine miles, more or less to the northeast corner of township No. 157; thence due east astronomically along the southerly limit of the Mississaga Forest Reserve along the northerly limit of townships 151, 145, 139, 132, 125 and 120 to the southwest angle of township No. 114; thence due north astronomically along the western limit of townships Nos. 114 and 115 and along a meridian line run due north astronomically from the northwest angle of township No. 115, in all a distance of twenty-four miles, more or less to where the same in intersected by O.L.S. Proudfoot's base line; thence due west astronomically 30 miles, more or less to the 12th mile post on O.L.S. Alexander Niven's base line run in 1902; thence due north astronomically along said meridian line thirty-seven miles, more or less to where the same intersects the northern limit of the right-of-way of the Canadian Pacific railway at a point about two miles east of Woman River station; thence northwesterly along the northerly limit of said right-of-way to the point where the same is intersected by the boundary between the Districts of Algoma and Thunder Bay, which point is near White River station; thence due north astronomically along said District boundary to the Albany river; thence down the Albany river along the boundary line between the Province of Ontario and District of Keewatin to Fort Albany on James Bay; thence southeasterly along the southwesterly shore of James Bay to the boundary between the Districts of Nipissing and Algoma; thence due south astronomically along said district boundary a distance of seventy-two miles, more or less, to where the same is intersected by the southerly bank of Moose river; thence southwesterly up stream along the southerly bank of said river to its junction with the Mattagami river; thence southerly along the easterly bank of the Mattagami river to its junction with the Groundhog river; thence southerly along the easterly bank of the Groundhog river to where the same is intersected by the base line run by O.L.S. Alexander Niven in 1900 in latitude 49 degrees 35 minutes and 30 seconds north; thence due east astronomically along said base line three miles, more or less, to the meridian line run by O.L.S. T. B. Speight and Alexander Niven in 1905; thence due south along said meridian line and its production south a distance of seventy-eight miles to the 36th mile post on the base line run by O.L.S. Alexander Niven in 1899, in latitude 48 degrees, 27 minutes, 54 seconds north; thence due east astronomically along said base line a distance of 20 miles more or less to where the same is intersected by the eastern bank of the Mattagami river, forming the westerly boundary of the Temagami Forest Reserve; thence southerly upstream along the easterly bank of the Mattagami river and along the easterly shore of the several lake expansions thereon, forming the western limit of said Forest Reserve to the portage on the height of land at the north end of Meteor lake; thence across said portage and southerly along the easterly shore of Meteor lake and along the several small portages and along the easterly shore of several small lakes on the canoe route between Meteor lake and Long lake at the head waters of Wahnapitae river; thence southerly along the easterly shore of Long lake, and south astronomically from the foot of Long lake to the 12th mile post on O.L.S. Proudfoot's base line; thence due east astronomically along said base line and its production due east astronomically 18 miles, more or less to the northeast angle of the township of Creelman; thence due south astronomically along the easterly limit of the said township of Creelman six miles more or less to the northwest angle of the township of Parkin; thence due east astronomically along the north limits of the townships of Parkin, Aylmer Mackelcan and McCarthy to the northeast angle of the latter, in all a distance of twenty-five miles more or less; thence due south astronomically, along the easterly limit of the township of McCarthy, six miles more or less to the northwest angle of the township of McNish; thence due east astronomically along the northern limits of the townships of McNish, Pardo, Hobbs, McCallum, and along the said northern limit produced east astronomically to the west shore of lake Temiskaming, in all a distance of fifty-nine and three-quarter miles; thence due east astronomically to the inter-provincial boundary between the Province of Ontario and the Province of Québec; thence southeasterly along said inter-provincial boundary passing through lake Temiskaming and down the Ottawa river to the place of beginning, near the town of Mattawa.

Mr. F. F. Lemieux, Recorder, reports as follows:

"This office was opened for business on the 23rd day of June, 1906.

"Miners' Licenses to the number of 128 have been issued.

"Applications for mining claims to the number of 126 have been filed, the great majority of which have been recorded.

"The total amount of fees collected and remitted to the Department is $1,915.00, a small portion of which has been refunded to parties whose applications for mining claims have been rejected.

"The mining industry has taken a decided upward trend during the year in this Mining Division. Besides the usual large operations of the Canadian Copper Company and the Mond Nickel Company, a new company known as Moose Mountain, Limited, has commenced to lay out works of an extensive character in the township of Hutton, for the purpose of mining the large iron deposits in said township. This latter company has not commenced actual mining operations as yet, the work consisting of test-pitting, trenching, stripping and magnetic surveying, and the clearing of land and erection of buildings. The James Bay Railway Company is building a line to this property, the grading of which is practically completed, and it is expected that the railway company will be able to haul ore next summer, the Moose Mountain company expecting to commence actual mining operations in the coming spring.

"The Mond Nickel Company is opening up a nickel deposit in the township of Garson, which it is understood is to be worked extensively by the use of electric power from the Wahnapitae Power Company, the line of transmission being now in course of construction. This company intends to ship the roasted ore to their works at Victoria Mines for smelting and treatment.

"Considerable prospecting is going on in the townships of Springer, Dunnett and adjoining townships for copper, silver and iron, and many claims are being taken up.

"In the township of Porter and along the line of the Sault branch of the Canadian Pacific railway considerable activity is manifesting itself in numerous finds of copper.

"In the townships of Bowell and Wisner and adjoining territory iron is being found in large quantities and of good quality.

"The establishment of this office is filling a long felt want among mining men and prospectors, owing to its ready access and great convenience in the matter of filing claims and obtaining information near at hand regarding mining matters."

Sault Ste. Marie

The Sault Ste. Marie Mining Division comprises the following territory:

Commencing at the southwest angle of the township of Pic; thence east astronomically along the south limits thereof to the southeast angle; thence due north astronomically along the east limit thereof to the southerly limit of the right-of-way of the Canadian Pacific railway; thence easterly along the southerly limit of said right-of-way to the boundary between the Districts of Algoma and Thunder Bay; thence southerly along said boundary to the north shore of lake Superior; thence westerly and northwesterly along the shore of said lake to the place of beginning.

To include also Michipicoten Island and all islands in lake Superior lying south of the above described area; also being composed of that portion of the District of Algoma hereinafter described.

Commencing at a point on the north shore of lake Superior where the same is intersected by the boundary line between the Districts of Algoma and Thunder Bay; thence due north astronomically along said district boundary to the southerly limit of the right-of-way of the Canadian Pacific railway; thence southeasterly along the southerly limit of said right-of-way to a point on said right-of-way where the same is intersected by the northerly production of a meridian line by O.L.S. Alexander Niven in 1902, which point is about two miles east of Woman River station; thence due south astronomically along said meridian line nineteen miles more or less to the thirtieth mile post on said meridian line, which point marks the northeast angle of the Mississaga Forest Reserve; thence due west astronomically along the north limit of said Forest Reserve fifty-four miles to the northwest angle thereof; thence due south astronomically along the west limit of said Reserve thirty-six miles to the southeast angle of the township of Curtis; thence due east astronomically along the north limit of townships numbers 201 and 195 to the northeast angle of the latter; thence due south astronomically six miles to the northwest angle of township No. 188; thence due east astronomically along the north limit of townships Nos. 188, 182, 176, 169, 163 and 157 to the northeast angle of the latter, which line forms the southern limit of said Forest Reserve; thence due south astronomically along the east limit of townships Nos. 157, 156, 155, township of McGiverin and township of Long, a distance of twenty-nine miles, more or less to the water's edge of lake Huron, about two miles west of Cook's Mills; thence westerly and northerly along the north shore of said lake and along the east shore of lake George and along the north bank of the St. Mary's river to the town of Sault Ste. Marie; thence continuing along the north bank of said river and northerly and westerly along the east shore of lake Superior to the place of beginning.

To include also the Great Manitoulin group of islands and all islands in lake Huron north of said Manitoulin group and west of the southerly production of the east limit of the township of Rutherford to a point east of Cape Smith. To include also St. Joseph Island and islands in lake George and the St. Mary's river lying north of the international boundary, and islands in lake Superior lying east of the southerly production of the boundary between the Districts of Algoma and Nipissing south of the international boundary, saving and excepting therefrom all the lands set apart and allotted to the Algoma Central Railway Company by Order-in-Council dated the 4th day of February, 1905, made under and by virtue of the Act passed in the sixty-third year of Her late Majesty's reign, chapter 30, entitled an Act respecting Aid by Land Grant to the Algoma Central Railway Company, such lands being colored green on the plan filed by the said company, and referred to in the aforesaid Order-in-Council, the same being as follows: The townships of Deroche, Hodgins, Gaudette, the township of West Gaudette, locally known as Hamilton, township 23, range X, townships 24 and 25 in Range XII, and 24 in Range XIII, also townships 22 and 23 in Range XI and XII, the eastern part of the township of Archibald, townships 26 and 27 in Range XII, 25, 28 and 29 in Range XIII, 24, 25, 28 and 29 in Range XIV, 26 and 27 in Ranges XV and XVI, 24 and 25 in Ranges XVII and XVIII, 28 and 29 in Ranges XVII and XVIII, 26 and 27 in Ranges XIX and XX, 30 and 31 in Ranges XIX and XX, 28 and 29 in Ranges XXI and XXII, 26 and 27 in Ranges XXIII and XXIV and townships 28, 29, 30, 31, 32 and 33 in Ranges XXV and XXVI.

Mr. Sidney T. Bowker, Mining Recorder, writes:

"I beg to report as follows on the operations of my office during the year 1906:

"The Mining Recorder's Office was opened at Sault Ste. Marie, on the 7th day of August, 1906.

"The total number of mining licenses issued from this office up to December 31st, 1906, was 75.

"The total number of mining claims received and recorded up to December 31st, 1906, was 115.

"The total amount of fees collected and forwarded to the Department up to the 31st December, 1906, was $1,393.50.

"I am very glad to report that the mining industry in my Division is progressing very favorably indeed. I have had a great many inquiries since I opened the office as to mining matters generally.

"Copper especially seems to be very active in this Division. The Northern Ontario Consolidated Copper Company, which is operating in the township of Thompson near Dean lake, appears to have struck a large body of exceptionally fine ore. I have seen samples of it weighing almost 100 pounds that will run nearly 15 per cent. copper. It is said they have a stock pile of about 2,000 tons, all good shipping ore. They have sunk a three-compartment shaft to a depth of 130 feet and are now crosscutting the vein. The reports I hear from this property are very favorable indeed.

"In the same vicinity, in the township of Patton, the Jury copper mines have been opened, and I understand they are already shipping ore.

"In the township of Cobden, about two miles from the property owned by The Northern Ontario, another good find was made late last fall, and I understand a company is being organized for the purpose of working it.

"There have also been one or two good finds reported on the Algoma Central railway, one by Frank Inglee. I have seen samples of this copper. It looks very good. It is Mr. Inglee's intention to start active development work in the spring.

"Another claim is that owned by the Cobden Mining Company. This has not been developed to any extent, but indications are very good for copper ore."

Port Arthur

The Port Arthur Mining Division includes the following territory:

(1) Commencing at the intersection of the boundary line between the Districts of Thunder Bay and Algoma with the north shore of lake Superior; thence north astronomically along said district boundary to the southerly limit of the right-of-way of the Canadian Pacific railway; thence westerly along the southerly limit of the said right-of-

way to the east boundary of the township of Pic; thence due south astronomically along said east boundary to the southeast angle thereof; thence due west astronomically along the southerly boundary of said township to the water's edge of lake Superior; thence southeasterly and easterly along the water's edge of said lake to the place of beginning, together with Michipicoten island and all islands in lake Superior lying south of the above described area.

(2) Also the township of Sibley set aside as a Forest Reserve.

Said Mining Division to include also within its limits all islands in lake Superior within the Province of Ontario lying west of a line drawn due south astronomically from the southwest angle of the township of Pic.

Mr. C. H. Shera was the Recorder appointed when the Division was established, but dying 24th November, 1906, his son Mr. W. L. Shera filled the position temporarily until the appointment of Mr. J. W. Morgan on 28th December following.

Mr. Morgan furnishes the following report:

"As I took over this office on January 1st, 1907, my report must be based entirely on such information as is contained in the books of this office, and on the opinions of the prospectors and mining men of this district.

"I have to report that this office was opened during the first week in August 1906, the first license was issued August 7th and the first claim was recorded August 13th. During the remainder of 1906 there were issued from this office forty-nine licenses, and forty-two claims have been recorded; $599.70 was received, and $520.00 remitted to the Bureau of Mines.

"Prior to the setting in of winter a considerable amount of prospecting had been done and some very valuable claims had been taken up. During winter very little has been done, the snow lying three or four feet deep, and the temperature frequently falling to thirty degrees below zero. I have not the slightest doubt that early spring will see a great deal of prospecting and actual mining development done in this district.

"Every mining man and prospector without exception speaks with the highest approval of the opening of a Mining Recorder's office in this town. Their reasons are:

(*a*) The avoidance of delays and additional expense in securing miner's licenses.

(*b*) Claims are recorded here and delay in commencing work is thus obviated.

(*c*) Disputes are much more easily settled.

(*d*) It is a very great convenience to have in this office for public inspection, maps and records in detail, so that a prospector can without delay ascertain what lands are open for staking out."

Kenora

The Kenora Mining Division was set apart with the following boundaries:

Commencing at a point on the boundary line between the districts of Rainy River and Thunder Bay where the same is intersected by a base line run by O.L.S. Thomas B. Speight in latitude 49 degrees 0 minutes 6 seconds north; thence due west astronomically along said base line 23 miles 71 chains 7 links to an iron post; thence continuing on the same course west astronomically 36 miles more or less to the 18th mile post on O.L.S. Niven's 5th meridian line; thence continuing on the same course west astronomically 30 miles more or less to the 18th mile post on O.L.S. Niven's 6th meridian line, thence continuing on the same course due west astronomically 35 miles more or less to the westerly shore of Clear Water lake; thence southerly along the westerly shore of said lake 10 chains, more or less, to the 49th parallel of latitude; thence due west along said parallel of latitude 32 miles more or less to the water's edge on the east shore of the Lake of the Woods; thence continuing due west astronomically along said parallel of latitude 14 miles, more or less, to where the same is intersected by the international boundary passing through the Lake of the Woods.

Mr. C. W. Belyea, Mining Recorder, reports as follows:

"Miner's licenses issued 9; amount paid, $45.00.

"Number of mining claims recorded in this office on which fees were paid here 13; fees, $77.50.

"Number of claims recorded in books of Department transferred to me, and fees paid into Department, 12.

"Total amount collected to December 31st, $122.50.

"Total amount sent to Department for year ending December 31st, $122.50.

"First license issued on 9th October, 1906.

"In the Lake of the Woods section of this mining district the work of development and mining has for the past year been of an intermittent and desultory character.

"On none of the well known properties that have been developed to any great extent has any important or progressive work been done. This is perhaps accountable for by lack of capital chiefly; as past years have fully demonstrated the richness of the ore bodies in and around Lake of the Woods. There are prospects, however, that the coming spring will see the opening up of the Golden Horn mine, the Combine mine, the Black Eagle or Regina, and the Sultana.

"From the Eagle lake district where the working properties of the Baden Powell Mining Company and The Northern Lights Mining Company and the Grace mine have been closed down during the winter, it is reported that work will be resumed this spring.

"Interest has been aroused by reports of large deposits of iron ore lying to the north and east of the route of the Transcontinental railway, but so far it has not been determined whether these deposits are of a valuable mercantile character or within reach of transportation facilities.

"The Manitou region merits separate mention from other parts of the District, it being in many ways isolated from the other belts that have been more or less worked, and also on account of the auriferous zone in which the work is being carried on differing in many respects from the general ore deposits of the district.

"The principal theme of interest in this district during the past year (1906) has been the Laurentian mine. The work that has been done on the property has been more in the nature of exposing the rich chute and crosscutting at the 200 foot level to the other parallel ore bodies, production being of secondary consideration, pending the organization of the operating company which is now organized and known as the Hugo von Hagen Exploration Company. The intention of this company, it is understood, is to commence aggressive work at once not only on the Laurentian, but on other properties which it has acquired in the same locality. The Von Hagen Company is capitalized at fifteen million dollars, par value of shares $5.00 each.

"The Northern Development Company at their Paymaster mine (H. W. 20) have worked energetically during the whole year, several parties of the shareholders having visited the property during the year, one party from Detroit and vicinity, numbering thirty-five, having come at one time. At present the company is crosscutting at the 200-foot level, having delayed sinking on account of water, and now awaiting pumping machinery.

"The Summit Lake Gold Mining Company resumed work on their Little Master mine, but had the misfortune to have their engine house burnt. This building contained the compressor and hoisting plants, and therefore work had to be suspended. However, the company is making arrangements to instal a heavier plant.

"The Detola Mining and Development Company is a new organization of the past year. It owns mining location H. P. 411, on which a preliminary test shaft was sunk. Machinery is to be installed this coming season. The company is composed principally of Michigan and Ohio stockholders.

"The Manitou Mines Company, Limited, is another new organization composed of local men and parties in the State of New York. They commenced operations on McA 28, known as the Victory mine. This property was the first location that had a fifty-foot shaft sunk on it in the Manitou country, which was done in 1896-7. Since then it has remained largely in a dormant condition, the shaft having been continued to the 100-foot level and some drifting and crosscutting done in 1897-8. This past summer the above company took hold of it under option and made further investigation, after which they built new camps and did a little surface work and straightened up the shaft, etc., ready for the installation of machinery in the spring. The company are now making preparations to put in at once a six-drill air compressor and hoist with two 60-h.p. boilers, and will then commence energetic mining work. "

"The Minnehaha Mining and Smelting Company of Buffalo, N. Y., operating on mining locations S. V. 434 and 435, continued their shaft from the 50-foot level another fifty feet. The vein at that depth having widened and become more mineralized, their intention is to now erect camps and instal compressor plant and hoist, the work so far having been done by contract during the summer months. No buildings were put up, but now with the installation of machinery it is their intention to commence permanent operations with a practical superintendent in charge.

"Several properties, the leases of which were recently cancelled for the non-payment of rent, etc., have been acquired by new holders, and these parties are mostly all preparing for operations more or less extensive during the coming summer. Other properties have changed hands, and taking every thing into consideration, the outlook for the year 1907 is promising. With the fresh life that the foregoing work has instilled into the prospectors, and the general prosperity of the whole district, I look for a very active season in gold mining."

Mississaga Forest Reserve

The Mississaga Forest Reserve Mining Division comprises the whole of the Mississaga Forest Reserve through which the river of that name runs into lake Huron. It is subject to the Forest Reserve Regulations, and is administered by the Department at Toronto.

Fort Frances

The Fort Frances Division is described as follows:

Commencing at a point on the boundary line between the Districts of Rainy River and Thunder Bay where the same is intersected by a base line run by Thomas B. Speight, O. L. S., in latitude 49 degrees 0 minutes 6 seconds north; thence due west astronomically along said base line 23 miles 71 chains 7 links to an iron post; thence continuing on the same course west astronomically 36 miles more or less to the 18th mile post on Ontario Land Surveyor Niven's 5th meridian line; thence continuing on the same course west astronomically 30 miles more or less to the 18th mile post on Ontario Land Surveyor Niven's 6th meridian line; thence continuing on the same course due west astronomically 35 miles more or less to the westerly shore of Clear Water lake; thence southerly along the westerly shore of said lake 10 chains more or less to the 49th parallel of latitude; thence due west along said parallel of latitude 32 miles more or less to the water's edge on the east shore of the Lake of the Woods; thence continuing along said parallel of latitude 14 miles more or less to where the same is intersected by the international boundary passing through the Lake of the Woods.

It is administered by the Department direct.

Parry Sound

This Mining Division comprises the territorial districts of Parry Sound and Muskoka, but does not include the islands in Georgian bay. Mr. McQuire reports as follows:

"Office opened in the month of October, 1906.

"Number of miners' licenses issued, 26.

"Applications for mining claims received and recorded, 33.

"Fees collected, $367.

"Fees remitted to Department, $337.

"Considerable activity in prospecting seemed in evidence both by inquiry and otherwise. The office being created so late in the fall the term was too short for much progress.

"I understand that now there is much inquiry for copper properties. Several of the old registered companies are prepared to resume active development work in the spring.

"The office is filling a long felt want and is appreciated by the public, but until it is supplied with the necessary maps, etc., showing the lots already taken up and those still open, it is handicapped to supply necessary information."

Larder Lake

The Larder Lake Mining Division includes the unsurveyed territory around Larder lake described as follows:

Commencing at the northeast angle of the township of Pense on the Interprovincial Boundary between the Provinces of Ontario and Quebec; thence due north astronomically along said Interprovincial boundary a distance of forty-two miles, thence due west astronomically twenty-three and a half miles more or less to the northeast angle of the township of Barnet, thence due south astronomically along the east boundary of the township of Barnet and along its production due south astronomically to the northeast angle of the township of Otto, twenty-four miles more or less, thence due south astronomically along the east limit of the township of Otto six miles more or less to the northwest angle of the township of Pacaud, thence due east astronomically along the north boundary of the townships of Pacaud and Catharine twelve miles more or less to the northeast angle of the latter, thence due south astronomically along the east limit of the townships of Catherine and Marter twelve miles more or less to the northwest angle of the township of Ingram, thence due east astronomically along the north boundary of the townships of Ingram and Pense eleven and a half miles more or less to the place of beginning, containing by admeasurement eight hundred and fifty square miles, more or less.

This tract was formerly comprised within the limits of the Temiskaming Division, but the discovery of gold on Larder lake in 1906 led to the staking out of several thousand claims in that neighborhood during the summer and fall of that year, and the following winter, and required the opening of an office on the ground for the accommodation of prospectors.

Montreal River

A somewhat similar state of affairs led to the setting apart of a portion of the Temagami Forest Reserve under the name of the Montreal River Mining Division. The finding of silver and cobalt ore in the township of James and at Anvil lake, similar in character to that of the Cobalt district, which was reported in the autumn of 1906, attracted a large number of prospectors who staked out claims freely during the winter months following. Part of the argentiferous region lay east and north of the Montreal river within the boundaries of the Temiskaming Mining Division, but the district situated west and south of that river was constituted a separate Division, with a recording office at Latchford. Its limits are as follows:

Commencing at a point on the west bank of the Montreal river at the mouth of Lady Evelyn river near Mattawapika Falls, thence northwesterly along the west bank of said Montreal river against the stream and along the west shore of the several lake expansions therein to where the same is intersected by the east bank of the east branch of said Montreal river about half a mile south of Sinclair's Exploration line run in 1867, thence southerly along the east bank of said east branch of said Montreal river and along the east shore of Smooth Water lake on said river to the portage at the extreme southerly end thereof leading southerly to Apex lake, thence southerly across said portage to Apex lake, thence easterly across Apex lake and down the small stream flowing easterly therefrom designated as Lady Evelyn river and easterly along the northerly shore of the numerous small lake expansions on said river to Lady Evelyn lake, thence easterly along the north shore of said Lady Evelyn lake to Mattawapika lake and along the westerly bank of Lady Evelyn river to Mattawapika Falls at its junction with the Montreal river or place of beginning.

The Montreal River Mining Division is a Complete Inspection area under the Mines Act, and all claims are required to be inspected for discovery before a lease can be obtained. It is also subject to the Regulations respecting Forest Reserves, which, among other things, require the permission of the Minister of Lands, Forests and Mines before any mineral deposit can be opened up, thus enabling due protection to be given to the timber.

Temagami Forest Reserve

The Temagami Forest Reserve Mining Division covers for mining purposes the same territory as is included in the Forest Reserve, excepting the territory included in the Montreal River Division, as described above. The following is a description:

Commencing at a point on O.L.S. Alexander Niven's base line run in 1881 in latitude north 46 degrees 49 minutes 27 seconds where the same is intersected by the rear or westerly limit of the timber berths laid out on the west shore of lake Temiskaming, which point is nineteen miles west of the west shore of said lake, thence due west astronomically along said base line, a distance of 42½ miles more or less to the southeast angle of the township of McCarthy, thence due north astronomically along the east limit of said township six miles more or less to the northeast angle thereof, thence due west astronomically along the north limit of the townships of McCarthy, McKelcan, Aylmer and Parkin, a distance of twenty-five miles more or less to the southeast angle of the township of Creelman, thence due north astronomically along the east limit of the township of Creelman six miles more or less to the northeast angle thereof, thence due west astronomically along the north limit of the township of Creelman six miles more or less to the boundary line between the districts of Nipissing and Algoma, thence due west astronomically along O.L.S. Proudfoot's base line run in 1888, forming the north boundary of the township of Roberts, six miles, thence continuing along said base line six miles to the 12th mile post thereon, thence northerly to the foot of Long Lake on the head waters of the Wahnapitae river, thence northerly along the east shore of said lake and down the Wahnapitae river to Oshawong lake, thence continuing northerly along the east shore of Oshawong lake and along the several small portages and small lakes on the canoe route to the north end of Meteor lake and across the height of land portage to Opickinimika lake, near the head waters of the Mattagami river, thence northerly along the east shore of said lake and down the Mattagami river and its lake expansions to O.L.S. Niven's base line, run in latitude north 48 degrees 27 minutes and 54 seconds, thence due east astronomically along said base line, ten miles more or less to the southwest angle of the township of Whitney, thence due south astronomically six miles, thence due east astronomically six miles more or less to the northwest angle of the township of Langmuir, thence due south astronomically along the boundary line between the Districts of Algoma and Nipissing, forming the west boundary of said township of Langmuir six miles to the southwest angle thereof, thence due east astronomically along the south boundary of the townships of Langmuir, Blackstock and Timmins, a distance of fifteen miles more or less to a small lake on the canoe route between the Great Northern Bend on the Montreal river and Night Hawk lake, thence southerly along said canoe route passing through Trout lake to the Great Northern Bend on said river, thence southerly along the easterly bank of the Montreal river down stream and along the easterly shore of the lake expansions thereon to where the easterly shore of Bay lake is intersected by the northern limit of the fifty square mile timber berth under license to Gillies Brothers, Limited, thence on a course south fifty-five degrees 35 minutes west astronomically along the north limit of said timber berth a distance of three miles and five chains to the northwest angle of said timber berth, thence southerly, westerly and southeasterly along the western or rear boundary of the several timber berths laid out on the west shore of lake Temiskaming to the place of beginning.

The Temagami Forest Reserve Mining Division is administered by the Department, because of the special attention required to be given to the valuable pine and other forests which it contains.

Provincial Assay Office

Mr. A. G. Burrows, B.A.Sc., Provincial Assayer, reports as follows on the operations of the office for the year 1906:—

This office was established in 1898, by the Government of Ontario, as an aid to the mineral development of the Province. It affords prospectors and others interested in mining, facilities for having samples from their finds examined reliably, and at a nominal charge. It is especially of value to parties living in the remote and partially settled portions of the Province, where there are no means at hand for having their minerals tested satisfactorily.

The office is located in the City of Belleville, on Victoria Avenue, where a two storey brick building is fitted with the necessary appliances. The lower floor is utilized as an office, store room and grinding room, while the upper floor is devoted to assay and analytical work.

During the year 1906, 1,838 samples were quantitatively tested for one or more constituents; and 191 samples were examined by hand inspection or rough qualitative methods to determine probable commercial value. This was the most successful year in the history of the office, due no doubt to the great impetus given to prospecting by the phenomenal finds in the vicinity of Cobalt. Samples were received from as far north as lake Abitibi. While the bulk of the material was from the region between Sault Ste. Marie and lake Temiskaming, still many samples came from the western portion of the Province (Rainy River and Thunder Bay), and the eastern mining belt of North Hastings, Addington and Frontenac. A very miscellaneous variety of samples was examined, including gold, silver, copper, cobalt, and nickel ores; clays, marls, limestones, peats and other non-metallic substances.

Work for the Bureau of Mines

The following services were rendered the Bureau of Mines:—

1. Issuing reports on samples submitted by the Government geologists, of rocks, peats, clays, etc., collected in their summer field work.

2. Analyses of a number of clays for Mr. M. B. Baker's Report on the Clay Industry of Ontario.

3. Assays of samples, taken by the Inspectors of claims for the Temiskaming Mining Division, to determine the presence of valuable mineral as required for the passing of claims.

4. Special analyses of rocks and rare minerals submitted by Prof. Miller, Provincial Geologist, which are of scientific interest.

Work for the Public

The following services have been performed for private parties:—

1. Issuing reports, consisting of assays, analyses, identifications, etc., of samples submitted for examination. These reports are confidential, and duplicates are issued only on the advice of the parties for whom the examinations are made.

2. Supplying information to parties having economic minerals, etc., who desire to be put in communication with prospective buyers.

3. Making check assays and analyses in cases of dispute as to correct values, and also examining samples in which it was claimed there were certain metals of commercial value. Samples supposed to carry molybdenite were found to be graphite or black mica.

Rusty mica was also mistaken for gold, while platinum was reported in several samples, in which none could be found. In several cases considerable money had been expended on properties supposed to carry certain metals, which could have been saved, had reliable tests been made on surface samples. One party stated that he had laid out a large sum on a property on which had been reported molybdenite, but which proved to be only a pyritous graphite. Another party had mistaken a yellowish iron pyrites for copper pyrites, and another did a good deal of work on a green schist, believed to be a very wide gold lode, the value of which had been obtained by panning, but samples of which showed no gold when subjected to a fire assay at this office.

The following determinations were made during the year, checked by duplicates where possible:—

Assays

	For Bureau.	For Public.	Total.
Gold, amalgamation	....	3	3
Gold, fire assay	737	744	1,481
Silver	750	607	1,357
Platinum	....	11	11
Copper	9	148	157
Nickel	11	32	43
Cobalt	25	35	60
Arsenic	3	22	25
Lead	1	47	48
Zinc	....	10	10
Tungsten	....	1	1
Bismuth	....	1	1
Molybdenum	....	3	3
Total	1,536	1,664	3,200

Analyses

	For Bureau.	For Public.	Total.
Metallic iron	7	80	87
Silica	32	23	55
Ferric oxide	32	13	45
Ferrous oxide	3	2	5
Alumina	18	13	31
Lime	32	25	57
Magnesia	32	22	54
Alkalies	32	4	36
Phosphorus	1	34	35
Sulphur	17	46	63
Titanium	1	15	16
Carbon	....	4	4
Volatile combustible	....	3	3
Miscellaneous	31	16	47
Total	238	300	538
Total determinations	3,738		

Fees amounting to $1,584.65 were collected during the year and forwarded to the Bureau of Mines. The value of the work rendered the Bureau of Mines at lowest circular rates was $1,428.65, making a total value of $3,013.30 for the work of the office.

All determinations are made by standard analytical methods, and in duplicate to avoid error in issuing certificates. A sample of pulp is retained for further examination on request of the sender.

Samples brought personally to the office are examined free of charge. This does not include any quantitative determination, but is simply an opinion as to probable commercial value.

Sample bags and mailing envelopes are supplied parties desiring to send in samples, and circulars of rates are forwarded on application.

One laboratory assistant was employed during the year, Mr. W. J. Embury, who left in January 1907 to accept a position as assayer with the Eldorado Copper Mine, Hastings County, Ontario.

SUMMER MINING CLASSES

BY W. L. GOODWIN

Itinerary

The first week of May 1906 was taken up with the work of preparing the mineral specimens, printed labels, etc., for the summer work.

I left Kingston on May 9th, and spent a few hours in Toronto conferring with Mr. Gibson, and buying some necessary supplies. It was decided to devote all the available time to the Temiskaming district. North Bay was reached next day, and on the morning of May 11th I took train by the Temiskaming and Northern Ontario railway for Haileybury. The train was crowded with prospectors and mining men. From some of these I obtained information about centres where prospectors were gathering. I learned that a good prospect of iron ore was being developed near Temagami (Mr. A. Scott in charge).

Next day (May 12th) I was joined in Haileybury by Mr. J. Watson Bain, and we made preparations for holding the class there in the Orange hall, which was engaged for us by the Council. The class was opened on Monday, May 14th, and closed on Saturday, May 19th. On that day Mr. Bain went to Toronto to give evidence in court.

I went as far as Cobalt and arranged with Mr. R. Y. Fitzpatrick, who was in charge of the reading camp there, to give some assistance. Monday, May 21st, was spent in moving the outfit down to Cobalt. I was met at the station by Mr. Armand de Bruyne (in charge of Major Morrison's camp) who kindly provided a packer to carry the tent down to the camp, where we slept during the stay at Cobalt. The class was opened that evening and closed the following Saturday. But the attendance had been so large that we decided to continue the work in Cobalt for another week.

This brought us to June 2nd, when we made preparations to move to Giroux lake. We were again indebted to Mr. de Bruyne for assistance in moving our camp outfit. From Cobalt we went on June 4th to Argentite, and thence by way of Cross lake to the University mine, where the class was to be held. After getting our luggage to the mine on one of Reamsbottom and Edwards' carts, we borrowed a canoe and paddled across Giroux lake to Professor Miller's camp on the Gillies limit. Here we found a hearty welcome, and a place already cleared for our tent. The class was begun at the University mine on Tuesday, June 5th, and closed on the 11th.

The 12th was spent in packing and moving to Cobalt, where we spent a day in rearranging the mineral boxes. We were so much interrupted by prospectors asking for specimens and information, that it was decided to give an opportunity for another class at Cobalt later in the season. We left for Gillies' Depot on June 13th, and were met by Messrs. Bromley, Smith, Singleton and Jones, who kindly helped us with our luggage. Mr. Riddell, manager for Gillies Bros. supplied a truck and teamster to take our stuff down to the camping place on the high bank of the Montreal river. The class was opened in the Gillies Bros.' repair shop next day, and was closed on Wednesday, June 20th.

On June 21st, we moved down to Latchford and opened a class in an unfinished store kindly put at our disposal by the owner Mr. Simpson. The class was continued here until Thursday, the 28th, when we proceeded to New Liskeard, where a class was opened in the Orange hall on the 29th.

Monday, July 2nd, being a public holiday, no class was held. We drove five miles to Ritchie's farm on Sutton bay, hired a boat and rowed across to Gray's. Mr. Gray was prospecting a small calcite vein showing on the face of a cliff near the shore. His boys guided us to Tighe's about a mile and a half, where we had dinner. We then followed a trail to Synder's, near which is Bucknall's mine, a fine vein of smaltite and niccolite with bismuth and small silver values. The rock is conglomerate. The claim (lot 5, Con. I, Casey township) was being worked by Mr. Bucknall and his sons. They had a shaft down 28 feet. On adjoining lots were other veins of smaltite and niccolite. We secured a fine lot of specimens, as many as we could carry over the trail. We were allowed to pick out the best of everything in sight.

The class in New Liskeard was closed on Friday, July 6th. In the meantime we had received a numerously signed petition to spend a third week in Cobalt. We accordingly moved down on Saturday, and opened a class there that evening in the reading camp, then in charge of Mr. E. W. Bradwin, who gave us much assistance while we were there. We again made our camp with Major Morrison, near the 101st mile post. His men carried our luggage from the Empire siding and put up the tent all ready for us when we walked down after the lecture, tired with the long day's work.

The third class in Cobalt was closed on Friday, July 13th, and on Saturday Mr. de Bruyne helped us pack our tent down to Empire siding, where we took train for New Liskeard. We were sorry to leave behind the pleasant associations of Morrison's camp.

An early start in New Liskeard on Monday morning, preceded by a hearty breakfast at the Chinese restaurant, brought us to the Gipsy's landing place at the bridge across the Wabi. We left for Tomstown at 7 a.m., and were received there by the student missionary Mr. Wm. Hay, through whose kindness we were allowed to hold the class in the comfortable log building which is a combined church and manse. There were other familiar faces at the landing place (a steep bank of slippery clay) and our luggage was taken in hand by mining students and graduates and rushed up the bank. It was a case of "many hands make light work." The class was opened that evening and closed on Saturday, July 21st.

The attendance was small at Tomstown, owing to the scattering of prospectors to somewhat distant points. We therefore made a flying visit to the End of Steel on the 20th, taking along a box of minerals and some apparatus. We found a large number of prospectors camped near the railway. Mr. Bain, therefore, stayed to open a class while I returned to Tomstown to wind up the class there.

On the way to End of Steel I met my brother E. P. Goodwin, C.E., returning to District D, Transcontinental railway survey. He reported that wheat had ripened at his camp near north end of lake Abitibi on September 1st. Potatoes, peas, beans, radishes, lettuce, etc., had been raised there.

On Friday, July 27th, the last class of the season was completed at End of Steel, the "farthest north" educational work for Ontario.

Notes

The summer's work was distinguished from that of every preceding summer, except to some extent that of 1905, by the large number of prospectors reached while they were in the field. There must have been several thousand prospectors at work in the district during the summer of 1906. But as they were constantly leaving the district, the number there at any one time was much less than the grand total. The majority prospected at large, searching for extensions of the field. Those who attended the classes were urged to prospect for minerals other than silver and cobalt, and the instructions given and the specimens supplied gave them a better chance to make finds. We tried also to give as clear directions as possible about the geology of the district, and the illustrated lectures given at the close of the lessons on minerals and rocks, constituted a short popular course on the elements of geology, with special reference to the district in which we were working.

The average of intelligence and education of the prospectors was very high, and it was felt that we were touching every part of Ontario with this elementary education in rocks and minerals. The prospecting in the Temiskaming district has certainly been done in great part by our own people, but there has been a good sprinkling of men from all parts of Canada, and indeed from other countries far and near.

There was constant enquiry for advice as to books to read in order to follow up and extend the information got in the classes. Prof. Miller's "Minerals and How they Occur," published about the time the classes began, was used by a great many.

By means of a very simple portable outfit we showed the classes how to identify bloom, how to distinguish smaltite from mispickel and pale iron pyrites, and how to test for silver. Some of the men made up small sets of apparatus for these tests and took them into the field.

The total number of men who attended the classes during the summer was about 930. This implies a distribution of about 30,000 mineral specimens.

Visitors from other countries remarked upon the rather unusual character of these summer mining classes, and expressed their wish that the same idea might be carried out in their own countries. Ontario was considered to be unusually enterprising in this respect. Now that the high schools have taken up the study of geology and mineralogy, it becomes necessary to consider whether the summer mining classes may not be discontinued in the near future, or their character be changed so as to convert them into summer schools of applied mineralogy and geology, held in some mining centre or centres during the months of July and August, so that they might be attended by teachers. The older prospectors and miners of the Province have been pretty generally reached during the twelve years since the classes were started. It may be urged that very few prospectors and miners ever reach the high schools. For this reason and on account of the great practical importance of the subject, some steps might be taken to put a practical acquaintance with the elements of mineralology and geology within the reach of every boy in Ontario. There are boys in every county who take to such studies naturally and eagerly. It is not necessary to make such subjects a necessary part of the curriculum required for High School Entrance. An enterprising teacher in a country or village school will find time and energy to lead a willing lad through a simple course of observation and testing, if the specimens and a good book are available.

Haileybury

Councillors Warner, Thompson and Norfolk arranged for the use of the Orange hall for the sessions of the class. An electric wire was put in by Mr. Beach, and we were looking forward to using the electric lantern instead of the less brilliant acetylene apparatus. But unfortunately for our hopes, the sawmill with which the power house was connected burned down next day, and we had to fall back on the acetylene lamp. The town was full of prospectors outfitting, or coming in to buy supplies or have assays made. We found that our old friend David John, formerly of the Mikado mine, had opened an assay office and was doing a rushing business. In spite of the large number of men crowding the little town, there was no disorder.

We visited a small prospect about a mile west of the house of Professor Sharp, who kindly guided us to the spot. A small party of men were at work. A little bloom and smaltite were noticed. A good quantity of diabase (gabbro) was collected at the first rock-cut south of Haileybury, Niagara limestone from the shore near the town, and specimens of granite, etc., from boulders. We were kept very busy examining specimens for prospectors. Several good pieces of copper pyrites were brought in. We laid a good deal of stress on the copper and iron possibilities of the district. Prospectors were anxious to complete their sets of specimens and to get out into the field. We therefore opened a morning class, so that altogether we kept three classes running, one at 9 a.m., a second at 4 p.m., and a third at 7 p.m.

By permission of the manager, Mr. Warner, we collected a fine lot of cobaltite samples from the ore pile at the Benn mine. Mr. E. Wright kindly took us down the lake in his gasoline yacht. While working on the ore pile we noticed a very heavy explosion towards the east. This was afterwards learned to be the explosion of a dynamite magazine in Cobalt (May 18th) caused by the bush fires, which were burning everywhere in the district. The explosion wrecked the northern part of the town, and broke windows everywhere. There were no fatalities, but some very narrow escapes. The fire was finally got under control by running a long pipe line from Cobalt lake and pumping water with the engine at La Rose mine.

The total attendance at Haileybury was about 95, and the average attendance 53.

Cobalt

The classes were held in the rooms of the Reading Camp Association. In the absence of Mr. Bain, the work would have been more than I could have managed, had I not had the volunteer assistance of Mr. A. Bromley Smith, who managed the lantern and helped hand around specimens. Mr. R. Y. Fitzpatrick proved a very efficient assistant, and his services were continued after Mr. Bain's return from Toronto, as the crowds were too large for us to serve with the mineral specimens. Classes were held at 10 a.m., 3 p.m., and 7 p.m., so as to give a chance to those who were engaged at different times of the day. We were kept busy between classes, examining specimens, testing for silver and cobalt, and showing prospectors how to make tests. It was hard to get time to eat. Fortunately our camp was two miles away, so that we were able to beat a retreat and rest when tired nature rebelled. The work grew in volume and intensity every day. The town was full of intelligent men, eager for information about minerals and rocks.

At the end of a week it was quite evident that another course would have to be given in Cobalt, as there was a constant stream of prospectors arriving. We therefore dismissed the first set on Saturday, May 26th, and began with a new class on Monday. The average attendance during the first week was 158, and the total attendance about 250. The attendance was quite as large the second week, but we were obliged to limit the work by cutting off the morning class. The average attendance for this week was 124, and the total attendance about 200.

In response to a petition signed by a large number of prospectors, we held a third class in Cobalt, beginning on July 7th. The town was not nearly so crowded as in May, but prospectors were numerous enough to give us plenty to do. Average attendance was 46, with a total attendance of about 65.

While at Cobalt we collected smaltite and bloom at Morrison's claim; good specimens of Keewatin greenstone from the east shore of Pickerel lake; and diabase crusted with epidote from the hillside across the railway track from La Rose mine.

The night of May 31st and the morning of June 1st were spent pleasantly at Seymour's camp on the west side of Sasaginaga lake, a short distance west of Cobalt. Mr. Seymour's cottage was a delightful haven of rest. The Trethewey mine was visited on the way back to Cobalt.

On the morning of May 31st, we walked across the Gillies timber limit from Morrison's camp at the 101st mile post to Prof. Miller's camp at Diabase point, Giroux lake. There we found a very pleasant party of Practical Science students and graduates prospecting the Government lands. Arrangements were made for holding a class at the University mine, Giroux lake. On the way back I took the trail past the Savage mine where I met the owners (Messrs. Chapin and Thomson) who kindly ferried me across Cart lake and accompanied me to the McKinley and Darragh mine, another of their properties.

On Sunday, July 8th, we made another visit to Prof. Miller's camp. Going across Giroux lake to attend religious service at the University mine, we found the miners fighting a fire which was threatening the buildings of the Foster mine. We joined in the fray. On the occasion of another visit (July 11th) accompanied by Major Morrison, we met a mining engineer who had come all the way from Erzeroum, Turkey.

Giroux Lake

On invitation of Mr. H. L. Kerr the class was held in the sitting room of the University mine camp, a large frame building, clean, comfortable, and well-appointed and managed. Superintendent D. Cameron, and mine foreman A. McDonald did much to assist us. The The attendance included men from the Foster, Drummond, McCormick, Wendigo and other mines. Good specimens of copper pyrites were collected from the open cut west of the camp. Mr. W. G. Blair gave us fine specimens of niccolite from the vein which outcrops close to the camp. Mr. J. G. McMillan, manager of the Foster mine, showed us over this rich property. Mention should be made of the kindness of Mr. A. Bromley Smith, who packed a missing and much needed box of minerals across the timber limit from Gillies Depot.

Average attendance was larger than expected, amounting to 46, with a total attendance of about 60.

Gillies Depot

On the way to this place we spent a day at Cobalt sorting the minerals. It was noticed that a wall-case of fair sized mineral specimens, which I had put up in the reading camp, was being a great deal consulted by prospectors. Prospectors' tents were very numerous along the track in the vicinity of Gillies' Depot. The flies were very bad in the woods, and many prospectors were unable to endure their attacks. A good deal of prospecting was being done around Mud lake and along the Montreal river. Cobalt bloom and smaltite had been found in many places. Our tent was pitched in the midst of a long line of tents along the high bank of the Montreal river, about half a mile south of Gillies' Depot. Our neighbours in "Tentville" were Messrs. Bromley Smith, Singleton, Jones, Leoney, Benson, Goodman and Haskin. These gentlemen were all artistic camp cooks, so that the problems of board and lodging did not arise in this camp. We were all cooks, but the rest of the camp considered Mr. Bain and myself as guests of the camp, so that it was only on sufferance that we were allowed to take a hand in the kitchen.

The class was held outdoors, the men sitting comfortably on a pile of square timber, or standing in the lee of the smudges when the flies were bad, as they generally were. Nearly all the members of the class were practical prospectors, and attended very regularly. We wish to record our appreciation of the kindness and hospitality of the people of "Tentville" and of Gillies' Depot. The average attendance was 34, and the total attendance 55.

Latchford

This place is about ten miles south of Cobalt. Here the Temiskaming and Northern Ontario railway crosses the Montreal river, which expands about this point into Portage bay, a promising region for prospecting. Several small steamers run up the river from Latchford to Pork rapids, and prospecting was active all along their route. Mr. H. M. Wilson, manager of the Edison mine took us up the river in his gasoline yacht on June 25th. We left the Montreal river a little below Pork rapids, and threaded our way up a small stream which drains Trout lake. At the Edison camp we had dinner, examined the mine—veins of smaltite in diabase with much copper pyrite. Close at hand in the same formation are claims held by Darby and others. Heard of much prospecting around Anima-Nipissing lake, where a considerable body of pyrrhotite was located.

Latchford is growing rapidly and should become a place of some importance. Two large sawmills form a nucleus, outside of possible growth of mining enterprises in the neighborhood. Owing to a difficulty and misunderstanding about the place of meeting, many of the prospectors missed us the first evening, but after that the attendance was very steady. The average attendance was 57, and the total attendance about 95.

New Liskeard

The class was held in the Orange hall, which was engaged for our use by Major McKelvie and the Council. The town had grown much since last year. Arrangements were being made to instal an electric light and waterworks system. The water problem is a serious one in the whole district, not because of the lack of water, but on account of the rapid influx of population, which gathers at centres in large numbers before any adequate provision is made for a water supply.

The class in this place was made interesting by an unusual amount of discussion started by members of the class. On July 5th we went with Messrs. Ritchie and Peters to visit some properties of the Blanche River Mining Company, situated in Hudson township about 14 miles west of New Liskeard. The formation is banded slate and diabase. We collected good specimens of malachite for the use of the class.

The average attendance was 37, and the total attendance about 50.

Tomstown

The class here was held too late in the season to catch a large number of prospectors. We put up our tent beside the log building which was church and manse, and boarded at McKay's hotel. Tomstown was named after the first settler, Mr. U. H. Thomas, known everywhere as Uncle Tom. It consists of a long street running back from the Blanche river, which gives it steamboat connection with New Liskeard and Haileybury. Uncle Tom has found the main street too noisy for him, and has moved back into the woods about half a mile, where he has built himself a snug house and made a garden, which attests to the kindliness and fertility of the soil of this region. We had the last of the strawberries from his luxuriant patch on July 22nd.

On account of the small attendance, it was decided to cut the class short and go on farther north. It was intended to hold a class at Charlton, a new settlement about six miles west of Tomstown, but experience at the latter place decided us to go on at once to the End of Steel in Boston township.

Average attendance was 11, and the total attendance about 25.

End of Steel, Boston

This class was opened here in the dining camp of Mr. A. R. Macdonell, contractor. Many prospectors were camped near, and prospecting was going on actively. We visited some of the prospects and noticed iron and copper pyrites, zinc blende, galena and molybdenite. There are a number of large quartz veins to be seen. Some of them may carry gold. Claims had been staked near the railway by Miller W. Young and others. Some specimens of specular iron ore were brought in for identification. There is a large quartz vein in the third rock-cut north of Macdonnell's "Boston Headquarters" as the camp is called. Quite a bunch of light colored zinc blende was seen on the hill on the east side of the railway track. The rock is greenstone and gneiss (apparently) much disturbed. Thanks are due to Mr. J. G. Mulligan for the use of the dining camp and for many kind attentions.

The average attendance was 20, and the total attendance about 35.

MINES OF ONTARIO

BY E T CORKILL

In the description of the working mines of Ontario the same subdivisions will be adhered to as in the Fifteenth Report, namely:

1. Northwestern Ontario, embracing all the region north and west of Port Arthur.
2. Sudbury and the North Shore, which includes the section from Sudbury west along the line of the Sault branch of the Canadian Pacific railway, and the Michipicoten District.
3. Temiskaming, which embraces all that part of the district of Nipissing, through which the Temiskaming and Northern Ontario railway extends, including the Cobalt, Montreal River and Larder Lake regions.
4. Eastern Ontario, comprising that part of the Province which lies south of the Canadian Pacific railway running from the Ottawa river to the vicinity of Sudbury.

Making a mine in the forest.

General Remarks

Very little gold mining was done in Ontario during 1906, with the exception of operations at Sturgeon lake and in the Upper Manitou region. Here considerable development work was done. With the excitement caused by the reported discovery of gold at Larder lake, a great rush was made for that section last winter, and thousands of claims were staked. Practically no development work has as yet been done there, and it is therefore impossible to make any statement regarding the future of the camp.

Gold is also reported to have been discovered in the Abitibi country. The building of the Temiskaming and Northern Ontario and National Transcontinental railways will furnish easy access into this section. With the usual rush and to satisfy the demands of stockholders or to assist in selling stock, stamp mills are being ordered by some of the companies operating in these new fields. This has been Ontario's great drawback, namely, the installing of expensive machinery before the ore bodies have been tested, and it is to be hoped that the majority of the companies will prove up their ground before going to the expense of erecting costly works on the surface.

A great amount of money has been spent in western Ontario during the last few years in prospecting for iron. The section of country in the vicinity of lake Nipigon is being quite thoroughly explored by diamond drilling as well as by magnetic surveys. In another part of the Report is Dr. Coleman's Report on this region. The branch of the Canadian Northern railway to Moose Mountain being now completed, the Moose Mountain Iron Company, Limited, will be in a position shortly to ship a large tonnage. The Helen mine at Michipicoten still ranks as the largest producer of iron in Ontario. In Eastern Ontario large shipments of magnetite are being made from the Mineral Range iron mines near L'Amable station on the Central Ontario railway.

Great interest has been taken during the last two years in the development of the copper properties, more particularly along the north shore of lake Huron.

The nickel mines in the Sudbury district still hold the lead in the world's production of nickel. This production is being increased from year to year both by the Canadian Copper Company and the Mond Nickel Company; and with the purchase of the big Whistle property we may hope soon to see some of the deposits on the north nickel range put on a shipping basis. The copper in the nickel ore adds materially to the copper output of the Province.

As in 1905, the greatest activity in mining in 1906 was in the Temiskaming silver-cobalt district. Several new properties have been added to the list of shippers, while none of the old producers have slackened in their output. The tonnage produced from the camp in 1906 bids fair to be doubled in 1907. The finding of silver and cobalt in the township of James and near Lady Evelyn lake, has caused a great inrush of prospectors, and the development of the Montreal river section will be watched with great interest. A full report of the working mines in the Cobalt district will be found in the third edition of the Report on The Cobalt Nickel Arsenides and Silver Deposits of Temiskaming by Prof. W. G. Miller.

In regard to the observance of the regulations of the Mines Act concerning the working of mines, it is necessary to call the attention of mine managers to the carelessness or ignorance of a number of their workmen in the handling of dynamite, also to the importance of reporting missed holes and the care necessary in having them reblasted. The attention of the mine managers is again called to that section of the Mines Act which prohibits any building to be erected within 50 feet of the shaft house.

I.—Northwestern Ontario

GOLD MINES

Operations in the gold mines of the northwestern part of Ontario in 1906 may be thus described:

Minto Mine or A L 200

This property, lying about three miles north of the Atikokan iron mine, had very little work done on it during the last year. A stamp mill had been hauled in and some work was done preparing a site for it. The owners are the Reading Mining Company of Buffalo.

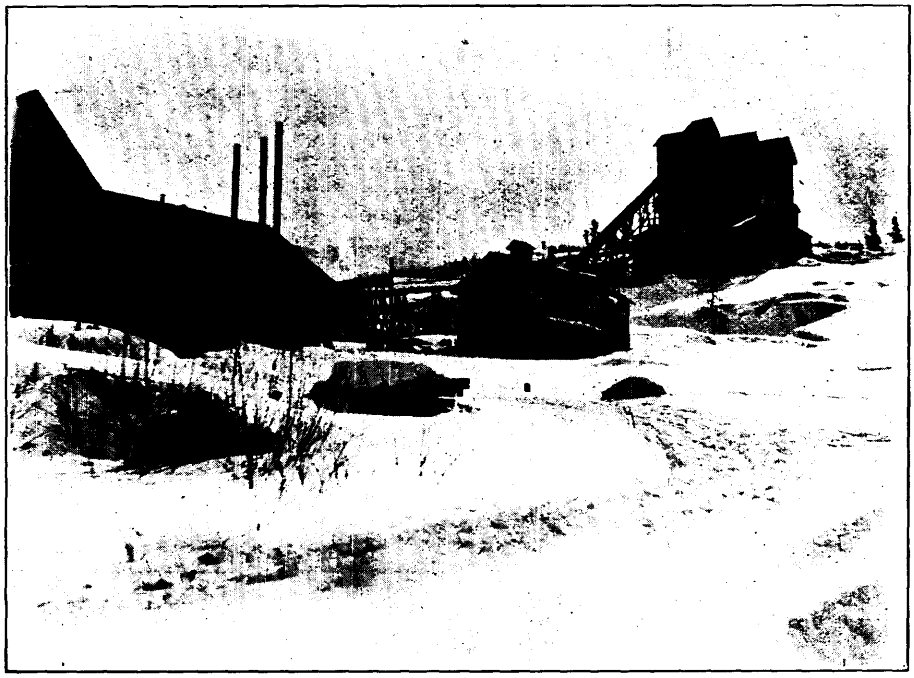
White Lily

Mr. Buxton, formerly of the Ideal mine, has purchased this property. It lies about eight miles northeast of Kawene station on the Canadian Northern railway, and near Crooked Pine lake. Considerable work is being done on the property by the present owners.

The Manitou district is reached either by the all land route, 22 miles in length, from Dinorwic, or by steamboat from Wabigoon to Beaudro's landing, thence by land to Manitou lake. Since the rich strike on the Laurentian in 1905, there has been increased activity in the development of the properties in this section.

Laurentian Mine

Since last inspection, work has been carried on continuously. No further sinking has been done, but on the first level north drift at a distance of 35 feet from the shaft a stope has been carried up for a distance of about 25 feet and for a length of 35 feet.



Stamp mill, Laurentian gold mine.

The ore from this stope, part of which was high grade, was milled. On the south drift a raise has been begun about 15 feet from the shaft and has been carried up about 50 feet. On the second level, which is at a depth of 200 feet, drifts run north 100 feet and south 25 feet. At 18 feet north of the shaft, a cross-cut has been driven 300 feet to cut the Trudo vein. About 35 feet of drifting north and south respectively has been done on this vein at the end of the cross-cut. Another cross-cut was run east 300 feet, and 40 feet of drifting done north and south respectively on the vein which the cross-cut taps. About 25 feet north of the shaft a raise is being carried up at an angle of 45 degrees. It has now reached a height of fifty feet above the level. A cross-cut has been driven east 40 feet at a point in the north drift 100 feet from the shaft, and a raise started from the end of this cross-cut.

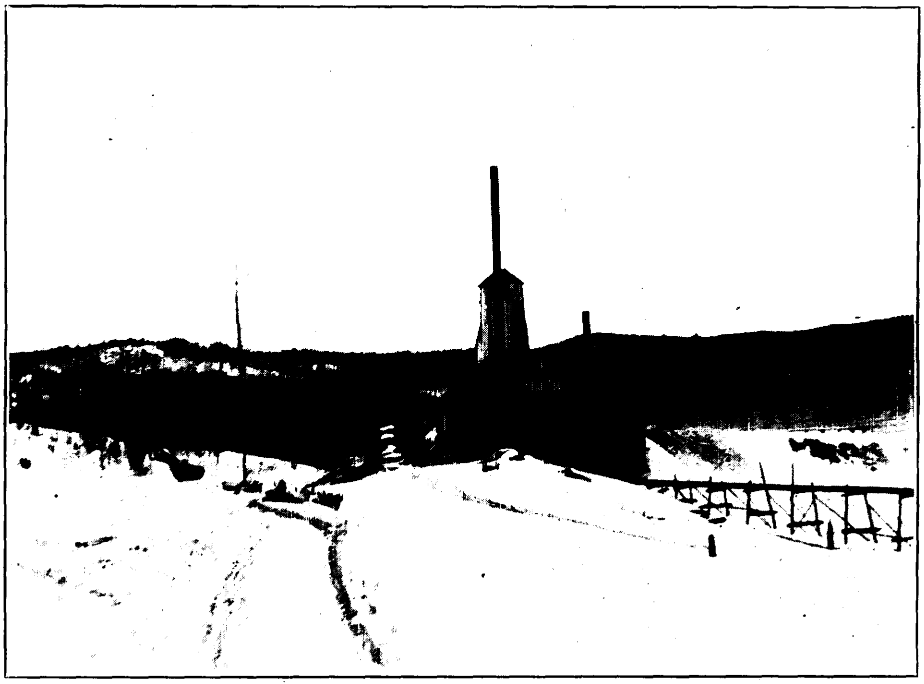
The 20-stamp mill on the property was in operation during part of the year, but was compelled to close down during the winter owing to the lack of water. Since that time a 5-inch pipe line has been laid to the lake one-half mile distant, and a pumping plant installed there.

At the shaft a new changing room for the men and mine office and store room were erected. A new skip road is to be constructed at once. The mine is connected by telephone with the railway at Dinorwic.

The mine is owned by the Anthony Blum Gold Mines, Limited, R. B. Nickerson being superintendent.

Big Master

No work has been done at this mine since last inspection.



Paymaster gold mine ; shaft house.

Little Master

This mine, owned by the Summit Lake Gold Mining Company, resumed work in the spring of 1906 with Dryden Smith as superintendent. Work was confined chiefly to the main shaft. Unfortunately the power house was burned last fall, which necessitated the cessation of work until the same could be replaced. During the winter wood was got out, and preparations made for a resumption of work in the spring.

Paymaster

This mine, owned by the Northern Development Company, has been actively in operation during the year. The first level is at a depth of 200 feet. From here a cross-cut has been driven 20 feet to cut the main vein. The vein has a strike northeast by southwest, and drifts have been run along it 78 feet and 65 feet respectively. Sinking has again been commenced, the shaft at the time of inspection being 241 feet in depth.

The machinery mentioned in the last report has been installed.

The attention of the management was drawn to the danger from fire from having the boiler house connected with the shaft house.

Mr. Manly is superintendent, employing a force of about 15 men.

Gold Rock Mine

The operations of the Gold Rock Mining and Milling Company on mining locations H P 405 and 407, described in the last Report of the Bureau of Mines, were discontinued in the spring of 1906, and no work has been done on the properties since that time.

Detola

The Detola Development Company commenced work on the mining location adjoining the Paymaster on the northeast in the spring of 1906. A shaft 57 feet deep was sunk, when work was abandoned for the winter.

Victory

This mine lies about one-half mile northwest of Gold Rock. Mining work was carried on during 1906, but work had ceased at the time of my inspection.

Eagle Lake District

Very little work was being done in this district at the time of my inspection. During the summer of 1906 the Eldorado and Baden Powell, owned by the Northern Light Mining Company, were in operation, while the Grace mine was engaged putting in machinery during the winter. The Ideal Gold mine, about 6 miles south of Dryden, had also been closed down.

Redeemer Mine

This mine is situated about 10 miles south of Dryden, and is owned by the Redeemer Mining Company, with Mr. Ames as superintendent. On the second level a cross-cut has been driven 400 feet to cut the vein that outcropped west of the vein on which the shaft was sunk. About 50 feet of drifting on the old vein has been done. The shaft has not been timbered from the first to the second level; this will require to be done before work is again resumed. The ore body is quartz interbanded with slate carrying pyrites. The country rock is a fine grained greenstone.

Attention of the management was drawn to the danger from fire of having the boiler house and other buildings connected with the shaft house.

Golden Park

The Golden Park Mining Company, of which Alex. McPhail is superintendent, owns the south 42 acres of lot 5 in the second concession, the southeast 35 acres and the southwest 40 acres of lot 6 in the second concession, Van Horne township. A shaft 37 feet deep has been sunk on the first of the above lots, and one 40 feet deep on the second.

Mining Location E D B 1

As mentioned in last Report, Mr. Holmes is prospecting on the above location for a company from Minnesota. A shaft 50 feet deep has been sunk.

Lake of the Woods District

In the Lake of the Woods district there was very little activity during the last year. The Sultana mine, which is probably one of the best developed mines in the district, closed down early in the summer of 1906, and has not since been reopened. The Bully Boy and Combined mines on Camp Bay stopped development work in 1906, but during the last winter wood was being brought to the mine and preparation being made generally for a resumption of operations this year. These mines were quite fully described in the Fifteenth Report of the Bureau.

On Shoal lake the only mines that showed any signs of activity were the Golden Horn and Olympia. At the Golden Horn work had been carried on intermittently during the last year. At the time of my inspection nothing was being done. The Olympia resumed operations in the spring of 1906, with George H. Vernon of St. Paul, Minn., as manager. A 10-stamp mill has been put in and a mill run was made last fall. A small gang of men are employed at the property.

Sturgeon Lake

The Sturgeon lake section during the last year has received considerable attention. The branch line of the Grand Trunk Pacific railway runs only a few miles to the south of the lake, and will thus afford easy access to the mines, and consequently reduce the cost of handling supplies and machinery. In this area the minerals found are gold, pyrite, chalcopyrite, stibnite, galena and zinc blende in quartz seams, sometimes in quartz and calcite. In nearly all the prospects the values appear to occur at the contact of the Keewatin with an igneous intrusion.

The St. Anthony mine, which has been steadily in operation since 1903, was the largest operator in this district in 1906. Mr. A. L. McEwen was manager, employing a force of 40 men. Two shafts have been sunk each to a depth of 100 feet, and a third shaft has been open cut forty feet in width to the shore of Couture lake. The 10-stamp mill on the property has been operated steadily during the past year with fair results. No attempt has been made as yet to treat the concentrates, which contain good values. The pyrite of the quartz vein is found to be gold bearing, and occurs in the chloritic schists of the Keewatin. These pyritiferous schists near the vein are often found enclosed in the quartz and have been proved to be auriferous.

The Belmore Bay Gold Mining Company have recommenced operations, and the prospects appear so favorable that they are erecting a 3-stamp mill for the treatment of the ore. This company formerly sunk a shaft 250 deep on their location.

A number of other prospects in the vicinity are being worked, one of which, owned by Mr. T. K. Bernard, situated just north of the narrows on a small island, shows some free gold.

Atikokan Iron Mine

Owing to the delay in the completion of the blast furnace at Port Arthur, there was practically no mining work carried on here in 1906. The power plant described in the last report of the Bureau was completed and boarding houses were erected. The tunnel which had been driven through the mill was widened to permit of double-tracking to the ore body. The spur from the main line of the Canadian Northern between Kawene and the Hospital siding to the mine has been completed. Mining operations commenced about the first of May 1907, and shipments will be made regularly to the company's smelter at Port Arthur.

The same company have completed their blast furnace at Port Arthur, and it was blown in about the fifteenth of July, 1907. This marks a new epoch in the mining and smelting industry of western Ontario. The ore body from which the company obtain their ore supply was opened up some years ago, but owing to the difficulty of transportation it has lain idle. The ore is a magnetite containing a small percentage of sulphur. The company have installed at the plant a roasting furnace for roasting off the sulphur contents before charging, using the furnace gases for fuel. The company have also built about 100 coke ovens and will thus be enabled to make their own coke. This was made possible by the Dominion Parliament allowing coal used for coking purposes to enter the country duty free.

Mr. J. C. Hunter is vice-president and general manager of the company, and Mr. R. R. Jones, superintendent of the smelter. The smelter is located on the lake front about half a mile west of the business section of Port Arthur.

Shilton or Northern Ontario Sulphur Mine

As referred to in the last Report of the Bureau and fully described in the report of Mr. E. L. Fraleck, on the Iron Pyrites industry in the present Report, this mine has been opened up for some two or three years. The ore body has been opened up to a depth of 125 feet and a considerable tonnage blocked out. During the winter of 1906 a plant was hauled in over the ice for installation, and shaft house, ore bins, boarding houses, etc., erected. Shipping will be begun as soon as the railway to Fort William is completed.

Tip-Top Copper Mine

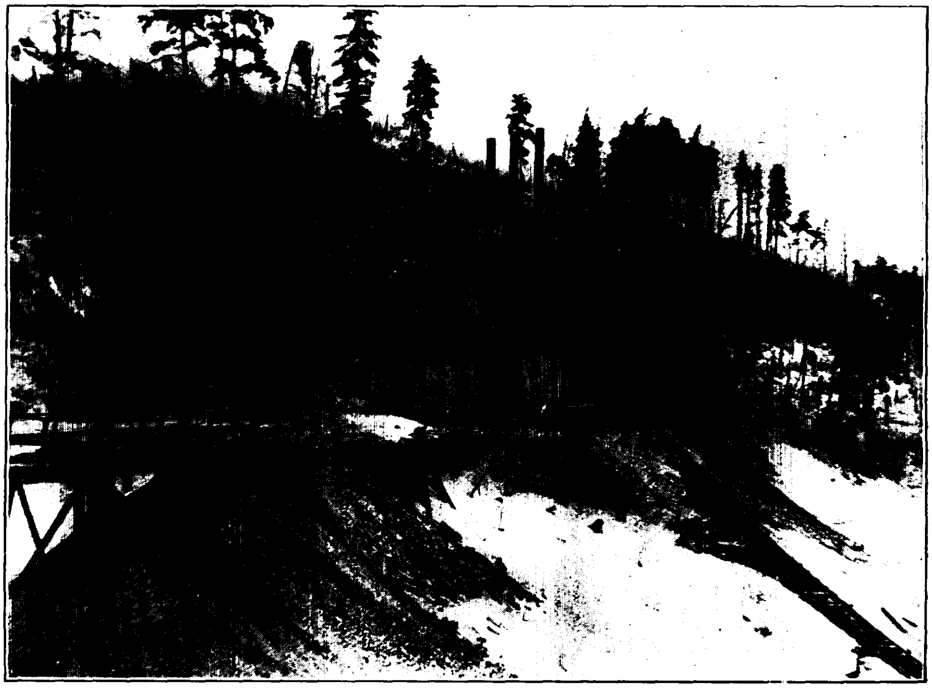
Owing to the advanced price of copper, many of the copper properties in the Province, which were either low grade or some distance from the railroad, have been re-opened. The Tip-top mine, seven miles distant from Kasheboiwe on the Canadian Northern railway has been working steadily during the past year. No inspection was made of the mine during 1906, as the main shaft was not unwatered and most of the work was done in stripping and opening up the vein on the surface. Col. Ray of Port Arthur is the owner, and work was carried on under the direction of Capt. Sandow.

West End Silver Mine

The former owners of this mine, the Consolidated Mines Company of Lake Superior, Limited, have sold out their holding to the Hanson Consolidated Silver Mining and Milling Company, Limited, with Mr. C. L. Hanson, manager. No work had been done on this property since the first of 1904 until the present owners began work in the fall of 1906. Since that time work has progressed steadily, operations being carried on chiefly on the third and fourth levels, the levels being approximately 35 feet apart. On the fourth level a drift has been driven east 850 feet. From this drift cross-cuts 30 feet in length have been run south, cutting a vein of calcite. About 500 feet east of the shaft stoping is being carried on at several places on the vein. No work is being done on the west side of the shaft. The vein varies in width from nothing to 12 or 15 feet, and is composed of white calcspar, amethystine quartz, zinc blende and pyrite, with argentite and native silver. The veins cut through the Huronian slates which are lying very flat. The shaft at this mine dips at 75° to the horizontal, following the pitch of the vein. The vein, although containing two of the principal silver-bearing minerals which form the chief values in the veins at Cobalt, differs from the latter in many respects. The silver values here are disseminated more throughout the vein and although very rich shipments have been made, there is much more low grade mineral than at Cobalt. The veins differ also in width and in their associated minerals. No cobalt or nickel minerals have been found here; while at Cobalt, the zinc blende found here abundantly, is in most cases absent.

The ore from the mine is concentrated in a 10-stamp mill by means of four corrugated rubber Frue vanners and five smooth rubber Frue vanners. The ore is first crushed to inch or inch-and-a-half size in a Blake crusher. From this it is fed to the stamp mill, where it is crushed to 30 or 40-mesh. The crushed product first passes over the corrugated rubber vanners and the coarser products are separated. The tailings from these are passed into hydraulic classifiers, making three products. These are fed to the smooth belt vanners and the slimes led to settling tanks from the classifier. The mill was not in operation at the time of inspection, but it was intended to start it as soon as the spring opened. The work at the mine was under the direction of Mr. Pritchard.

At the time of my inspection none of the other silver mines in this district were working, but it was reported that two or three were to be re-opened during the present year.



West End Silver Mountain Mine.

II.—Sudbury and the North Shore

Canadian Copper Company

With the completion of the company's smelters at Copper Cliff, the attention of the management was turned to the equipment of the mines with the most modern machinery. This was necessitated by the decision of the company to instal electrical machinery at all their mines and works. The development work at the mines, principally the Creighton and Crean Hill, has been pushed ahead, and large bodies of ore proved up, chiefly by means of the diamond drill. At the smelters about 800 to 1,000 tons of ore per day are being put through, and provision is being made to increase their capacity.

All the ore is at present being brought to Copper Cliff and roasted by means of open heap roasting at No. 3 roast yard, which is north of the town. The size of the roast heaps has been constantly varied for the purpose of ascertaining the most suitable size, and it has been found that the roast heap most advantageous is that which requires a three months' roast.

The ore is loaded from the roast heaps to the cars by means of a steam shovel. The old system of building the roast heaps, namely, unloading the cars by wheel barrows, has proved most satisfactory as yet, the superintendent claiming that a much better roast is obtainable from roast heaps built by this means than by any other method yet devised. The management of the different departments remains practically the same, Mr. A. P. Turner being president and general manager, Capt. John Lawson, general superintendent and mine captain, and Mr. D. H. Brown, superintendent of the smelter.

Creighton Mine

Since last inspection the work carried on at the Creighton mine has been continued on the same method. The open pit 140 feet deep has been extended west and northwest, following the continuation of the ore body. The west and northwesterly face of the open pit is all ore, and is being mined as a large over hand stope. The ore is all handled, after being blasted down, by shovelling into cars and tramming to the shaft. About 1,200 to 1,500 tons of ore is hoisted every 24 hours. No. 2 shaft has been sunk 180 feet deep, about 330 feet west of No. 1 shaft. This is a three-compartment hoisting shaft, the walls being concreted for a depth of 40 feet. A cross-cut has been put through to the ore body on the 160-foot level, and a raise put through to the surface. From the cross-cut a drift has been put through to the open cut. The mine water is handled by a 100-gallon pump geared to a 15-h.p. 550-volt motor, which operates at 750 revolutions per minute. A new rock house has been erected at No. 2 shaft. This is 72 feet high and 42 feet by 46 feet in plan. The ore is fed direct over grizzlies to two 18 by 30-inch Blake crushers. The product from the crushers passes through revolving screens to rubber belts 3 feet wide and 50 feet long. Here the rock is picked out and thrown into a rock pocket, while the ore passes over the belts into the ore bins. The two railway tracks beneath the rock houses admit the trains on which the ore is taken to the roast yards at Copper Cliff. The crushers and belts, which are in two sets, are each operated by a 50-h.p. 3-phase 550-volt induction motor. The bottom arches of the rock house are built of reinforced concrete.

During the last year the entire surface equipment of steam-driven machinery has been removed and replaced by electrical machinery. The sub-station at the Creighton mine contains three transformers of 275 kw. capacity each. These bring the voltage down from 35,000 to 550 volts. There are two hoisting engines each carrying three drums, which are so arranged that any two can be run in counterbalance, or all three run independently. These hoisting engines are operated by 150-h.p. 3-phase variable speed induction motors. The rope speed is 500 feet per minute, and a capacity is three tons to each skip. The two hoisting engines are set at right angles to each other, the new shaft being operated by a hoist which is parallel with the new rock house. The old rock house and shaft, 500 feet to the east, is operated by the second hoisting engine, the ropes making a turn through sheaves behind the old rock house.

The mine drills are supplied with air from a compound, direct driven compressor, running at 120 revolutions per minute, and giving 1,635 cubic feet of free air per minute. This is driven by a constant speed 550-volt induction motor of 300 horse power. The air regulation is obtained by automatic Corliss step valves.

The fire protection equipment consists of a 1,000 gallon 6-inch 4-stage pump, direct connected with a 150-h.p. 3-phase 550-volt induction motor. To supply this a steel tank holding 60,000 gallons is erected just outside the power plant.

A new fire proof "dry" and store house has been built. The "dry" has been constructed on the most modern plan with concrete floor, brick walls and tile roof; it is 36 feet by 80 feet in plan, and well lighted and heated. Two hundred and five lockers are provided, each separate. Between the rows of lockers are long enamelled iron basins for the use of the men. In one corner of the building are lavatories and shower baths. Mr. William Hambly is mine superintendent, employing a force of 200 men.

Crean Hill

This property, located on the south half of lot 5 in the fifth concession of the township of Denison, and about a mile and a half northeast of the Vermilion mine, was opened first in 1905. Since that time the property has been diamond-drilled very extensively, and the shaft sunk to a depth of about 300 feet. The latter is on an incline of 57 degrees to the horizontal, having four compartments with three hoistways and a ladder way, and is concreted to a depth of 40 feet. The first level has been sunk to a depth of 80 feet, and a cross-cut 40 feet in length driven to the ore body. The ore body on this level has been opened out to a width of 50 feet and 70 feet in length. The old prospect shaft was sunk about 100 feet from the new shaft, and they are connected underground. The second level at a depth of 140 feet has a cross-cut driven to the ore body, and the latter has been opened up the same as on the level above. Raises have been put through from the second to the first level, and from the third to the second. The third level is at a depth of 200 feet, and has been opened up to the same extent as the other levels.

The shaft has been sunk about 60 feet below the third level. The ore body is found to be dipping at about the same angle as the shaft. The ore contains a larger proportion of visible or massive pentlandite than the normal nickel-copper ores, and as the rock involved is a mixture of soapstone and greenstone, it requires entirely different treatment from the ores found at Stobie and Creighton.

A new rock house has been constructed on the same plan as the one at the Creighton mine and described under that head. The power house is also built on the same plan as the Creighton, except that it is only equipped with one electrically driven hoisting engine with 3 four and-a-half-foot drums. A new "dry" and store house has been built, similar to those at the Creighton mine.

A spur from the mine to the Sault branch of the Canadian Pacific railway at Victoria mines has been built, and ore is hauled thence by rail to Copper Cliff.

Mr. C. T. Griswold is superintendent, employing a force of about 100 men.

No. 2 Mine

This mine was in operation until the first of 1907, when work was temporarily stopped. The ore on the fifth level has been stoped out, and the shaft sunk another hundred feet to the sixth level. The old machinery at the mine has been replaced by an electrically driven compressor and hoist. The mine is being kept free of water.

Quartz Mine

The quartz mine opened up by the Company on lot 8 in the fourth concession of the township of Waters, about one and-a-half miles northeast of Naughton, has been in operation continuously. The new rock house has been completed, and the ore is crushed and screened before shipment to Copper Cliff. A shaft has been sunk on the vein and a quantity of quartz blocked out. About 150 tons of quartz is shipped per day to the smelters at Copper Cliff, where it is used as flux and for lining the converters.

Cobalt Refining Plant

The cobalt refining plant described in the last Report of the Bureau of Mines has been in operation since its completion in 1905. A considerable proportion of the high grade ores shipped from the Cobalt mines has been treated here. The company make no effort to separate the cobalt and nickel at this plant, the rich speiss, which is obtained after the rock matter has been slagged off in the cupola furnace, being shipped to New Jersey for final treatment. Very few changes have been made in the plant since its installation. The company are however, contemplating doubling its capacity.

The former superintendent, Mr. S. B. Wright, has resigned, and has been succeeded by Mr. McKenzie.

Smelting the Nickel Ores

From the published notes of Mr. David H. Brown on "The Mining and Smelting Equipment of the Canadian Copper Company" I have taken the following description of the new smelter and transformer building at Copper Cliff.

"At Copper Cliff the transmission line enters the sub-station, a concrete building 203 feet by 100 feet, and is there stepped down to a proper voltage for the various electric motors. In this sub-station are installed three Nordberg radial valve blowing engines, while a fourth similar engine is being constructed at present. These engines are rope driven by Allis-Chalmers-Bullock induction motors of 600 horse-power working at 2,200 volts. These motors are arranged to work at three speeds, so that the volume of air delivered to the furnace is under control. The engines are duplex, 42-inch stroke, 70-inch piston diameter, and deliver 320 cubic feet of free air per revolution. The blast for the Bessemer converters is furnished by a Nordberg blowing engine, rope driven by an Allis-Chalmers-Bullock 500-h.p. induction motor running at a constant speed of 375 revolutions per minute. This blower is 36-inch stroke, 40-inch diameter duplex, and runs at 100 revolutions per minute, delivering 12,600 cubic feet of free air per minute at a pressure of 12 pounds.

"For air hoists on furnace doors, for running drills, and for similar mechanical work, a 100-lb. air compressor, made by the Laidlaw-Dunn-Gordon Company, is provided. This is 25-inch stroke, 15-inch diameter on the high pressure cylinder, and 24-inch diameter on the low pressure side, and is direct connected to an Allis-Chalmers-Bullock induction motor of 300 horse-power, running 125 revolutions per minute at 2,200 volts. The motive power for the electric locomotives which take the trains of ore from the ore bins to the furnaces is furnished by one 40 kw. motor generator set, which takes 550 volts, 40 amperes, alternating current, and delivers 250 volts, 100 amperes, direct current.

"The alternating current arc lighting system used for street lamps is supplied by a 75 kw. frequency changer set, in which the 25-cycle current from the transformers is changed to 60 cycles, as required by the arc lamps.

"The blast from the three Nordberg air compressors is carried through 36-inch pipes on an overhead system of supports to the furnace building, which adjoins the sub-station. The furnace building is 357 feet long and 85 feet wide. It covers at present three cupola furnaces, four converter stands, and the relining platform, but these converter stands and their lining machinery are in this building merely as a temporary expedient during the erection of the main converter building. The furnace building is designed to cover five cupolas, of which two have been in operation since July 1904, and the third has been in blast since April 1906, and two more are under construction. These cupolas stand in row down the centre of the building, having on one side two standard gauge tracks for the disposal of furnace slag, and on the other side a 32-foot crane span, on which two 50-ton cranes attend to the handling of furnace matte to the converters, and of Bessemer matte from the converters to the casting moulds.

"The platform on which stands the settlers is 10 feet above the floor of the smelter building. On this rise the concrete bases of the furnaces, so that the hearth plates of the furnaces are 6 feet 6 inches above the tapping platform. The furnaces are 50 inches by 204 inches at the tuyeres, and consist of two tiers of water jackets, the lower or tuyere jackets being 8 feet 6 inches and the upper or top jackets being 6 feet in height. The total height from the lower floor of the furnace building to the charging floor is 35 feet, and the total jacket height of the furnaces is 14 feet 6 inches.

"Each of the tuyere jackets contains four six inch tuyeres, which are bushed down to four inches. The side tap is notched out of one of the middle tuyere jackets on the crane side, and is filled with a water cooled cast-iron side tap jacket 10 inches by 24 inches.

"The furnace slag flows off at the back of the settler into cast iron slag pots, each holding 22 tons. These slag pots are made in sections, with four side pieces and a separate bottom piece. The train of three slag pots is handled by a yard locomotive and poured over the slag dump.

5 M.

"Matte from the settlers is tapped as required into cast steel ladles 5 feet high and 5 feet in diameter. This is picked up by the electric crane and poured into the converters.

"Four converter stands are provided, and three are in use all the time. The shells are 7 feet by 10 feet 6 inches inside, and revolve in tread rings, 7 feet 8 inches in diameter. The lining is the ordinary mixture of white quartz and local clay, as there is no quartz in the neighborhood containing copper or precious metals. The blow in the Bessemer converter is carried on in exactly the same manner as in blowing for blister copper, except that the operation is stopped as soon as the iron is eliminated. It is a curious point that copper-nickel behaves as one metal in the converter, and that the ratio of elimination of sulphur and iron in these mattes has exactly the same relation to the amount of copper-nickel present as the elimination of these elements in ordinary copper work has to the amount of copper present. The point of elimination of iron is readily known by the color of the flame, and when this shows that nickel has begun to slag, the converter is turned down and the matte cast into a ladle which is poured by the crane into iron moulds. This matte contains about 80 per cent copper-nickel.

"The charges are brought to the furnaces by three trains of seven or eight cars each. These are accurately weighed before leaving the ore bins, and the amount of flux adjusted to the ore under treatment. Some ores, such as Creighton, require silica; others, as Crean Hill, sometimes require lime; in each case the endeavor is to produce a fluid slag which shall carry as little copper-nickel as possible. Slag from the converters, as well as all scrap and cleanings from the cupolas are returned to the ore bins. These ore bins are parallel with the furnace building, and 200 feet behind it. The roast ore from the roast yard, green ore from the mines, slag and scrap from the furnaces, coal and coke, quartz, clay and limestone are all delivered on the upper tracks of the ore bins, 35 feet above the charging floor. The ore bins are 700 feet long and 35 feet wide. This makes a row of bins about 30 feet wide inside, and subdivided into pockets, the length of which differ according to the contents and amount of each substance handled. Ore from the roast yard is handled from the roast beds by a steam shovel into Ingoldsby drop-bottom cars, which can be dumped readily into the bins.

"The ore and other furnace supplies are drawn from the bottom of these bins by means of curved bin gates actuated by a sectional gear wheel and crank. These are spaced at intervals of six feet above two tracks, on which run the charging trains. These tracks form an oval one-third of a mile in circumference, and pass on each side of the furnaces, allowing the cars to be dumped directly into the cupolas. At a tangent from the curve at one end of the charge track, a line branches off to the sample house. The same cars used in charging the furnaces are used to carry the samples of ores, slags, etc., to the sample house bins, twenty-four in number. On the floor below these sample bins, small end dump cars are used to bring samples to two crushers from which the ore is automatically sampled and passed through the various fine-grinding machines. The revert or discard from the samplers is collected in a bin, from which it is dumped into charge cars and taken back to the furnaces."

Mond Nickel Company

The Mond Nickel Company have enlarged their operations during the last year and are now operating in addition to the Victoria mines, the Garson mine on lot 5 in the third concession of the township of Garson. A spur from the Canadian Northern railway running to Moose Mountain is to be built to the mine for shipping the Garson ore to the smelters at Victoria Mines.

Work has been carried on at the Victoria mine on the same system as that described in the last Report. During the summer months the upper levels which have not been completely worked out are worked when the cold weather will not interfere with them. During the winter months all work is confined to the lower levels. The shaft has been sunk to the ninth level. On the ninth level a cross-cut has been run to the ore body, a distance of about 200 feet. The ore body has been cut out the full size, and a drift run on 100 feet further towards the east ore body, where a diamond drill station has been cut and drilling commenced to cut the latter. A raise has been put through from the ninth to the eighth level. On the two ore bodies at the seventh and eighth levels raises have been put through to the levels above and stoping begun. The system adopted to stope out the ore between the levels is to cut out the ore body the full size on the level. A raise is then put through to the level above. This raise is carried up on a sufficient incline to allow men to walk up without the aid of ladders and yet sufficiently steep to permit the ore from the raise to run to the level below. After the raise has been put through, a floor of twenty feet or more is left and the ore is cut out from under this, all the ore being cut out from one section before going down on the section below. In this manner the roof is kept well scaled as well as the wall of the stope above the men. The ore is taken to the roast yards and smelters by the aerial tram as formerly. About 200 tons of ore per day are hoisted. Mr. C. V. Corliss is superintendent, employing at the mine an average of 50 men

Garson Mine

Considerable diamond drilling was done at this property to locate the ore bodies underground accurately before development work was begun. The shaft was consequently located to the east of and midway between the ore bodies. The shaft which has two hoist ways and ladder way has been sunk to a depth of 225 feet. The first level at a depth of 100 feet has a cross-cut driven west 130 feet. At 75 feet from the shaft drifts have been run 50 feet north and south respectively on the extension of the south ore body. The two ore bodies are about 80 feet apart, and are designated respectively as the north and south ore bodies. The second level is at a depth of 200 feet. The station was cut on this level at the time of my inspection, and a diamond drill hole was being put in to locate the ore body. A new rock and shaft house are in course of erection as well as a new power house. The Wahnapitae Power Compay have built a transmission line from their power plant on the Wahnapitae river two and a half miles south of Wahnapitae to the mine, a distance of about ten miles. The company are putting in an electric hoist and an electric belt-driven compressor. Camp buildings have been put up suitable for accommodating about 150 men. Mr. Hall is superintendent in charge, employing about 100 men.

Ontario Nickel Company

This company commenced work during the first part of the present year, having taken over the holdings of the Canada Nickel Company. The mine known as the Totten mine, about half a mile west of Worthington station, has been pumped out, and a 3-drill compressor, boiler and hoist installed. The shaft is 90 feet deep, with little drifting done. North of the Canadian Pacific railway track the company have begun the construction of a refining plant. It is the intention of the management to treat the ore from the mine by a new process, worked out by the manager, for the recovery of nickel. Mr. G. E. McGinley is president, and Mr. W. S. Gates manager of the company.

Shakespeare Gold Mine

The control of the Shakespeare Gold Mining Company has since last inspection been brought up by other interests represented by Mr. B. W. Dunn, who was elected president and general manager. As soon as the new owners assumed control a plan of active development of the mine was adopted, the stamp mill closed down, and all energy devoted to underground work.

The shaft has been sunk to a depth of 300 feet. The first level at a depth of 50 feet is the same as at last inspection. The second level, at a depth of 88 feet, has a drift running east on what was styled No. 1 vein, or rather No. 1 pay streak, for a distance of 270 feet and west 200 feet. A cross-cut has been driven south 30 feet through the quartz and chlorite schists to No. 2 pay streak. The management claim that all the rock between No. 1 and No. 2 pay streaks, is milling ore. Drifts have been run east 170 feet and west 120 feet along No. 2 vein. These veins have been connected by cross-cuts at the easterly and westerly ends of the drifts. A cross-cut has been run north 30 feet at the westerly end of No. 1 vein. The third level at a depth of 128 feet has a drift running east along the vein 312 feet and at the easterly end of the drift a cross-cut running south 45 feet and north 20 feet. A drift has also been run west 70 feet. From the shaft a cross-cut has been run south 30 feet, and on No. 2 vein a drift has been run east 60 feet. The fourth level at a depth of 175 feet has a cross-cut from the shaft south 60 feet and north 20 feet. Drifts have been run east 100 feet and west 60 feet. On the fifth level at a depth of 227 feet the vein formation has been cross-cut for a distance of 70 feet. The management now claim to have sufficient ore blocked out to warrant them in putting in a 50-stamp mill, which they purpose doing during the next year. A new shaft is to be sunk about 400 feet west of the present shaft.

In the Michipicoten district no work was done on the old gold properties during 1906. Some assessment work was done on claims staked.

The Algoma Power Company are still at work on their power plant at High falls on the Michipicoten river. It is stated by some of the mining companies that as soon as power is obtained from this they will begin operations.

Copper Mines

With the re-opening of the old Bruce Mines and the discovery of some very fair copper prospects, the outlook for the copper industry along the north shore of lake Huron, seems brighter than for some years. The wide area over which copper has been found along the north shore furnishes an inviting field for the prospector. The very siliceous nature of the vein material in which the chalcopyrite is generally found, makes the smelting of the ore a more costly undertaking. The ore also, after a depth of two or three hundred feet has been obtained, is as a rule a concentrating proposition. This of course does not present any insurmountable features, and if ability and common sense are shown in the handling of a number of the properties in this district, a good industry should be the result. In the section of country north of Webbwood a number of copper prospects are being exploited, while the copper deposits on Whiskey lake are attracting considerable attention.

Massey Station

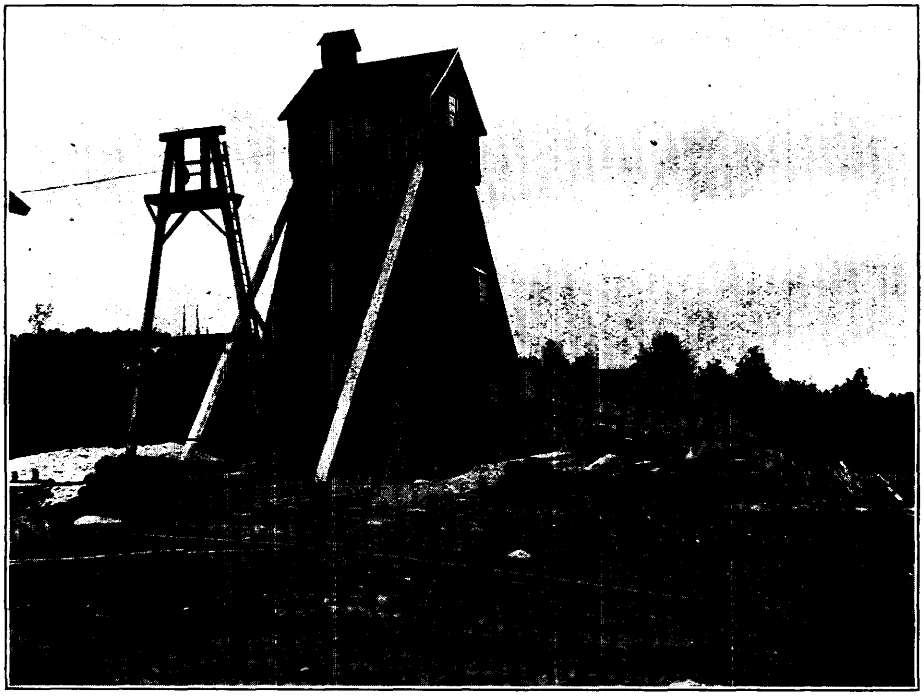
This mine has been developed to a greater depth than any other of the properties on the North Shore. The development work has been fully described in former Reports of the Bureau of Mines, as well as the Elmore oil concentrating plant experimented with there. Some very rich surface showings were opened up in 1906, but very little development work was done. Work was suspended at the mine in the latter part of 1906. The mine was pumped out again this year for the purpose of examination, but work has not as yet begun.

Hermina

Mining work was carried on continuously at No. 3 shaft during the year. It has now been sunk to a depth of 421 feet. The first level is at a depth of 118 feet where a station has been cut. The second level at a depth of 220 feet has 147 feet of drifting east and 75 feet west. The third level at a depth of 320 feet has a cross-cut of 110 feet to cut the vein, and 33 feet of drifting on the vein. The fourth level at a depth of 420 feet has a station cut. A pump station has been placed in a drift 33 feet long, 22 feet below the second level. A sump has been cut here and water syphoned from the level above. One Dubois and two No. 5 Cameron pumps keep the mine free of water. A shaft house 50 feet high has been erected since last inspection.

Mr. S. H. Bryant is superintendent, employing a force of 46 men.

Hermina copper mine.



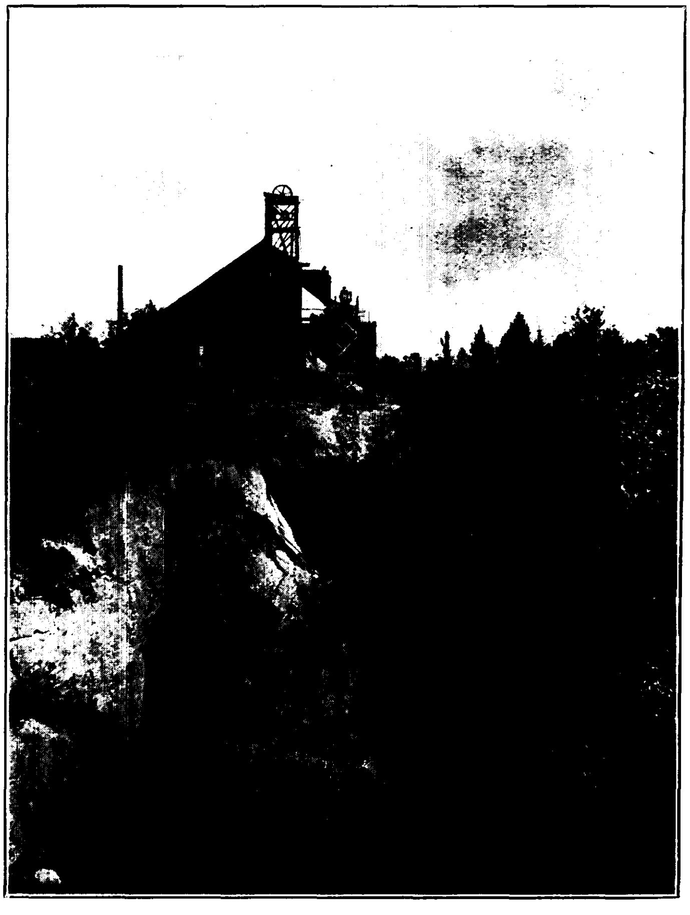
Shaft house at Hermina copper mine.

Northern Ontario Copper Company

Work was started on this property during the winter of 1905 by the Northern Ontario Copper Company. This company have their head office in Sault Ste. Marie. The property is situated on the north half of section 13 in the township of Thompson, near Dean lake. Access is attained either from Dean lake on the Sault branch or by a nine-mile drive from Blind river. A shaft has been sunk to a depth of 117 feet, and 200 feet of drifting done on this level.

Mr. J. A. Montague is superintendent in charge.

In the vicinity of the Northern Ontario Copper Company's mine, are two properties which have been doing considerable development work during the past year. These are the Jury and the Cobden, and are controlled chiefly by local interests.

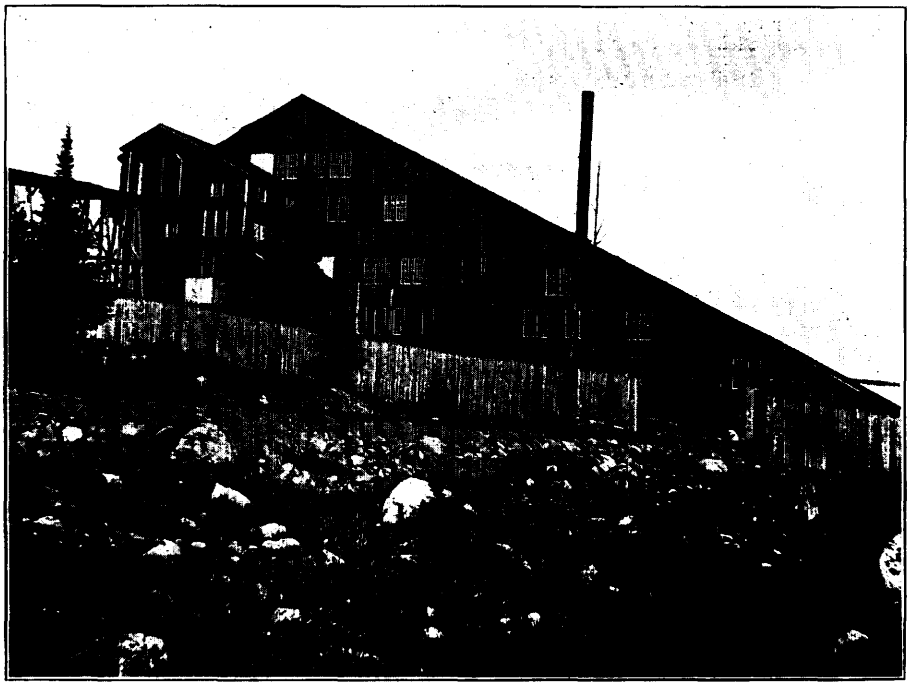


No. 2 shaft, and old caved-in stope, Bruce Mines.

Bruce Mines

These mines, which are the oldest in Ontario, have been acquired by the Copper Mining and Smelting Company of Ontario, Limited, and active development work has been begun. Most of the mining work is at present being done at No. 4 shaft. This shaft has a depth of 340 feet, and work is being confined chiefly to the three lower levels, the upper levels having been pretty well worked out by the old operators. At the 183-foot level stoping is being carried on to the southeast between No. 4 shaft and Craize's shaft, a distance of 145 feet. On the 274-foot level a drift has been driven southeast along the vein to a distance of 375 feet from the shaft. To the northwest of the shaft stoping is being done on the stope between the shaft and No. 3 dike. Northwest of the dike on the continuation of the vein some stoping has been done from the old stope between No. 2 and No. 3 dikes. On the 340-foot level, drifts are being carried southeast and northwest from the shaft on the vein. The drift to the northwest has been carried through to No. 3 dike, a distance of 200 feet.

No. 2 shaft, which is 1,000 feet northwest of No. 4 shaft, is sunk to a depth of 450 feet. All the work in this shaft is being done from the 355-foot level, where a drift is being driven southeast to connect with the drift from the 340-foot level at No. 4 shaft. This drift has been driven southeast 600 feet.



Concentrating mill, Bruce Mines.

The plant at No. 4 shaft consists of two boilers having a combined capacity of about 300-h.p., a 14-drill Rand air compressor, compound air and steam, a 30 kilowatt dynamo operated by a 50-h.p. high speed engine, and a duplex cylinder 12 by 18 inches double-drum hoisting engine, with drums 60 inches in diameter by 36 inches face.

The concentrating mill erected by the old company, situated about 1½ miles east on the lake shore, has been overhauled, and a new 300-h.p. engine for driving the mill machinery, and a 75-h.p. engine driving a Gates rotary crusher, have been installed. The ore is dumped direct from the cars to bins, which feed direct to the crusher. A new bucket elevator raises the crushed product to a travelling belt which delivers it to the storage bins, from which it is fed to the rolls by automatic feeders.

The tracks of the Bruce Mines and Algoma railway lead from the mine to the concentrator. The old system was to have the locomotive haul the cars directly to the bins at the top of the mill. This method has been done away with and a hoist has been put in at the top of the mill and the cars are hauled to the bins by this means. The main structure covers a ground area of 176 feet in length by 66 feet in width, with a height of 90 feet from the roof to the lowest floor. To the east stand the engine house, 30 by 32 feet in plan; the boiler house 48 by 48 feet, and the concentrate storage bins, 40 by 77 feet. The plan of concentration consists essentially of having the ore crushed by a gyratory crusher to an inch-and-a-half or two-inch product, from which it is fed to rolls. The product from the rolls passes over trommels, and the oversize passes back to the rolls to be re-crushed. The rest of the product is fed to 24 3-compartment Hartz jigs, and the tailings from these, after re-crushing and classifying, are passed over Frue vanners, of which there are 18 installed. It is the intention of the management to instal one unit of the new vacuum process for the treatment of the tailings.

Mr. T. Hayes Sheen is president and general manager, with Mr. H. J. Carnegie Williams, superintendent.

Superior Mine

The Superior copper mine comprises mining locations W D 220, 221, 222, 223 to 227, in all 680 acres in area, lying 4½ miles east by road from Superior mine on the Algoma Central railway. The property is owned by the Superior Copper Company, with head office in Sault Ste. Marie. Mr. F. M. Perry of Sault Ste. Marie, Mich., is president of the Company.

A great deal of development work has been done on the property, chiefly in stripping the ore and sinking shafts on it. No. 6 shaft, on which the work has been largely concentrated, has been sunk to a depth of 300 feet, with considerable drifting and cross-cutting at the different levels. The development work has shown up the property so favorably that the management have decided to build a concentrating plant of 400 tons capacity, and also to build a spur from the railway to the mine. The mill erected at the mine in 1905 has been run at intervals since completion.

Another copper deposit is being opened up at Root River on the Algoma Central railway about eight miles north of Sault Ste. Marie. A shaft has been sunk to a depth of 40 feet with a very fair showing of copper.

But very little work has been done on the Whiskey lake copper deposits since last report. Most of the work done consisted in prospecting the location for other showings of ore. The locations are in places very heavily drift covered, rendering thorough investigation difficult.

Iron Mines

Helen Mine

This mine continues to hold the premier position in the production of iron ore in Ontario. The former superintendent, Mr. R. W. Seelye, has been promoted to the position of superintendent of mines for the Lake Superior Power Company, and Capt. Keenan has been made resident superintendent. During the summer of 1906 the mine was closed down for some time owing to the destruction by fire of the shaft house, crushing plant, machine shop, blacksmith shop, etc. Through the strenuous efforts of the management, new buildings were constructed, and the mine again began shipping within two months of the time it was shut down. The mine has since that time been producing on an average about 800 tons a day.

Since last inspection the work has been chiefly carried on on the third level, which is at a depth of 286 feet. No. 2 shaft has a double compartment hoistway and is used altogether for hoisting ore. All timber and supplies are taken down through No. 1 shaft, which is a double compartment shaft consisting of a cage-way and ladder-way. Both shafts are sunk in the greenstone, and from No. 2 shaft a drift 11 feet in width has been driven 150 feet to the ore body. No. 1 shaft is connected with No. 2 drift by a drift 100 feet in length. This main drift from No. 2 shaft has been driven approximately north 250 feet to the northern boundary of the merchantable ore. From the point where this drift cuts the ore body the main drift has been run east through the length of the ore body to the eastern boundary of the merchantable ore, a distance of 450 feet. From this main drift auxiliary drifts have been run northeast and southeast at intervals of 50 feet. These auxiliary drifts are driven to the boundary of the merchantable ore. In these auxiliary drifts raises are put up every 40 feet to within about 20 feet of the level above. These raises are then connected and shoots put in, from which the ore is trammed after being blasted into the raise. All the ore is blasted from the stopes into the raises as long as it will run, when the shoots at the extreme end of the drifts are taken out and the whole ore body removed, gradually working back to the main tramway. The stopes are never more than 60 feet in height.

Several shipments of iron pyrites were made in 1906 from the pockets of iron pyrites, which occur in the northwesterly section of the deposit. It was the intention of the management to store the ore in the stopes during the winter in place of stock piling it as formerly. This method was adopted on account of the ore being so solidly frozen in the winter time while stock piling, that operations were much delayed in the summer months in getting it to the boats. The ore from the mine is all shipped by boat during the summer, part to the company's smelters at the Sault, and part to smelters in the United States.

Moose Mountain

The following has been taken from Professor Miller's notes:

"A branch of the Canadian Northern has recently been completed from the main line of the Canadian Pacific a few miles east of Sudbury to the township of Hutton, in which the Moose Mountain iron mine is situated. Moose Mountain is about twenty-five miles north of Sudbury. Ore can now be shipped by rail from the mine. The Canadian Northern, a part of the Sudbury-to-Toronto branch, is in course of construction to the shore of Georgian bay, which will give direct connection between the mine and lake Huron. The Moose Mountain ore, when the railway is completed, can be laid down on lake Huron by a shorter rail haul than the Minnesota mines have to lake Superior. The water route to lower lake ports will be considerably shorter than that from lake Superior ports, and the navigation of the Sault Ste. Marie locks will be avoided.

"The Moose Mountain iron deposit occurs in rocks of Keewatin age, the oldest series of rocks known in this part of the continent. The Keewatin is essentially an igneous complex, the predominant rocks being greenstones. The deposit or deposits at Moose Mountain may be briefly described as follows: On hill No. 1, there is an exposure of a lens of magnetite 300 feet by 100 to 150 feet. The ore has been proved in two drill holes 257 and 400 feet in length, run at angles of 45 and 60 degrees respectively. This deposit is being worked by a cut which is 75 feet lower than the top of the hill. In line with the larger axis of the lens, west by north one-half mile, another large ore body has recently been found 600 by 50 feet in size. East by south from No. 1 one-quarter mile, another promising lens is being opened up.

"Analyses of iron ores from the Hutton township ranges are as follows:

No.		Iron	Sulphur	Phosphorus	Titanium
		Per cent.	Per cent.	Per cent.	Per cent.
1	Eugene Coste's sample	51.45	.001	.058	None
	Prof. Coleman's report	62.64	.056	.011	"
2	Eugene Coste's sample	55.45	.010	.011	"
	Prof. Coleman's report	59.12	.008	.016	"
2	Extension E. Coste's sample	44.54	.020	.037	"
3	Eugene Coste's sample	59.75	.013	.072	"
	D. D. Mann's sample (Heys' assay)	55.75	None	.001	"
	D. D. Mann's sample (Hersey's assay)	53.07	.100	.014	"
4	Prof. Coleman's report	46.08	.006	.094	"
4(1)	E. Coste's sample	42.76	.015	.036	"
4(2)	" "	55.24	.015	.055	"
4(3)	" "	44.19	.002	.011	"
5	" "	31.70	.026	.051	"
6	" "	54.30	None	.025	"

Sixteen miles north of Moose Mountain a similar iron range is found at Burwash lake."

III.—Temiskaming

Temagami Mining and Milling Company

This company is developing a mispickel property at Grey's siding in the Temagami Forest Reserve about 3 miles north of Temagami station. A concentrating mill was put up about two years ago for treating the ore, but has not been much operated. This year a spur has been put into the mine, and it is proposed to ship a considerable tonnage of ore.

James Lake Pyrites Mine

Under the management of Ronald Harris shipments of pyrites have been made regularly from the above property during the last year. A spur has been built into the mine from the Temiskaming and Northern Ontario railway. The shaft has been sunk over 100 feet with considerable drifting and cross-cutting. The property is fully described by Mr. Fraleck in his account of Iron Pyrites in Ontario in this Report.

The silver mines of the Cobalt camp will be found fully dealt with in Prof. Miller's report, being Part II of this volume, hence it is unnecessary for me to mention them here, further than to say that they were duly visited and inspected with the view of seeing that the regulations contained in the Mines Act 1906 for their safe operation were being properly observed.

IV.—Eastern Ontario

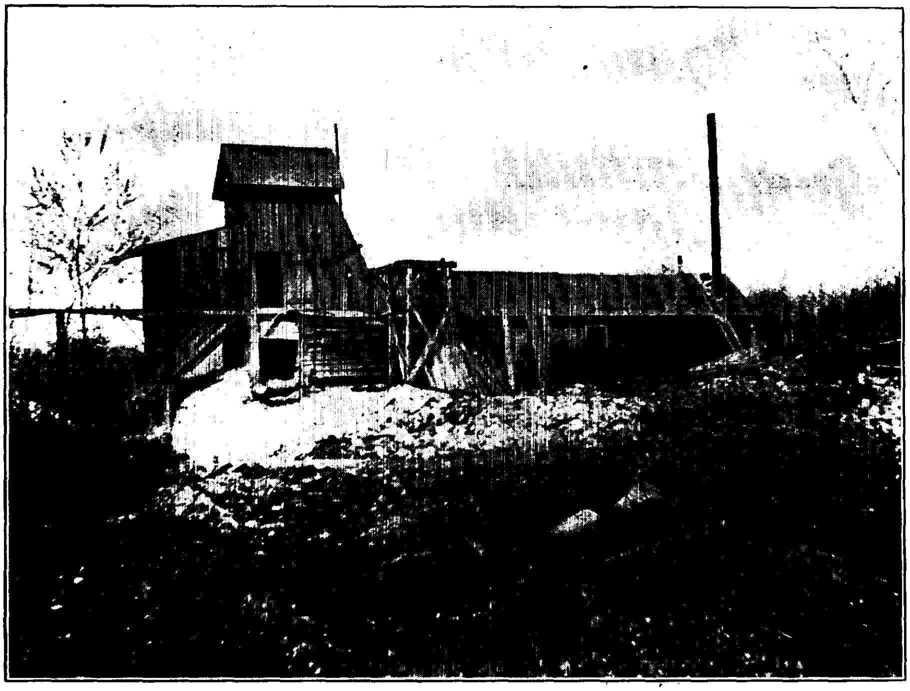
Gold Mines

There are at present two companies engaged in development work on gold properties in North Hastings. The richness of the surface showings has led to a great amount of needless expenditure, particularly in the matter of building stamp mills and the erection of large and expensive camp buildings. With the erection of the new refining works at Deloro, there is a prospect of the Deloro mine being re-opened. The mines in the eastern section of the Province have suffered during the year from a scarcity of labor, particularly of skilled miners. The scarcity is due largely to the prospecting boom in the Nipissing district, as well as the increased demand for labor in that section, where the wages are largely in excess of those paid in other sections of the Province.

Star of the East

Since last inspection the management of the mine has been changed, Mr. J. A. Steele being now secretary-treasurer, and Mr. Brooks superintendent. At the time of inspection a mill run of 500 tons of ore was being made to thoroughly test the value and milling properties of the ore. Samples of the concentrates were being sent away to ascertain whether the gold could be extracted economically by the cyanide method. Very little development work has been done under ground since last inspection. The shaft, which is 213 feet deep, has had a cross-cut driven south 196 feet to cut what is known on the surface as the south vein. A drift has been driven west on the vein on this level a distance of 75 feet. Some drifting has also been done on the first level.

Instructions were given regarding riding in the bucket and also with regard to shaft and ladder way.



Shaft house, Star of the East gold mine.

Prospect shaft, Star of the East gold mine.

Golden Fleece

This gold property, situated on lot 25 in the sixth concession of the township of Kaladar, has been re-opened. In his report on the Eastern Ontario Gold Belt, in the Eleventh Report of the Bureau of Mines, Prof. W. G. Miller states that: "The deposit lies near the contact of the diorite schist and a conglomerate. The ore is found in association with the schist where it occurs in quartz in the form of a vein and in quartz more or less mixed with the schist. . . . The sulphide in the ore is pyrite. The schist which strikes southwestward contains quartz stringers through it for a considerable distance along the strike. Exposures of quartz also occur on the more northern part of the property. Very rich specimens of gold bearing quartz were obtained at the top of the shaft when the property was discovered. At the present time there is no difficulty in obtaining shows of gold by panning the quartz and impregnated schist. The deposit cannot be considered a high grade one. Any attempt to work it should be made on the assumption that it is a large low grade ore body."

A pit 35 feet deep has been sunk, and a 50-h.p. boiler, hoist and 3-drill compressor installed. Very comfortable camp buildings have also been erected. The work is under the direction of Mr. E. J. Cowain.

Eldorado Copper Mine

//

Much interest has been taken in this property on account if its being the only copper producer in Eastern Ontario. The smelter, which was blown in on the 25th of June, 1906, has been run at intervals since that time, the intermittent nature of its operations being accounted for by the development work not being far enough advanced to furnish the requisite supply of ore. At a depth of 75 feet the vertical shaft was discontinued, and all mining has since been confined to sinking on the ore body. The ore body occurs in a shoot about 36 feet in length by 7 to 10 feet in width. In sinking the body of the ore shoot was taken out and smelted. The total depth of the working is now 300 feet from the surface. The ore is hoisted by bucket on skid way placed on the southwest end of the ore body, which dips to the northeast at an angle of about 65 degrees. Stulls covered by heavy lagging have been placed at intervals of 25 feet in the stope. No drifting or cross-cutting has been done below the 150-foot level.

The attention of the management was called to the unprotected condition of the upper part of the incline shaft, and also to the location of the thawing house. The high pressure half of a 10-drill air compressor has been installed since last inspection.

The furnace is located south of the shaft on the face of the hill. It is 4 feet in diameter, water-jacketted with solid cast steel crucible, and has a capacity of 50 tons of ore in 24 hours. The ore is very basic, as shown by the following analysis of a high grade sample:

	Per cent.
Copper	16.40
Iron	24.90
Sulphur	28.54
Ferric oxide	17.70
Lime	1.00
Magnesia	2.12
Silica	5.68
Undetermined	3.76

The flux required for the ore is silica, which is obtained from the adjoining property. An average charge for the furnace is as follows: Ore 750 lbs.; coke, 130 lbs.; low grade matte, 110 lbs.; silica, 135 lbs.; slag, 175 lbs.

The ore is not given any preliminary roasting. The matte and slag flow into a 3-ton fore-hearth from which the matte is tapped at intervals, and the overflowing slag is received in unlined iron settling pots.

The property is owned by the Ontario Copper Company, of which Cole Saunders is president. Mr. G. H. Hambly was in charge at the time of the last inspection.

Eldorado copper mine; surface works.

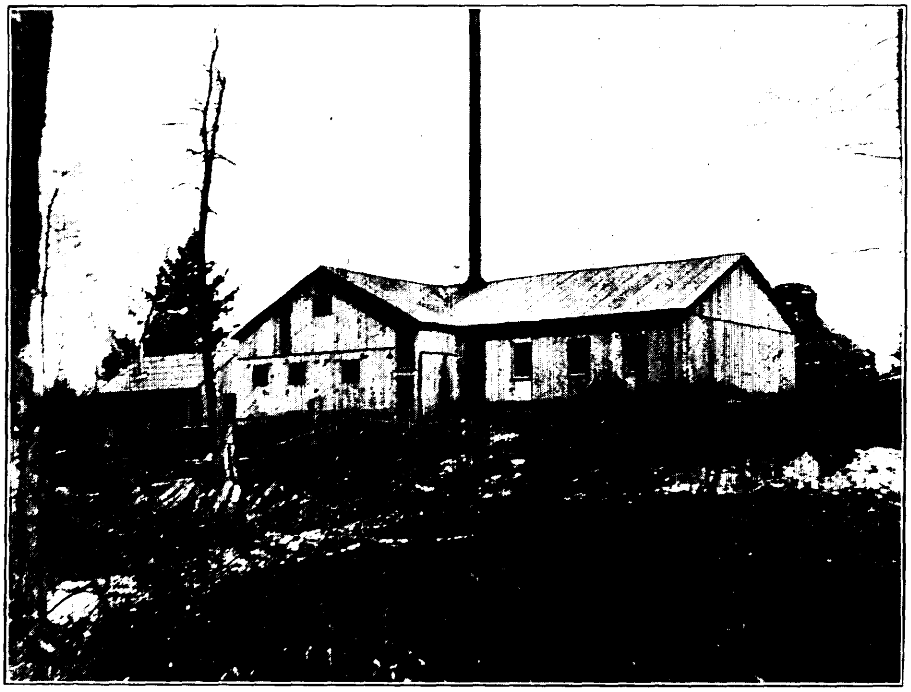
Copper smelter, Eldorado.

Lead Mines

There has been some revival of interest in the lead deposits of Hastings and Frontenac counties, due doubtless to the high price of lead. Following are brief notes on those properties which have been under operation:

Hollandia Mine

This property has been taken over by the Stanley Smelting Works and is being operated by them. The main shaft remains the same as at former inspection, namely 100 feet in depth. From this level drifts have been driven east on the vein 150 feet and west 75 feet. A raise was being put through from the east drift to connect with No. 2 shaft which is about 100 feet east of No. 1 vein. The concentrating mill was not in operation at the time of my inspection, as the mine had been unwatered only a short time, and no stoping had begun. A 4-drill straight line air compressor and a 100-h.p. boiler have been installed.



Frontenac lead mine, power house.

Mr. Cushman is manager of the company, and Mr. Burnette superintendent of the mine.

The Stanley Smelting Works located at Bannockburn, at the junction of the Central Ontario and the Bay of Quinte railway, have not been in operation for the last six months. The company contemplate moving their smelting works to the city of Kingston, where they have been granted certain concessions. This new site will be advantageous, as it is a lake port and is also near the Frontenac lead mine, which the company have acquired recently.

Frontenac Mine

The Frontenac lead mine was worked over thirty years ago, and was the first producing lead property in Ontario. It is mentioned by Mr. Henry G. Vennor in the report of the Geological Survey, 1866-1869. It has recently been taken over from the original owners by the Stanley Smelting Works.

Work during the first part of 1907 has been done on the surface showing about 500 feet west of the shaft, on what was formerly known as the back lead mine. Here a shaft 7 feet by 18 feet has been sunk a depth of 50 feet on a vein of calcite carrying galena and sphalerite, the percentage of the latter being small. The calcite vein has been traced for a considerable distance, and runs in an easterly and westerly direction, cutting across the granite and crystalline limestone. The latter occurs in wide masses, which generally have a strike of north to south, in some places being quite crystalline. It was noticed that where the limestone was highly crystalline, graphite was generally found disseminated through it, giving the limestone a bluish color. This resembles somewhat the crystalline limestone of North Hastings. At the back, or westerly lead mine, an 80-h.p. return tubular boiler has been installed and a 3-drill straight line air compressor.

At the No. 1 shaft, which is on the south half of lot 16 in the ninth concession of Loughboro, the work of pumping out had been begun. The old Cornish pump is being refitted and pumping will commence shortly. Two 100-h.p. boilers are on the ground ready for installation.

Mr. D. G. Kerr is superintendent.

Katherine Mine

The Katherine lead mine, situated on lot 7 in the second concession of the township of Lake, Hastings county, three miles northwest from Millbridge, was unwatered in 1906, and some work done on it by the Stanley Smelting Company. An air compressor and boiler were installed.

Richardson or Olden Zinc Mine

The Olden zinc mine is the only zinc property at present in operation in the Province. It was closed down temporarily during part of the winter of 1906, but was again opened in the spring of 1907. Since the last report on this property work has been confined chiefly to stoping out ore in Nos. 1, 2 and 3 shafts. Part of the low grade ore taken out was concentrated by means of hand jigs and the rest was put on the dumps for future treatment. A cable way has been put in connecting No. 2 shaft with No. 3 shaft, so that the ore can be hauled direct from the shaft to the mill, where the crushers are located.

Mr. J. Sullivan was foreman in charge, employing about 25 men.

Iron Pyrites

Development work in the pyrites mines of Hastings county has shown so much ore that the Nichols Chemical Company, the owners of some of the largest properties, have felt justified in building a chemical works for the manufacture of sulphuric acid, adjoining what was formerly known as the Hungerford pyrites mine.

Hungerford Mine

The property known as the Jarman pyrites mine, near Bannockburn, which has been operated by this company for some years under lease from the owner, has been closed down and the lease relinquished by the company. All their work is at present being done on what was known as the Hungerford pyrites mine on lot 23 in the twelfth concession of the township of Hungerford, about 5 miles east of Tweed and adjacent to what is now known as the town of Sulphide.

An incline shaft on the south vein has been sunk to a depth of 320 feet, with levels at 100 feet, 200 feet and 300 feet respectively. The shaft dips to the south at approximately 60°. Cross-cuts have been driven north from the shaft to cut the middle vein and the north vein on each of the levels at a distance of 60 feet and 115 feet. On the first level north vein drifts have been driven east and west on the vein 220 feet and 140 feet respectively. At the end of the east drift a raise has been put through to the surface. The vein on this level, where it has been cut out to the full width, is about 20 feet wide. Some ore has been stoped from this vein. On the second level south vein drifts have been driven east and west on the vein 210 feet and 130 feet respectively. A raise has been put through from where the cross-cut from the shaft cuts the vein on the second level, to the first level. On the third level the cross-cut has been driven north, cutting the north vein, but no drifting had been done at the time of my inspection. A survey had been made for a tramway from the mine to the burning house at the works, which are distant about 800 feet south.

The plant at the mine was being doubled by the addition of the machinery taken from the Jarman pyrites mine.

Acid Works

The sulphuric acid works of the company are located about 500 feet from the main line of the Canadian Pacific railway, from which a spur line has been constructed to the works. The plan of the works and process is similar to the works of this company at Capelton, Quebec, the acid being made by the contact process, the method being a secret one held only by this company. The power house, gas tanks, burner building, process building and nitric building are all separate. It is expected to treat at first about 25 tons of ore per day. The works were put in operation about July 1st, 1907.

Mr. Pritchard was superintendent of the mine and works at the time of my inspection.

Canada Mine

The property formerly known as the Oliver property on lot 26 in the twelfth concession of Hungerford, has been purchased by the Canadian Pyrites Company, and is being operated by them. A shaft is being sunk on the vein which is on an incline of 60°. It has now reached a depth of 110 feet, and drifting has begun on the vein at the 85-foot level. The vein has a strike east and west. This property adjoins the mine operated by the Nichols Chemical Company. Mr. W. A. Hungerford, formerly of Deloro, is superintendent.

A small prospecting plant has been installed.

British America Mine

Work had temporarily closed at this mine at the time of my inspection. During 1906 a considerable tonnage of ore was mined and shipped. Great trouble was experienced in keeping the mine free of water.

Iron Mines

The iron ores of Eastern Ontario have had many vicissitudes of fortune, but the prospects for a large production of ore, principally magnetite, have not been better in many years that at the present time. This improvement in the situation is largely due to the development of the Mineral Range properties near L'Amable.

Radnor Mine

This mine has been a producer of iron ore for the last four or five years. During last year steady shipments were made. In the spring of 1907 a more energetic development of the deposit was undertaken. Mr. R. W. Seelye, superintendent of mines for the Lake Superior Corporation, was appointed consulting engineer, and Mr. L. L. Bolton made resident superintendent. The management have decided to open out the

Childs mine, Mineral Range Iron Mining Company.

Mineral Range iron mine. Ore after blasting.

deposit, and in order to do so it was necessary to remove a great deal of surface covering. This is being begun from the northwesterly side of the property, which will leave sufficient room for ore piles below the level at which the ore will be taken out. The ore is shipped by wagon from the mine to the railway station at Caldwell on the Canada Atlantic railway.

Mineral Range Mines

During the last year the Mineral Range Iron Mining Company have developed their No. 3 and No. 4 mines from prospects to shipping mines. This has caused an increased activity in this district both in prospecting and in money coming into the section to develop the properties. No. 3 and No. 4 mines, on adjoining lots, were thoroughly drilled and tested before shipping was commenced. As these properties were situated four and a half miles from the Central Ontario railway, it was necessary to build a branch line from the main line of the Central Ontario railway to the mine. As a result a charter was obtained for the Barry's Bay and Bessemer railway, and the first part of the road built from the junction about one-quarter of a mile south of L'Amable station to Bessemer, a distance of 1½ miles.

At No. 4 pit a rock house has been constructed 50 feet in height. The ore from No. 4 pit is hauled up by means of a skip and dumped direct into a 1,200-ton Gates gyratory crusher. The ore from the crusher passes to bins which deliver direct to the cars. No. 4 pit is at present worked as an open cut. The face of the ore body above the floor of the open cut is about 30 feet high by 40 feet in width. This has been worked back from the shaft a distance of 100 feet. The ore body dips to the east at an angle of about 60 degrees. The ore is sorted in the pit before loading on the cars. The ore in carload lots from this pit will run from 55 to 58 per cent. in metallic iron and is low both in sulphur and phosphorus. A shaft is being sunk from the level of the open cut in the ore to give additional ore faces to work from.

At No. 3 pit, which is at present about 25 feet deep, the ore is also being taken out by open cut work and is hoisted by derrick and dumped direct on to cars, which are hauled down to No. 4 shaft house and the ore put through the crusher. No work is at present being done at No. 2 pit or the Childs mine, but it is the intention of the company to begin work on these two properties as soon as practicable. A saw mill has been built near the mine at the foot of the lake and all lumber used at the mine is sawed here. A number of houses have been built for the workmen.

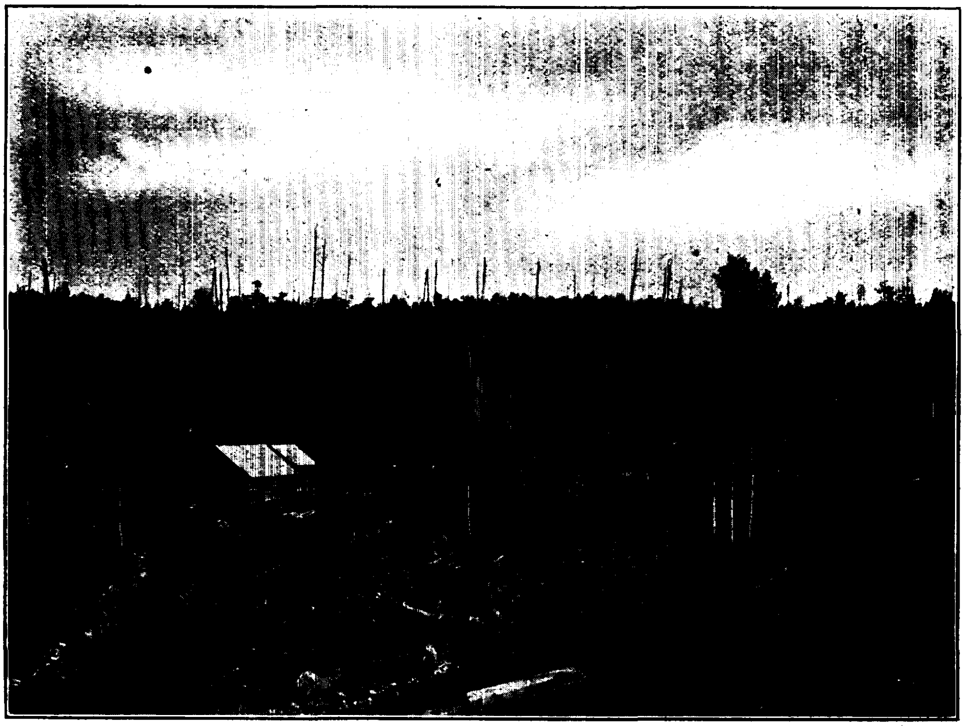
Mr. H. C. Farnum is the manager of the company, and Mr. Patterson superintendent. About 100 tons of ore are shipped daily from the mine. It all goes at present to blast furnaces at Midland, Radnor and Sault Ste. Marie.

Marble

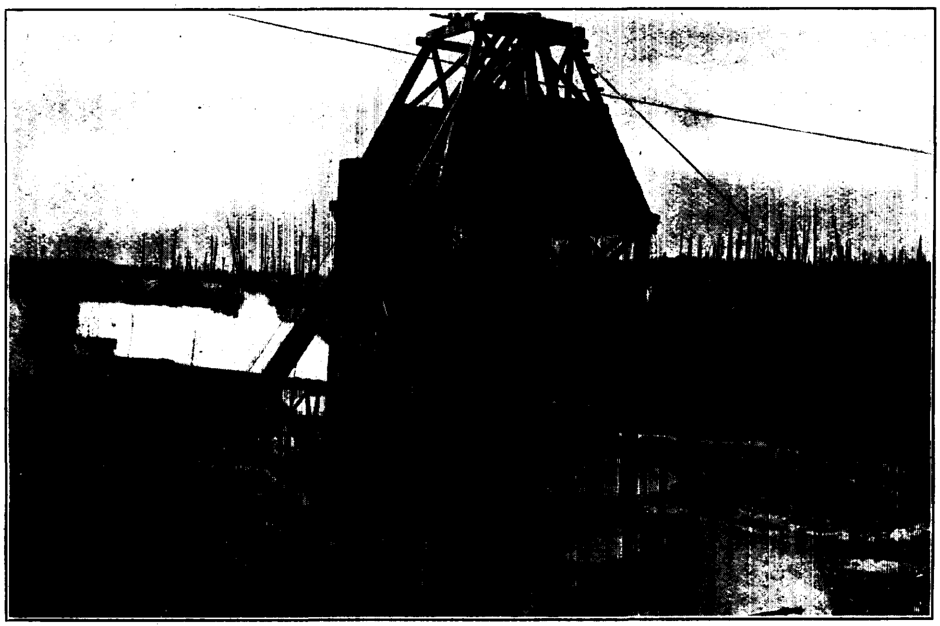
The marble quarry opened up last year near Bancroft by the Trenton Granite and Marble Company was not in operation at the time of my inspection. A spur has been built from the railway to the mine and channelling and cutting machines installed. It is reported by the management that operations will shortly be renewed. Mr. Sergeant was in charge of the work.

Corundum

The corundum deposits of Renfrew and Hastings counties are being worked by the two companies who have between them developed a considerable industry in producing grain corundum for abrasive purposes.



Railway siding, Mineral Range Iron Mining Company.



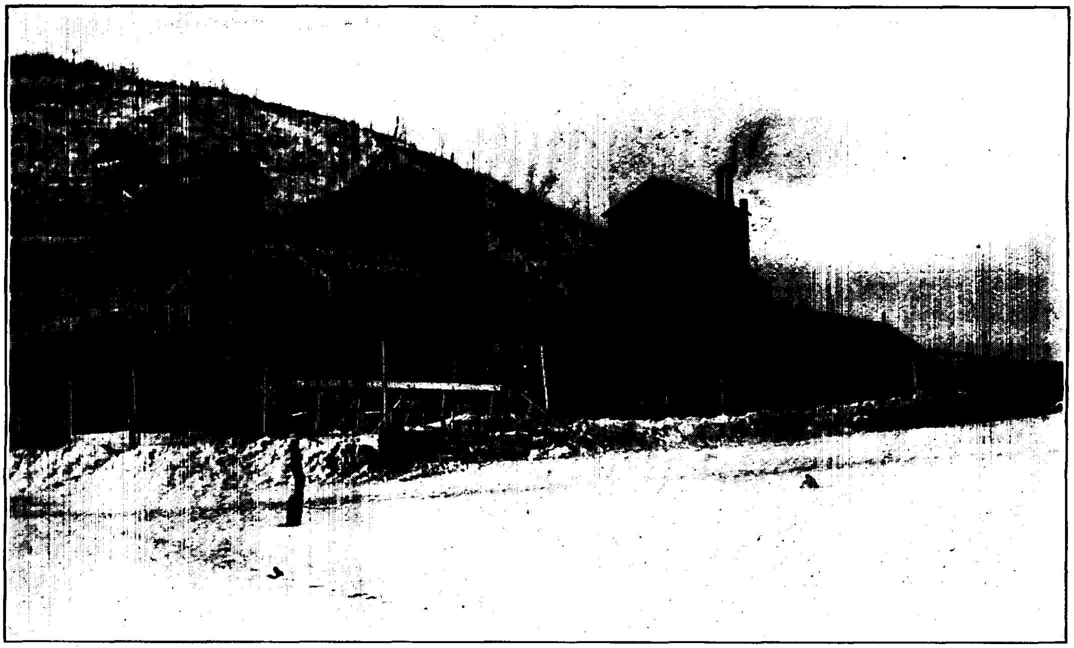
Mineral Range Iron mine ; shaft and crusher house.

Canada Corundum Company

The production of refined corundum from the company's concentrating mill at Craigmont has been largely increased during the last year, while the production of corundum bearing rock from the quarries has been more than doubled. In April 1907, 7,000 tons of ore were mined and milled. This gave a daily production and mill run of about 300 tons. The increased production at the mill allows a much lower grade of ore to be handled profitably. Several new improvements have been perfected in the mill by the manager. One of these is the electrostatic separator used for taking out the pyrites.

On the hill the same system of open cut work is still in vogue as that described in former reports. Several new openings have been made on the face of the hill, and good corundum bearing rock extracted.

About one mile west of the old workings on the same hill, an opening has been made and considerable ore taken out and hauled to the mill during the winter by sleigh. This working is called the Klondyke.



Concentrating plant, Canada Corundum Company.

On the York branch of the Madawaska, in the township of Monteagle above Foster's rapids, the company did considerable prospecting and stripping during the summer of 1906. This work has shown up a very good deposit of corundum.

About 200 men are employed in the mine and mill. Mr. H. E. T. Haultain has been promoted to the position of general manager of the company.

Ashland Emery and Corundum Company

The Ashland Emery and Corundum Company have been prospecting several locations in the vicinity of their mill during the last year. At present they are prospecting lot 10 in the twelfth concession of the township of Carlow. Ore is brought to the mill by wagon a distance of about three miles, where it is concentrated and made ready for shipment. On account of the difficulty of transportation to the mill, the shipments are very irregular. In the mill dry crushing is used and dry and wet concentration.

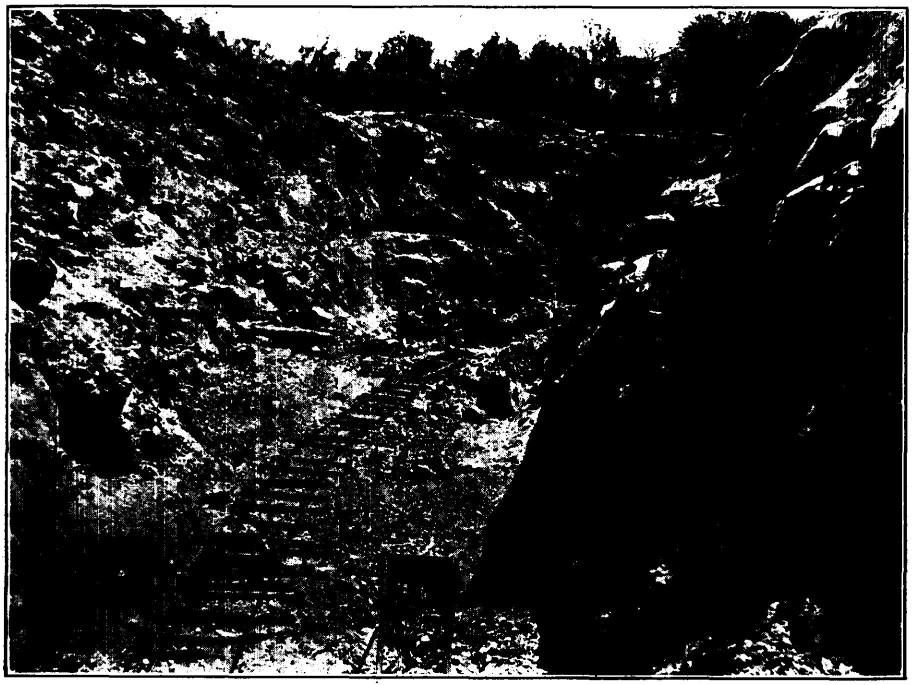
Mr. W. Mackie is in charge of operations for the company.

Feldspar

Frontenac county still leads Ontario in the production of feldspar. Chief among the shipping mines is the Richardson mine, which produces 90 per cent. of the whole production for the Province.

Richardson Mine

This mine is under the same management and ownership as mentioned in last report, namely, the Kingston Feldspar Company, with Mr. M. J. Flynn as superintendent. The same system of working is still in use as that formerly described. A sump 30 feet deep was sunk during the winter, and 12-foot stopes are being carried



Richardson Feldspar mine.

back from sump to No. 1 and No. 2 pits. The northeasterly end of No. 2 open cut has been extended and a 25-foot face of feldspar opened up. A quantity of quartz on the hanging wall of the northeasterly pit was removed during the winter. This quartz was used chiefly for grading the tramway recently constructed. The feldspar appears to be dipping quite uniformly to the southwest. The pit at its greatest depth is now about 80 feet over all.

A new tram has been constructed from the mine to the lake, a distance of 1,300 feet. The cars are hauled by team up a slight grade to the top of the hill, where by a system of balanced hoisting the cars are run down grade to the barge on the lake, the empties being hauled up by the loaded cars. A drum with friction brake is used for regulating the speed. The old system of hauling by teams from the mine to the lake is thus dispensed with. The other system of lake haulage by barge and tug to the railway siding at Glendower, remains as formerly described.

Border Mine

The Border mine on the west half of lot 5 in the twelfth concession of the township of Portland and two miles east of Verona, has been a small producer of feldspar during the last two years. Here a pegmatite dike cuts across the granite gneiss in a northeasterly and southwesterly direction. Large masses of feldspar and quartz are developed in the dike, from which feldspar is sorted and shipped. The feldspar is mined by open cut work.

A number of other small properties are being developed in Frontenac county, but none have reached the shipping stage.

Mica

The mining of mica in Ontario dates back to about the year 1860, when a quantity of large and carefully selected sheets from lot 17 in the ninth range of the township of North Burgess was sold in Paris for the use of the French navy, at a price of $2 a pound. Some of this mica was in sheets twenty inches square, or larger. At this time, 1860, and for the following thirty years, mica was used chiefly for stove fronts, lanterns, lamp chimneys and also instead of glass in the windows of ships of war, to save breakage from concussion. The production of mica from the sixties until the beginning of the nineties was chiefly as a by-product of apatite. These two minerals are very intimately associated, and during that time there was a large trade in apatite, with a rather small demand for mica, and then only for the large sizes. Between 1890 and 1895 mica, particularly phlogopite, or amber mica, was used more extensively in the manufacture of electrical apparatus, which gave an impetus to the industry in Ontario. Prior to that time the small sizes of mica had not been marketable, but this new industry created a market for material of which a large quantity had already been mined and thrown away as useless. This has, therefore, been re-sorted, and the small sizes previously thrown away saved and sold. The sizes of amber mica now asked for by the buyers and the approximate price which the cleaned mica will bring, are the following:

1 in. x 1 in.	5-6	cents per pound.
1 in. x 2 in.	10	"
1 in. x 3 in.	20	"
2 in. x 3 in.	45	"
2 in. x 4 in.	65	"
3 in. x 5 in.	75	"
4 in. x 6 in.	100	"

Loughboro Mining Company

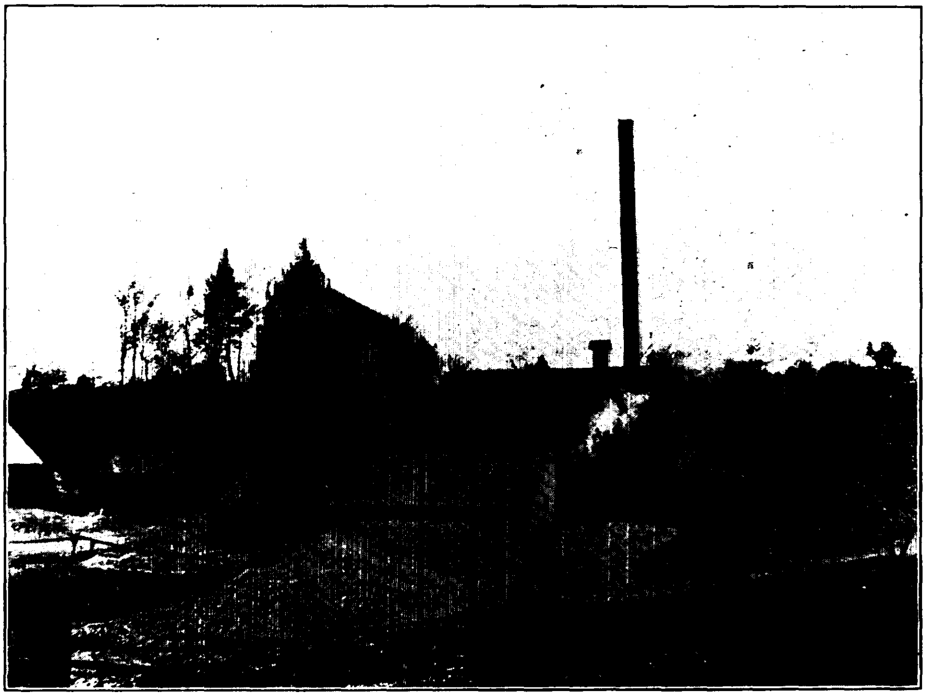
The mines formerly owned by the General Electric Company have been transferred to the Loughboro Mining Company, of which Mr. G. W. McNaughton is manager.

One of these properties, the Lacey mine on lot 11 in the seventh concession of Loughborough township, has proved a steady producer, and has probably produced more mica than any other property in the Province.

The first work was done on what has since been known as the Lacey mine in 1884, when a shaft was sunk on the vein. This was owned at that time by Messrs. Smith and Lacey, who took out a large tonnage of an exceedingly good grade of mica. The pit was sunk to a depth of about 130 feet, and the vein stoped out for a distance of about 130 feet in length, with an average width of 10 to 15 feet. This pit was abandoned in the early nineties, and the mineral right of the lot sold to the General Electric Company of Schenectady, N.Y.

In 1899 a new discovery of mica was made about 200 feet southeast of the old workings. This has been operated continuously since that time and has been a large producer. It has been worked to a depth of 185 feet and longitudinally over 200 feet. The vein in some places is 20 to 25 feet in width. On the first level at a depth of 60 feet the drift has been run southeast on the vein a distance of 175 feet. On the fourth level at a depth of 117 feet two drifts run southeast, the easterly drift being 150 feet and the westerly drift 135 feet in length. Northwest of the shaft the mica has been stoped out for a distance of about 50 feet. On the second level a cross-cut has been driven a distance of 55 feet to cut a parallel ore body, which thus lies between the old and new workings. This body is about 75 feet in length, 60 feet in depth, and has an average width of about 8 feet.

A shaft has been sunk on the hill northeast of the present shaft. It is proposed to connect this shaft with the first level. A shaft is also being sunk about 20 feet from the air shaft. From this shaft an open cut is to be made to take out the mica from the first and second levels to the surface.



Lacey mica mine.

The mica, which is a phlogopite, occurs in a vein matrix of calcite and pyroxene. The phlogopite is well crystallized, sometimes occurring in crystals 6 feet in diameter, and sometimes 4 to 5 feet in thickness. The wall matter surrounding the vein is essentially a mica pyroxene schist. The bedding of this rock cuts the vein at right angles. This is very marked on the fifth level of the mine, where the bedding occurs at an angle of about 20 degrees from the vertical and at right angles to the vein.

The mica from this mine is shipped to the General Electric Company's shops at Ottawa for cleaning, splitting, etc.

Hanlan Mine

The Hanlan mine owned by the Loughboro Mining Company, was re-opened this year after being closed down for some time. It is situated on lot 11 in the sixth concession of North Burgess, and is probably the best example of a true fissure vein of any amber mica mine in the Province. Here the vein has been mined for a depth of 120 feet, and a length of about 200 feet, without a break in it. The vein is quite uniform in width, averaging about 6 to 8 feet, while in some places it widens out to about 15 feet. The vein matrix, as is usual, consists of calcite and pyroxene, with occasional pockets of apatite. The mica in parts is well crystallized, while in adjacent parts it is quite badly crushed. The wall rock is a mica pyroxene schist, but not enough cross-cutting has been done to show whether there is any distinct bedding. In other respects it is quite similar to the corresponding mica pyroxene schist at the Lacey mine. This vein strikes east and west, cutting the granite gneiss of Laurentian age, and dips to the south at an angle of about 75 degrees to the horizontal.

The mica is rough cobbed at the mine and then shipped to the General Electric Company at Ottawa for further treatment.

Mr. S. Cordick is foreman, employing about 15 men.

Cave worn by water in crystalline limestone near Craigmont.

The Canton mine in South Burgess, originally owned and worked by Webster and Company, but taken over from them by the General Electric Company, is now being worked by the Loughborough Mining Company. The Company have a diamond drill at work exploring the property.

Smith Mine

This mine is situated on lot 13 in the fifth concession of the township of North Burgess, and is owned by the Dominion Development and Improvement Company. It was originally opened up for apatite, but after a pit had been sunk about 25 feet on the vein, mica crystals were found throughout the apatite. The apatite is soft and granular, thus giving the mica a favorable matrix in which to crystallize out freely. The vein in some places is 10 feet wide, consisting of apatite, calcite and mica. It dips at an angle of 50 degrees to the horizontal. On each side of the vein is a mica pyroxene schist some few feet in thickness, which in turn cuts through the granite gneiss. This belt of mica pyroxene schist can be traced for some distance along the surface, where at different places a little mica has been taken out. The association of the pyroxene rock with the mica veins is very marked over the whole mica area. In fact, it is very rare to find a large healthy deposit unless it is enclosed by this rock.

James Thompson is foreman, employing about 20 men.

On lot 12 in the sixth concession of North Burgess, being the lot between the Martha mine on the west and the Hanlan on the east, Edward Watts of Perth and associates are working some small surface outcrops.

On lot 13 in the seventh concession of North Burgess, directly south of the Hanlan, Mr. Terry Smith has started opening up a surface show. Considerable work was done on the Martha mine last year.

Brockville Mining Company

About three miles from the town of Elgin, on lot 7 in the sixth concession of Bastard township, county of Leeds, the Brockville Mining Company are working a property which is of interest in that it occurs some distance from any other workable deposit. The mode of occurrence of the mica is also unusual. The mica is a very dark amber, almost verging upon a biotite. The pit has been sunk to a depth of 85 feet, and is 40 feet in length. The vein is about four feet in width and dips at 45 degrees to the horizontal. The vein material is composed as usual of calcite and pyroxene, the mica crystals being crystallized throughout. The main difference between it and the larger mica deposits in the Province is that there is no (what the miners term) mica rock lying along each side of the vein. This mica rock is generally a mica pyroxene schist, which occurs between the vein and the granite or granite gneiss. At this particular deposit the vein cuts the country rock, which is a very dark hornblende granite, thus leaving the mica crystals lying right against the granite. On account of the hardness of the rock, the mica has been crushed considerably on crystallization, and the vein is more liable to be in the form of lenses.

Mr. H. Stanger is superintendent, employing a force of 15 men. A new 40-h.p. boiler has been installed. The mica is shipped to Perth to be cleaned.

Bobbs Lake Mine

On the west side of Bobbs lake Messrs. Stoness and Kent are working a mica property which was closed down during the winter. The main pit is 60 feet deep and about 35 feet long and 6 to 7 feet wide. The vein matter is calcite and pyroxene enclosed on both sides of the vein by mica and pyroxene gneiss. The veins are running east and west. A number of parallel veins have been exposed on the property. The mica is rough cobbed at the mine and shipped by way of Olden to the Kent Bros.' mica shop at Kingston.

Mr. J. Stoness is manager of the property.

Freeman Mine

The New York and Ontario Mining Company are working on the north end of the Freeman property, which is lot 7 in the ninth concession of Loughborough township. A pit about 50 feet deep and 40 feet long has been sunk on the vein. The vein matrix is pink calcite, which contains the crystals of amber mica. The deposit has been worked by open cut, the hoisting being done with derrick and small hoist. A small boiler supplies power to the hoist and drill. About twelve men are employed at the property under superintendent S. Orser. The mica is rough-cobbed and cleaned at the mine.

Amey Property

Adjoining the Freeman mine Mr. H. Amey is engaged in opening up a mica property for Mr. Austin, of Toronto. The open cut is 60 feet deep by 40 feet in length. Hoisting is done by horse whim and derrick. The occurrence is similar to that described above.

Mica Trimming Works

At the present time the preparation of mica for the trade has created quite an industry in Eastern Ontario, especially in Ottawa, which is quite favorably situated as the centre of the mica producing sections of Ontario and Quebec. In Ottawa two

Mica prospect, S. Orser, Loughborough township.

of the large consumers, The Laurentide Mica Company (Westinghouse) and the General Electric Company, have built factories in which they employ from 500 to 600 girls in the preparation of the mica for the market. The preparation consists of cleaning or breaking off all the ragged or broken edges of the run of mine crystals, and splitting the mica down to about one-eighth of an inch in thickness, and grading it to the different marketable sizes. This is then knife-trimmed, and taken to the tables for thin-splitting. The chief and essential characteristic of mica is its highly perfect basal cleavage, permitting the mineral to be split exceedingly thin. This characteristic is made use of in thin-splitting. The purpose of the mica being thin-split is to enable it to be built up into what is known as micanite. Most of the mica mined in Ontario is shipped to the United States.

The General Electric Company have built a new factory on the corner of Bridge street. This factory is very modern in every way. The question of ventilation being an important factor in the health of the employees on account of the dust, fans have been so placed that the dust is drawn down through pipes and thus prevented from floating in the air in the rooms. The company will employ about 400 hands.

The Laurentide Mica Company's factory on the corner of Queen and Bridge streets, employ a force of about 500, the majority being girls.

Kent Bros. of Kingston have removed their factory from Ottawa and have leased the building on Brock street, Kingston, formerly used as McGowan's cigar factory. A large force are at work, the mica trimmed being brought from their mine near Ottawa and also from their Bobbs lake mine.

Eugene Munsell and Company, at 400 Wellington street, Ottawa, employ a force of about 75 girls under superintendent F. Fillion.

Norman B. Holland at 427 Sussex street, Ottawa, employs about 75 girls in his mica works.

The other smaller operators in Ottawa are the Wallingford Mining and Mica Company on Sussex street, R. Blackburn on Sussex street, Webster and Company and the Comet Mica Company on Wellington street. All these concerns buy mica from the smaller producers in Ontario and Quebec.

Talc

The Henderson talc mine is the only producer of talc in Ontario. It produces yearly about 1,000 tons, which at the quoted market price of 15 to 25 dollars a ton makes a fairly good industry. Mr. S. Wellington of Madoc has a contract for taking out 1,000 tons yearly, consequently the mine is only worked for a short time during the summer.

Silver King

A silver property is being worked by an American syndicate about 7 miles north of Queensboro. A shaft has been sunk to a depth of 60 feet, showing up some fairly good values. Captain Williams is in charge.

OIL AND GAS IN KENT

BY C W KNIGHT

Acting under instructions from Thos. W. Gibson, Deputy Minister of Mines, the writer spent the second week of July 1907, in the new Tilbury and Romney oil and gas fields, Kent county. The city of Chatham, served by both the Canadian Pacific and Grand Trunk railways, is the most convenient railway point in going from Toronto west, and is distant from the latter city 183 miles (via Hamilton).

Location of Field

Chatham is some ten miles northeast of the Tilbury field, while the Romney pool is about seven miles southwest of the latter. Both fields derive their names from the townships in which they occur. They lie between lake St. Clair on the northwest and lake Erie on the southeast.

While visiting the district it is the custom of some operators to make their headquarters at Chatham and drive thence to the fields. The town of Tilbury, six miles west of the field, is also used by oil men as headquarters. At the time of my visit the majority of the operators were said to be there. The post office of Fletcher is a central point in the Tilbury field; there are one or two boarding houses here where accommodation may be obtained. The village of Merlin (two miles east of the Tilbury field) on the Pere Marquette railway, may also be used as headquarters by anyone desiring to see the new region.

All of the country around the Tilbury field is cleared and is regarded as good farming country. At the Romney pool, however, there is much bush, but the roads are numerous.

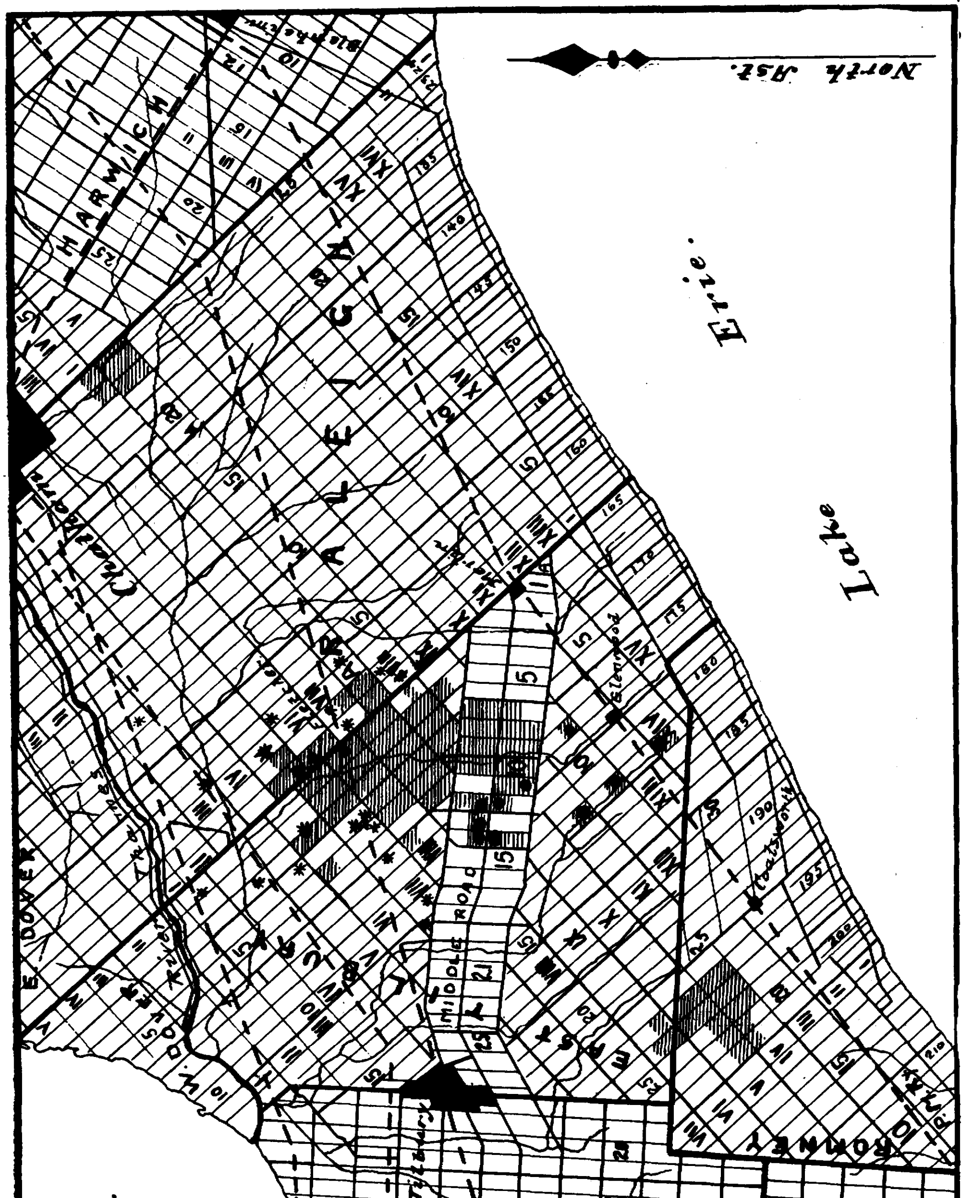
It was not possible to visit every farm which is producing oil. Further, the nature of an oil field is such that it is necessary in a hurried examination to get a great deal of the information secondhand from men actually operating. The country is entirely drift covered, so that any data regarding the underlying formations comes from the logs of wells. These are, unfortunately, not fully recorded.

The Fourteenth Report of this Bureau contains accounts of the oil operations in Kent county up to March, 1905. The Bothwell field in the northern part of Zone township was producing from 5,000 to 6,000 barrels a month at that time. The "Gurd gusher," on lot 18 in the twelfth concession of Raleigh township, and the Wheatley field in Romney township also, at one time, produced some oil.

The First Strikes

Within the last eighteen months, however, there have been very important developments of both oil and gas in Kent county. The following account of the early work is quoted from a paper in the Journal of the Canadian Mining Institute, March, 1907, by Mr. Eugene Coste:

"Oil was first struck in the new Tilbury field in December 1905, on the John Kerr farm in the northwest part of lot 10 of the Middle Road, North Range of the Township of Tilbury East, in the County of Kent, Ontario. The first well was drilled by the Acme Oil Company of Detroit. This company had been operating unsuccessfully in the narrow Leamington pool in the adjoining county of Essex. Before finally abandoning its venture in oil it decided to take another chance, and this time of a purely "speculative" nature, as the location selected was in an entirely new and undeveloped territory. As luck would have it, it turned out to be a winning throw. At the depth of 1,360 feet a rather strong gas vein was struck; then another at 1,375 feet; then the first oil pay with more gas at 1,385 feet; then a second oil pay at 1,410 feet, and a third one at 1,430 feet. A little below that some salt water was found, and the drilling was stopped at 1,450 feet. The well after the shot started to flow at the rate of 40 barrels of oil per day, the gas being quite strong, about half a million cubic feet per day.



Plan showing East Tilbury and Romney oil and gas fields, Kent County, Ontario. Shaded parts, approximate oil and gas area. Gas wells=● Dry holes=* Scale, 3.95 miles=1 inch.

"The second well was drilled in at the end of March 1906, on the Janes farm about three-quarters of a mile southwest of the first well. It struck gas and oil at about the same depths, but it proved to be a small well, not starting at better than eight or ten barrels per day after the shot.

"The third well was completed on April 6th 1906, on the J. Smith farm, half a mile southeast of the first well, and it started at the rate of sixty barrels per day after the shot; the first gas was struck at 1,363 feet and the first oil at 1,393 feet, the second oil at 1,418 feet and the third pay of oil, which was the best, with some salt water, at 1,430 feet.

"The Romney oil field, or rather pool, as it is yet only about three-quarters of a mile long and only a few hundred feet wide, is situated some seven miles southwest of the Tilbury field in the north part of lots 21, 22 and 23 in the fourth concession of the township of Romney. Kent county, Ont. It is only a few months old, and there are now seven producing wells in it, several of which came in as very large wells, making each over 1,000 barrels per day of oil."

The usual agreement which the operators have made with the farmers is that the latter shall receive a royalty of one-eighth of the output, the operator being allowed to drill where he pleases and to erect such buildings as may be necessary. In the case of some of the more recent leases, in addition to the one-eighth royalty, a bonus of several hundreds or thousands of dollars in cash has been paid, and the operator has been required to place his pipes and surface rods in such locations as would interfere as little as possible with farm operations.

Towards the end of 1906 and during the early months of 1907 there were said to be about 25 drilling contractors at work, each operating from one to three "strings" (separate drilling outfits) or about 55 strings in all. At the time of writing drilling operations had fallen off, and the estimated number of drilling outfits was 20. As it takes about a month on the average to drill a well, this means that 20 wells a month are being added to the number already in existence.

It is difficult, unless one should go over the field in detail, to learn the exact number of wells that have been drilled in Tilbury. In March 1907, there were said to be 150 wells drilled in, of which only about four were dry.[1] On July 1st the number of producing wells was 235. Besides these there were 33 dry holes and 26 new wells being drilled. In the Romney pool, at the same date, there were 47 wells, of which 24 were dry. The percentage of dry holes in the latter field is seen to be much higher than in the Tilbury field.

Oil Production

The production of oil from the Tilbury and Romney fields is given by Mr. C. O. Stillman of the Imperial Oil Company, Sarnia, as follows. This company buys all the oil from both fields.

East Tilbury:—

No. of bbls.[2] from December 1905 to end of June 1906	4,000	
July	4,315	
August	13,897	
September	14,651	
October	23,679	
November	26,558	
December	28,101	115,201
1907		
January	29,172	
February	26,098	
March	29,600	
April	31,055	
May	35,004	
June	35,654	186,583

It will be seen from these figures that the increase has been rapid from the beginning. Mr. Stillman considers that there is room for a considerable number of new wells in the proven area.

[1] Journal Canadian Mining Institute; Paper by Eugene Coste, March meeting, 1907.

[2] Throughout this report 1 bbl. contains 35 gallons.

Romney :—

1907	
January	2,871 bbls.
February	5,939
March	11,104
April	9,685
May	5,534
June	3,163

The rapid rise and fall in production is striking. There are several reasons given by oil men and operators for this. Some companies have shut down on account of a lack of fresh water for their boilers. Up to the present, water in the farmers' drainage ditches has furnished some of the supply, but this source is becoming exhausted with the hot weather. Some oil men have also suspended operations until natural gas can be piped in from the Tilbury field. The Romney pool has little natural gas, and the majority of operators have been using coal or oil for fuel. Some wells are said to be pumping considerable salt water, which is probably another cause for the falling off in production. But the main cause is the ceasing of drilling in of new wells. At the time of my visit there was only one new well being drilled.

The Romney oil is shipped from Coatsworth on the Pere Marquette railway.

The following table gives the total receipts of crude oil from all sources in Ontario received by the Imperial Oil Co. for the first six months of 1907. These figures include also the Tilbury and Romney fields.

January	60,850 bbls.
February	56,770
March	64,081
April	69,945
May	71,062
June	68,642
Total	391,350

This does not include some oil which is bought by other buyers, so that the actual total production for Ontario would be higher than these figures indicate. If this total be compared with the Tilbury and Romney output, it will be seen that these two new fields have produced for six months of 1907 considerably more than half for all of Ontario.

Mr. Stillman estimates the production from both the Tilbury and Romney fields at 30,000 bbls. per month for the next ten months. The explanation of this anticipated reduction lies in the fact that there has been a falling off in the drilling of new holes. It is necessary for Mr. Stillman to make such an estimate, because the capacity of the Sarnia refinery being 75,000 bbls. per month, he must import from the United States the difference between the Ontario production and the capacity of the refinery.

The Price of Crude Oil

The price of oil per barrel varies little from month to month. Practically the only purchaser is the Imperial Oil Company at Sarnia, Ont. The Tilbury crude oil in July brought the operator $1.16 per bbl.; the Romney oil, 84 cents per bbl. In addition to this there is a Government bounty of 52½c. per bbl.

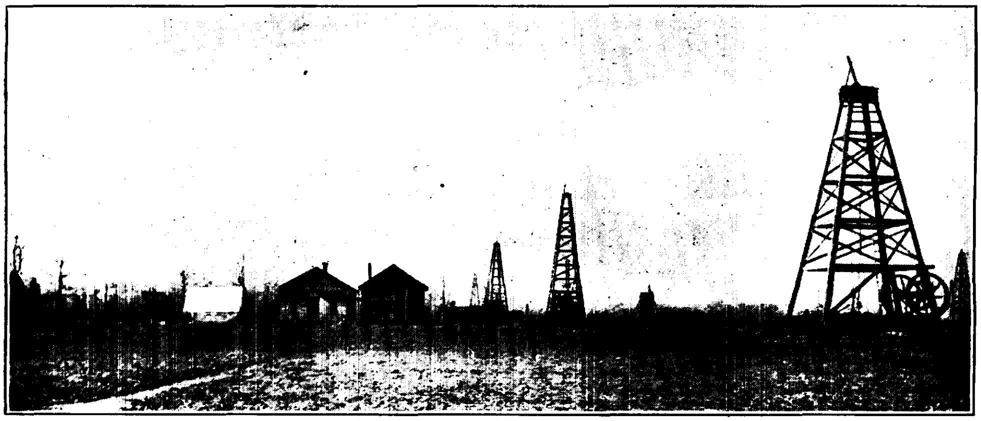
The following quotation from the "Chatham Oil and Gas Derrick," May 11th, 1907, shows how prices of crude oil vary at different points in Canada and the United States. The price given for Tilbury and Romney includes the Government bounty.

	Per bbl.
East Tilbury	1 68½
Romney	1.42½
Pennsylvania	1.78
Tiona	1.78
Corning	1.14
New Castle	1.22
Cabell	1.22
North Lima	.94
South "	.89
Casey, Ill	.68

	Per bbl.
Indiana	.89
Princeton, Ind	.68
Kansas and Ind. Ter. 32% and above	.41
Somerset	1.20
Ragland	.70
Corsicana, light	1.02
" heavy	.65
Mid-continent, heavy	.28
Henrietta, Tex	.60

The color of the Tilbury oil in bulk is a dark olive green. This, however, as is frequently the case with liquids, changes when viewed in a thin layer. If a few drops of the oil be poured upon a piece of window glass and then allowed to spread out, the color appears to change to a pale yellow or amber. It runs from 38 to 41 Baumé standard.

The Romney oil is described by refiners as a "dead" oil. It contains a high percentage of sulphur. A small quantity of naphtha is extracted from it at the refinery, and the balance is sold as fuel. It is about 28 to 30 Baumé.



The John Cooper farm, East Tilbury, showing the flat topography of the region.

The Tilbury Field

From the map accompanying this report it will be seen that, though the oil and gas producing territory is spoken of as the "Tilbury field," the eastern part lies in the township of Raleigh. The lots which were producing oil or gas at the time of my visit, or those which were said to have produced oil at one time, are shown by light shaded lines. The gas wells are indicated by a black circle, while the dry holes are shown by a star. Time did not permit the obtaining of a complete list of dry holes. It was considered by Mr. Wilson McCright, of the Imperial Oil Company, that the field on the east, north and west is fairly well defined. The plan shows that the dry holes surround the oil territory on these three sides. If the Nelson farm (north part lot 12 in the fourteenth concession of East Tilbury) be regarded as the southern limit, the field would then have a length in a north and south direction of about eight and a half miles. There is, however, considerable untried territory between the Nelson farm and the producing farms farther north. The average width is about three miles.

The southern part of the field is regarded by operators as the gas territory, and the majority of the large gas wells are there. Two gas wells occur at the north end of the field, one on the north part of lot 1 in the sixth concession, the other on the south part of lot 1 in the fifth concession, of the township of Raleigh.

Some Leading Operators

Following are some of the largest operators: Volcanic Oil and Gas Company, Chatham, Ont.; Roth, Argue & Co., Chatham, Ont.; Leamington Oil Co., Detroit, Mich.; Congress Oil Co., Wellsville, N.Y.; E. C. Bradley "and others," Wellsville, N.Y.; F. S. Clark, Andover, N.Y.; The Empress Tilbury Oil and Gas Co., Chatham, Ont.; The Maple City Oil and Gas Co., Chatham, Ont.

It was not possible to visit every producing farm. Only a few of the properties are therefore mentioned in detail.

The Volcanic Oil and Gas Company was operating on the following lots:

The Stevenson farm, lot 3, concession X, East Tilbury.

The John Holmes farm, north half lot 1, concession V, Raleigh.

The Halliday farm, north half lot 1, concession VI, Raleigh.

The Finn farm, south part lot 2, concession V, Raleigh.

The Campbell farm, lot 4, concession IX, East Tilbury.

For June of 1907 this company produced 4,530 bbls. oil. The gas well, (which is supplying the city of Chatham) on the Halliday farm, lot 1, in the sixth concession of Raleigh, is also one of the best oil wells owned by the company; it was said to be making 500 bbls. of oil per week the first part of July. The company has also other gas wells in Tilbury.

The Empress Tilbury Oil and Gas Company is operating on lot 5 in the eighth concession of East Tilbury; the lot is known as the Mat. Campbell farm. This is said to be one of the best leases in the field. It contains 100 acres, and had six producing wells on July 15th. The monthly production for May and June was said to be about 2,000 bbls.

The Henry Cooper lease immediately to the north was also regarded as one of the best farms in Tilbury, and was said to be making 3,000 bbls. per month.

The Maple City Oil and Gas Company was operating the following lots:

The Irwin farm, lot 7, Middle road north.[3]

The Robinson farm, southeast quarter lot 11, Middle road south.

The Burgess farm, east half lot 14, Middle road south.

There were nine producing wells. The monthly output was stated by the secretary of the company, Mr. J. W. Aitken, to be about 1,500 bbls. from the Irwin farm. The two wells on the Burgess and Robinson farms are gas wells, though the latter* does produce a little oil.

The Nelson lease (north half lot 12, in the fourteenth concession) was the most southerly lot in the Tilbury field. The well was producing about 40 bbls. a day. A pipe line conveys the oil to Glenwood on the Pere Marquette railway about a mile to the northeast. A gas well supplying Merlin is also found on this lot. Some five new wells were being drilled in at the time of my visit.

Dry Holes

It was found impossible to learn the number and location of wells that had at one time been producing oil, and that had subsequently ceased to produce. But Mr. McCright of the Imperial Oil Company supplied the location of the following dry holes:

In Raleigh township: Lot 4, concession III, southwest corner; Vince farm, lot 3, concession V, centre of west half; Williams farm, lot 4, concession VI, the north part; Newham farm, lot 2, concession VII, centre west part; Kahlar farm, lot 1, concession VII, near township road; Lahey farm, lot 1, concession VIII, centre of lot, near township road; McKeon farm, lot 1, concession IX, northwest part; McKeon farm, lot 2, concession VIII, centre west part; Lecocq farm, lot 4, concession A, west part of lot; Orr farm, lot 9, concession III.

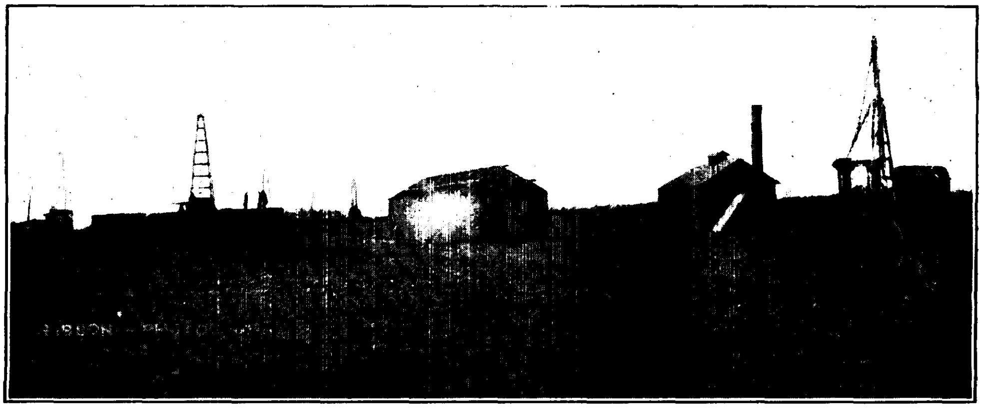
[3] What is known as the "Middle road" cuts across the township of East Tilbury in an east and west direction. The lots on the north half are referred to as "Middle road north," those on the south as "Middle road south."

East Tilbury: Roman Catholic Church, lot 1, concession III, west part of lot; R. Purdy farm, lot 3, concession IV, southeast part; Reaume farm, lot 4, concession V, southeast corner; A. Simard, lot 3, concession VI, east part, (a well here did produce oil but the well has been abandoned and the casing withdrawn); Adam farm, lot 4, concession VII, west part, produced a little oil, but abandoned; Gracey farm, lot 4, concession VII, south part; J. D. Cooper farm, lot 5, concession VII, southeast part; Murphy farm, lot 7, concession VII, centre east part; Norry farm, a small triangular lot or gore, lot 11, concession VII; Ross farm, lot 10, concession VII, south part.

Gas in East Tilbury and Raleigh

There are several important gas wells in the territory which are of great service to the towns and villages taking advantage of the situation. The following is a list of these wells, supplied by Mr. Wilson McCright, of the Imperial Oil Company:

Burgess, lot 14, Middle road south, northeast corner, East Tilbury; J. Richardson, lot 14, Middle road north, southeast corner, East Tilbury; J. Sloan, lot 13, Middle road north, southwest corner, East Tilbury; W. Sloan, lot 12, Middle road north, southwest corner, East Tilbury; W. Graham, lot 12, Middle road south, north part, East Tilbury;



Oil tanks and derricks, East Tilbury field.

J. D. Grant, lot 12, concession XI, southeast part, East Tilbury; Nelson, lot 12, concession XIV, East Tilbury; J. J. Irwin, lot 8, concession XII, southwest corner, gave gas at first, when "shot" water came, East Tilbury; Joyce, lot 12, concession XII, southeast part, East Tilbury; Halliday, lot 1, concession VI, northwest part, Raleigh; Wm. Robinson, south half lot 11, Middle road south, East Tilbury; lot 1, concession V., southwest corner, Raleigh.

The city of Chatham has for the past two months, been supplied with natural gas. At the time of writing, the total supply was derived from one well, on the David Halliday farm in the northwest part of lot 1, in the sixth concession of Raleigh. The depth of this well is 1,421 feet, gas having been struck at 1,417 feet. It is lined with 3-inch tubing and packed with a Dresser packer, and was closed in on September 16th, 1906. The gas is at present conveyed to Chatham some 10 miles distant, in a 3-inch pipe on the surface of the ground, which is to be replaced later on by a 6-inch pipe. The rock pressure of the closed-in gas was, when first measured, 650 lbs. per square inch. It is said, however, to have decreased somewhat since then. At the time of my visit the pressure was said to be about 460 lbs. The gas is conveyed to the city limits under a pressure of 200 lbs., where it is reduced to 60 lbs. At the Chatham Gas Company's works, which is the distributing point, it is further reduced to 6 ounces, at which pressure it is delivered to the consumers.

On lot 14, Middle road north, East Tilbury, the company has another gas well giving 500,000 cubic feet per day. It is to be used to supply gas to Chatham consumers, and will act as an auxiliary. The company will, later on, have other wells for the same purpose.

Mr. P. S. Coate, manager of the Chatham company, has supplied the following figures regarding the price at which natural gas is sold in Chatham. It varies from a maximum of 35 cents per 1,000 cubic feet to the smallest consumer, down to 12 cents for the very largest consumers. The rate for lighting and cooking combined is 35 cents per 1,000. For heating it is 27 cents per 1,000 for the first 100,000 cubic feet; for the next 50,000 the price is reduced to 22 cents; for any quantity over 150,000, the rate is 17 cents. For manufacturers using gas engines for power, the minimum charge is $37.50 per month in the expectation that the consumer will use not less than 250,000 feet per month, which is at the rate of 15 cents per 1,000. In the case of manufacturers using gas under boilers, the rate is 12 cents per 1,000 for any desired quantity.

That natural gas has been a boon to the citizens of Chatham can be seen from the fact that artificial gas was formerly sold for lighting and cooking purposes at $2.50 per 1,000, with a discount of 30 per cent. off for cash within 10 days of rendering the account.

Nearly every farmer along the gas pipe line into Chatham now uses gas for lighting and cooking.

Professor E. B. Shuttleworth of Toronto gives the following as the composition of the gas:

	Per cent.
Hydrocarbons, principally methane	92.20
Carbon dioxide	1.40
Oxygen	trace
Carbon monoxide	.21
Hydrogen	.40
Nitrogen	5.59
Sulphuretted hydrogen	.20
Total	100

A comparison of this with the natural gases found in Ohio and Indiana shows that they closely resemble each other. Some objection was at first made to the use of Tilbury gas on the score that it contained sulphuretted hydrogen. The Chatham Gas Company are therefore preparing to purify the gas by the removal of this objectionable constituent.

The Burgess well, lot 14, Middle road south, East Tilbury, is also an important producer. It is owned by the Maple City Oil and Gas Company. Before being finally closed in the gas escaped for five months. On July the 18th the writer was present during a test made by D. Robertson and A. A. Crawford, Pittsburgh, Pa. The well was opened one hour and twenty minutes before the gauge was put on.

At the end of the first minute the pressure was 280 lbs. per square inch.
" " " second " " " 400 " "
" " " third " " " 460 " "
" " " fourth " " " 495 " "
" " " fifth " " " 510 " "

The gas flowed at the rate of 3,100,000 cubic feet per 24 hours. This well is supplying the villages of Tilbury and Merlin, and also the farmers along the pipe line. It is conveyed to Tilbury part of the way in a 2-inch pipe and the remaining distance in a 3-inch, under a pressure of 100 lbs. per square inch. At Tilbury it is distributed in 4-inch mains.

The Maple City Oil and Gas Company also own what is known as the William Robinson well, south half lot 11, Middle road south. The well produces some oil also. It was capped at the time of my visit for future use. On July 18th the well was tested by the same gentlemen who tested the Burgess well. It was left open three-quarters of an hour before the gauge was put on.

At the end of the first minute the pressure was 160 lbs. per square inch.
" " second " " 220 " "
" " third " " 280 " "
" " fourth " " 300 " "
" " fifth " " 320 " "

The gas flowed at the rate of 1,000,000 cubic feet per 24 hours.

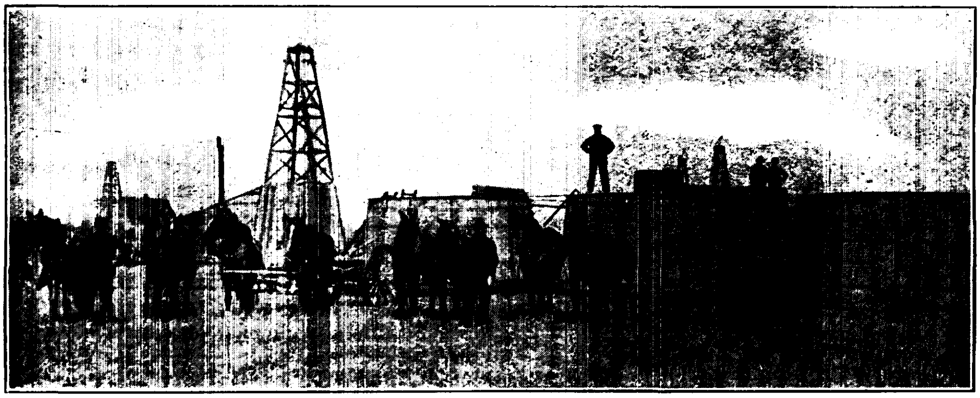
The gas well on the Nelson farm, north half lot 12, in the fourteenth concession, East Tilbury, has a 2-inch pipe line to the village of Merlin, some five miles east.

There is also another good well at the southwest corner of lot 1 in the fifth concession of Raleigh. It was being used for drilling purposes only.

Owing to the lack of time, the other wells given in the above list were not visited.

The Romney Field

This territory is sometimes referred to as the shallow pool. The oil is struck at less than 300 feet. It is a much smaller field than the Tilbury, and the relative importance up to date of the two fields may be seen by comparing the production in each case.



Oil tanks and derricks, Romney field.

From the accompanying plan it is seen to lie at the north part of the township of Romney, but a small part occurs in East Tilbury.

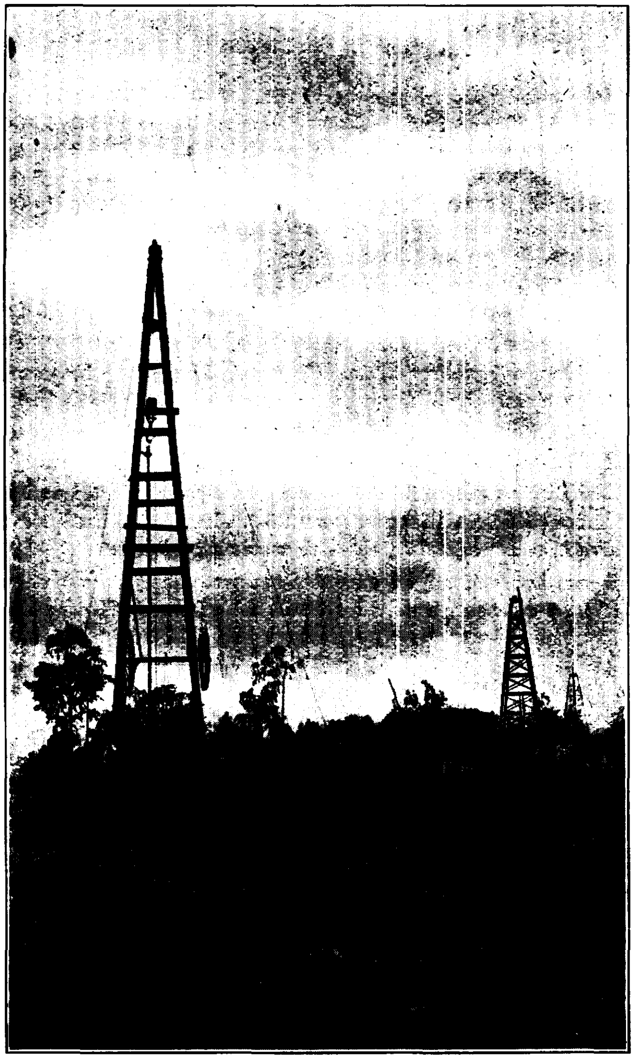
Forty-seven wells have been drilled, of which 24 were dry. There are no gas wells proper, though on lot 23 in the ninth concession, one well was said to be giving enough gas to run three gas engines if required. At the time of my visit the field was quiet compared with the March previous. Several causes have already been stated for this. The Hornick Farm Oil Company (lots 23 and 24, in the ninth concession of Tilbury) was said to be the largest oil producer about the middle of July. The daily production was given as 100 bbls. per day. Four wells were pumping.

The oil is piped to Coatsworth station on the Pere Marquette railway, about two miles southeast.

Some of the principal operators are: Norton, Church, Bowlby and Benson, Chatham; Barnard-Argue-Roth-Stearns Oil and Gas Company; Hoverstate and Chase; Hornick Farm Oil Company, Tilbury, Ont.

Handling the Oil in Tilbury

Three stages occur in the collection of the oil. It is first piped from the different wells on a farm into one or two tanks. Thence it goes to a large central station for the whole field; the third step is its transference to the railway station tank at Merlin. Pipe lines have been installed carrying the oil from the wells to the central storage tanks and pumping station. These latter ore owned by the Imperial Oil Company of Sarnia, and are situated on lot 3, in the ninth concession of East Tilbury. The main tank is steel, with a capacity of 3,840 bbls. There are also other tanks, bringing the total capacity up to 6,000 bbls. Two pipe lines—one 4-inch and one 2-inch—convey the oil from here to Merlin, four and a half miles distant. It is pumped under a pressure varying from 200 to 400 lbs., and it is possible to send 3,500 bbls. in ten hours. At



Portable derrick (on left). This type is replacing the stationary derrick.

Merlin the receiving tank is built higher than the oil cars (which convey the oil by rail to the Imperial Oil Company's works at Sarnia) so that no pumping is necessary at this point in the transmission.

In order to understand the system of pumping the oil from the wells and piping it to the local tank on each farm (or for each group of wells) a description is given of the method on one lot. This holds good for the whole field.

The Irwin farm, lot 7, Middle road north, East Tilbury, is operated by the Maple City Oil Company, Chatham. There were nine producing wells on the farm. The power for pumping is a gas engine in which natural gas is used. This power plant is placed in a central position. Surface rods run to each well at which a pump is placed. The power plant is so constructed that the pumps are run by the surface rods simultaneously. The length of the rods will of course depend on the distance each well is from the power plant. The local tanks on each farm are generally 250 bbls. capacity.

Drilling the Wells

The drilling is generally done by contractors. In the Tilbury field the contractors get from 85 cents to $1.00 per foot. Most of the wells are about 1,400 feet. Besides the $1,400 paid the contractor, the owner must shoot the well with nitro-glycerine, at a cost varying from $150 to $200. Adding the expense of lining a well to the above the cost will run up to about $3,000. If the well proves a "duster" (a dry hole) the casing is removed, and the operator probably loses about $2,000.

About 150 bbls. of water per day are used by a contractor in drilling; this includes water for the boiler. The lack of fresh water was somewhat of a problem at the time of my visit. On the average it takes about 25 days to drill a well in Tilbury.

The number of wells sunk on a farm depends on its size and fertility. The general rule was to place them not nearer than 500 feet. They are, however, drilled much closer on adjacent lots owned by different companies.

Because the wells are shallow in the Romney pool, drilling costs considerably less than in Tilbury. The wells have been drilled closer together than in the latter field.

After a well has been drilled in and cased the newer practice with oil men is to use a portable derrick which will serve some 25 wells. It is used for making repairs to the wells. This form is replacing the old stationary derrick.

Contractors work day and night except Sundays. Only two men are engaged at each shift, that is from 12 noon until 12 o'clock midnight, and from 12 midnight until 12 noon. These two men run the engine, remove the drill and clean out the hole.

Notes on Geology

In driving from Chatham to the Tilbury oil field the surface of the ground is seen to be very flat and monotonous. It is, however, in the vicinity of Chatham slightly rolling, but these gentle undulations apparently disappear before the oil country is reached. The only marked relief to the flatness of the country is at the village of Blenheim on the Pere Marquette railway, some ten miles southeast of Chatham. Here the country rises gradually about 25 feet or more above the flat regions to the north. A pit at one point on the top reveals gravel. Going from Blenheim to Merlin by railway the hill is seen to disappear to the southwest. More boulders were noted in the vicinity of Blenheim than in the country further north. The long tangents of the railway are another evidence of the flat topography. This condition has made it necessary to build numerous drains, some of them several feet in depth and twenty feet wide, in order to carry on successful farming. The soil is largely clay with a few boulders in sight.

According to Eugene Coste[4] the drift varies in thickness from 100 to 150 feet, "and is composed of boulder clay on the top and sands and gravels varying very much in thickness below. The first strata struck under this drift (in the Tilbury field) are the gray blue shales of the Hamilton or Middle Devonian formation, the so-called upper soapstone or soap of the Petrolia driller; then comes the middle lime and the lower soap of the same formation followed by the Corniferous or big lime of the Lower

[4] Journal Can. Min. Inst. Vol. X.

Devonian, which is struck at depths ranging from 230 to 285 feet, and is about 150 feet thick. Below this are the dolomitic limestones with flint and gypsum of the Onondaga, or Upper Silurian, a little more than 1,000 feet thick; then come the Guelph and Niagara, Silurian dolomitic limestones in which, so far, the drilling of the wells has been stopped, but it is likely that in future in some parts of that field or not far from it, the wells will be drilled deeper still, and will obtain their gas and oil either from the Clinton limestone immediately underlying the Guelph and Niagara and about 150 feet thick in that section of the country, or from the still deeper strata of the Trenton limestone lying about 900 feet under the Clinton from which it is separated by the Medina, Hudson River and Utica soft shales, which can be drilled through very quickly and cheaply.

"The gas and the two upper oil pays in the southern part of the field are found in the lower brown dolomites and gypsum of the Onondaga, while the lower oil pay is struck in the upper beds of the Guelph and Niagara. In the north end of the field, north of the Michigan Central railway, the lower beds of the Onondaga are barren of oil, which is there altogether found in the Guelph, but the gas is still found there in the lower beds of the Onondaga in the strata which form the first and second oil pays of the south end of the field. In the middle part of the field on the other hand, the oil is struck in the Onondaga strata which constitute the gas pays in many of the wells of the middle western part of the field."

In the Romney pool, Mr. Coste goes on to say that "the oil is struck at the shallow depths of 200 to 270 feet, in the upper part of the Corniferous formation or Big Lime, the top of which is struck at 180 feet."

The following log of a well on the J. W. Campbell farm, East Tilbury, is quoted from Mr. Coste's paper.

Log of the Central Oil and Gas Company Well No. 1 on the J. W. Campbell farm (southeast corner of lot 6 in the IX concession of the township of Tilbury East, Kent county, Ont.) Elevation 600 feet, A.T.

Formation.	Description of Strata.	Thickness feet.	Depth feet.	Remarks.
Drift	Boulder clay	95 to	95	
	Grey sand	5 to	100	A little gas.
	Clay and gravel	28 to	128	10 in. drive pipe to 138 ft.
Hamilton	Blue clay shale (upper soap)	37 to	165	
	Middle lime	10 to	175	
	Blue clay shale (lower soap)	67 to	242	
Corniferous or Big Lime	Yellow Limestone	158 to	400	8 in. casing to 243 ft. A show of oil at 250 ft.
Onondaga	Grey, drab, brown and blue dolomites with gypsum and flint (shaly series with darker shaly dolomites and more gypsum from 835 to 1,185)	1,020 to	1,420	6¼ in. casing to 835 ft. Gas at 1,250 ft., 1,362 ft., 1,370 ft., 1,376 ft., 1,382 ft. Oil at 1,392 to 1,400 ft. and at 1,416 ft.
Guelph	Blue white dolomitic limestone	9 to	1,429	Oil at 1,426 ft.

On the Mat. Campbell farm, East Tilbury, lot 5 in the eighth concession, oil was struck in five wells at the following depths: 1,390, 1,395, 1,398, 1,399, 1,405 feet respectively.

In the Romney pool a well on lot 23 in the ninth concession, East Tilbury, gave the following log: Drift to 148 feet; soapstone to 192 feet; oil at 250 to 270 feet in Big Lime.

Further south on the Trembly farm the drift is 145 feet, and gas was struck at 176 to 283 feet.

In shooting a well fragments of the oil-bearing rock an inch or so in diameter may be blown up the drill hole. One of these from the Mat. Campbell farm, lot 5 in the eighth concession, East Tilbury, has a dull grey color. It effervesces fairly freely with hydrochloric acid. The oil pores vary in size from microscopic cavities to one-quarter of an inch in diameter. They are more abundant in some spots than in others. For instance a surface containing half a square inch will sometimes show comparatively few visible pores, while on another surface they are more numerous.

The Kipp Field

About two miles southeast of Chatham there is in Raleigh township, a small shallow oil pool, the position of which may be seen by consulting the accompanying map. There are two companies operating here: The Kipp Oil Company, Chatham, and The South Western Oil and Gas Lands, Limited, Petrolia. The oil is struck at 360 to 400 feet.

The Kipp Oil Company is operating on lot 25 in the eighth concession of Raleigh, and lots 23 and 24 adjacent to the northwest. Nine wells are pumping, and the output was said to be 150 bbls. per month. The Imperial Oil Company at Sarnia has received 259 bbls. from this company for the first six months of this year. The wells give sufficient gas to run the power plant. The company is said to have been producing oil continuously for the last four years.

The South Western Oil and Gas Lands, Limited, is operating on lots 23 and 24 in the eighth concession, Raleigh. Eight wells were pumping at the time of my visit. No oil has as yet been shipped.

Mr. W. MacIntosh, secretary of the company, has given the following log of well No. 14 on the property: Drift to 110 feet soap to 185 feet; middle lime to 190 feet; lower soap to 236 feet; oil at 360 feet in Corniferous lime.

I.—IRON RANGES EAST OF LAKE NIPIGON

By A P COLEMAN

Introductory

In accordance with the instructions of Mr. T. W. Gibson, Deputy Minister of Mines, work was carried on during the summer of 1906 on the east shore of lake Nipigon in the neighborhood of Poplar Lodge and Sturgeon river. Mr. T. L. Goldie was appointed my assistant during the earlier part of the work, and took in hand the topographical side of the survey, rendering very useful service in this capacity. During July I was called off to join an "International Committee on the Correlation of the Pre Cambrian Rocks" of Eastern Ontario and New York, and so had to leave the Nipigon field. Mr. E. S. Moore then took charge of the work as geologist, Mr. Goldie continuing to act as topographer. Their field work was devoted to the extension of the Sturgeon river iron ranges eastward beyond a band of eruptive rock which cuts them off about 17 miles inland from Poplar Lodge.

The iron ranges east of lake Nipigon have been more or less known for a number of years, and several geologists have touched the region, Mr. Peter McKellar having surveyed the shore many years ago as assistant to Dr. Bell,[1] and more detailed work on lake Nipigon and its islands having been done at a later time by Mr. Dowling.[2] The most important work, however, so far as our immediate area is concerned, was that of Prof. Parks in 1901;[3] and I am much indebted to Mr. A. P. Low, Director of the Geological Survey of Canada, for his kindness in supplying a tracing of Dr. Parks' forthcoming map of the region. Part of the southern range was visited by Mr. J. W. Bain for the Bureau of Mines in 1900, and a brief account of his work appears in the report of the following year.[4] None of these geologists made any attempt at mapping the Iron formation, however.

Within the last few years many claims have been staked and surveyed on these ranges and a certain amount of stripping and diamond drilling has been done to open them up, Mr. Flaherty and the Lake Superior Power Company having been most active in the development. I am under much obligation to Mr. P. A. Leitch, Mr. R. H. Flaherty, and Prof. A. B. Willmott for numerous tracings and blue prints giving the results of their exploration. Thanks are due to Mr. Leitch also for aiding us in securing canoemen and guides for the work.

We were fortunate enough to have the services as guides of H. J. Scott and Michael Ralph, who originally located many of the claims, so that nothing known to them in the way of outcrops of iron range was overlooked.

Owing to the great demand for canoemen and guides for parties locating the line of the Grand Trunk Pacific railway north of lake Nipigon, Indian helpers were very scarce, and wages abnormally high.

Geographical Relationships

Lake Nipigon is 852 feet above sea level, according to White's "Altitudes in Canada," so that in reaching it there is an ascent of 250 feet, implying numerous rapids and falls on Nipigon river on its course from the lake to Nipigon bay of lake Superior. As the river is famous for its brook trout the route is much frequented by fishing parties, and during the last two years it has also been much travelled by expeditions connected with the survey of the Grand Trunk Pacific railway. On this account the portages are

[1] Geol. Sur. Can., 1866-69.
[2] Ibid., 1898.
[3] Sum. Rep. G. S. C., 1902, pp. 211-20.
[4] Bur. Mines, 1901, pp. 212-4.

well beaten, and on two of the longest teams are kept for the transport of supplies, etc., past the rapids. On lake Nipigon itself two steamers were built during the winter of 1905-6, one by Mr. Flaherty, the other by Revillon Freres, a rival to the Hudson Bay Co., so that transport on the lake can be easily arranged.

Split Rock Rapids, Nipigon river.

Split Rock Rapids, looking south.

There are three depots or posts on the lake, one at South bay, another on the west shore, and the third at Obabicon bay on the northeast side. Poplar Lodge, on the east shore, was once a Hudson Bay post, but is now practically abandoned, the few supplies remaining in the log houses of the post being left in the charge of an Indian.

Route to Poplar Lodge

The canoe route to lake Nipigon begins at lake Helen, an expansion of Nipigon river just east of Nipigon station on the Canadian Pacific railway, and follows up the river to the Long portage of 2½ miles, across gravel terraces and a moraine. Plans have been made to develop water power here by turning the river into a depression suggesting an old channel.

About 8 miles of paddling bring one to Split Rock rapids, where a bold island of rock parts the river into two foamy channels. For a mile below this the river flows through a wild gorge or canyon with steep walls of vertically jointed diabase. Then come Island portage, which is short, over gneiss, and Pine portage, about a mile and a half long.

Near Victoria camp we turned west up a tributary creek to lake Hannah. From this a portage of about three-quarters of a mile across flat sheets of diabase brings one to the shore of South bay on lake Nipigon. The landing here is over steep rocks exposed to a heavy sea in westerly winds, so that it is sometimes dangerous to launch canoes.

About five miles south is South bay post, in a narrow-mouthed, well sheltered harbor to which supplies are teamed in winter. It was in this harbor the two small steamers mentioned before were built.

The route round the promontory toward the outlet of lake Nipigon is somewhat risky for canoes, owing to the wide reach of water, but near the southeast corner of the lake the Virgin islands give some protection. Beyond them open water extends as far as the eye can see toward the north, and canoes generally coast carefully along to Poplar Lodge, near the mouth of Sand creek.

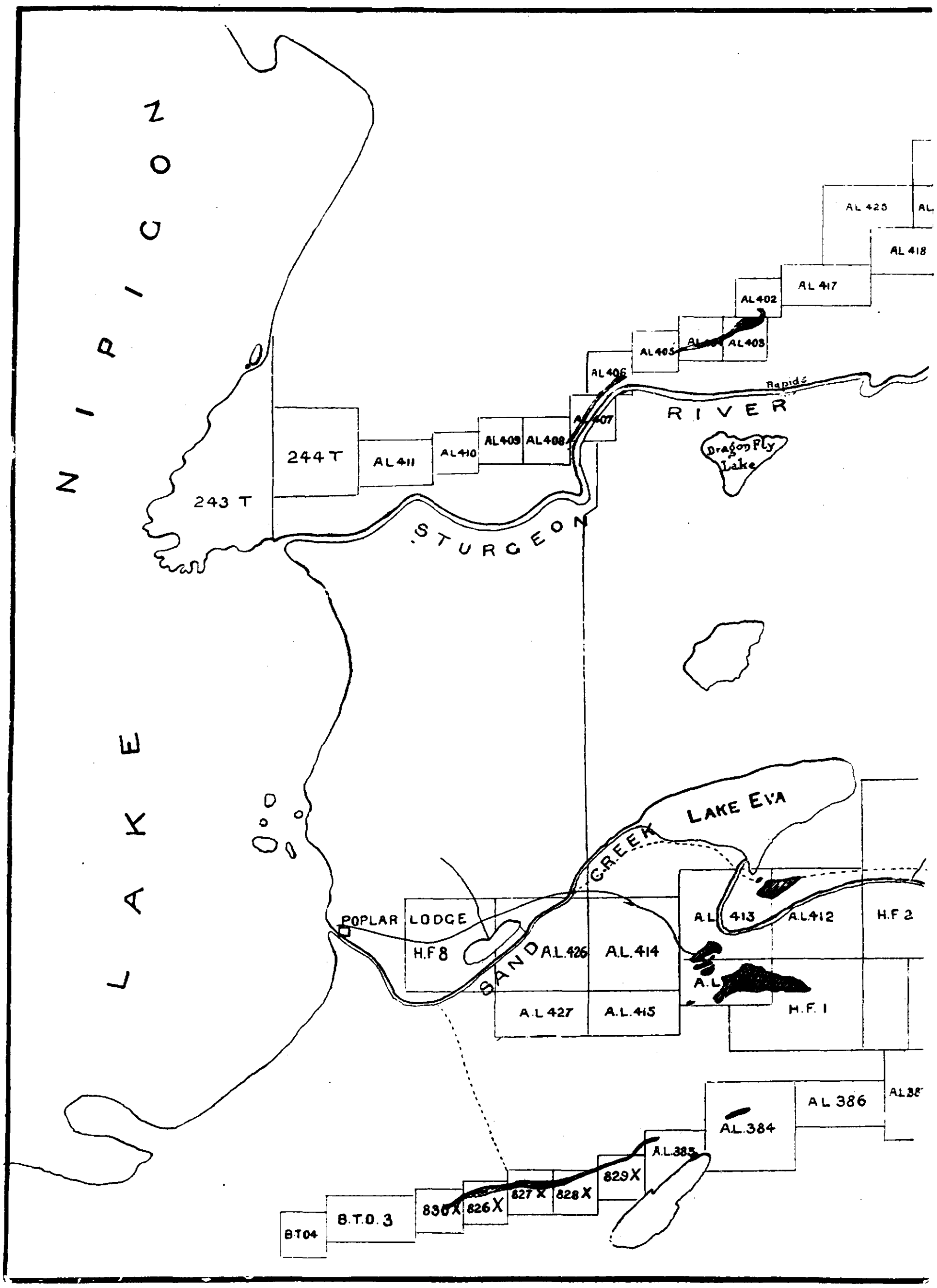
There are several log houses at Poplar Lodge in addition to the two belonging to the Hudson Bay Co., winter quarters for a small band of Indians, who scatter in summer, leaving the place deserted.

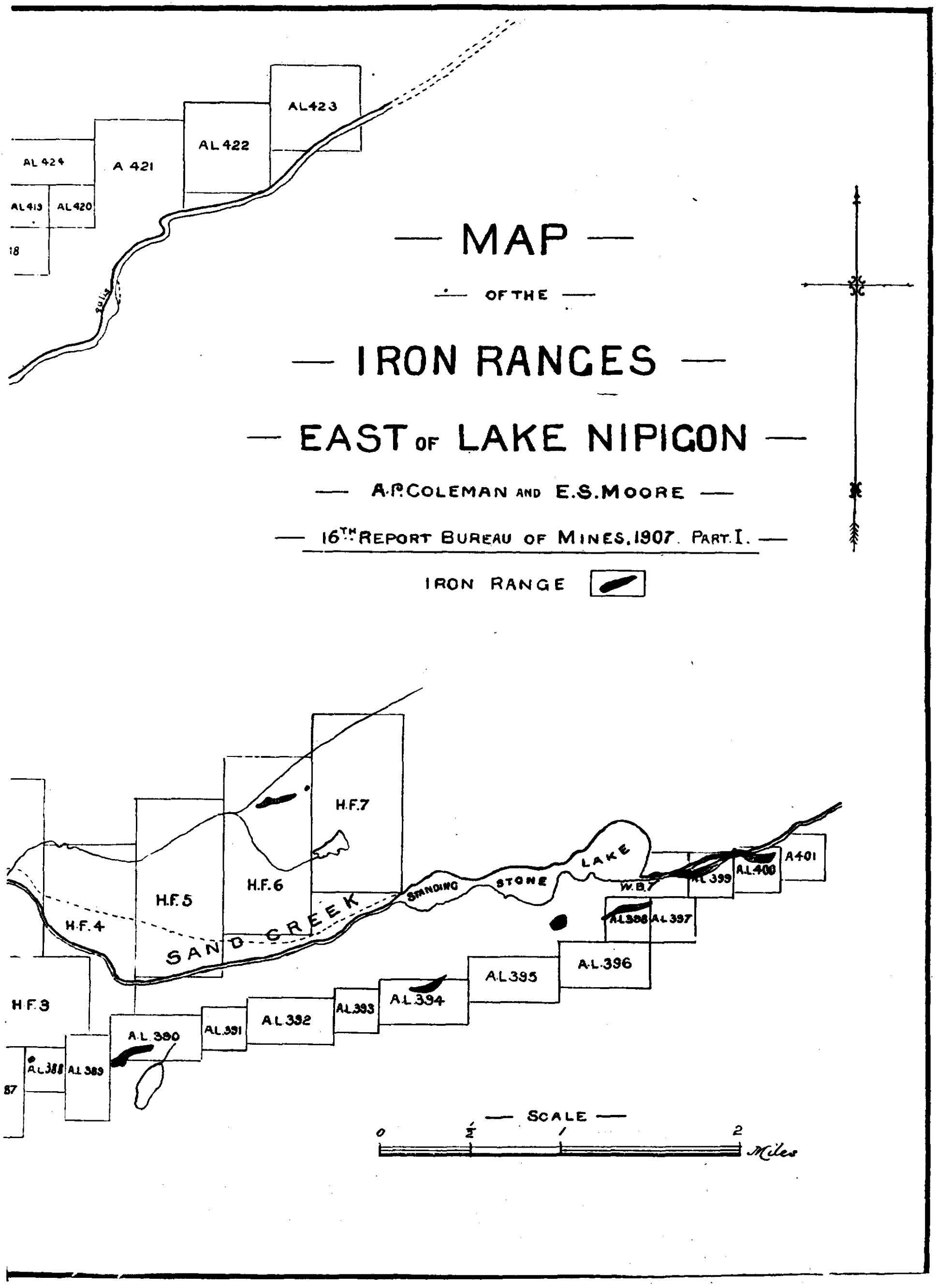
Years ago the Hudson Bay post was about a mile up Sturgeon river, which enters lake Nipigon about two miles above Poplar Lodge, but the only trace now left of it is the hollows of the cellars under the houses. There are two camps in the region, provided with good log houses for the use of men employed two or three years ago in stripping and drilling on the iron ranges, one of them about two miles east of Poplar Lodge, the other about two and a half miles up Sturgeon river. Both are now deserted. Travel in the region east of the lake may be undertaken in canoes on Sturgeon river, and a chain of lakes beyond, or by roads and trails cut out for exploring purposes east and south of Poplar Lodge.

Topographical Features

The region cut by Nipigon river is in general rugged and even mountainous, especially in the neighborhood of Split Rock, where the canyon walls are wild and imposing. Most of the hills are flat-topped by reason of the nearly horizontal sheets of diabase with which they are capped. The southeast shores of lake Nipigon partake of the same character, showing often steep cliffs and flat-topped ranges of hills with deeply cut valleys between. These features are characteristic of the Animikie region, with its massive sills of diabase.

Farther north, near Poplar Lodge, older rocks having much less regularity, give a more varied topography, with a general east and west strike of the hills and ridges, corresponding to the strike of the rocks and their schistosity. Here the valleys are sometimes wide and flat-bottomed, and swamps and sand and gravel beds hide the bed rock.


LAKE NIPIGON
STURGEON
RIVER
Rapids
Dragon Fly Lake
LAKE EVA
SAND CREEK
POPLAR LODGE
244 T
243 T
AL 411
AL 410
AL 409
AL 408
AL 407
AL 406
AL 405
AL 403
AL 402
AL 417
AL 418
AL 425
H.F 8
A.L.426
A.L.414
A.L 427
A.L.415
A.L 413
A.L.412
H.F 2
H.F. 1
A.L. 386
A.L. 384
A.L.385
829X
828X
827X
826X
830X
B.T.O.3
BT04

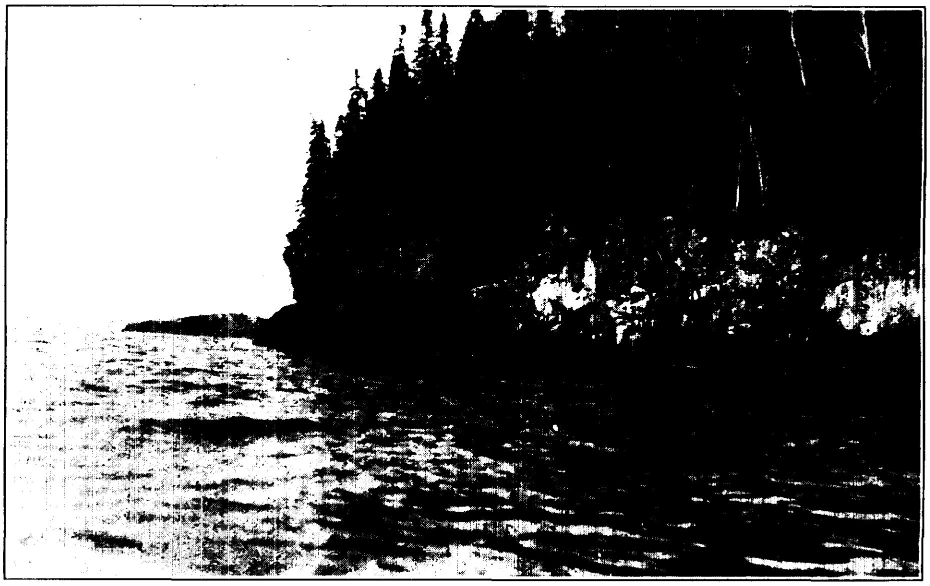

MAP
OF THE
IRON RANGES
EAST OF LAKE NIPIGON
A.P. COLEMAN AND E.S. MOORE
16TH REPORT BUREAU OF MINES, 1907. PART I.
IRON RANGE
AL 423
AL 422
A 421
AL 424
AL 419
AL 420
H.F.7
H.F.6
H.F.5
H.F.4
H.F.3
SAND CREEK
STANDING STONE LAKE
W.B.7
AL 399
AL 400
A401
AL 398
AL 397
A.L.396
A.L.395
A.L.394
AL.393
A.L.392
AL.391
A.L.390
AL.388
AL.389
SCALE
0
1/2
1
2
Miles

Hydrography

Lake Nipigon may be looked on as the first of the chain of Great Lakes, though it differs greatly from the others of the chain in the vast number of large and small islands which rise from its clear deep waters. In this respect it may be compared to Georgian bay, though the islands are largely flat-topped hills of diabase, unlike the rounded Laurentian islands of the latter body of water.

It is about 65 miles long, by 44 miles wide, and but for its islands would be a very impressive body of water, suggesting lake Superior by its clearness, depth and the boldness of its shores.

The Nipigon river is probably the largest affluent ot lake Superior, carring off the waters collected in the lake by dozens of small and large streams, some of them very respectable rivers. In the district studied, Sturgeon river is the largest, having a width of 50 to 100 yards in the lower part of its course, where its current is not rapid. About five miles up there are falls, and above this numerous falls and rapids. South of



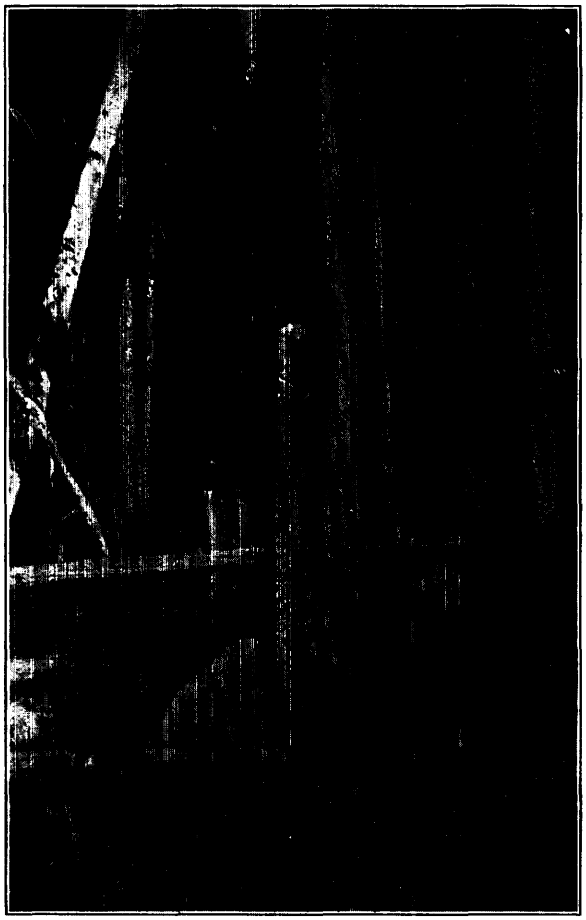
East shore of Lake Nipigon ; sill of diabase.

Sturgeon river there are several small lakes, drained mainly by Sand creek, which enters lake Nipigon at Poplar Lodge, and is navigable by canoes for only about a mile. The rivers have brown water, unlike the crystal clear water of the lake into which they flow.

Surveys

The region has not been surveyed into townships, and, consisting as it does in the main, of rocky ridges, muskegs and sand plains, it cannot be looked on as of value for agricultural purposes. The oldest surveys carried out were either for the location of the old Hudson Bay post, near the mouth of Sturgeon river, or of two mineral claims near it. Later a large number of iron claims were blocked out by compass lines, and afterwards surveyed into locations of various sizes. The lines enclosing the locations are easily followed, since they were cut only a few years ago and no fires have run to destroy them, but some on the southern range were cut in the winter when the snow was deep, so that the stumps are eight or ten feet high, and the trees chopped at this level make a very difficult slash to work one's way through. In mapping the formations the lines were paced and points determined from the nearest corner post.

Except for some fairly good spruce, not much timber of value is to be seen in the area mapped, which belongs to the Nipigon Forest Reserve, looked after by a small force of rangers. The beauty of the scenery and the excellence of the trout fishing no doubt justify the reservation, which can never be of value for farming purposes. The lake itself supplies excellent whitefish and salmon trout, which are caught by the Indians in nets; and sturgeon are numerous in the river bearing that name, and are taken by the Indians at the usual season.



Surveyor's post east of Poplar Lodge.

Classification of the Rocks

The rocks of the region mapped include a number of types divided between the Lower Huronian and the Keewatin. The only undoubted Lower Huronian rocks are coarse conglomerate, sometimes schistose; but probably some slaty and arkose rocks found near the conglomerate are also of this age. The Keewatin includes the Iron formation, of banded quartzite and magnetite, or jasper and hematite, and some slate; various schists and arkoses, chloritic, hornblendic, sideritic, dolomitic; and basic eruptives, now so weathered that they can only be called greenstones, but originally, at least in part, lava flows, since pillow and amygdaloidal structures occur.

There are also some gabbro and quartz diorite areas of uncertain age, some of them later than the Iron formation, and probably later than the Lower Huronian conglomerate. The rocks of the region may be tabulated as follows:—

ARCHEAN	Later Eruptives--gabbro, diabase, etc.	
	Lower Huronian—conglomerate and probably slate and arkose.	
	Keewatin	Iron Formation.
		Green and gray schists, sometimes sideritic.
		Greenstones and volcanics.

The Lower Huronian Conglomerate

Conglomerate, classed as Lower Huronian, is rather frequently found in the Poplar Lodge region, generally not far from the Iron formation; but no large areas are known. Occasionally this rock, somewhat metamorphosed, stands up as sharp hills or short ridges, but often it is in narrow bands parallel to the Iron formation and not rising above the general level.

The most striking outcrop is a quarter of a mile north of the first rapid on Sturgeon river, where the rock forms a narrow, very steep ridge rising about 200 feet above its immediate surroundings and 550 feet above the river. It has a length of only about 600 feet and then drops down to a drift-covered surface, but small outcrops are found in the lower ground to the west. The rocks enclosed as pebbles and boulders include granite, aplite, diorite, felsite, various greenstones and green schists, white quartz, black silicious iron ore and a little jasper. The pebbles are mostly well rounded, but some are subangular. The matrix is a somewhat re-crystallized arkose, with angular fragments of quartz and feldspar, and little schistose structure, though the cleavage has a general trend of east and west, parallel to the direction of the ridge.

A much larger area of quite similar conglomerate forms part of a small range of hills about a mile to the northeast, crossing the boundaries of A L 418, 419, and 420. Here, however, drift somewhat obscures the outcrops, and much of the surface is covered with moss.

To the south of each of these hills there is gray slate or slaty gray schist, dipping nearly vertically or to the north, with a general strike of about 80°, corresponding to the usual direction in the region. Whether the slate overlies the conglomerate or underlies it is uncertain. The rock to the north of the conglomerate is greenstone with green schist.

On the central range conglomerate has been found as narrow bands in A L 414 and H F 5, the first being the most interesting. The road from Poplar Lodge to the camp on A L 413 crosses a small outcrop of well-preserved conglomerate containing pebbles of various rocks, and going south two other bands are crossed with green schist and Iron formation between, suggesting repetition by close folding. The best outcrop of conglomerate stands nearly vertical with a band of Iron formation to the north. It is about 20 feet wide and was followed for over 100 yards, each end dipping under swamp or drift. In character this conglomerate is very much like that of the northern range, but is much less extensive.

The conglomerate observed in H F 5 is narrow also, and seems to fade into gray green schist which lies to the north. A band of Iron formation runs parallel to it a little to the south, schist occupying the intervening space.

Conglomerate has been found only in one small outcrop along the southern iron range. But for the large amount of swamp and old lake deposits, it is probable that at least two bands of conglomerate could be traced across country, connecting up the outcrops mentioned above; but on the whole, this rock is present in much less quantity than the schist conglomerate near the Michipicoten iron range on lake Superior. No evidence has been found to prove a glacial origin for the Nipigon conglomerates, though nothing was observed that conflicts with that hypothesis, which has been used by the present writer to account for a Lower Huronian conglomerate which is probably of the same age in the Cobalt silver region.[5]

The slate found beside the conglomerate in the northern range is dark gray, and with a well developed cleavage parallel to the schistose structure of the country. It appears to have been originally a muddy sediment; while the arkose, part of which may belong to the Lower Huronian, would represent sandy deposits.

As the Lower Huronian conglomerate is the next rock above the Iron formation, it is of importance as a guide to the structural relationships, especially in the working out of synclinal basins in which ore deposits might be found. On this account special attention was devoted to it.

Camp, Poplar Lodge.

Rocks of the Keewatin

The Iron Formation

At or near the top of the Keewatin occurs the most interesting rock of the region east of lake Nipigon, the Iron formation, including two rather distinct types, one banded gray and black with silica and magnetite, the other banded red and bluish gray or black, consisting of jasper and hematite. The former variety sometimes passes into the latter, a few dull bands of jasper occurring with the magnetite and gray silica. The black variety with magnetite is found on the northern and southern ranges, and the jaspery variety in the central range; and the three ranges seem to be quite separate but run parallel to one another. Just why the ore should be different in ranges less than a mile apart, associated with very similar rocks, is not quite clear, but even the small jaspery parts of the northern and southern ranges are easily distinguished from the brightly colored banded material of the central range.

[5]Am. Jour. Sc., Vol. XXIII., 1907, pp. 187-192.

The dark variety of Iron formation is often interbanded with dark slate having a similar appearance on outcrops, and there is every gradation between slate with no magnetic attraction and heavy magnetite.

The Iron formation of all three ranges is very commonly crumpled and folded on a small scale, though the general arrangement of the banding maintains a fairly uniform direction, a little north of east, and in most cases the bands dip at steep angles, or are vertical. Often the formation has been shattered, and the fissures filled by later white quartz, giving a very vivid, striking appearance to the rock.

In a general way the Iron formation of this region is more like that northwest of lake Superior, between Fort William and Hunters island, or on the Vermilion range in Minnesota, than that of the Michipicoten region. None of the soft sandy variety of Iron formation found near Helen mine was observed near lake Nipigon; nor is siderite present in appreciable quantity. A marked difference is observed in the absence of pyrites from this range, while in the Michipicoten region it is abundant.

Other Keewatin Rocks

Gray and green schists are always associated with the banded silica and jasper of the Iron formation; often lying interbedded with it or serving as a kind of matrix in which strips or crumpled masses of the Iron formation are enclosed. Usually the strike and dip of the two rocks are about the same. The green schist, consisting mainly of chlorite and hornblende, represents perhaps a basic volcanic ash, while the gray variety of schist contains some siderite and also sometimes quartz grains, like the Wawa tuff in the Michipicoten region, suggesting a sheared and altered quartz porphyry or rhyolitic ash rock, or perhaps arkose.

The green schist frequently seems to pass into greenstone with little or no schistose structure, like the Gros Cap greenstone of Michipicoten. Frequently this rock is filled with small white spots representing amygdules, as along the coast north of Poplar Lodge, and occasionally there is pillow structure indicating lava flows. At a few points this rock becomes coarsely brecciated with large and small angular fragments of at least four kinds of rocks, greenstones of different sorts, but no granite. The rock is probably a volcanic breccia or an agglomerate.

Evidently the region was one of great volcanic activity, with surface lava flows and explosive eruptions in Keewatin times. In general the schists and eruptives just described are characteristic of the Keewatin of northern and western Ontario, and occur in almost all the areas which have been studied in detail.

Slaty rock occurs with the schists in small amounts, and occasionally also arkose, green or rusty with small angular fragments of quartz and greatly weathered feldspar; and these rocks may represent ordinary sediments; but the distinctly eruptive materials mentioned above form the prevalent rocks.

Some of the darker slate is charged with magnetite grains and passes into the banded iron ore, so that it is often hard to fix the precise edge of the formation.

Later Eruptive Rocks

Rocks probably later in age than the Lower Huronian, and certainly later than the Keewatin, occur in large and small areas in the region, especially north of the northern range and west of the southern range. These rocks occur rather as bosses or batholiths than as dikes, and generally show a granitoid structure with no hint of surface conditions.

They vary considerably in character, but are often so mixed together that in our work, which was devoted chiefly to the iron-bearing rocks, it seemed unadvisable to map them in detail. They include pale greenish gray granitic looking rocks with much quartz, found in thin sections to be quartz diorite; a paler yellowish gray rock with the feldspar greatly weathered, probably grano-diorite; and a dark green porphyrite with white plagioclase crystals.

Still later in age are some areas of fairly fresh gabbro or diabase, cutting off the southern iron range toward the southwest. It is possible that the last rocks are remnants of larger areas of diabase belonging to the Keeweenawan, but they may be merely the channels through which the material for the sills in the Animikie blocking the south end of lake Nipigon rose from the depths. They show no sill-like character in the region studied, but it is not improbable that Animikie sedimentary rocks with the usual Logan sills of olivine diabase once covered the Lower Huronian and Keewatin area, and have since been completely removed, leaving only the diabase of the necks through which the magma of the sills ascended.

Diabase of the same character is very wide spread in northern Ontario, occurring from the Cobalt region on the east to points beyond Fort William, always as dikes, rather small bosses, or sheets intercalated in sedimentary series. It is probable that all are of Keeweenawan age, but represent lavas which cooled below the surface, while the Keeweenawan amygdaloids were the corresponding surface lava flows.

The Northern Iron Range

The Northern iron range has been traced for about a mile in a general northeasterly direction on the north side of Sturgeon river, sometimes cropping out immediately beside the river, but generally separated from it by sand and gravel terraces. Locations have been surveyed, however, for long distances to the southwest and northeast, with the idea that extensions of the range would be included in them beneath the old lake deposits; so that the row of locations in about six miles long. To the west of the properties taken up for iron are two old locations, 243 T and 244 T, which it is said, were surveyed on account of deposits of copper.

As the Iron formation was the chief object of our work, its outcrops will be described first in some detail, while the locations in which none was found will be taken up more briefly.

A L 408 to 404

Going northeast along the line of locations the Iron formation is first met at the western boundary of A L 408, where it rises out of a gravel plain 65 paces north of the southwest corner post of A L 407, the next location to the northeast. Here the banded silica and magnetite are narrow so far as exposed, but may continue beneath the gravel plain. The Iron formation stands nearly vertical against the foot of a steep cliff of greenstone, which runs as a precipitous ridge northeastwards through A L 407. In places the banded silica seems to dip under the greenstone cliff, and as one advances along a rough trail cut out so as to follow its outcrop, it widens to about 30 feet.

This relation of high and rugged hills of greenstone or gabbro to the northwest and Iron formation resting against the steep southeastern flank, while old lake deposits hide the foot of the cliff, continues through the southeastern end of A L 406. Near the northwest corner of this location the highest hill along the range rises to 1,117 feet above the sea, or 265 feet above the river and lake Nipigon.

In A L 406 near the river bank some stripping has been done, showing about 30 feet of banded Iron formation running down to the water's edge, and a little to the east a diamond drill hole has been sunk, but I have no information as to the results. The silica here is partly in the form of jasper, and a finely banded rock with red, gray, green and white layers replaces the usual white or gray and black. At this point the strike is nearly north and south and the dip 35° or 40° to the west, showing a rather sharp bend from the usual northeast and southwest direction.

In A L 405 the Iron formation is almost entirely hidden by drift, and only shows on the eastern edge, at a point 90 paces north of the southwest corner of the next claim, A L 404. Very little of the range is exposed on the western half of this location, but a considerable amount is found on the eastern side. At a small waterfall it has a dip of 35° to the northwest, beneath the greenstone which rises to the north. Near the boundary of A L 403 the banded formation widens out and includes a little bright red jasper, the dip being 45° to the northwest, under greenstone which no longer rises much above the general level.

A L 403

A L 403 the broadest outcrops of the Iron formation on the Northern range occur, about the middle of the northern side of the location, the width being 80 paces, though

Near mouth of Sturgeon river.

some greenish slate is mixed with the banded silica and iron ore. Most of the ore looks black and affects the compass, but when pounded shows a reddish powder, indicating a mixture of magnetite and hematite. The banded rock strikes a little east of north, and has a dip of 45° to 80° to the north, with greenstone and green schist beyond. In one section, about 150 paces west of the east side of the location a band of conglomerate occurs, so placed as to suggest a synclinal fold with Iron formation on each side and conglomerate in the middle, but moss and drift cover much of the section, and Iron formation was not found to the north, so that the relationships are not very certain

For about a quarter of a mile south the surface is covered with old lake deposits, but on the shore of Sturgeon river fine grained greenstone crops out forming the rapids at that point.

Passing into A L 402 from the northeast corner of A L 403 the band of Iron formation changes its direction to northeast, with a dip of 45° to 60° northwest, greenstone and green schist rising above it. Beyond this the banded silica was lost under drift. Lower Huronian conglomerate is found a little to the east rising as the short steep ridge described on a former page.

In A L 417, the next location to the northeast, no banded rock was found, but some very rusty bands in green schist rising near the northwest corner are possibly a continuation of the range. To the north is the usual hill of greenstone; while to the south and east only drift plains were found. In A L 425 and the northwestern part of A L 418 the only rocks observed are greenstone and green, or rarely gray, schist, having a strike of 75° or 80° and a nearly vertical dip. At the northeastern corner of A L 418 and the southern parts of A L 419 and 420 a large hill of conglomerate occurs, mentioned before under the head of the Lower Huronian. Half a mile southeast of the conglomerate hill on A L 418, 419 and 420, at the falls, there is green schist, striking about 60° and dipping 45° to the northwest. Greenstone rises above the falls.

The only rocks observed on the other locations to the northeast are greenstone and green schist; but A L 422 and A L 423 are almost completely covered with sand plains and swamp. Whether the Iron formation extends out through them is quite conjectural.

Southwestward from the end of the range in A L 408 the conditions are similar, drift of various kinds covering the southeast sides of the locations and hills of greenstone rising toward the northwest; but in the greenstone paler and coarser grained eruptives occur; much better preserved than the bulk of the rock, perhaps because later in age. Examples of these coarser eruptives were found in several locations, and a very acid type with much quartz occurs a quarter of a mile north of the northwest corner of A L 408 and of A L 409. No evidence of the iron range was found, though the rocks rising as hills to the northwest of the drift plain are very like those under which the Iron formation dips in the locations described before from the centre of the range.

244 T and 243 T

Two large locations taken up so many years ago that the blazes on the lines are now very hard to follow, 244 T and 243 T, were briefly examined, without finding the Iron formation or any other deposit of importance; though it is said that they were taken up for copper. A very little iron and copper pyrites was found disseminated in a mass of diorite, but nothing that could be called an ore body. The only rocks observed were fine grained greenstone, irregularly mixed with coarser diorite, and a curious breccia, probably of volcanic origin, showing on the lake shore to the north and along the northern side of the mouth of Sturgeon river. It is probable that this rock is really much more extensive in its distribution, but it is hard to recognize except on wave cleaned shores, and might easily be overlooked on mossy surfaces inland. The best exposure is along the shore from the mouth of the Sturgeon river to the northward bend of the promontory beyond the bay.

At least four kinds of rocks occur as fragments in the breccia, a whitish green felsite, a dark very fine grained greenstone, a fine grained rock speckled with white and green, and green schist, all apparently eruptive in origin, and of angular forms not at all waterworn. The matrix consists of smaller angular fragments of the same materials. It is possible that the rock is a boulder clay, since the fragments are of all sizes up to two or three feet in diameter; but usually the boulders from till have their corners rounded, leaving them subangular. No pebbles or boulders of granite or the Iron formation were noticed. On the whole the breccia is more probably volcanic than glacial in origin.

A dike of felsite or quartz porphyry in a badly weathered condition cuts the greenstone north of the old Hudson Bay post near the mouth of the river, the only example of the kind found in the region. It has a width of ten feet and runs about 60°, the usual direction of the strike of all the rocks showing any marked cleavage.

Rocks between Northern and Central Ranges

The Northern iron range with its associated schists, greenstones and conglomerate lies entirely north of Sturgeon river, and no rock shows to the south, except small outcrops of green schist and basic eruptive at the first rapids, south of A L 403, and the falls, south of A L 420. Southeast of the river there is a band of drift materials, chiefly lake terraces of sand and silt, extending for half a mile or a mile, with no outcrops of solid rock. Beyond this to the southeast there is a band of greenstone and green

Mouth of Sturgeon river, Lake Nipigon.

schist averaging a mile wide before the Central iron range is reached. This barren region was crossed twice on lines running south from the rapids and from a bend of the river near A L 407. The last line was cut out some years before, apparently as a tie line to connect the two series of location surveys. These two lines and the section exposed along the shore of the bay between the mouth of Sturgeon river and Poplar Lodge have provided the information embodied in the map.[6]

Going south from the mouth of the river for the first mile only sandy shore with low cliffs of sand and silt are encountered; then the shore becomes rocky and greatly indented with tiny bays and inlets, while rocky islands give good exposures of similar rocks.

[6] As Dr. Coleman is to continue the exploration of the Nipigon iron ranges during the season of 1907, it has been thought advisable to postpone publication of the geological map until the work has been more nearly completed. —T.W.G.

In the southern part of this section different phases of greenstone are found, some showing little structure, others with pillow forms, and a small amount of amygdaloids, evidently ancient lava. Along with these massive varieties there are breccias like those described from the mouth of the Sturgeon river.

On the line run from A L 407 rock is not well exposed, though ridges rise through the muskegs and sand plains toward the south. The rocks observed are all green schist and carbonate schist, having the usual strike and a nearly vertical dip.

On a compass line run south of the first rapids on Sturgeon river, similar conditions were encountered, two little lakes interrupting the line across the sand plains. In the southern part much more rock is displayed, beginning as gray green schist having a strike of 60° and vertical dip, a little south of Dragon-fly lake, as we named the first body of water. Then comes swamp and a greenstone hill, followed by vertical green schist striking 50°. Around the second lake the rocks are greenstone and green schist, also; but a schistose carbonate comes in later, and then greenstone with small scattered amygdules reaching to the north shore of lake Eva.

The schistose rocks extend round the east end of lake Eva to the point where Sand creek enters it; and rise as hills also near the outlet of the lake, but much of the area to the south is swampy or drift-covered, except for low outcrops near the central iron range. East of lake Eva so far as known green schist is prevalent with comparatively small areas covered with old lake deposits, and this continues along the north shore of Standing Stone lake; but how far it extends to the north was not determined.

Still farther to the east a wide band of diabase, probably Keweenawan, separates the Keewatin containing the iron ranges near the shore of lake Nipigon from that near Windegokon lake. Lack of time prevented us from running lines to fix the boundaries of the diabase, which lies away from canoe routes or trails of any description.

No bands of the Iron formation reach so far east as the diabase and Mr. Moore has found that they run out in the green schist on the Wendigokan side also; so that the diabase cannot be said to cut across the iron ranges.

The Central Iron Range

The Central iron range is first seen on location A L 414, about three miles inland from Poplar Lodge by the road cut out to take in a diamond drill, sand plains covering the solid rock before this. Soon after the road crosses the northern boundary of the location a little banded hematite with red jasper is seen, with conglomerate to the southeast. South of this lean slaty ore occurs as a thin band, followed by lean hematite with silica, the whole striking 70° to 75° with a nearly vertical dip. A few paces south there is another band of lean slaty ore about ten feet wide with a parallel band of conglomerate 20 feet wide beside it, and another still thinner strip of lean ore to the south. The banded silica can be followed for 200 paces from its first outcrop above a swamp to its northeast end, where it is cut off by an irregular dike of gabbro. The strips of Iron formation just mentioned are valueless as ore, but interesting as illustrating a synclinal arrangement on a small scale with the overlying conglomerate nipped in between.

A hundred paces to the southeast near the dike of gabbro mentioned before banded silica and hematite crops out once more, evidently bent out of its course and cut in two by the eruptive. Some of the hematite shown by a stripping close to the gabbro is heavy, black and lustrous, evidently an excellent hard ore, but occurring only in bands a few inches or a foot thick.

Still farther south one finds green and gray schist and another band of conglomerate, all having a strike of nearly east and west. A quarter of a mile south of the north line of the location there is a third band of conglomerate, succeeded by a few paces of greenstone, and then swamp.

Evidently there has been sharp folding, repeating the conglomerate and the band of Iron formation several times. Afterwards these rocks and their accompanying green and gray schists were greatly disturbed by the eruption of gabbro. The small amount of fair ore seems due to the action of the gabbro.

This area of rock rises as a low island out of a great expanse of sand plain and swamp.

Locations A L 413 and 416

The most extensive outcrops of Iron formation in the region are in A L 413 and A L 416, where a considerable amount of stripping and diamond drilling has been done and a camp has been made including several good log buildings. Here also the rock really forms low islands in the drift and swamp, and it is hard to say how widely the formation is distributed beneath its covering, since in several places stripping away the moss shows banded jasper running under the swamp.

Crumpled Iron Formation, 2 miles east of Poplar Lodge.

All the known outcrops were carefully examined and mapped on a large scale as the most promising in the region.

The Iron formation in this range is non-magnetic, showing the absence of magnetite, and our work could be done with the ordinary compass instead of the dial compass needed on the northern and southern ranges. In general the formation consists of interbanded dark blue or black hematite with a brilliant lustre, and bright red jasper. As these have often been crumpled in the most extraordinary way and then shattered and seamed with narrow veins of white quartz, the rock as exposed on glaciated ridges is exceedingly showy. In general however it is hard to get more than a few inches of fairly solid hematite free from jasper.

The crumpled Iron formation does not occur in wide and long bands, but is found in strips a few feet wide with gray schist between, the latter containing some crystals of siderite. The schist runs in the main parallel to the banded jasper, but sometimes cuts across it. The strike is about 70° and the dip 80° to the north.

From the intricate relationships of schist and jasper they appear to have been squeezed and folded at the same time and to have been plastic when acted upon, since the jasper is usually sharply bent with no hint of fracture or brecciation. The compressive force acted probably for a long time, since the narrow quartz veins crossing the other rocks are thrown into complex crumplings also.

The Iron formation shows near the camp in four outcrops separated by swamp and drift, but probably stripping would show them to be connected in reality. Beginning at the north an outcrop 800 feet long and 150 feet broad is found at the southwest corner of A L 413, and a narrow strip occurs on the southern boundary just south of the main body. The general strike is about 65° with many local bends and crumplings.

Two hundred feet to the south of the large area just mentioned is a smaller band 300 feet long by 40 broad, in the northwest corner of A L 416, having a strike of about 75°.

About 100 feet farther south is the fourth area, 450 by 300 feet in dimensions, the banding having about the same strike.

In the Northern and middle areas the banded jasper makes up not much more than a third of the whole, but the rock is too poorly exposed to give definite amounts. In the southern area several sections are pretty well disclosed by stripping across the strike. In one of the most complete the jasper and schist were measured up for a breadth of 126 feet, showing eleven bands of jasper and as many of schist. At the north end there were eleven feet of jasper and lean ore followed by two feet of schist, one and a half feet of jasper, etc., the total width of jasper and lean ore being 79 feet out of 126 feet. In the next stripping there were six bands of jasper running in width from 10 feet to 30½ feet, 113 feet in all, in a total width of 175 feet, so that the banded jasper and lean ore made about two-thirds of the whole. Probably the sideritic gray schist should also be reckoned to the Iron formation, though it is not very high in iron.

The greatest width measured across the strike is 700 feet, the greatest length something over 800 feet; but there is good reason to believe that the formation continues to the east and west beneath the swamp, and probably has a greater width than that measured. The strike varies from 60° to 80° and the dip is always steep. It is possible that there has been reduplication by close folding, but no direct evidence of this was found.

About 500 feet southeast from the southern outcrop described above, rock begins to rise above the swamp, and outcrops are frequent over most of the eastern half of A L 416, gray schist being the most common, though banded jasper occurs on almost every outcrop in greater or less amount. Some slate and green schist are found also. The usual strike is from 80° to 90°, *i.e.* about east and west, and the dip is vertical.

The jasper was traced for a third of a mile eastward into H F 1, where the drift cuts it off, and no further outcrops were found to the east. A small patch of jasper was found in the southwest corner of A L 416, completely surrounded by swamp.

The Iron formation near the camp has been found from point to point for five-eighths of a mile, with a total width of a little more than a quarter of a mile; and it may be supposed to be still more extensive, since it sinks everywhere under swamp and drift. It is, however, almost always greatly mixed with schist, in most cases forming less than half the total area of the outcrops, the largest proportion of banded jasper and ore occurring near the camp. The thickest seams of ore observed occur in the eastern part of A L 416, where some finely banded strips of brownish red hematite have a thickness of a foot or two. While the ore is nearly pure hematite in a few places, in others it grades into slaty material with only a little of the sesquioxide, and it is not always easy to determine the line of demarcation; since black slaty bands looking like ore seem to replace it. In general the Iron formation grows leaner and more slaty toward the east until lost about 200 yards east of the boundary between A L 416 and H F 1.

Location A L 412

The only other large area of Iron formation observed in the central range crosses the line between A L 413 and A L 412 near the northern end of the two locations, separated by a third of a mile of swamp and sand plain from the areas to the south and southwest near the camp. A stripping shows a similar mixture of banded jasper and ore with gray schist. In 299 feet the section from north to south presented 1 foot of lean ore, 37 feet of gray schist, 84½ feet of drift, 29½ feet of lean ore mixed with schist, 30 feet of gray schist, ½ foot of ore, 67½ feet of gray schist with some streaks of ore, 15 feet of lean ore and jasper, 35 feet of drift, 5 feet of lean ore and schist, and 14 feet of schist with a little ore, running under drift to the south. This section represents about the average.

At some points slate occurs rather closely imitating the lean ore, the two seeming to pass into one another. The rocks strike from 80° to east and west, and have steep dips, often vertical. In one place the original sedimentation planes, as indicated by lighter and darker bands have a strike of 110°, while the strike of the schistose cleavage is 85°; but this is quite local, and generally the two structures seem to coincide.

To the north of the Iron formation there is a narrow band of drift, followed by a hill of hard green schist and greenstone. To the south is drift with a few outcrops of gray schist; but at one point a little west of the boundary between the two locations conglomerate was found, running under the drift.

This area of iron formation is probably a continuation of the area described from the north end of A L 414 to the west, from which it is separated by about three-quarters of a mile of sand plain and swamp. The strike of the banding points in that direction, and the finding of conglomerate to the south is a point of resemblance. Ore has been found here over a length of 1,200 feet from northeast to southwest, with a width of 600 feet, but except in the southern part, represented in the section given, the jasper and ore are very thinly scattered.

Location H F 5

The last known outcrop toward the east of the Iron formation in the Central range is found in the north half of H F 5, a mile and a half nearly due east of the area described above, sand plains and the valley of Sand creek intervening. The first ore is seen about 400 paces east of the boundary between H F 4 and H F 5. There is the usual association of banded jasper and hematite with slate and gray schist, but the relative amount of ore is less than in the other areas. Part of the material is bright red, but most of it is dull and slaty in character. The widest band of iron-bearing rock is about ten feet across, but there are several much narrower ones in the gray schist. The strike of the schistosity is from 60° to 70°, and in one place an appearance of bedding had a direction of 80° as compared with 60° for the cleavage. To the north a ridge of hard green schist with some greenstone puts an end to the formation and encloses a small band of conglomerate; while to the south swamp and drift cover the solid formations.

A small patch of red jasper and ore was found to the east, not far from the eastern boundary of the location, but this could not be traced for more than a few feet east and west on a hill of greenstone and green schist.

The outcrops of Iron formation extend from east to west about 1,000 feet, and from north to south about 100 feet, but they are sparsely scattered in the general schist and give little hint of ore bodies of any importance.

This small strip of Iron formation is certainly not continuous with the areas described to the west and southwest; for green schist devoid of jasper or ore extends for nearly a quarter of a mile westwards before the solid rock is covered with drift. It may be that these separate areas of Iron formation are really the lowest parts of canoe shaped synclines, the upper parts and the connecting links between the areas having been eroded away.

Summing up matters for the Central range, outcrops of jasper and rich or lean hematite have been found in six areas of considerable magnitude, scattered through a plain largely covered by sand and peat bog. From east to west they extend three miles with an average strike of 70° or 80°; while from north to south, in A L 413 and A L 416, there is a greatest width of five-eighths of a mile, over 3,000 feet. Whether some of these different areas are really connected beneath the swamp and sand plains is uncertain, but fairly probable. While the width of the formation is unusually great, the banded ore and jasper is generally much interrupted by interbedded gray schist, which often contains a good deal of siderite, but must be looked on as greatly diminishing the total amount of iron in the formation available for concentration in secondary ore bodies. In the close interbedding of schist with the banded silica and iron ore, this iron range presents a feature seldom found in other iron ranges of the lake Superior region, a feature which cannot be considered promising; but taking into account

Landing, Split Rock Portage, Nipigon river.

the great width of the range, three times the width of the Helen Iron formation, for example, there should still be abundance of iron available for the production of secondary ore bodies. Up to the present, however, no large bodies of such ores have been found.

The Southern Range

The Southern iron range comes within two-thirds of a mile of the Central range near the camp, but is separated from it by steep ridges or hills of greenstone and green schist, and usually also by sand plains or swamps. The Southern range may be reached by a trail from the head of canoe navigation on Sand creek, by following survey lines south of the camp on the Central range, or from the south shore of Stone Standing lake.

Beginning at the southwest end of the range, the Iron formation is first seen on location 830 X towards the northeast corner. Two other locations have been taken up farther west, B T O 3 and B T O 4, but only coarse gabbro or diabase and muskeg were found on them. About the middle of 830 X the iron range is cut off rather suddenly by a gray rock thought to be gabbro in the field, but proving to be olivine diabase, with rather imperfect ophitic structure, when examined with the microscope. The diabase, probably Keeweenawan in age, is fresh and distinctly later than the rock to the northeast, since it grows finer grained at the contact.

The Iron formation of the Southern range resembles that of the Northern rather than the Central range, containing enough magnetite to make the compass useless. With the black magnetite there is also some hematite, shown by the reddish black color of the powdered material, and a little dull red jasper. In 830 X the band is comparatively narrow, and slaty gray schist lies to the north and south.

826 X and 827 X

In the next location to the northeast, 826 X, it widens out and is much better exposed on a high rocky ridge running through the northern part of the claim, but it is partly covered by swamp and drift on the south. Beyond the drift green schist is found. The greatest width of iron range near the middle of the location is 550 feet, but the southern end, where not drift-covered, contains much less ore than the northern part. Other sections have a width of about 250 feet, about half of which is slate and interbedded schist, but much of the banded material is not very heavy and should be called hematitic or magnetitic slate rather than ore. On one section there is a small fault with a horizontal throw of ten feet.

The north edge of the Iron formation for a few feet against the schist appears to contain no hematite, only magnetite and slaty material, while the bands to the south contain mainly hematite with a few seams of jasper.

On 827 X a good deal of stripping and sinking of test pits has been done, disclosing a smaller width of banded material, but some fairly heavy ore of a blue black color, mostly hematite. Green schist forms the wall rock in some of the pits.

Less than half way across the location a fault plane cuts diagonally across the range, and is followed by drift, but the banded Iron formation reappears on a hill at the east side, though narrower and with more gray schist interposed between the bands. The strike of both Iron formation and schist at this end of the range is about 85° with a nearly vertical dip. The arrangement is probably synclinal, though this was not certainly proved.

In 828 X drift occupies the centre of the location and iron ore is first met with on a hill at the northeast corner, where magnetite occurs with green schist, having a strike of about 60°.

A band of ore at this point is nearly solid magnetite, for a few feet, but this can be traced for only a short distance along the strike.

In 829 X, after a stretch of drift, lean magnetite with green and gray schist occurs near the northern boundary 200 paces east of 828 X. One hundred and fifty paces farther east the band of magnetitic slate crosses the northern boundary and is lost under drift and a tangle of vegetation. On the western boundary of A L 385, about 100 paces north of the northeast corner of 829 X, magnetite and some hematite and jasper are found in green and gray schist, and a little is found 100 paces to the northeast; but beyond this the whole north end of the location is drift-covered.

On the north shore of a small lake at the southeast corner of this location an outcrop of slaty magnetite three feet wide is found, but can not be traced for more than a few feet. The rest of the north shore consists of a steep hill of gray schist and slate.

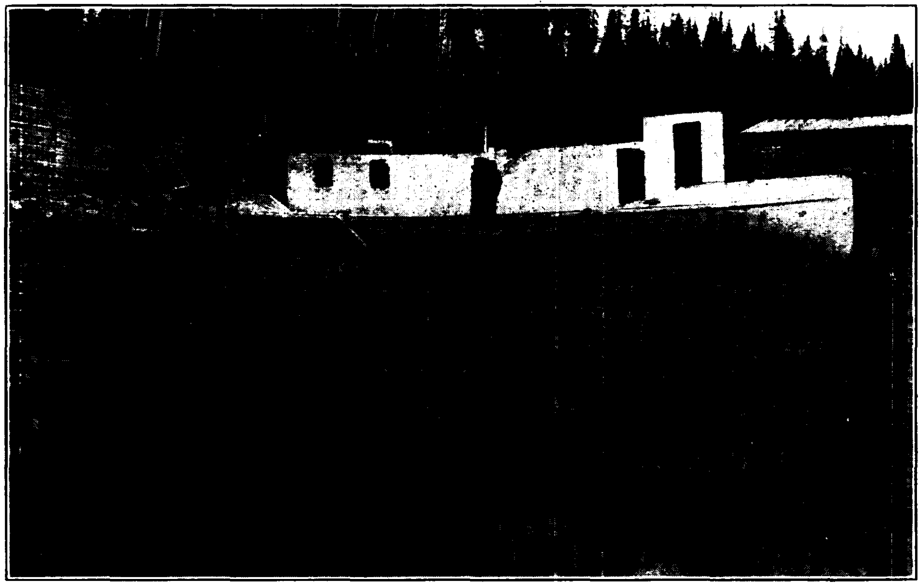
In all this part of the range the ore is very narrow and slaty, showing much less promise than in 826 X and 827 X, and its strike has somewhat changed, averaging about 70°.

A L 384 to 398

In A L 384, a little north of the corner of A L 385, the Iron formation was found again, and traced for a quarter of a mile to the east as a lean banded ore with slate and a little jasper. A litle farther east a small outcrop of conglomerate was found with gray schist on each side. Beyond only drift and swamp is encountered in A L 386, and in A L 387 only drift and green schist, though compass disturbances toward the east side suggest drift-covered magnetite. In A L 388 near the northwest corner a low outcrop of gray schist contains a strip of banded jasper and magnetite 12 feet wide, but boulder clay covers most of the rest of the location, and the same is true of A L 389.

Near the southwest corner of A L 390 some small outcrops of lean Iron formation occur in gray schist, but are lost under drift to the northeast.

No jasper or hematite was found on this part of the range, but only slaty magnetite in thin bands in the wide spread gray schist.



Steamer under construction, South Bay, Lake Nipigon.

In A L 391 the Iron formation is found toward the eastern side running in the direction 60°, mostly as lean and slaty ore, but including some heavy magnetite. The width is about 20 feet at the west end, including strips of green chloritic schist between the bands. The dip is 80° or 85° to the south. Near the southwest corner of A L 392 there is a band of very slaty Iron formation which does not continue the strike of the outcrop just mentioned. Beyond this only schist and drift are seen until A L 394 is reached, where a band of rather lean slaty Iron formation 50 to 75 feet wide occurs near the middle on the north side. In the next location to the northeast only drift, swamp and green or gray schist were observed, and in A L 396 also no Iron formation was found. A small outcrop of gabbro or coarse diabase occurs near the southwest corner of this location and another small ridge of the same rock on the northwest corner. They penetrate gray schist like that associated with the Iron formation, but apparently without ore. A little slaty magnetite is found however a short distance to the north of the location.

In A L 398 this band is continued as slaty ore showing from point to point in small amounts across the north end of the location in association with gray schist. Except on its western boundary no Iron formation was found in A L 397; but with a jog of about one-fifth of a mile to the north, suggesting a fault, the Iron formation shows itself near the middle of W B 7 where banded ore with a strike of 75° or 80° is found just north of a little creek.

A L 399 and 400

The Iron formation is much more extensively displayed in the next two locations, A L 399 and A L 400, along the south bank of the same marshy creek, having a width of 150 feet or more along some sections, and containing some heavy, good-looking ore with bands of jasper. Gray schist, the associated rock, is more or less interbedded with the richer ore, and increases in amount toward the south on a hill side, until at last only a few slaty bands with little oxide of iron remain. These are the most promising locations of the east end of the range, but are surpassed by two or three at the west end.

The last location to the east, A L 401, shows only drift except for a fringe of gray schist on the north side, and sand plains extend for some distance farther east. South of the location gray schist appears.

Beyond the drift plain to the east a wide belt of gabbro or diabase intervenes before the Iron formation appears again near Windigokan lake.

The Southern range is 7¼ miles long, very straight and with few interruptions, except where swamp and drift hide the rock. It has been traced for twice the length of the Central range, but is not nearly so wide. Like the smaller Northern range, it contains a good deal of magnetite as well as hematite and some jasper, while the Central range is entirely free from magnetite. The difference may have been produced by somewhat more energetic folding and metamorphism of the Northern and Southern ranges, driving off a small part of the oxygen from the hematite.

It is probable that the Northern and Southern ranges are each a narrow syncline enclosed in the gray and green schists of the Keewatin; while the Central range may represent a number of parallel close folds, less vigorously compressed in the mountain building process.

The total area of Iron formation in the three ranges is large, but the interbedding of barren slate and gray and green schist greatly cuts down the amount of iron contained by them. Nevertheless, there has been plenty of the metal to form ore bodies by downward concentration in several parts of the field, the most promising localities being those near the camp in the Central range, and the west and east ends of the Southern range.

If the assumption is correct that the ranges consist of the lower parts of greatly denuded canoe-shaped synclines, the green schists enclosing them should afford fairly impervious basins. In only one case, A L 414, was the Iron formation discovered to be interrupted by a dike, giving a possibility of a basin cut off from some pitching syncline; and here there is a small amount of good ore.

The wide spread muskegs and sand plains make it difficult to work out the structural relations completely enough to give definite ideas as to the attitude of the basins enclosing the Iron formation.

Character and Relationships of the Ore

While the Iron formation is widely and thinly diffused in many cases, and intermixed with much slate and schist, there are a few places where seams of a few inches or a foot or two of ore occur, suggesting secondary concentration on a small scale. Generally even these richer parts show a small amount of interbanded silica, often in the shape of jasper; but when broken so as to expose the shiny surfaces of blue hematite the ore looks very attractive. Assays show however that even at these points the percentage of iron is low, though there is very little in the way of injurious impurities, minerals suggesting sulphur and phosphorus being largely absent, and titanic minerals entirely so.

The region was visited in 1900 by Mr. J. Watson Bain, who collected a number of samples from the Southern range, afterwards assayed with the following results:

	1.	2.	3.	4.	5.
Metallic Iron	38.06	30.06	37.19	37.79	34.02
Silica	40.60				
Sulphur	traces.				
Phosphorus	traces.				
Titanium	none.				

No. 1 was the best sample; No. 2 represents an average sample of the formation for a width of 82 feet; and No. 3 an average of 54 feet, excluding the leaner part of the outcrop. No. 4 was taken in the same way, but 100 feet west, and No. 5 from 300 feet east, all apparently being from location 826 X.[7]

A specimen of magnetite and hematite mixed, the richest looking ore obtained by myself from the Southern range, on location 826 X, yielded 45.27 per cent. of iron (soluble), and .52 per cent. of iron in the residue, when assayed at the Provincial Assay office in Belleville; and the best specimen from 827 X gave 34.20 per cent. of iron.

Three samples of ore taken by myself from the Central range gave similar results when assayed at Belleville:

	1	2	3
Hematite (iron soluble)	43.74	36.86	39.66
(iron in residue)	.45	.60	.35

Nos. 1 and 2 are from H F 5, and No. 3 from A L 414.

In a report on the region by Prof. Willmott, communicated by the kindness of Mr. Henry Weill of Buffalo, hard blue hematite from a lens on the surface is stated to have the following composition:

Iron	64.42
Silica	3.80
Phosphorus	.071
Manganese	.10

This was probably a carefully selected sample, since the average of the ore penetrated by drill holes is stated to be only 40 to 50 per cent.

Three drill holes were put down on the iron range, on locations A L 413 and A L 416, the latter being south of the former, one by Mr. Flaherty, and two by the Algoma Commercial Company, one of them under the direction of Prof. Willmott.

The first hole, on the north side of the formation, was sunk 628 feet at an angle of 45° to the south, equivalent to 440 feet across the formation. "It passed through a number of bands of lean ore varying from two to sixteen feet in thickness and from 40 to 50 per cent. in iron. A second hole, which was really put down first, started directly over the bottom of the first and was bored for 542 feet at an angle of sixty degrees. This crossed 271 feet more of the formation. 'The core revealed continuous jasper with narrow bands of hematite, and at the bottom a passage into quartzite.' The portion reported as jasper contained a large amount of iron and the 'narrow bands of hematite' were nearly pure ore. A third hole crossed the balance of the formation with similar results."

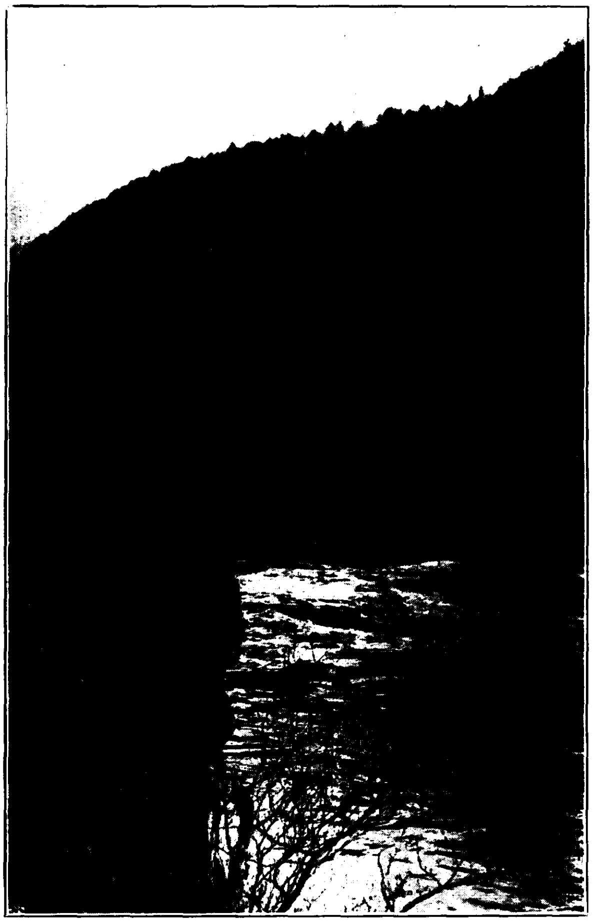
The above quotation from Prof. Willmott's report, kindly placed at my disposal by Mr. Leitch, gives a good general idea of the relations of ore and country rock on the two locations.

Adding up the amounts of ore recorded in the borehole of 628 feet there are in all about 36 feet on the dip of 45°, or about 25 feet measured horizontally. The other two

[7] Bur. Min., 1901, p. 213.

records show about 7 feet of ore each, which amount to 3½ and 5 feet respectively; so that the total width of ore shown in the section cut by the drill holes is about 33½ feet, the rest being mainly jasper and gray schist.

In general it may be said that in the aggregate there is a considerable amount of lean ore with comparatively small amounts of injurious impurities, but generally in narrow lenses separated by several feet of jasper and schist. It is of interest to note that ore was struck at a depth of 414 feet, showing that the formation is not shallow.



On Nipigon river.

Very little pyrite occurs in the banded silica or ore, but the intervening gray schist generally contains small crystals.

Thin sections or the ore show minutely crystalline silica disseminated through the magnetite of the Northern and Southern ranges and the hematite of the Central range. Where magnetite is the ore there is a possibility of magnetic concentration; but the feebler magnetism of the hematite would probably render it incapable of concentration by this method. In any case the particles of ore are small and would require fine pulverization and subsequent briquetting or agglutination to make it available for the blast furnace.

In some of the "blue" hematite ore there is a considerable amount of chlorite instead of finely granular silica mixed with the oxide of iron. This accounts probably for the iron in the insoluble residue reported in the assays given above.

As the Northern range seemed on the whole lower in grade than the others, no samples from it were sent for assay.

Petrography of the Keewatin

Much the larger part of the area near Poplar Lodge, not covered with drift, consists of greenstones and various green and gray schists belonging to the Keewatin. In some cases these rocks include pillow structures and amygdaloidal phases, and in others there are greenstone breccias connected with them, all, probably due to surface volcanic action. It may be that some of the chloritic schists and phyllites also are re-crystallized ash rocks, and therefore of volcanic origin. Many of the greenstones, however, show no traces of a volcanic source, and must be looked on as diabases or other basic rocks which have cooled at some depth below the surface; and mixed with them are some porphyrites and quartz diorites, perhaps of later age, which are almost certainly plutonic rocks. Much more time than we could spare for the purpose would be necessary to separate these rocks in the mapping, so they are all included in the same color.

Another type of rock, gray schist or carbonate schist, often associated with the iron ranges or parallel to them, has been separated where possible, but often these schists are so interbanded with the others that they could not be indicated on a map of the scale adopted. The gray and carbonate schists may be ordinary sediments or chemical sediments and not of eruptive origin, but this has not been established with certainty.

In taking up the petrography of the Keewatin the plutonic rocks, as being the best preserved, will be considered first, and the more highly metamorphosed greenstones and schists afterwards.

The exact relationship of the Keewatin schists to the Iron formation is not clear, since there are often gradations between the two rocks, and the banded silica and ore are often interbedded with gray schist or arkose or slate in very intricate ways, the contorted bands of Iron formation in the Central range being sometimes enclosed in gray schist as a matrix. This may be due to the deposit of varying materials as sediments, or to the close folding of small synclines and anticlines with the gray schist beneath, the whole being squeezed and bent, when the softer schist yielded more easily, adjusting itself to the twisted and often broken bands of the harder banded silica and jasper.

Older Eruptives—Partly Plutonic

The most acid variety of the plutonics occurs a quarter of a mile north of the line between A L 408 and 409, where it rises as rugged hills. The rock is coarse grained and pale gray, suggesting granite, and thin sections show a very large amount of quartz of granitic appearance; but the feldspars are more than half oligoclase. All the feldspars are greatly decomposed into turbid materials obscure in character, apparently kaolin, but with some epidote present also. The plagioclases tend to be idiomorphic. The darker silicates are green biotite and a little green hornblende, the two together making up perhaps a tenth of the rock. As there is very little magnetite, it is evident that the rock is of a highly acid type, grano-diorite or acid quartz-diorite.

Iron pyrites, copper pyrites and molybdenite are disseminated in small particles through this rock.

A quarter of a mile to the east, in A L 407, a distinctly granular rock of a grayer color is found mixed with the more obscure greenstones, and proves under the microscope to be quartz diorite, with less quartz than the rock described above, and with a large amount of the dark minerals, chiefly hornblende, but with some biotite. The feldspars are very turbid, but appear to be entirely plagioclase (mainly oligoclase) with a tendency to crystal form. In the thin section examined there is a good deal of titaniferous magnetite, partly changed to leucoxene, and a little pyrites.

A few small outcrops of porphyrite occur in connection with the Central iron range, one of which, from near the camp, may be described. The rock is dark green with a compact ground mass enclosing many small greenish white feldspars. Thin sections show the ground mass to consist almost entirely of chlorite, sometimes in radiating clusters of scales, with a little saussuritic material. The phenocrysts, often well formed, have the extinction angles of oligoclase or andesine, where not too much weathered to show the original twinning. Some of them have been broken and the parts shifted, narrow bands of chlorite filling the spaces between. A very few large anhedra of augite, fractured and with the parts somewhat separated, give the only other evidence as to the original composition of the rock. Very little magnetite occurs in the ground mass.

Camp on Nipigon river.

Besides the rocks mentioned above in which some of the minerals are still recognizable, there are large areas which one can only call greenstone, meaning thereby somewhat basic eruptives in which the ingredients have been completely rearranged, mainly into chlorite and fibrous hornblende with some quartz and saussurite representing plagioclase feldspars. They are unsatisfactory rocks to study, and will not be described at length.

They often include parts which have the forms of surface volcanics, pillow structure and scattered amygdules, filled with chalcedony or quartz or a rusty weathering carbonate.

In other places they pass into breccias made up of angular fragments of all sizes from tiny grains up to blocks two or three feet in diameter. The only specimen of these breccias studied in a thin section has the fragments completely replaced by aggregates of chlorite, fine grained silica, carbonates, etc. Some of the paler fragments appear to be microfelsite. In one such pale compact fragment there are numerous irregular patches of calcite with a rim of chlorite, not rounded like amygdules, however.

A thin section of a pale green amygdaloid consists mainly of small crowded feldspar laths streaming in varying directions as a result of flow. The laths are completely turned to saussuritic substances, and the spaces between consist now of chlorite and a grayish carbonate with some magnetite. An amygdule contains a fine mosaic of quartz in the centre with calcite, epidote and chlorite about it. The original lava was probably a basalt.

Schists

There is no sharp line of demarcation between the greenstones and the green schists, but the latter have a parallelism of the re-crystallized minerals which is lacking in the former. Many of the green schists show suggestions of fragmental structure in thin sections, and may have been volcanic ash or even water-formed arkose in the beginning. In most of them there are quartz grains, often with a radiating rim of chlorite scales, and much decayed feldspars, generally plagioclase, with chloritic substances and small amounts of carbonates between. In some sections the fragments have clearly been broken and shifted a little, as a result of squeezing and shearing such a rock as quartz diorite or quartz porphyrite.

Other specimens are probably slightly re-crystallized arkose, the fragments being due to the action of water rather than crushing in mountain building.

A puzzling group of gray or brownish schists is found interbedded with the Iron formation or occurring with the green schists. They often weather rusty, showing that they contain a considerable amount of iron; and seem in some cases to contain a good deal of siderite, so that they might almost be included as a phase of the Iron formation. In most cases, however, the carbonate appears to be ankerite, containing magnesia or lime as well as iron.

Thin sections vary in composition, some consisting mainly of very fine textured quartz and feldspar with sericite, having 20 per cent. or more of the ankerite crystals disseminated through the mass. They have the appearance of felsite schists enclosing crystals of some carbonate. Others contain fragments of quartz and plagioclase along with numerous patches of ankerite, suggesting an origin from a crushed porphyrite or else an arkose.

On the whole, the carbonate schists resemble phases of the Wawa tuff of the Michipicoten iron region, but seem to contain more iron and less silica.

Only three of the slates have been studied "in thin section," and they vary greatly, one having the character of a phyllite, consisting of minute anhedra of quartz, feldspar and chlorite, with many small knots of rutile and a very few slender tourmalines; the others containing no rutile but innumerable crystals of magnetite. The latter variety was taken from near the Iron formation, and might be considered a very lean variety of the banded silica, but for the presence of minute crystals of plagioclase.

True slate with clastic material not yet entirely re-crystallized was not found, the black slaty rock getting its color from magnetite.

The black carbonaceous slate with pyrite, so commonly associated with the Iron formation in other parts of Ontario, has not yet been found in the Nipigon region.

Later Eruptives—Probably Keweenawan

In a number of places small bosses or dikes of basic eruptives penetrate the Keewatin, not infrequently cutting off the Iron formation or penetrating it. These have generally the habit of diabase or gabbro, and probably represent the channel by which the Keweenawan lavas reached the sills of the Animikie or the surface as volcanics. The overlying rocks with which they were once connected have been destroyed, leaving only the stumps or necks now to be described. Only one small outcrop has been found in the Northern range; and only two samples were collected from the Central range; while most of the outcrops occur in the Southern iron range or the coast of lake Nipigon south of Poplar Lodge.

Of the specimens collected from the Central range, one comes from a dike cutting the schist and Iron formation in A L 414, having a length of 250 paces and a width of 40. It is gray with a greenish tinge and rather coarse grained. Thin sections show a little quartz, sometimes with a rude micropegmatitic structure, a rather small amount of andesine, and a very large amount of brownish augite, often somewhat idiomorphic and occasionally twinned parallel to the longest axis. The augite makes up nearly two-thirds of the rock, but is more or less re-arranged into hornblende and serpentine. Some large masses of magnetite and a little pyrite represent the earliest crystallizations of the magma. Though the rock contains a comparatively small amount of plagioclase, it may probably be called gabbro.

The other outcrop of eruptive is a small one near the east side of A L 416. The rock is fine grained and dark green with many small paler green phenocrysts. Thin sections show a greatly weathered groundmass now consisting chiefly of serpentine, in which are well shaped turbid crystals of plagioclase and a very few portions of augite. Whether the groundmass was originally of basic glass or of fine grained augite, etc., could not be determined; and the general habit of the rock is so different from the Keweenawan eruptives that it should perhaps be placed in a different and older class.

Basic eruptives occur at several points along the Southern range, and specimens were collected from three localities, which will be taken up in order from east to west.

The most easterly outcrops are on the north and south sides of A L 396, where small bosses of greenish gray eruptive rocks penetrate the usual Keewatin schist. At the northern outcrop the rock is porphyritic in part, enclosing greenish masses of plagioclase half an inch or more in diameter, the masses usually consisting of more than one individual. Thin sections show the matrix to consist of about equal parts of labradorite and augite. There are small amounts of secondary hornblende, magnetite, pyrites and micropegmatite, the latter lying between the somewhat lath-shaped feldspars. The feldspars are somewhat ophitic in form and in relationship to the augite, so that the rock stands between diabase and gabbro, with a porphyritic separation of the feldspar

The larger outcrop of gabbro on the southern boundary of A L 396 is more basic, and not porphyritic; but consists of the same minerals. Augite and secondary hornblende make up three-fourths of the thin section examined.

Eruptive Contact on 830 X

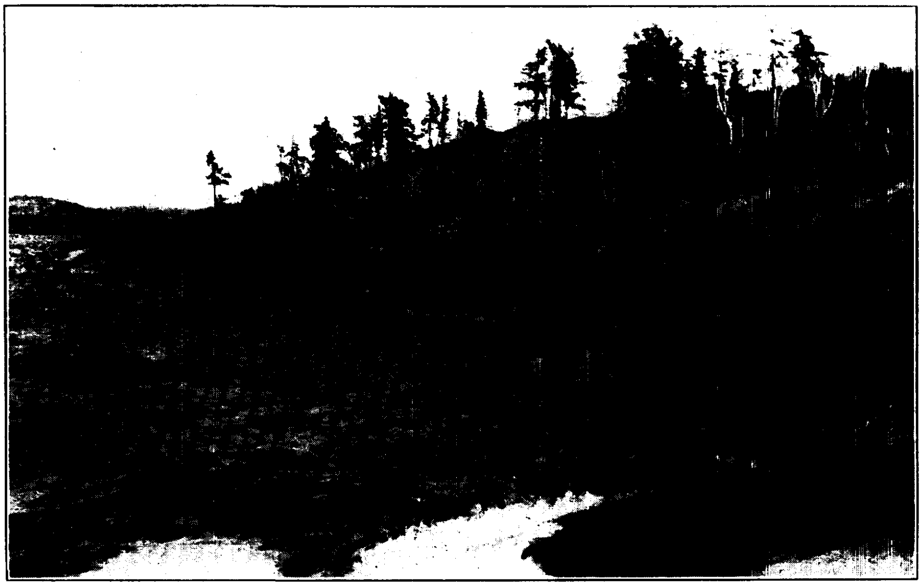
The eruptive which cuts off the Iron formation about the middle of 830 X, at the west end of the Southern range, probably extends under a swampy tract to a large area well seen in B T O 4, and may continue to the coast of lake Nipigon two or three miles south of Poplar Lodge. At its edge against the Keewatin schist and Iron range the rock is very fine grained, but becomes rapidly coarser as one advances westwards. The rock is ophitic, and consists chiefly of labradorite and augite in about equal amounts with a sprinkling of magnetite, and a little olivine. It has the usual characters of dikes and sills of the Keweenawan eruptive where it penetrates the Animikie.

The rock to the west was touched only on a promontory on the lake shore, where it looks like the diabase from 830 X, but is much coarser in grain. Thin sections show some differences, however; since there is a small amount of quartz present in the form of micropegmatite, and the shapes of the plagioclase crystals correspond rather to gabbro than to diabase. If it was not probably continuous with the rock described before, one would naturally describe it as gabbro, though some of the feldspars are platy and project into the augite masses.

As an addendum to the basic eruptives of the Southern iron range two other specimens may be described, one from Halfway point on the east shore of lake Nipigon halfway to its outlet into Nipigon river, the other at the rapids with which Nipigon river begins.

The first specimen was taken from an island off the point, where a cliff of rough, pitted, dark gray rock rises from the water. It is very coarse textured and differs in appearance from the usual diabases of the Keweenawan. Thin sections consist chiefly of augite and olivine, in about equal amounts, the latter partly turned to serpentine. A little plagioclase is wedged in between the augites, not more than a tenth; and there is much magnetite scattered through the sections. The only other mineral of importance is biotite of a red brown color, occurring in small quantities. The rock comes nearer to the picrites than the gabbros in composition; but may be a very basic phase of the Keweenawan olivine gabbro or diabase.

A somewhat similar rock from the portage past Virgin falls, at the second locality, shows more of the plagioclase, perhaps one-eighth of the whole, the rest consisting of



End of Flat Rock Portage, South Bay of Lake Nipigon.

augite, olivine, a little mica and magnetite with some decomposition products. This rock may be described as intermediate between picrite and a basic gabbro.

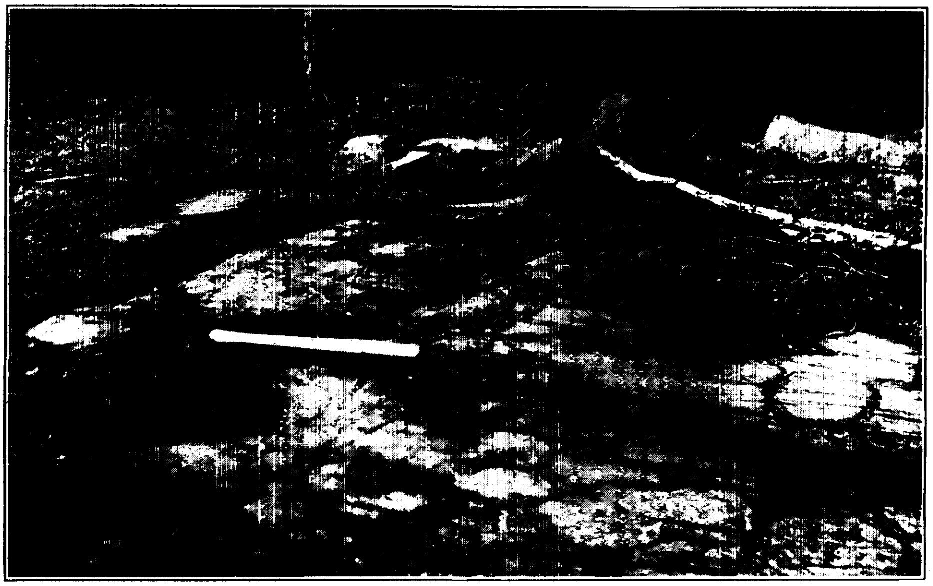
From the examination of the thin sections of diabase or gabbro mentioned on previous pages, it appears that the Keweenawan basic eruptives have quite a wide range in composition, from augite-olivine rocks with very little plagioclase to diabases with no olivine and a considerable amount of quartz in micropegmatite. The bases of the channels which supplied the usual olivine diabase of the Animikie sills seem to have undergone much more differentiation than the sills themselves, which appear to be pretty uniform in composition.

Rocks of Flat Rock Portage

On our way to the Poplar Lodge iron ranges we turned off from the usual route at lake Hannah to complete our outfit at the South bay of lake Nipigon. The previous route had been through Laurentian granite or gneiss, generally low-lying, or between steep walls of diabase resting upon the Laurentian. In many cases the thick flat-topped sheets of diabase rose as imposing cliffs in canyons of the river, but no time was taken to examine them in detail.

Being delayed by a storm on Flat Rock portage, between Hannah lake and South bay, there was an opportunity to study the diabase of the region. For three-fourths of a mile the path crosses a gently undulating or perfectly flat surface, evidently the top of one of the diabase sheets of the region, once probably covered by Animikie (or Nipigon) sediments, now completely removed from the much harder and more enduring sill of diabase, leaving its upper surface almost intact in many places.

The diabase surface, where not exfoliated, is very fine grained and broken into polygonal shapes a few inches or a foot or two across with a sunken margin half an inch wide. The appearance is that of the ends of columns which have shrunken a little apart leaving a narrow fissure to be filled later. The reddish filling of the marginal seam does not appear to go far down, and is probably only a part of the diabase attacked by percolating water at the fissure.



Columnar parting of diabase, Flat Rock portage, Lake Nipigon.

The surface of the freshest polygons was often covered with faint curved ridges always convex toward the northeast, probably a flow structure, showing that the molten diabase pushed northeastwards between the layers of Animikie.

Several very small dikes of fine grained granite have penetrated the diabase in various directions, in some cases having apparently followed the rims of the polygons mentioned above. The largest dike observed is a foot wide and is traceable for a considerable distance.

As the diabase sill is probably Keweenawan in age, the narrow granite dikes must be still later, Cambrian or Post-Cambrian; like the narrow granite dikes found in diabase dikes near Sudbury.[8]

Thin sections of the surface rock of the sill show a composition like basalt, with a large amount of former glass, now rearranged into turbid, vaguely polarising minerals, sometimes nearly opaque, at others more transparent, enclosing minute black cubes of magnetite. Embedded in this ground are many tiny laths of plagioclase, generally split or frayed at the ends, and a few larger phenocrysts of plagioclase and still fewer of augite. One well shaped crystal of olivine was seen. The rock might be called

[8] Bureau Mines, 1905, Part III., p. 124.

epi-basalt or perhaps more appropriately, to correspond with the coarser textured parts of these sills, fine grained diabase porphyrite.

The small granitic looking dikes penetrating the diabase contain much quartz, partly intergrown rudely with the feldspar as micropegmatite, some orthoclase, some microcline and much oligoclase, all badly weathered. The bisilicates are badly weathered also, but seem to be chiefly hornblende, perhaps augite originally, with a little biotite. Epidote occurs as a secondary mineral. The rock should perhaps be called quartz diorite, from the large quantity of plagioclase; but its pink color and the large amount of quartz present suggest granite.

Pleistocene Geology

About one-third of the area mapped is covered with Pleistocene deposits or peat bogs, the latter mainly in the lower levels. The Pleistocene consists especially of old lake formations, though occasionally boulder clay is found, and rarely rock surfaces were observed showing striations, having an unexpected direction, from 60° to 70° west of south, indicating a motion of the last ice sheet from the southern end of James bay. The best marked striae were on the Iron formation in the Central range and on greenstone along the shore north of Poplar Lodge. Boulder clay is found at several points near the foot of cut banks along the rivers, but elsewhere is generally buried under stratified materials.

Much the most important development of the Pleistocene consists of broad plains and terraces of old lake deposits, silt, sand, and gravel, laid down in a great northern bay of lake Warren.

On ascending from lake Superior to lake Nipigon, a rise of 250 feet, terraces occur at various levels up to 170 feet or more above the present lake level, or 1,020 feet above sea level. The following elevations were determined, partly by hand level, but mainly by aneroid:

	Feet above sea
Sand terrace, Poplar Lodge	860
Flat of silt and sand, south of mouth of Sturgeon river	882
Silt plains, near lake Nipigon	872 to 915
Sand plain, south of Sturgeon river, 2½ miles up	930-938
Rear of sand terrace, about four miles up Sturgeon river	947
Sand plain, above falls of Sturgeon river	1020

Small sections of the Pleistocene occur on Sand creek, where at one point a foot of peaty clay rises above the water, followed by 14 feet of stratified sand. Near by a cedar log projects from the bank half way down. On Sturgeon river thicker sections are found about three or four miles up, near the first rapid and the falls. One measured by the hand level showed 98 feet of silt followed by 14 feet of sand and gravel. The flat plain extending for a distance inland is undoubtedly an old lake level, and shows some low sand ridges perhaps due to wave work, or else of a duny character.

The great extent of these sand and silt plains formed a very serious difficulty in working out the distribution of the Iron ranges, and it was thought advisable to give the drift and peat bog a separate color rather than to connect up the formations in a problematic way beneath the wide spread mantle of superficial materials.

The hills of greenstone and other rocks rise often very steeply to the height of three or four hundred feet above the sand plains like long islands in the ancient lake.

The bay of lake Warren indicated by these terraces must have included a much larger area than the present lake Nipigon, and have pushed its shore more than 100 miles north of the old beaches recorded by Lawson, Taylor, the present writer and others from observations along the Canadian Pacific railway. This great bay must have been island filled, like Georgian bay of lake Huron, and covered about as large an area.

II.—IRON RANGES EAST OF LAKE NIPIGON

THE RANGES AROUND LAKE WINDEGOKAN

By E S MOORE

Introductory

Reports of extensive deposits of iron ore in the Nipigon region have been frequently circulated during the last few years. To learn of the extent and value of these deposits the Department of Mines began field work there in the summer of 1906, and the writer was instructed by Mr. T. W. Gibson, Deputy Minister of Mines, to act as assistant to Dr. A. P. Coleman in his work on the Iron ranges east of lake Nipigon. On reaching Nipigon village just as Dr. Coleman was leaving the field, the writer received directions from him to proceed to take Windegokan and report on the Iron ranges in the surrounding region.

Very efficient service was rendered during the season in the field, by Mr. T. L. Goldie, B.A., who had also been acting as one of Dr. Coleman's assistants, and who remained in the field until the close of the season.

Considerable prospecting had been done around lake Windegokan by the Algoma Commercial Company and others, and a map of the surveyed claims furnished by the Surveys branch of the Department was of great service in our work.

The accompanying map[1] will give the reader some idea of the geology and topography of the district. In obtaining the material for this map, we followed the plan of pacing all the lines, of making a few offsets into the larger claims, where there were no definite indications of iron range; and where there was any range of importance, of making offsets from the lines, at 150 paces from each other. Compass lines were run where necessary, and if magnetite were present the dial was substituted for the ordinary compass. As our time was limited, we only completed the exploration of the region as far east as the eastern boundary of mining location H F 38.

The writer would here express his appreciation of the kindness of Mr. P. A. Leitch of Nipigon, and others, for generously assisting us in our work.

Nipigon Village to Lake Windegokan

We left Nipigon village on July 4th, and proceeding up the river camped on lake Nipigon the following evening. It is not surprising that the Nipigon river is a favorite stream with anglers and tourists, who visit its banks in large numbers during the fishing season. The water is so clear that splendid speckled trout may be seen lying at the head of the rapids, and the stream is in many places lined with high vertical cliffs of columnar diabase, which make its scenery very attractive to the traveller.

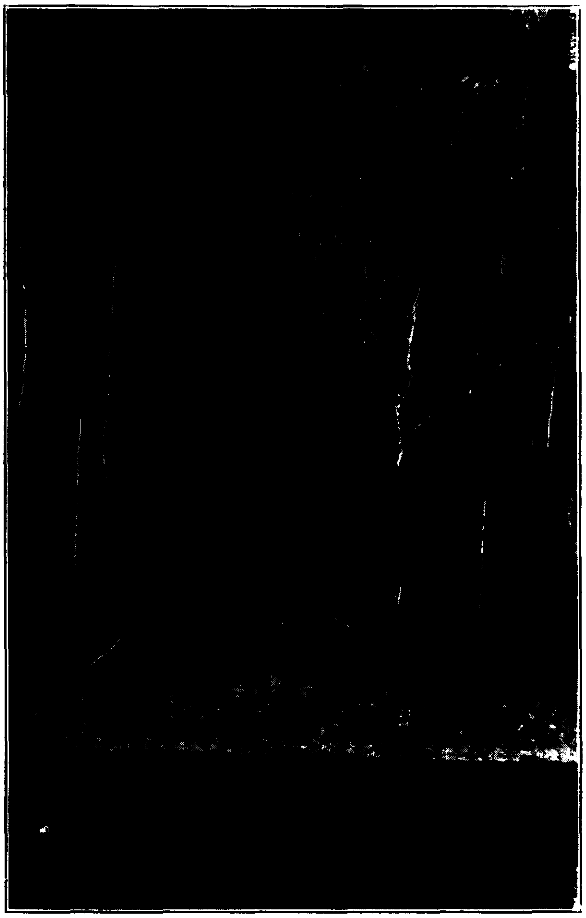
On account of the treacherous nature of lake Nipigon when any wind is blowing, we were held up on its shores for nearly a day by rough water, and then experienced great difficulty in crossing the long bay at the southeast corner of the lake. We next camped at some old shacks about two miles up the Sturgeon river, and after completing a little work there, proceeded up the stream to the foot of the long rapids.

The river is deep, dark and wide below the rapids. At about 5 miles from its mouth there is a short rough rapid with a fall of about nine feet, and at a mile and a half farther up, occur the falls of two leaps, making a total drop of about 39 feet. Nearly three miles from the falls, the long rapids begin, but between these two points there are two small rapids with a drop of not more than three or four feet each.

[1]See note on page 118.

The portage around the long rapids is about one and one-half miles long and lies in the route to Long lake. A barometer reading shows the rapids to have a total fall of 99 feet over very rough ledges of diabase.

In the diabase at the foot of these rapids there are some interesting pot-holes from one foot to 18 inches deep and about 6 inches in diameter. In each hole a rounded stone and some gravel was found, which had been used by the water as tools to grind out the cavities. One of the holes will not grow larger, because a stone had become so tightly wedged in it, that it could not be moved.



Cliff of diabase, Nipigon river.

All along the Sturgeon river the sand terraces rise to a good elevation above the stream, and on the portages around the long rapids and to lake Windegokan they may be found from ten feet to 125 feet above the foot of the rapids.

The portage of about two and a half or three miles in length, between the river and lake Corrigan, begins at the foot of the long rapids and runs nearly east, crossing sand plain and muskeg before it rises over a large flat area of diabase, and then descends to the lake. This lake is about one and a half miles long, and is nearly 150 feet higher than the foot of the rapids. A creek flows from near the western end of it to the Sturgeon river, but unfortunately it is too small to be used as a canoe route.

The portage between lake Corrigan and the next lake on the route, which is small and marshy, is about a mile long, pretty rough, and follows near the contact between the schist and conglomerate. From this little lake to lake Windegokan is about 250 yards, and the trail extends along a low area at the foot of a hill of conglomerate.

Topography of Windegokan Region

The map shows lake Windegokan to be about 3 miles in length and divided into two long arms. It is a very beautiful lake containing a number of islands and lying among high hills of schist and moraine. The portage between it and the little lake to the west crosses a water divide, because the water from it flows westward joining the Sturgeon river not far above the long rapids, while the creek leaving lake Windegokan at its northeastern extremity is there flowing northward. We did not explore this creek, so cannot say what course it takes to reach the Sturgeon, nor whether it could be successfully used for a canoe route, though the volume of water is sufficient for that purpose.

Clear creek enters lake Windegokan at the east end, and one is charmed by the splendid display of color in the plants of this stream. Its bottom is covered with clay, sand and gravel and one seldom sees such fine green mosses, algae and fresh water chara as are found there. The water is as clear as some of the springs flowing from our southern limestone hills, but the thirsty traveller is doomed to disappointment when he finds it quite warm. The stream is navigable for canoes at any time to Bear-skin lake, and at time of high water far beyond Clear lake, but it was impossible to use it when we were there because the water was so low on account of the scarcity of rain; the water in the Sturgeon river fell about 18 inches in five weeks.

In the neighbourhood of Clear lake there are morainic hills rising from 35 feet to a much higher elevation, and also low sand plains from 6 to 10 feet above the lake, while around lake Windegokan the sand plains rise from 15 to 30 feet above that lake. To the north of the latter green schist hills rise 125 feet and to the westward 175 feet above the lake, while to the south morainic hills reach an elevation of 80 to 240 feet. Much swamp and many small lakes lie to the west and south of Windegokan.

Watson or Rocky lake, as the latter name might indicate, lies in a rocky hollow surrounded by green schist hills, which on the north side reach an elevation of about 135 feet above the lake. This lake drains southwestward and probably by Sand creek. There is little difference in elevation between it and lakes Windegokan and Tallon.

The arm of lake Windegokan called Dead lake is marshy and slimy, over half of it having not more than six inches of clear water, and it is quite troublesome for canoe travel.

The country as a whole is not nearly so rough as most of the region along the north shore of lake Superior, and it seems to grow less rough towards the eastern end of the district explored.

The Plants and Animals

Only a few of these will be mentioned, and those which will be most likely to prove of interest. The timber is composed mostly of spruce, balsam, cedar, jack pine, white birch, poplar and tamarac. No red or white pine are seen here. The finest cedar was found south of Tallon lake, where some trees have a diameter of 30 inches. A few tamarac and spruce were noticed of similar size, but they were not very common.

The mosses are a great impediment to the geologist and prospector. A great deal of the surface of the ground is covered with moss to a depth of six inches, and it not only excludes the rocks from view but in dry weather causes endless anxiety when fires have to be kindled.

We were attracted by the vast numbers of early wild roses which make some parts of the country around Sturgeon river look almost like a southern flower garden.

It is more by its fish than by its plants that the Nipigon region is known. The river has long been famous for its speckled trout, which reach an unusually large size, and some of the inland lakes contain an abundance of pike, yellow pickerel, suckers and whitefish. Some sturgeon are found in the river of that name, and some bass farther south. If one chose to do so, he could kill pike with a paddle, in Clear creek. The voracious habits of these fish practised on the inoffensive and less aggressive suckers, prove of interest to one who observes them. The writer has seen a small sucker leap from the water to the beach to escape a fierce pike which was pursuing him, and while he was floundering on the shore the pike calmly waited near by to seize him should he return to the water.

A good many rabbits were seen, but few moose or red deer, and no caribou. The Indians say that the moose of this region are small of stature, and what the writer

Noon camp, east shore Lake Nipigon.

has seen of them would confirm the report. Some partridge, bears, wolves, and mink were in the region, but we saw no foxes, lynx or beaver, though they are reported to inhabit the district.

Classification of the Rocks

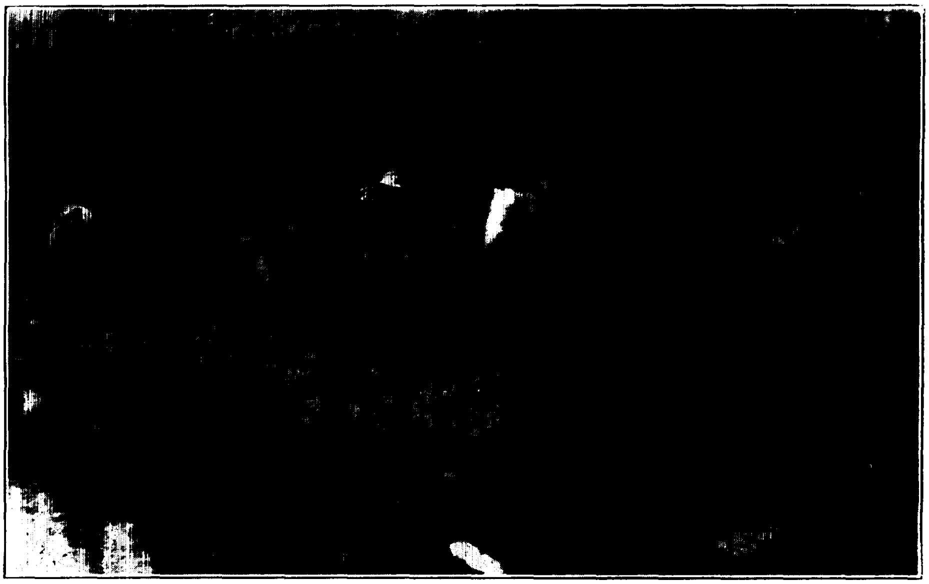
Adopting the classification recommended by the International Committee on the Pre-Cambrian Nomenclature of the rocks in the Lake Superior Region, we would have in the Lake Windegokan district the following series of rocks:

PLEISTOCENE:—Drift and Swamp.
KEWEENAWAN:—Basic Eruptives.
LOWER HURONIAN:—Conglomerate.

KEEWATIN { Arkose
Iron Range.
Carbonate Schists.
Green Schists.

It is difficult to decide whether the different members of the Keewatin series are arranged in their proper order of succession, because most of the rocks are badly decomposed and the contacts are so poor and complicated that little can be learned from them. The Iron range fixes a definite geological horizon and most of the green schists are older than that formation, but the case is not so clear with regard to the position occupied by the carbonate schists and arkoses. The former correspond closely in composition to the Wawa tuffs of the Michipicoten region, and we have placed them in the same relative position here.

The arkoses, which are widely distributed in the region, are the most troublesome of all the rocks to classify in their proper order. In older works they are commonly included in the Upper Huronian, and on account of the presence of some jasper fragments which were seen in one section from location H F 19, one would suppose that they should be placed in the Huronian above the conglomerate. Another thing which would make it appear as if the arkose were later than the conglomerate, is the absence in



Portaging, Lake Nipigon region.

many places of any sign of schistosity, which is so common in the other rocks. But in some parts the arkoses are quite schistose, and it may be that in others they resisted the forces which caused the schistosity and remained massive, just as portions of the greenstones have retained their original structure, while others became schistose. Also the absence of any considerable quantity of jasper, or any definite relation to the conglomerate, which would fix the relative ages, and the presence in the region of arkoses which are distinctly associated with the green schists, make it seem wiser to place them in the Keewatin.

The conglomerate forms a fixed horizon separating the Keewatin and Lower Huronian. It contains pebbles of practically all the types of rock in the region, and some which are not now found there. The absence of arkose pebbles is significant, but these rocks seem to be rather local, and since the material for the conglomerate has probably been transported some distance, this might account for the absence of these pebbles.

One finds no objection to placing the basic eruptive in the Keweenawan, since it is composed of a large sheet of olivine diabase cutting the other rocks of the region.

The various members of the different series classified will be taken up in detail, beginning with the green schists which are the oldest rocks found in the region.

The Green Schists

The green schists comprise the oldest greenstones of the region and a series of schistose rocks composed of slates, and greatly sheared ash rocks, arkoses, and greenstones. These rocks correspond closely to the Michipicoten schists mentioned in last year's Report of the Bureau of Mines. They are undoubtedly the oldest rocks of the region, and have been the origin of some of the others. They are widely distributed and are generally characterized by their green appearance, which is due to the presence of chlorite and secondary hornblende, the products of weathering of other minerals.

The different types of rocks comprising the green schists can be best considered separately.

Greenstones

These rocks consist of porphyrites with large crystals of plagioclase or hornblende, amygdaloids containing amygdules of quartz or calcite, and quartz diorites. Most of them are badly weathered and not very suitable for detailed study in thin section.

A specimen of a porphyrite taken just east of the southwest corner of location H F 19 weathers brown on the surface to a depth of about half an inch. It is very compact and on the fresh surface is light gray in color and shows many crystals of pyrite. In thin section it shows a great deal of pyrite, some chlorite, very little hornblende, and large crystals of plagioclase, badly decomposed.

It has been suggested that the pyrite in these Keewatin rocks is of secondary origin, having been derived from sulphates through reduction by carbonaceous matter. This is probably the case to some extent in the sediments, but it appears more reasonable to regard it as primary in these greenstones. The pyrite is no doubt the source of the brown iron oxide covering the weathered surface of this rock.

The amygdaloidal rocks which are most common west of Tallon lake are greatly weathered light or dark green rocks, having the cavities filled with quartz or calcite. It is noticeable that calcite is very common among many of these older rocks, filling cracks and cavities, and its presence is readily detected by the action of acid on the rock. A thin section of an amygdaloid which occurs a short distance east of the southwest corner of location H F 23, shows it to be a basic lava with many amygdules filled with chlorite resulting from the decomposition of minerals formerly contained in the cavity, and along the south side of location H F 26 a greatly weathered greenstone occurs which shows no characteristic features in the thin section.

In location H F 34 was found a mixture of greenstone and green schist, some of the former in small patches showing the lava pillow structure.

There are some quartz diorites in the region, and they may not be of the same age as the other greenstones, but as they cannot be classed by themselves they are put in here. They are found west and south of lake Windegokan. The greenstones are not so widely distributed as the green schists, and are most common west of Tallon lake, though a few small outcrops occur scattered over a good deal of the southern part of the region. These rocks have been the origin of some of the schists, but parts of them have resisted the shearing action and largely retained their original and massive condition. They have also exerted quite an influence upon the strike of the schists in the neighborhood.

Banded Slates and Arkoses

The slates are rather widely distributed, but are not in very large masses. They almost invariably occur with the Iron range and although a good indication of the presence of that formation in the immediate neighborhood, they may occur without it. On account of their intimate connection with the Iron range it is difficult to say to what extent they should be considered part of it. They are black or sometimes gray on the greatly weathered surface, and are made up of argillaceous deposits no doubt derived from the disintegration of granite and deposited by the pre-Cambrian rivers. The slates occur on either side of the Iron formation, showing that the conditions existing before the deposit of the Iron range must have been repeated afterwards. They also occur interbanded with the iron-bearing silica, showing that while there was a cessation of the deposit of slate, a deposit of silica occurred.

A thin section of a specimen taken near the jasper in location H F 38 shows interbanded slate and arkose. The slate is too fine grained to show many distinctive features, but contains considerable pyrite in very small grains and some very fine pieces of feldspar. The arkose bands show distinct angular fragments of quartz, pieces of feldspar, much pyrite, chlorite and fine grained material. A few pieces of quartz show evidences of water action.

The bands of slate and arkose vary greatly in width, some being as much as three-quarters of an inch in width, and others extremely narrow; and as these bands must represent the deposits laid down during some regularly recurring periods the extent of the weathering action must have also varied at different times.

There are besides those associated with the slates, some arkoses which in the field have been placed with the schists on account of their schistose condition, but whose age would correlate them with the group of arkoses later than the Iron range formation.

The Green Schistose Rocks

We have yet to consider the true green schists, which are very old rocks and as their name would suggest are green from the presence of chlorite and hornblende. Their origin is partly from sheared greenstones and, probably, partly from ash rocks and other volcanic detrital material. They do not now possess their former constituent minerals, and as they are so badly changed, they are entirely unsuitable for study in thin section.

On the portage between lake Corrigan and the small lake to the east, an old hornblende schist green with chlorite and containing much calcite in the cracks, is found. Along the southern side of location H F 20 there is a distinct hornblende schist in which quartz and hornblende are the chief constituents. A little south of the northeast corner of the same claim was taken a specimen of sheared porphyrite which had contained large crystals of plagioclase, and still farther south occurs a large schist hill about 100 feet high, evidently formed by the shearing of a hornblende porphyrite.

No estimate of the thickness of these rocks can be formed. The dip is usually about 90°, but in the southern parts of the district it is nearly 70° southward.

The strike of the schists in the southern part of the region is about 70°, but at about 600 paces east of the southwest corner of location H F 31 the strike changes from 70° to about 95°.

The Carbonate Schists

The name, carbonate schist, has been applied to those schists which are distinguished generally by their quartz crystals, greatly weathered condition, and yellowish brown color. They are sheared quartz porphyry rocks containing considerable carbonate and oxide of iron, and correspond closely to the Wawa Tuffs of the Michipicoten region. In the Windegokan district it is almost impossible to say just how they stand in relative age with the other rocks, but we have placed them in the same relative position as the Wawa tuffs whose age has been pretty well fixed. Along the north shore of lake Windegokan they occur intermingled with the green schists, showing that some of them at least are of the same age as some of the latter.

The quartz crystals stand out prominently from a fine grained indefinite ground mass of iron ore and feldspar. The ore is in the form of hematite and carbonate, either siderite or ankerite, the carbonate giving a very active effervescence with hydrochloric acid. The oxide has probably been derived from the carbonate by oxidation. There is considerable iron in the schist, as an analysis of a specimen taken just south of Whitefish lake shows 20 per cent. of hematite.

The distribution of these schists is quite general, but they are found in small quantities. No doubt they were at one time quite widespread, but owing to their greatly weathered condition they have largely disappeared. Their strike and dip correspond closely to that of the associated rocks, being about 70° in the southern part of the region, and east and west in the northern part.

Indian Encampment.

The Iron Ranges

In another part of this year's Report, Dr. Coleman has given an account of the Iron ranges on Sand creek and Sturgeon river. It was supposed that the three distinct ranges found there would be continued beyond the basic eruptive sheet to the northeast. This supposition proved to be only partly correct. Whereas on Sand creek and Sturgeon river the ranges are clearly separate, and one is a considerable distance from the other two, near Windegokan there are no such definite ranges, and the outcrops are more scattered. The two districts are alike in respect to the presence of jasper and hematite in all the bands, and magnetite in two of them. One must ascribe the formation of the magnetite to some local reducing agent, probably carbonaceous matter, as there are no such conditions as those Dr. J. M. Bell reports as always seen where magnetite was found in the Michipicoten region, viz., excessive metamorphism or the proximity of some intrusive mass which had caused reduction by heat effects.

The strike of the rocks of the range in the northern part of the region is nearly east and west and in the southern part about 70°. This difference in the strike brings the eastern ends of the bands rather close together while they are some distance apart at the western end.

The dip of most of the bands is nearly 90°, though in location B T O 1 the dip is about 75° to the north, and in H F 35, 70° southward, while between the two outcrops a narrow band dips at about 90°. This might suggest a closed fold having the anticlines removed by erosion, the outer limits of the anticlines dipping north and south and the inner ones standing vertically, but in the remainder of the bands the dip is practically always 90° or indefinite, and one concludes that in most cases the folding has been on a smaller scale and more complicated and irregular.

The folding and crumpling within the banded silica is very elaborate, and suggests the application of pressure from several directions, as in some cases the jasper lying between the bands of slate appears to be folded while the latter is not, and *vice versa*. This condition is evidently due to folding in different planes.

The iron-bearing rock almost invariably lies embedded in a dark slate, or hard slaty schist, and in some cases this slate is distinctly interbanded with arkose of fairly coarse texture. An analysis of a rather pure form of this slate from beside the Iron range on Whitefish lake, shows that some iron is present in it. The composition was as follows: silica, 56.36 per cent; alumina, 18.91; ferric oxide, 6.46; ferrous oxide, 1.50; lime, 2.06; magnesia, 2.93; soda, 2.74;potash, 2.18; loss on ignition, 6.02; moisture, 0.20. This analysis would indicate that while the mechanical deposits were being formed there was a deposit of iron taking place, and that later the chemical deposits of iron and silica increased while the mechanical deposits of material containing these other substances diminished.

It has been suggested that these iron deposits have been precipitated from superheated sea water. It scarcely seems necessary to hold that the water should be superheated in all cases, as amorphous silica may be deposited from water at a fairly low temperature, although in a boulder in the region the writer found a specimen containing hematite and crystals of quartz, which is interesting as showing how these substances may be deposited together from water at a high temperature. It is necessary to suppose that the temperature was high in this case, because quartz is deposited at about 180° or higher, and the other forms of silica at lower temperature.

There are some bands of fine Iron range in the region, but the percentage of iron in them is low. A number of analyses were made by A. G. Burrows, Provincial Assayer of specimens from various parts of the ranges, and the results were quite disappointing, as scarcely any of them showed enough iron to make the ranges of commercial value.

Distribution of the Iron Range

There are three prominent outcrops of the Iron formation, one west of lake Windegokan, one on Still lake, and one northeast of Watson lake. Besides these, there are a number of lesser outcrops occurring in various parts of the region, but they are unimportant.

West of Lake Windegokan

Lying in locations H F 13, 12 and 10 there is a mass of range of considerable proportions. It is composed of gray slate and jasper, in parts very finely banded and from appearance it should yield a fairly good percentage of iron, but two analyses of some of the best of this outcrop show only 35.75 and 36.56 per cent. of iron as hematite, respectively. Much of the mass lies under swamp and drift, and although the drift has been partly removed by trenching it is impossible to say what lies under the swamp. Nothing was seen to justify the assumption that a large ore body exists, the ore being of so low a grade. There is much schist in some of the range, the dip is about 90°, and there seem to be no particular geological conditions to cause a concentration of ore at this place. This outcrop becomes greatly mixed with schist before running into the eruptive sheet to the west, and also at the east end before disappearing under the drift. Just south of this outcrop and in location H F 11 is a small mass of jasper and banded magnetite.

On Still Lake

In the old location B T O 1 which had been surveyed earlier than the others, there is a large outcrop of Iron range. A large portion of it is excluded from view by drift and swamp, but it extends right through from Still lake to Whitefish, and although at either end it is not more than 15 to 20 paces wide, it widens out in the centre to about 160 paces, disappearing into the lake on the north side.

There is some fine looking range here, but there is much silica in all of it, and it is in places much broken into by schist. The best analysis gives 36.86 per cent. of iron as hematite, which is too low to make ore. The strike of the rock here is east and west, and dip 75° to the north. It is badly excluded from view by drift, so that it was not possible to form a proper conception of the geological conditions of the range, but its dipping under the lake and the size of the mass suggests a possibility of a small lens of ore being found under part of the lake. It is the most promising looking mass in the region, but the low grade of the ore is against it producing much iron.

Northeast of Watson Lake

On the map may be seen a streak of Iron range running from location H F 32 through H F 35 and 39. It mixes with the schist at both ends, and appears at intervals in the swamp all along the line. The widest part of the deposit, about 35 paces, is near the centre of H F 35, and it gradually narrows towards the extremities. The formation is composed of magnetite and jasper, and is bounded on both sides by green slaty schist. A swamp extends most of the way along the north and part of the distance along the south side, and in H F 39 there is considerable magnetic attraction in the swamp on one side of the range.

Some of the best samples of this range would make ore of low grade, as one analysis shows 48.9 per cent. of iron, as magnetite. Considering the narrowness of the band, it would probably not yield any quantity of ore unless perchance magnetic survey work might discover a body of ore now excluded from view. The strike of this band is about 70° and dip 70° southward.

Other Outcrops of Iron Range

There are many other small outcrops of the rock, but none of importance. On the north shore of Watson lake a small mass of jasper and magnetite occurs, which is probably a portion of the same range appearing farther northeast. In H F 10 and 15 streaks of jasper and hematite are found running through the schist. All the small masses scattered over the region and not previously mentioned are of jasper and hematite enclosed in slaty schist and in most cases with vertical dip.

The Arkoses

The arkoses are generally massive gray rocks, weathering brown on the surface, and quite common around lake Windegokan, but scarce in the vicinity of Sand creek or Sturgeon river. They are clastic rocks, having originated from the weathering products of others, laid down by water. The difficulty in classifying them and the reasons for placing them in this relative position are given in the notes on classification of the rocks.

In almost every case these arkoses are more than half made up of angular quartz fragments, and as they make good thin sections for examination, a number of sections were made from different parts of the region. One from a short distance west of Clear lake shows a few of the quartz fragments more or less rounded and probably water worn. In some specimens the fragments may be seen with the naked eye.

A specimen taken from the long point running out into lake Windegokan on the west side of H F 21 shows in the thin section many angular fragments of quartz, some weathered plagioclase, and some chlorite, but it is peculiar in being the only specimen examined which exhibited fragments of jasper.

Another specimen from near the middle of the south side of location H F 19, and on the shore of Windegokan, very much resembles a conglomerate on account of its concretionary structures, which in the hand specimen look like pebbles. Under the microscope may be seen smaller mosaics of quartz among the angular fragments, also badly decomposed plagioclase, zoisite, orthoclase and chlorite.

Arkoses originate by the disintegration of granite, and the origin of these rocks is an interesting subject. The presence of so much quartz and plagioclase would indicate that they probably originated in this case from quartz diorites and quartz diorite-schists,

Indian Graves, Lake Nipigon.

some of which are found in the region, but which are much more common to the southwest. If these rocks were formed from material *in situ*, a large mass of rock once present in the region must have been transformed, and it seems strange that there are not more jasper fragments in them when there is so much jasper in the region. It is more probable that the material has been transported some distance before being deposited, which also seems to have been the case with that forming the conglomerate, and it has frequently happened in other regions that detritus has been carried considerable distances and then been deposited as arkoses not showing much evidence of water action. If all this material has been brought from outside points and deposited later than the Iron range, it seems probable that it has buried considerable of that formation.

The Lower Huronian Conglomerate

The conglomerate appears in nearly every part of the region explored, but generally in small masses. It is one of the rocks about which there can be no doubt respecting its relative age, and like the Iron range it fixes a definite horizon. It contains pebbles of green schist, greenstone, carbonate schist, granite and jasper cemented together by a matrix of fine grained green material. The most common pebbles are greenstone, green schist and granite. Jasper pebbles are not very common, but enough were found to fix the relation with the Iron range. The absence of many jasper pebbles when jasper is so common in the region, and the presence of numerous granite fragments when no granite appears in the immediate neighborhood, show that the material for the conglomerate was either derived from rocks which were once exposed in this district and have completely disappeared, or was transported thither from some outside point. It is said that granite exists to the north of this region.

The Huronian has been subject to much the same foldings and contortions as most of the Keewatin rocks in the region, and its strike corresponds with that of the other rocks.

The most conspicuous outcrop of this rock is seen on the north side of lake Corrigan. Here there is a hill of typical conglomerate at least 150 feet high. Its strike is about 70°, but rather indefinite. It is not known how far this mass extends northward. The portages between lakes Corrigan and Windegokan run pretty closely along the contact between this mass and the schist.

On the line along the east side of location H F 27 and just south of Whitefish lake, there is some conglomerate containing pebbles of carbonate schist in a matrix of rusty iron ores. As the rock lies next to the schist, it looks as if it might have been derived directly from it. This was the only patch of this type of rock found. Near the southeast corner of location H F 15, some conglomerate contains distinct jasper pebbles, but as a whole, jasper pebbles in the rock were not common.

The Keweenawan—Basic Eruptive

The only mass of distinctly basic eruptive of this age seen in the region, is the large sheet which is crossed on the portage from Sturgeon river to lake Corrigan. It is at least six miles long and though its width is not definitely known, it is some miles wide. It seems to have flowed out over the other rocks, and presents large flat areas on top of the mass. In the field this rock is readily mistaken for gabbro, as the ophitic structure of the plagioclase is not so prominent as it is in the diabases of many other regions, but under the microscope the thin section shows the well developed lath-shaped crystals of plagioclase, polysynthetically twinned, the crystals of augite, a little secondary hornblende, magnetite, small quantities of biotite and a few crystals of olivine, changing to serpentine. The rock is thus an olivine diabase, which is characteristic of the Keweenawan of this region. The specimens are quite fresh, and are suitable for study in the thin section.

We expected to find that this sheet had cut off the Iron ranges to the southwest from those in this region, but it was found that in every case where the Iron formation meets the eruptive sheet, it had first almost entirely run out into the schist before coming into contact with it. The intrusion of this sheet may have to some extent helped to mix the two formations.

No diabase dikes or small intrusions of this rock were seen here, as in most of the other regions in which the writer has worked.

Pleistocene Geology

The work of the glacier is much in evidence in the Windegokan district. This is shown chiefly in the vast amount of drift which is scattered over the country, in some places forming immense morainic hills, and in others large stretches of swamp, sand plain, or clay on which the most abundant vegetation is found. There are some boulders west of lake Windegokan which contain hematite and must have been transported some distance, as the ore is not found in the immediate neighborhood in such a direction that the boulders could have originated there.

The highest hills of drift whose elevation was measured with the barometer are about 240 feet above lake Windegokan, and they vary from this elevation to a little above lake level. But the most interesting feature furnished by the Pleistocene era are the sand plains which may be seen all along the Sturgeon river, and which rise on the portage to lake Corrigan 125 feet above the foot of the long rapid. As lake Windegokan has so much higher elevation than the foot of these rapids, the plains only rise from about 10 feet to 30 feet above the prèsent level of the lake, and from 6 feet to 10 feet above the level of Clear lake. These sand plains no doubt represent remnants of the old beaches of lake Warren, and the lakes lie in what was once a long bay of this lake opening towards lake Nipigon by way of the Sturgeon river, and stretching farther up from lake Superior in this region than in any yet explored.

IRON PYRITES IN ONTARIO

By E L FRALECK

Introductory

On the first of June, 1906, the writer, in accordance with instructions received from the Department of Mines, began an investigation of the Iron Pyrites deposits of the Province. Those of Eastern Ontario, being easier of access by means of better developed transportation facilities, were first examined; in almost every instance one can get within a short distance of the prospects by a good wagon road. In Northern and Western Ontario, where deposits are farther apart, and in many cases somewhat inaccessible, recourse was had to cadge teams, tug boats, fishing steamers, and in some instances a guide, canoe and supplies had to be procured for a several days' trip. No personal prospecting was attempted, and only those places were visited where the occurrence of pyrite had previously been reported, or which were brought to notice by others. Owing to defective knowledge in some sections as to what constitutes a pyrite prospect, many barren trips were taken, but only those deposits will be mentioned which may at some time possess an economic value.

Pursuant to instructions, not only the size and occurrence of the deposits were noted, but wherever possible, an examination of the ore was made to determine the quality and grade. This could not always be done, as in some instances, the available ore was in too advanced a stage of decomposition to be a fair criterion of the unaltered deposit. Country rocks were collected and carefully compared, as at the inception of the work it was thought possible that all deposits might be confined to a definite geological horizon. It can readily be seen how valuable it would be, and how much time could be saved in prospecting, if one's work could be narrowed down to special formations or certain areas. On the other hand, it was found that, speaking generally, none of our great series of formations of pre-Cambrian age is barren of pyrite occurrences in economic quantity. Nevertheless, as will be seen, outside of the Brockville and Iron Range types certain geological features and associations are common to all, and also that certain relationships are shared with deposits which have become well known in other parts of the world.

Historical

The first Iron pyrites mining in Ontario was in 1868 on Lot 19, in the second concession of Elizabethtown township, known as the Billings property, near Brockville. The mines were closed down in 1880 under the assumption that they were exhausted. The chemical works there then drew their supply of ore from across the line, until their stoppage in 1889, notwithstanding the fact that occurrences in this country were well known. See Chapman's "Minerals and Geology of Central Canada," page 75. "Large veins occur . . . . in Hastings and throughout that district; as well as on the north shores of lakes Huron and Superior." "Extensive deposits are likewise seen . . all of which are likely to become available at no distant day, in the manufacture of sulphuric acid."

In his Report on the Basin of Moose River, 1890, page 47, E. B. Borron says:

"I found, however, an apparently large body of iron pyrites on Big river, one of the tributaries of the Opazatika river. This from its purity and the amount of sulphur it contains would be valuable in some places, as great quantities of pyrites are now used in the manufacture of sulphuric acid."

Also in the report of the Royal Commission of 1890, page 56, Edward Haycock states: "Just above Cross lake on lake Temagami, I saw a great deal of mineral. I saw a great deal of iron pyrites in deposits . . . .Some of the deposits were very large. One into which I put a few blasts, I should say was five feet wide, and it has been traced a little over half a mile, all solid pyrites. There is a great quantity there in the vicinity of the lake, but it is too far from a railway."

In the same report on page 141, W. H. Wylie states:

"I also own an iron pyrites property on lot 5 in the fourth concession of Darling. It is about eight feet wide at the top and it widens out to about 10 or 12 feet at the bottom of the pit, which is now down about 35 feet." It was about nine years, however, before any further work was done on the last mentioned property

In Bureau of Mines Report, 1894, page 74, Dr. A. P. Coleman reported occurrences of iron pyrites at Nickel lake in the Rainy River District.

In Bureau of Mines Report, 1895, page 243, E. B. Borron gives the result of John Driver's exploration of "an apparently large deposit of iron pyrites" discovered by him (Borron) in the year 1886 near the river Opazatika. These results will be referred to when the northern deposits are being considered. No doubt this is the same occurrence as that mentioned by Mr. Borron in his report of 1890.

In the year 1900 in the Report of the Bureau of Mines, page 207, W. G. Miller, under the head of Pyrite states:

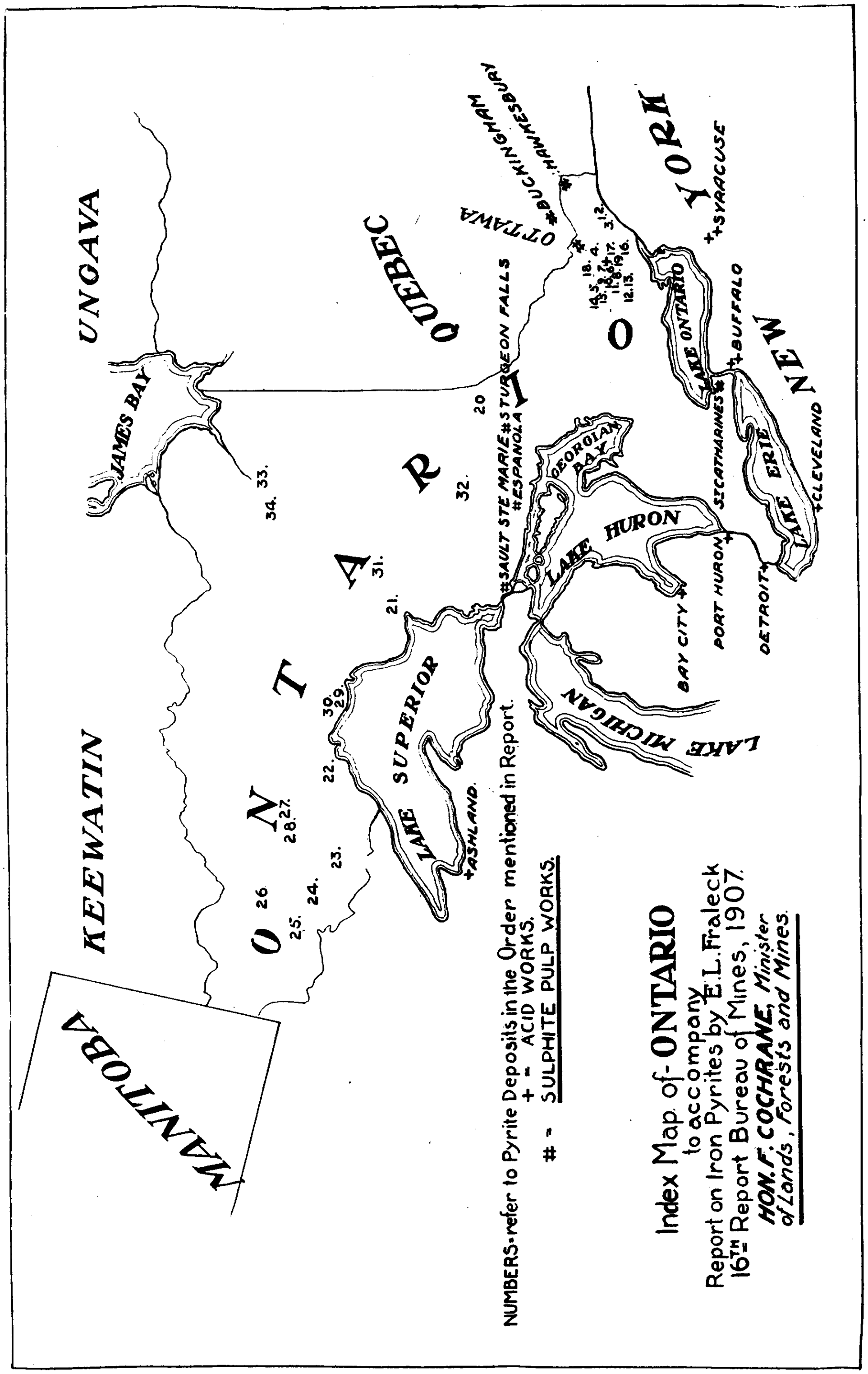
"Deposits of it have been developed to some extent with the object of securing a supply of the material for use in the manufacture of sulphuric acid, for which it is in considerable demand. These deposits are situated in the townships of Darling and Elizabethtown, and near Schreiber on the Canadian Pacific railway. There are no doubt numerous workable deposits in the Province: Bedford, Devil's Lake; Big River, a tributary of the Opazatika; Darling, Lot 5, Con. 4; Elizabethtown, Lot 19, Con. 2; Hungerford; Graham, Lot 12, Con. 3; Madoc, Lot 11, Con. 11; near Schreiber station on the C. P. R.; Nickel Lake, Rainy River District; Lake Temagami, Nipissing District."

Since the last-mentioned report was published, three of the above properties, namely, Hungerford; Madoc, Lot 11, Con. 11; and a deposit near lake Temagami, Nipissing District, have become shipping mines. The others have been taken up and are being held for mining or speculative purposes, except Bedford, Devil's Lake, which has not yet been located. From 1900 on, belongs the history of the working mines and the steady development of the pyrite industry throughout the Province.

In the following descriptions, the prospector's term "diorite" is used as a general term to denote intrusive greenstone, unless otherwise designated. The term "talcose" is employed for the alteration of the schist due to vein formation, although "sericite" may in many instances be more correct. The term "fahlband" denotes a zone of pyritous schist showing the rusty stains along a definite strike. The analyses were made by A. G. Burrows, Provincial Assayer, Belleville.

The Eastern Ontario District

The oldest rock in the district is a coarsely laminated, pink granite-gneiss—biotite more frequent than hornblende—called by the older geologists the "fundamental gneiss." Upon this has been deposited various metamorphic schists, argillites, mica schists, chlorite schists, talc schists, pyroxenites, amphibolite schists, etc. The foregoing series has been cut by various basic intrusions, gabbros, diorites, anorthosites, norites, etc. These latter have in certain localities been metamorphosed to a highly developed schistose structure, and in some localities have later been invaded by finer grained eruptions probably from the same magma. Deposition now occurred of conglomerates or an autoclastic rock which has been called the Hastings or Grenville series. A long period of deposition then ensued, when limestone subsequently metamorphosed to marble, calc-schist, and sometimes to a calcareous pyroxenite, was laid down.


Index Map of ONTARIO
to accompany
Report on Iron Pyrites by E.L. Fraleck
16TH Report Bureau of Mines, 1907.
HON. F. COCHRANE, Minister
of Lands, Forests and Mines.
NUMBERS refer to Pyrite Deposits in the Order mentioned in Report.
+ = ACID WORKS.
# = SULPHITE PULP WORKS.
MANITOBA
KEEWATIN
UNGAVA
JAMES BAY
ONTARIO
QUEBEC
NEW YORK
OTTAWA
BUCKINGHAM
HAWKESBURY
SYRACUSE
BUFFALO
CLEVELAND
DETROIT
PORT HURON
BAY CITY
ST CATHARINES
SAULT STE MARIE
ESPANOLA
STURGEON FALLS
ASHLAND
LAKE SUPERIOR
LAKE HURON
GEORGIAN BAY
LAKE MICHIGAN
LAKE ERIE
LAKE ONTARIO

The above formations were then invaded by granite and syenite bosses, and probably from the same magma a great series of pegmatite dikes. Diabase dikes cut all the above formations except the granite, and quartz veins a little later were quite as impartial. We now have a period of deposition, when first Potsdam sandstone, then Trenton limestone, and other members of the Silurian were formed. During the above periods several glacial epochs occurred; that at the close carving the surface of the country into its present shape, denuding it of Potsdam sandstone and Trenton limestone, except comparatively small outliers, and removing over nine-tenths of the crystalline limestone. The metamorphic sedimentaries occupy great troughs or anticlines in the older gneisses, and outliers of limestone and sandstone lie on the southern flanks of large hills along the shores of lakes and rivers, while the higher hills are composed of granite, syenite-gneiss, and the synclines of the older gneiss.

In the older gneiss, in addition to the pyrite deposits of the Brockville section, occur also working mines of mica, and where cut by pegmatites, mica and working feldspar mines.

To the schists and basic eruptives are to be assigned working mines of pyrite, copper, and where influenced by granite eruptions, gold.

The crystalline limestone possesses mines of graphite, talc, lead and zinc, and also a couple of pyrite deposits.

And to syenite intrusions we owe the working corundum mines.

The district, though in the main rocky, contains several areas of fine farming land, the remainder being used for grazing. All of it is well settled.

The Brockville Section

In 1868 John Cowan and J. B. I. Robertson began mining for pyrite on Lot 19 in the second concession of Elizabethtown township, Leeds county. (No. 1)[1]. The pyrite occurred in a series of lenses conformable to the laminations of a highly foliated pink granite gneiss. A series of irregular cavities, caused probably by folding, had occurred; in these were deposited calcite and iron pyrites in parallel lines of deposition, and mining took the form of gouging out the richer shoots of ore, irrespective of any other consideration. No timbering was done, and when a part of the pit became unsafe, work at that spot was abandoned. The main pit was sunk to a depth of two hundred and fifty feet. The strike of the deposits was northeast, and the dip to the southeast. Mining operations ceased in 1879, and pyrite was obtained from the American side near DeKalb Junction. During these times the property was the scene of considerable chemical activity. In the report of the Geological Survey for 1883, page 10 L, the acid works are thus described:

"Brockville Chemical Company's mine, in the township of Brockville, has been closed since 1879. The chemical works, are, however, still in operation. The pyrite, at present used by the Company is being brought from New Hampshire at the rate of a carload a day. There are sixteen kilns in operation each having a capacity for 300 lbs. of ore. The kilns are charged every hour and produce about eighty-five carboys of sulphuric acid a day. In the distillery there are twenty-four glass retorts attached to glass receivers for redistilling the crude acid. Besides the above, about fifteen carboys of nitric and hydrochloric acids can be produced per day. In this case iron retorts and earthen receivers are used. The company employ twenty-six men."

A portion of the sulphuric acid was used at fertilizer works in Brockville. Mixed acid was supplied to two dynamite works in that neighborhood. One of these was started by C. W. Volney, the inventor of the Volney blasting powders, who afterwards sold out to one Griffin; and the other by Smith and Nelson, who were succeeded by Abbott and Harrison. Operations of all kinds ceased in 1880, and to-day not a vestige of these industries remains.

---

[1] The numbers in brackets after mention of Iron Pyrites deposits refer to corresponding numbers showing their position on the Index Map of Ontario accompanying this Report. See page 151.

The cause of the decline and obliteration of these at one time flourishing industries was due to the prohibitive price of the raw material. To the cost of mining near DeKalb Junction must be added hauling to the railroad and loading, freight rate to Ogdensburg, unloading, loading into barges, water haulage to wharf at Brockville, unloading, loading on wagons, and hauling three miles to the acid works. This evidently could not compete with the Nichols Chemical Co.'s plant at Capelton running on a sulphur ore carrying valuable bye-products in copper and silver. In other words, Canadian and English capital turning their backs on their own country went to the States for their raw material, while American capital established itself on Canadian ore and put them out of business. The evidence of the men who worked in the old pits is to the effect that they were never completely exhausted. Be that as it may, the Brockville Chemical Company did not prove themselves very good prospectors, as a promising prospect has, in recent years, been uncovered on an adjoining lot.

The Sloan prospect (No. 2) is situated on Lot 18 in the second concession of Elizabethtown, adjoining the old Billings mine on the east. A band of gossan strikes in a northeast direction along the edge of a swamp. The disturbance that caused the vein formation is here accentuated by the intrusion of a dark green dike. On this deposit a shaft has been sunk to a depth of nineteen and a half feet. The gossan cap is from six to eight feet in depth. The shaft is on the foot wall and dips quite strongly to the southeast. The cross section of the shaft is 10 by 10 feet, and it is all in vein matter. There is a width of three feet of solid pyrites along the footwall, and the remainder is composed of alternate bands of pyrite and crystallized calcite, locally called spar:—about one-half pyrite to one-half spar. The pyrite is high grade, the only impurity being the calcite that gets intermixed in the course of mining. The method of mining consists in drilling, shooting and mucking the pyrite and calcite separately. They break from each other quite freely. As much as possible of the soft friable calcite is mined out, then the pyrite broken down, which of course is done quite readily, there being a good face to break to. Two carloads, eighty tons, were shipped to Buffalo and Capelton. The returns were forty per cent. of sulphur.

The prospect is one-half mile from the Brockville and Westport railway, and two miles from the St. Lawrence river.

On the Shipman farm about six miles to the west is another occurrence of pyrite in gneiss (No. 3). The deposit lies on the northern flank of a rocky hill about sixty feet in height. Pyrite has been mined from an irregular pit forty feet long and thirty feet wide. Small stringers leading out from this pit have been followed, making irregular surface workings to the extent of one hundred feet square. The pyrite is high grade, but very much intermixed with pyrrhotite and country rock. The prospect is one-half mile from the Grand Trunk railway and one mile from the St. Lawrence river.

McIlwraith Mine

This property (No. 4) is situated on Lot 5 in the fourth concession of the township of Darling, Lanark county. The vein strikes slightly north of east along a contact between diorite on the south and crystalline limestone on the north. It was first opened up many years ago by W. H. Wylie of Almonte and Wm. Hall of Darling when prospecting for gold. They sank a shaft to a depth of thirty-five feet. The Nichols Chemical Company instituted mining operations under an option in September, 1899. The old shaft was deepened to seventy-five feet and from the bottom a drift run eight feet to the east. A tunnel, one hundred and fifty feet long, with an outside approach of fifty feet was driven along the strike of the vein. This discloses a length of over ninety feet of workable ore, clean high grade pyrite enclosing lenses of quartz. A cross cut of twelve feet to the south failed to pierce the width of the deposit. The lens dips to the south at an angle of 60°, and pitches to the east away from the shaft which pierced the lens, which it is claimed was caught again by the drift. Work ceased at the expiration of the option, the end of April 1900. Three carloads were shipped away and the mining was all done by hand. The gossan cap is fourteen feet deep.

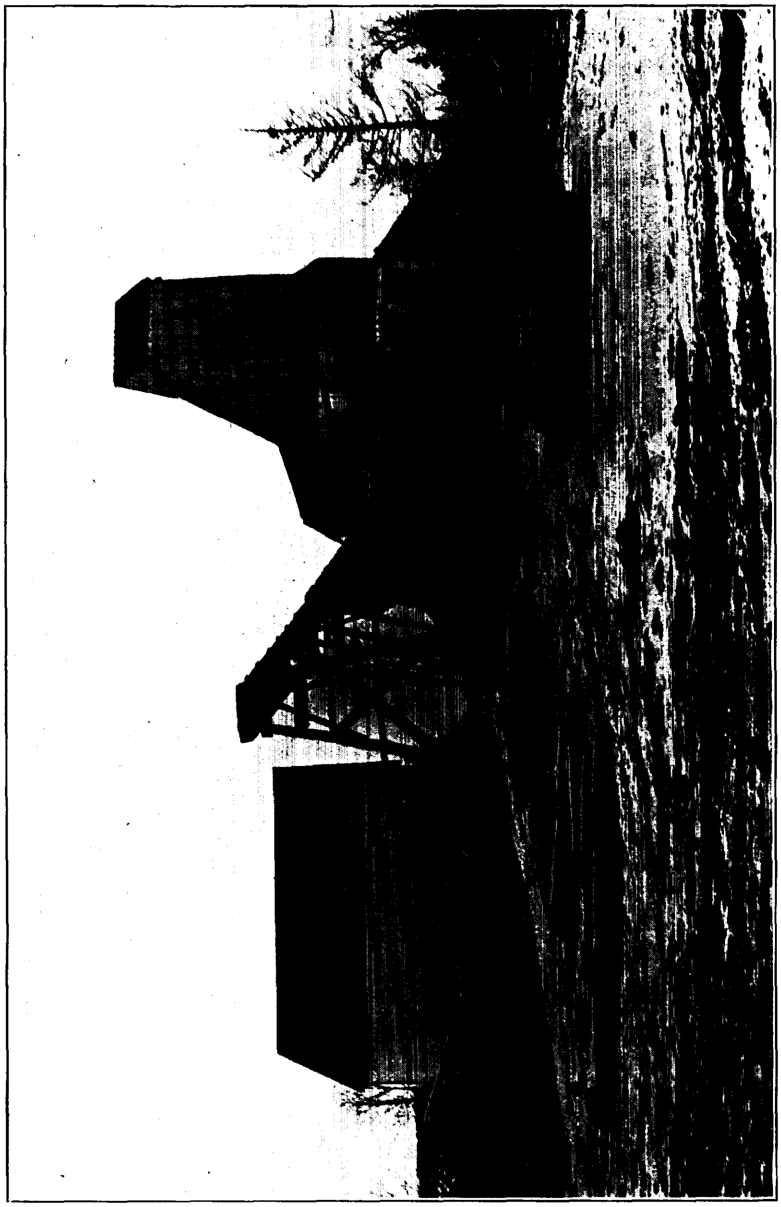
In a line of weakness caused by the contact of the diorite with the crystalline limestone, pyrite-bearing solutions have eaten out cavities and lenses in the limestone, depositing in them pyrite and quartz. These break quite free from each other, and the only impurity in the pyrite is small intermixed particles of quartz. Allowing for reasonable culling, an average sample from the tunnel assayed by A. G. Burrows, yielded 42.60 per cent. of sulphur, and a sample from a dump of three hundred tons removed from the property to an adjoining lot, and which had been exposed to weather for six years, yielded 38.86 per cent. of sulphur.

The property is ten miles by winter haul from Clyde Forks on the Kingston and Pembroke railway.

Dump at McIlwraith mine, Darling township.

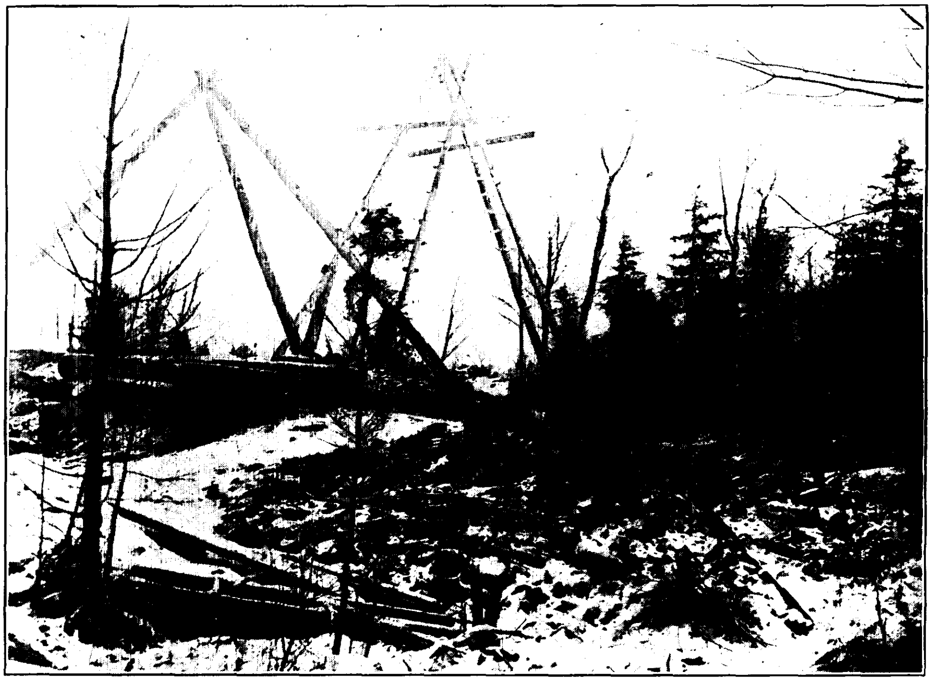
Bannockburn Pyrite Mine

The Bannockburn pyrite mine (No. 5) is situated on Lot 25 in the sixth concession of the township of Madoc, Hastings county, about one mile southeast of the village of Bannockburn. In 1898 openings were made for iron ore, and Stephen Wellington of Madoc shipped eleven carloads of bog iron ore or limonite to the Hamilton Iron and Steel Company. This ore, which ran upwards of 38 per cent. metallic iron and low in sulphur, was merely the gossan capping of iron pyrites deposits. These were further prospected by Thomas Burnside and Wm. Coe of Cleveland. In the summer of 1900, they transferred their lease to the American Madoc Mining Company, who abandoned operations at the McIlwraith in favor of the more accessible deposit. The gossan capping at the Bannockburn mine varied in depth from eight to fifteen feet. A pit about eighty feet in diameter and ninety feet deep was sunk, but at this stage had to be abandoned. Through the oxidation of low grade ore, large masses began to scale off the sides of the pit, necessitating either an expensive system of square set timbering or



Bannockburn mine, showing power house, head frame and rock house.

cessation of the work. In the meantime a new lens had been opened up about five hundred feet south of the open pit. A shaft was here sunk, levels run every sixty feet, overhand stoping adopted and a skipway with guard rail provided. A battery of boilers and a five-drill straight-line air compressor were installed, which supplied the drills, steam being used for the pumps. In later years this method of working was abandoned for the following practice. Eight or ten feet was sunk, followed by underhand stoping back the full length of the lens. For convenience in mucking the skip was replaced by a bucket. The lens pitching to the north and the shaft having pierced it also rendered the operation of a skip impossible. The skids at the top of the rock house were inclined to the horizontal. As the loaded bucket was hoisted into this position a chain was hooked into a ring in the bottom, enabling the bucket to dump as it was lowered slightly, the skids being pulled apart. The chain was unhooked as the bucket was hoisted, it was then thrown back on the skids and lowered. Each bucket dumped its load on steel



Bannockburn mine, showing tripods at the open pit.

bars, six inches apart set above a series of grizzlies spaced to one-half inch. The fines from the grizzlies discharged through the rock house floor, and the culled lump ore was wheeled out to a loading dock, whence wagons drew it a half mile to the siding on the Central Ontario railway.

Some shipments from the open pit graded from 46 to 48 per cent of sulphor, and some from the south lens did not run higher than 37 per cent. A fair average of the property would be 40 per cent. of sulphur. The ore is hard and makes very little fines.

The country rock is a chlorite schist, showing talcose or micaceous alteration in the vicinity of the ore bodies. The south lens and enclosing schist strike slightly west of north until west of the open pit, when a fold of an angle of 90° turns the strike to a little north of east. The south lens dips with the country to the east, and the open pit in a similar manner to the south. Unfortunately, the surface of the schist at the apex of the fold is covered by a deposit of limestone subsequently metamorphosed to calc schist, but there is no evidence whatsoever of faulting. Folding, whether of a simple nature or a pitched anticlinal subsequently eroded, produced the lines of weakness through which the pyrite bearing solutions seeped, the deposits being formed by replacement. The ore comes readily off a fairly good foot wall, but gets lower and lower in grade on the other side, shading away gradually into the schist. It is impossible to obtain fresh specimens of the schist. It is probably of a hornblende type originally; the chloritic alteration being due to surface weathering and the influence of vein formation. The south lens is one hundred and sixty feet in length, and varied from eight to fifteen feet in width. The mine employed from thirty-five to forty men and shipped during its six years of operation about five hundred and eighty tons per month; all of which went to the General Chemical Company at Buffalo.

Although the ore fell off neither in grade or quantity with depth, yet on account of the open method of mining, (the south lens being stoped out to a depth of 275 feet), and the tendency of the walls to scale, mining became so hazardous that operations were abandoned in August 1906.

The Hungerford Fahlband

The Hungerford fahlband lies about five miles east of the village of Tweed north of the Canadian Pacific railway. It strikes north 65° east, and is easily traceable for two miles. Level farm land to the south is underlain by garnetiferous crystalline schist cut by massive diorite, into which, five hundred yards north of the deposits, has intruded a pink hornblende granite that rises above the country in a series of rugged hills (locally called the Bald mountains), and has protected the deposit from denudation. The deposits are strung along the contact of the diorite and the schist, the strike of the lenses, the contact, the fahlband, and the schist being identical.

Hungerford Mine

The Hungerford mine (No. 6) situated on Lot 23 in the twelfth concession of the township of Hungerford, Hastings county, was opened up thirty years ago as a gold property, and a smelter was erected to extract gold from the barren pyrite.

The present operators, the American Madoc Mining Company, (now Canada Nichols Chemical Company) 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.

A shaft with cross section 14 by 8 feet has been sunk on the diorite foot wall to a depth of three hundred feet, and levels run every hundred feet. On each level cross cuts have also been made to catch the middle and north veins. The shaft dips to the south at an angle of 59° to 61° at the bottom.

The south vein, on which the shaft is located, has been exploited to a length of 150 feet.

The middle vein, which was a pleasant surprise when struck, as there is no visible outcrop on the surface, is eighty feet to the north of the south vein, and has been explored to a length of eighty-five feet. This vein has on the first level a width of about six feet of high grade ore, but on the second level contains a very large quantity of calcite.

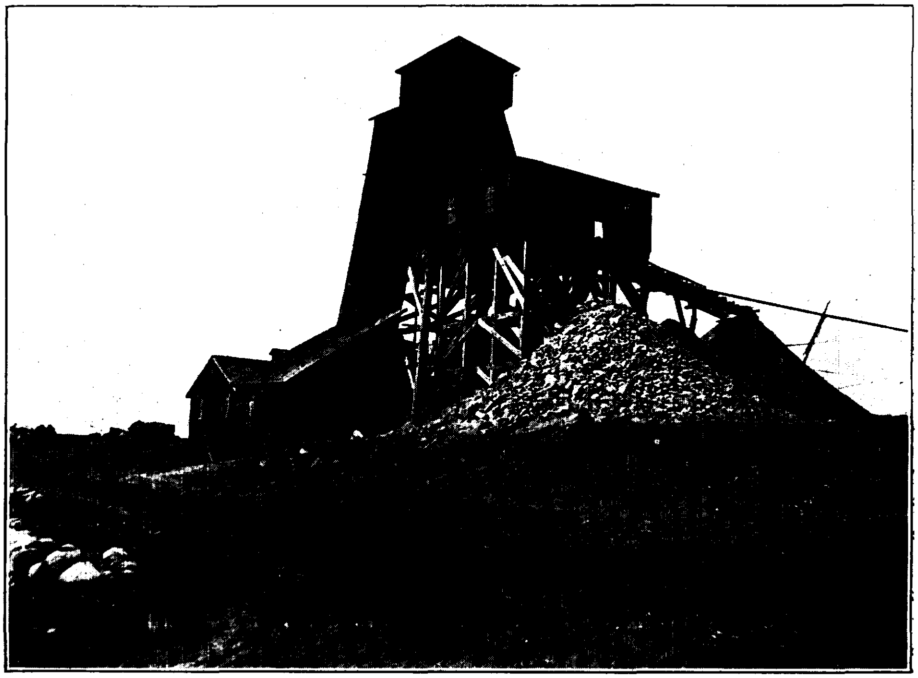
Forty-five feet farther to the north the north vein was encountered. This vein when cut was twenty-two feet wide, seventeen feet representing massive pyrite. The length of the drift on this vein is 380 feet, and the ore still continues; the length as indicated on the surface being about 500 feet. The width varies from six to twenty-two feet. The mine is practically a dry one, very little water being encountered except that from surface seepage which is trapped on the first level.

The ore is coarsely granular and makes a large percentage of fines. The main impurity is calcite, very little quartz being present. A small quantity of pyrrhotite occasionally occurs, mainly in the north vein.

The power plant consists of an 80-h.p. return tubular boiler, and a straight line, Ingersoll-Sergeant air compressor, with 14¼ by 16-in. cylinder. These, with an 8¼ by 10 Lidgerwood hoist, are housed in a building forty-five feet square. The other buildings consist of a blacksmith shop, men's dry, coal bin, office, store room, stables, etc.

The head frame, one of the very neatest in the Province, consists of four legs of 12 by 12 timbering, six sixty feet in height, and so designed that the resultant of the cable stresses each side of the sheave pierces the ground at the intersection of the diagonals of the base, thereby throwing an equal strain on each leg.

The ore is raised by a skip, and is dumped on two sets of grizzlies spaced two and one-half and one-half inch; yielding three products, lump, spalls and fines. The larger lumps of the over size are broken by men with hammers, a certain amount of culling being done at the same time. All ore shipped has been sent to the plant at the General Chemical Company at Buffalo. An acid works, however, is now being erected on the



Nichols Chemical Company's pyrite mine, Sulphide.

property by the Nichols Chemical Company at Sulphide station. The lump ore will grade from 42 to 44 per cent. sulphur, the fines of course much lower.

The Canadian Pacific railway crosses the southern end of the property about five hundred yards distant.

The systematic development of this mine reflects the greatest credit upon the engineering ability of the late A. W. Rising, the superintendent up to the time of his death in the fall of 1906.

Oliver Prospect

The Oliver prospect (No. 7) is situated along the same fahlband on Lot 26 in the twelfth concession of Hungerford township. A lead of gossan is traceable across this lot along the side of a depression. The property is being prospected by means of New York capital, and a shaft, which has attained a depth of twenty feet, is being sunk on a vein averaging from four to seven feet. The ore on the dump, pyrite with a little calcite and pyrrhotite, will grade upwards of 40 per cent. in sulphur.

The prospect lies about 125 yards north of the Canadian Pacific railway.

W. A. Hungerford of Madoc is superintendent in charge.

Hungerford Western Extension

The Hungerford Western Extension (No. 8) comprises lots twenty-one and twenty-two in the twelfth concession of Hungerford township. This property has been fairly well prospected by means of surface trenches at regular intervals along the strike of the fahlband.

The western lens has been exploited by surface trenches to a length of five hundred feet, and exhibits, in the trenches near the line between the lots, a width varying from

The Oliver prospect.

sixteen or eighteen feet of ore, which will grade from forty-two to forty-four per cent. of sulphur. The only impurity consists of small included lenses of calcite.

The eastern lenses have not been prospected, but are presumably continuations of the Hungerford mine ore bodies.

Pyrite has also been located to the south near the railway. The gossan is about forty feet wide, but not enough work has been done to determine the extent of the pyrite.

The Canadian Pacific railway crosses the southern end of the property, about three hundred yards distant.

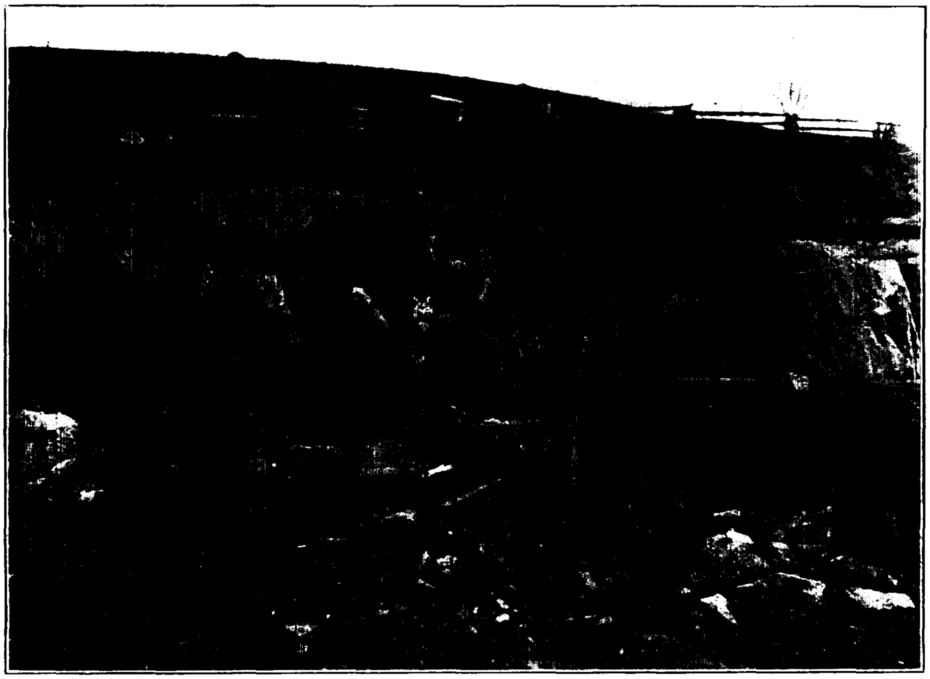
At certain points along the zone of weakness as denoted by the contact, cracks and lines of superior permeability have been induced, thus producing conditions favorable to the circulation of ore-bearing solutions and the deposition of the pyrite. The diorite shows no pyrite, but the schist is considerably impregnated here and there for a distance of over two miles. The intrusion of the granite has no connection with the ore bodies, except probably to accentuate the planes of weakness.

The Queensboro Fahlband

This fahlband, which is near the eastern boundary of Madoc township, strikes in a general north-of-east direction, and can be readily followed for a distance of two miles, stained, rusty and decomposed schists being discernible throughout that distance.

Queensboro Mine

The Queensboro pyrite mine (No. 9) is situated on lot eleven in the eleventh concession of Madoc township, Hastings county, about one mile southwest of the village of Queensboro, and one-half mile west of the Bay of Quinte railway.



Open cut, Queensboro mine.

The deposit lies in a depression at the contact of a garnetiferous crystalline schist to the south, resembling that at Hungerford, and an intrusion of light gray granite to the north.

A small spring creek ran through the depression over a part of the deposit. This it was necessary to divert, and a shaft has been sunk, at the edge of the old creek bed, to a depth of eighty-five feet. At fifty feet in depth water came in to such an extent that a drift was driven to the east for thirty feet and a cistern constructed into which by means of wall plates and troughs, the water was trapped. At the bottom of the shaft a drift has been run to the west for twenty-five feet, and a cross cut made twenty feet to the north. At the present time work in this shaft consists of drifting to the west from the fifty-foot level.

One hundred and fifty feet to the west another shaft has been sunk to a depth of thirty feet.

About one hundred feet southwest of the main shaft a zone of highly pyritous rock is being worked. Through this run several lenses up to four or five feet thick of medium grade pyrite shading off into leaner ore. One lens contains disseminated copper pyrites. This is being worked by an open pit.

The mine is operated by the British American Development Company of Toronto.

The plant consists of two boilers, one 65-h.p. and one 50-h.p., both locomotive type and asbestos covered; also one McEwan Drill Co. of N. Y. four-drill, straight-line air compressor with cylinder 12 by 18 inches, and one steam hoist 10 by 12 inches. There are likewise blacksmith shop, storehouse, office building, etc.

The pumps comprise one Knowles with 6-inch suction and 5-inch discharge and two vertical plunger Camerons $2\frac{1}{2}$ by 2 and 3 by $2\frac{1}{2}$ respectively.

The pyrite is hauled by teams to Queensboro station and there shipped to the Contact Process Company at Buffalo. The first twenty-one cars shipped averaged forty-seven per cent. of sulphur, and shipments up to the fall of 1906 amounted to sixty-five carloads.

The highest grade ore comes from a series of lenses close to the granite contact. That on which the main shaft is sunk has at the shaft a width of fifteen feet and a length of about fifty feet, thinning out towards the ends. To the west is a similar lens, as yet undeveloped, which shows a width in a surface trench of twenty feet of very high grade pyrite. The iron pyrites in these lenses is a hard, heavy, dense ore resembling a massive magnetite, the only impurity being thin veinlets of quartz. To the south is an extensive area of more or less imperfect impregnation, yielding places from which a thirty-five per cent. sulphur ore can be quarried.

A noteworthy feature at this deposit is a small vein to the west of the workings which has a northwest strike and is about two feet wide. It has been opened by a trench sixteen feet long and four feet deep. It cuts the formation at an angle of 45° and appears to possess well defined walls. The vein is composed of quartz, pyrite, copper pyrite and argentiferous jamesonite. This vein is of later age than the pyrite deposit. The jamesonite fills the interstices and is formed around crystals of pyrite. This vein possesses an interest on account of the rare occurrence of jamesonite in this country, and the present high price of antimony.

Wellington Prospect

The Wellington prospect (No. 10) is situated on the north half of lot nine in the tenth concession of the township of Madoc. A series of pits and trenches have disclosed a belt of gossan over five hundred feet long, two hundred feet wide and about twelve feet in depth. The gossan is mainly conglomerate with iron oxide as a cementing material. Certain portions however are a fairly fine limonite. Here and there throughout this material are found boulders of high grade pyrite up to twelve inches in diameter. Although the outside of these is oxidized, the angular outline is still discernible. Prospecting has as yet failed to reveal the parent ledge.

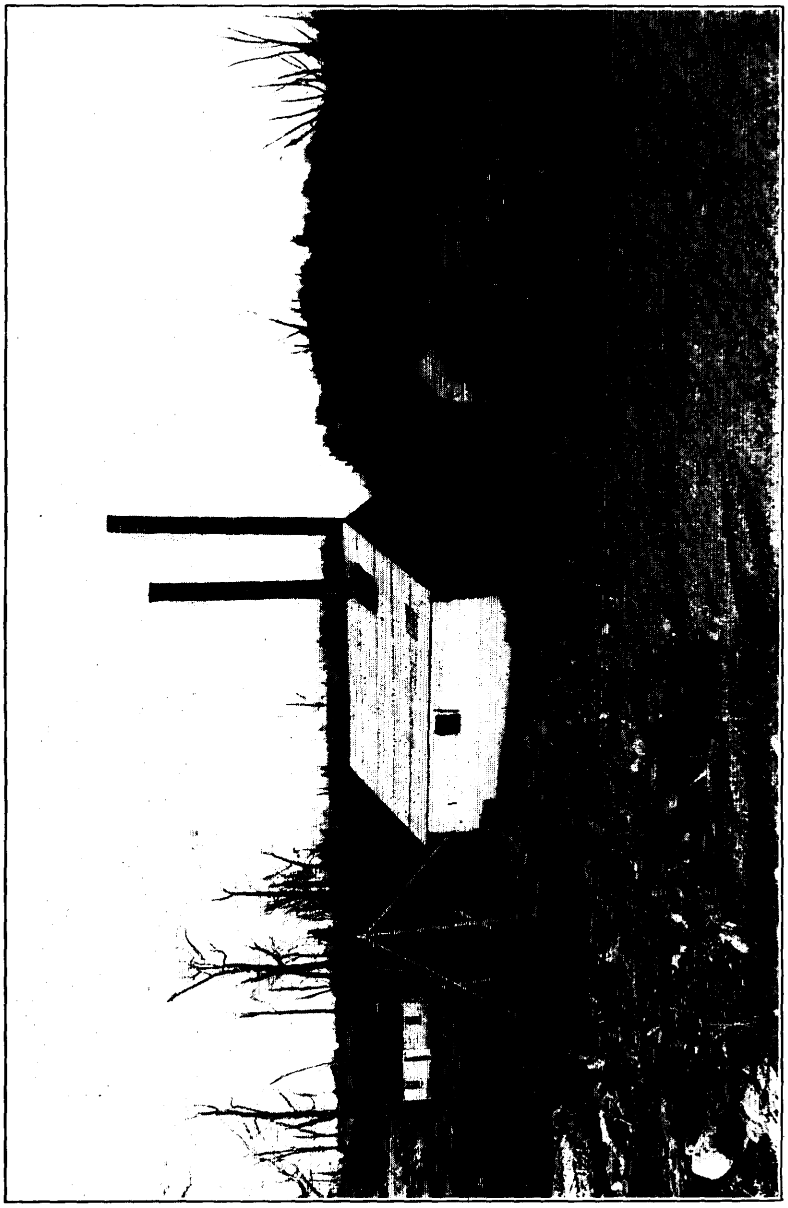
Davis Prospect

The Davis prospect (No. 11) corners on the Wellington to the northwest. A test pit about ten feet deep has been sunk on pyrite somewhat intermixed with crystalline limestone. At another point on the same lot a heavy band of gossan is being prospected.

The Farrell Prospect

The Farrell prospect (No. 12) is situated on the Farrell farm about two miles northeast of Madoc village, Hastings county.

The country rock of the deposit is a calc schist with a northwest strike to which the deposit conforms. Test pits for a distance of two hundred feet show either gossan



Power house, Queensboro mine; shaft with tripod at left.

or pyrite. A shaft has been sunk to a depth of about twenty-five feet. About forty tons of ore lie on the dump. A sample representing an average of seventy-five per cent. of this material yielded 40.64 per cent. of sulphur. The deposit maintains a uniform width of five feet. The only impurity in the ore is crystalline limestone.

McKenty Prospect

The McKenty prospect (No. 13) lies on the McKenty farm at Mullet's Corners, two miles east of the village of Madoc. Hematite was shipped from this property thirty years ago, and desultory iron mining has been carried on ever since.

A pit at one time sixty feet 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 pyrite. In the writer's opinion, this is one of many instances throughout Eastern Ontario where hematite constitutes the gossan capping of a sulphide ore body.

An interesting feature is a talus breccia to the south of the deposit, composed of sharp angular fragments of hematite cemented with a sandstone bond.

Deposits in Cashel

The Little Salmon Lake deposit (No. 14) is located on the shore of Little Salmon lake on lot twenty-three in the seventh concession of the township of Cashel, Hastings county.

A hill rises sharply above the level of the lake to a height of eighty feet. Half way up the hill a trench forty feet long has exposed a deposit of pyrites. In the north end of the trench, the pyrite uncovered is fifteen feet wide. An average of seventy-five per cent. of the pyritous material yielded 38.83 per cent. of sulphur. The country rock of the deposit is a chlorite schist and the strike is east and west.

The Central Ontario railway is nine miles distant by winter draw at Gilmour, and six miles winter draw across Big Salmon lake to the gravel pit.

The Gunter property (No. 15) is situated on lot twenty-three in the fourth concession of Cashel.

A shaft has been sunk on the lead to a depth of twenty feet in alternate bands of quartz and pyrite. The work was done while prospecting for gold. The soil on the surface is quite unaltered, and no gossan, fahlband or other indications of a pyrite deposit are visible. The pyrites in the shaft, however, uniformly increased with depth. A sample representing two-thirds of the dump yielded 39.50 per cent. of sulphur. The total width of the vein is five feet.

The Central Ontario railway is seven miles distant by summer road and six miles by winter haul.

Other Eastern Ontario Prospects

The Snooks prospect (No. 16) is on lot seven in the fourteenth concession of the township of Loughborough, Frontenac county.

A fahlband strikes northeast through a coarse, impure crystalline limestone. At the only opening massive pyrite shows to a width of seven feet, and, mixed with crystalline limestone, to a width of twenty-five feet. This is on the road allowance and was uncovered in obtaining material for the road. The fahlband can be easily traced across lot six in the fourteenth concession to the shore of Desert lake.

It is nine miles distant by rough wagon road to Hartington on the Kingston and Pembroke railway.

Ladore Prospect

The Ladore prospect (No. 17) comprises a portion of the east half of lot nineteen in the seventh concession of the township of Dalhousie, Lanark county.

A heavy fahlband strikes north of east along the contact of a coarse amphibolite and a fine grained gray granite. Nearly every trench in the marshes and depressions exposes gossan in the form of a good grade of bog iron ore. Two pits one hundred yards apart have been sunk to a depth of twenty and twenty-two feet respectively, in gossan and decomposed rock matter. The south pit is noticeable for quantities of delicate cellular silica. Outside of seams up to a foot in thickness, pyrite in quantity has not yet been located.

The same fahlband continues across lot nineteen in the sixth concession, along a contact of crystalline limestone and granite. Here are a series of interesting caverns in the limestone, which have been caused by solvent action of acid solutions, followed by deposition of pyrite in the cavities and subsequent oxidation.

The property is seven miles winter draw from Wilbur siding on the Kingston and Pembroke railway, and is being prospected by Wellington and Henderson of Madoc.

The Stalker Prospect

This prospect (No. 18) is situated on lot forty-two in the sixth concession of the township of Clarendon, Frontenac county, about two miles east of the village of Plevna.

Laminated limonite (Ladore).

A well defined fahlband strikes in an east and west direction. A small test pit has been sunk on a lens of pyrite which shows at that point a width of six feet. A quartz vein one foot in width lies along a hanging wall of clay slate, the foot wall consisting of crystalline limestone. A six-foot depth of gossan shades into hematite as the fahlband crosses on lot forty-two in the fifth concession.

This prospect is referred to by W. G. Miller in the Eleventh Report of the Bureau of Mines, 1902, page 203, as follows: "A deposit of iron pyrites has been opened up on one of these lots. Although the deposit is of a promising character, it is apparently too far from the railroad to be worked profitably at present."

The Foley Prospect

This property (No. 19) is situated five and one-half miles by fair wagon road, north from Enterprise station on the Bay of Quinte railway. The work consists of a pit eighty feet long, forty feet wide, and ten to fifteen feet deep, sunk on pyrite and pyrrhotite in about equal proportions, intermixed with pyroxene, calcite, mica, and molybdenite. A sample treated at the laboratory of the Kingston School of Mines was successfully separated by combined washing and magnetic concentration. As an economic proposition, however, mining costs, separating costs, condition of markets, costs of transportation, etc., have to be considered. The pyrite consists of small masses in the rock and pyrrhotite, and the deposit is irregular. The occurrence is in an outlier of crystalline limestone surrounded on all sides at short distances by granite.

The Harris Mine

This mine (No 20) is located on the shore of James lake, about three-quarters of a mile west of the Temiskaming and Northern Ontario railway, at the eighty-third mile post.

The discovery was made in 1903, but active development was not instituted until December 1906.

A shaft has been sunk to a depth of seventy feet with a drift on the vein of forty feet to the south and twenty to the north. A test pit twenty feet deep has been sunk on another lens about forty feet northeast of the main shaft.

Another lens was being opened up by an open pit about two hundred and fifty feet to the southeast of the shaft. This showed a width of over twelve feet of solid pyrite. Three lenses have been located in a pyritous zone, four hundred and ten feet in length. The fahlband is fairly strong and traceable for a quarter of a mile.

The mine equipment consisted of one 50-h.p. boiler, locomotive type, one Lidgerwood hoist 8¼ by 10, and one four-drill, straight-line Ingersoll-Sergeant air compressor with four hundred and two cubic feet of free air per minute capacity. The shaft is fairly dry and equipped with a Cameron sinking pump, 2½-inch suction and 1½-inch discharge.

Hoisting is done by bucket with an ingenious bucket tripping device, which will be described later. The shaft on the deposit dips with the schist 70° to the west.

The lens lies in a soft green schist about one hundred feet east of the contact with a gray hornblende granite. The intrusion of the granite has caused planes of weakness and fracture in the schist, subsequently filled by pyrite.

The only impurity in the ore consists of small veinlets of quartz and massive pyrrhotite on each wall of the lenses. Occasionally pyrrhotite is also finely disseminated through the pyrite. The ore breaks nicely, making very little fines in the course of mining. Shipments up to 1 July 1906, were 220 tons averaging 42 per cent in sulphur. All ore goes to the General Chemical Company of Buffalo.

A force of sixteen men was employed at the mine with Mr. Ronald Harris, engineer in charge.

Helen Iron Mine Pyrite Deposits

The Helen iron mine (No. 21) has been described in several Reports of the Bureau of Mines, *i. e.* by A. P. Coleman in 1900 and 1901, and in a thorough and detailed account of the mine and Michipicoten Iron Range in the Report for 1902 by Messrs. Coleman and Willmott.[2]

As, however, the existence of pyrites in large quantity has only been revealed by the underground work of the past two years, the reports deal almost wholly with the occurrence of the iron ore.

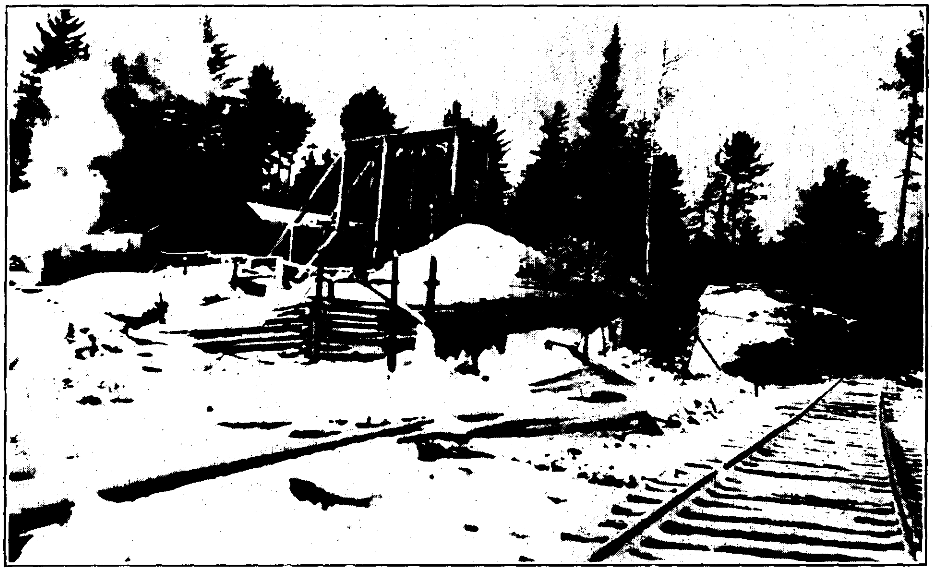
Roughly, the pyrite and hematite deposits may be said to lie in the arena of a vast elliptical rock-rimmed amphitheatre bounded on the east by a large steep hill of iron carbonate, on the north by cherty carbonate and quartz-porphyry schist, on the south by quartz-porphyry schist, and on the west by pyritous and cherty iron carbonates. The several series of rocks are interbedded and stand almost vertical.

Pyrite in Iron Ore

The Helen iron mine occupies the eastern end of this great pit-like depression. The ore body, as evidenced in the second level of the workings, is in the form of an ellipse

[2] Also by A. B. Willmott, Am. Geol., Vol. XXVII., No. 1, July, 1901, pp. 14-19.

Harris mine, Rib lake.



Harris mine, Rib lake, showing railway spur.

with an east and west axis, five hundred feet in length by a width of three hundred feet. The occurrence of pyrite intimately associated with this large body of brown hematite presents certain features differing from any other pyrite property examined. The pyrite as encountered near the surface is described in the Eleventh Report of the Bureau of Mines, 1902, page 170, as follows:

"At points in the ore body, pockets of pyritic sand are occasionally met. The largest of these, which was exposed during an examination of the Helen mine last May, as seen in the bottom of the pit, was forty-five feet by eight feet, but was probably wider. At both ends, however, it was cut off very abruptly by the ore body, there being no gradation between the solid ore and the pyritic sand. Occasionally in this bed, some boulders of solid ore were noticed, the largest being two feet in diameter. Little stringers of pure white fine sand were occasionally seen in the pyrites, but apart from these minor occurrences, the pyritic sand seemed to be a pure concentrate. It is said that on the surface this deposit first made its appearance as a chimney of sand about thirty feet in diameter, and that as followed down the siliceous sand was gradually replaced by pyritic sand until the present level was reached, and that the pyritic sand has been replaced in the bottom with solid ore just as abruptly as it changed on the sides."

From such a small beginning the pyrite has steadily increased with depth. At the first level, *i. e.* the depth of the bottom of the old pit, the amount is not very considerable, but on the second level the pyrite shoots or lenses assume something of a definite character. The hematite ore body is here found to be enclosed by a vast crescent-shaped deposit of pyrite. It is bounded on the east, north and west by this material, the south only having a rock contact. There are also throughout the iron deposit, large pyrite lenses with a strike parallel to the longer axis of the elliptical hematite ore body. The base of the iron pyrites deposits is found to have broadened with the opening up of each successive level. Although certain isolated pockets of pyrites are occasionally met with, the main shoots are sufficiently well defined to enable their location to be predicated on future levels, and the workings (especially the main gangways) directed so as to escape them. Although the fragile looking hematite is very cohesive, in mining such a large ore body pillars have to be left as supports. The mode of occurrence of the iron pyrites is skilfully taken advantage of, and the pillars consist almost entirely of pyrite enclosed in a shell of hematite. Although the work is laid out with this object in view, these pillars are frequently broken into, in order that no chances may be taken as to their real character. Notwithstanding the increase of the amount of pyrite, the hematite is not suffering appreciable diminution, as the base of the whole ore body seems to be broadening with depth. The pyrite however is increasing at a much faster rate and a horizontal cross section at the second level would reveal a pyrite area almost if not quite equal in extent to the iron ore. Although the third level has been only partially developed, the pyrite shoot disclosed by the workings appears to have a much larger area than it occupies on the level above.

Pyritic Sand

Another extraordinary feature in connection with this mine is the fact that the pyrite consists almost entirely of fines. Lumps of hard ore are occasionally met with, but the remainder is in a fine granular condition resembling very clean concentrates. A haphazard sample taken at a point in the second level resulted in 50.96 per cent. of sulphur, the impurity being silica This is probably a little higher than the average, as shipments from the mine have graded from 45 to 46 per cent. sulphur, but these, owing to contamination by hematite, *i. e.* in the mine tramcars, skip, surface cars, chutes, etc., run somewhat lower than the clean ore. It is safe to say, that in mining for pyrite alone and all due precaution being taken, the material would grade between 46 and 48 per cent of sulphur.

The pyrite in these lenses possessing a fine saccharoidal structure, and being closely confined by the hematite, exhibits the quality of flowing like hot dry sand at any point where the pressure is relieved. The horizontal flow at these points in a similar

Michipicoten Power Company, High falls, Michipicoten river, showing power house and penstock.

manner to water or grain in the bin of an elevator is the direct equivalent of the downward pressure of the superincumbent material. Therefore, if an opening happens to be made in one of the lenses prompt measures are at once taken to timber against the pyrite, preventing it from invading the mine workings. Owing to the smallness of the opening this is usually effected without much difficulty, but on at least two occasions the pressure was too strong for any ordinary means of resistance. In drifting on the third level one of these lenses of pyrite was encountered, and an endeavour made to drive through it. Ordinary timbering was of no avail; even the largest posts buckling under the immense load. A measure of success, however, was achieved by using large posts—sixteen inches in diameter and upwards—set almost skin to skin with similar caps, set in place by the aid of powerful jacks. This provided for the pressure, but the inrush of pyrite at the face was so great—evincing no diminution, regardless of the amount removed—that the project had to be abandoned, and the level laid out in a manner to avoid the pyrite.

Boyer Lake Deposit

The Boyer lake pyrite deposit is thus referred to by W. G. Miller in the Twelfth Report of the Bureau of Mines, 1903, page 103:

"The diamond drill now operating in Boyer lake has penetrated 100 feet of what is said to be a very clean iron pyrites. This is to the west of the mine proper . . . . All the pyrite is in a large body similar in consistency to a sand pile . . . . The pyrite is overlain with 40 feet of mud and 20 feet of intermixed pyrite and sand."

The diamond drill holes were put down through an area of one hundred by two hundred feet and disclosed pyrite to the depth, they were drilled, *i. e.*, 125 feet for the deepest. That similar masses in the Helen mine about one hundred yards east have increased in size with depth encourages the expectation that this deposit may be relied upon down to the same level as the bottom of the mine workings at least.

Pyrite at Sayer Lake

At the head of Sayer lake a small tunnel about forty feet in length has been driven in a hill just at the water's edge. The material is iron carbonate interbanded with pyrite. About one-quarter of the formation penetrated by the tunnel appeared to be pyrite. A sample from the dump (discarding all pieces absolutely barren) yielded 32.80 per cent. of sulphur. This formation runs along the shore to the north, pyrite outcropping at a distance of four hundred feet. The trench between Boyer and Sayer lakes cuts through an extension, the interbanded pyrite and carbonate here being fifteen feet in width. Some of these bands of pyrite are several feet in thickness. An average sample of these yielded 31.70 per cent. of sulphur.

To the north of Sayer lake a side cut for the railway has exposed interbanded chert and carbonate, pyrite and graphitic shale. The pyrite varied from half an inch up to a foot in thickness. Rapid oxidation is here going on, and the action of the decomposing pyrite and sulphate on the carbonate can be observed on the streaked and stained portions of the side of the hill. The whole range is about three hundred feet in width.

Considering the topography and the number of pyrite occurrences, there is some reason for believing that pyrite may be found under the little acid pond constituting all that is left of Boyer lake.

Not taking into consideration, however, probable ore or possible ore, 500,000 tons of high grade pyrite is not too high an estimate of ore in sight and disclosed by diamond drilling at and near the Helen iron mine.

Mention may be made here of a deposit of yellow ochre which covers the western portion of the Helen ore body. No work has been done on it, but a large amount of material is visible. Ries in "Economic Geology of the United States," page 187, states: "Ochres are classified according to shade of color, thus: yellow ochre is colored by hydrous iron oxide; red ochre owes its color to ferric oxide, and hence can be produced by roasting yellow ochre." He gives the imports of ochres into the United States in 1903, as 9,960,334 pounds valued at $100,447, France being the largest producer. The Mining World of Chicago states that yellow ochre is largely used in the linoleum industry, the quotations ranging from nine to sixteen dollars per ton. Simple screening, or grinding and screening, would be necessary to render the raw ochre marketable.

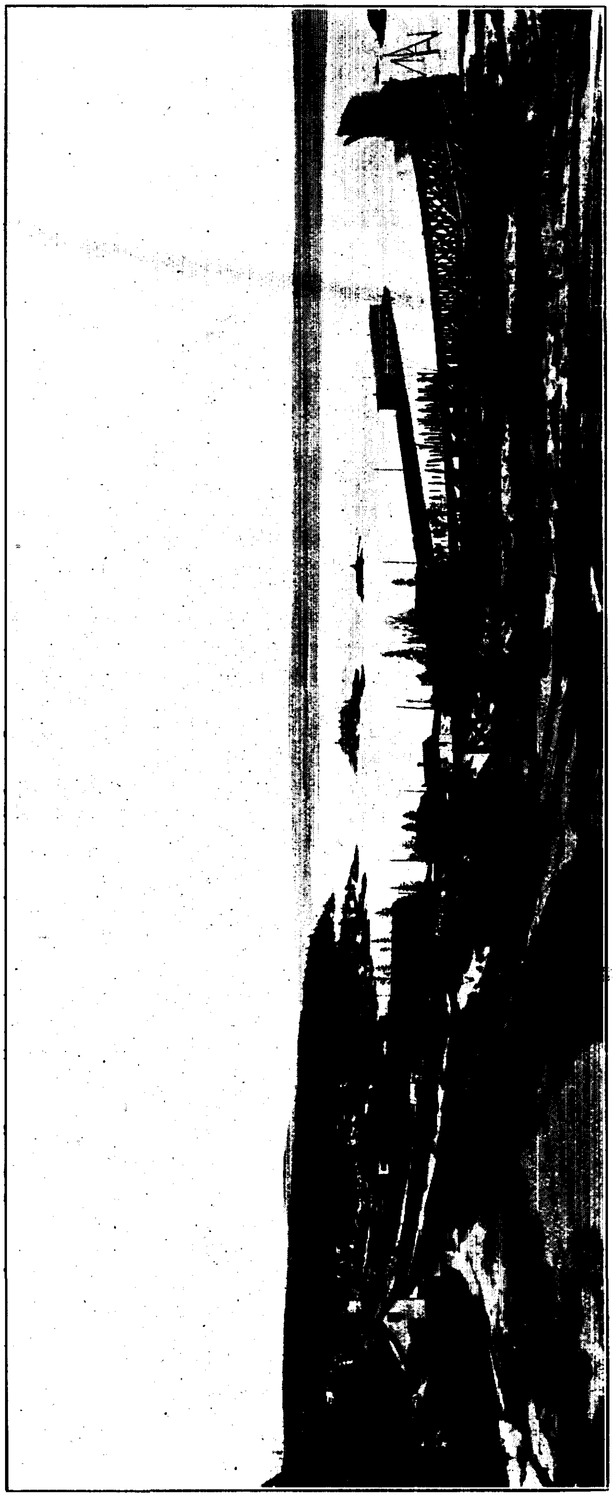
By the work of Messrs. Coleman and Willmott, referred to above, it has been shown that the Boyer lake depression has resulted from the folding and tilting of the underlying schists, followed by brecciation and denudation and the subsequent action of solvents.

Origin of the Pyrite

The Helen ore body has evidently resulted from the action of oxidizing conditions upon material in place. There are reasons for believing that this material was wholly composed neither of iron carbonate nor iron pyrites. The theory that the deposit as originally laid down consisted entirely of carbonate compels the assumption of vast cavities, *i. e.* at least three hundred feet in depth—equal to one-half of the whole ore body, and a concentration of pyrite fines in these cavities, as clean as mechanical means would effect. An enormous mass of finely desseminated pyrites, close at hand in a material more soluble than the grains of pyrite would also have to be assumed. On the other hand, if the whole ore body at one time consisted of iron pyrites only, it would now, except for difference of local conditions, resemble an ordinary pyrite mine.

If, however, the deposit originally consisted of a series of very high grade pyrite lenses lying in a formation of pyritous carbonate, oxidation would proceed in the following manner: The surface of the pyrite and the pyrite in the carbonate would be oxidized to ferric sulphate. This would immediately react upon the unchanged pyrite and the carbonate, being itself reduced to ferrous sulphate, and this in turn would be changed to the hydrous oxide with the setting free of sulphuric acid, which would at once begin anew the cycle of oxidation. Now, when iron carbonate is altered to limonite there is a shrinkage of fully 20 per cent. The resultant iron ore would therefore possess a very open, porous texture, and this is characteristic of the Helen ore. Also, at portions of the deposit, surface waters having passed over partly changed pyrite and dissolving the sulphates, would accumulate and seep through the underlying pyritous carbonate, the sulphate and acid in solution carrying on the cycle of change. This process would go on as far as surface waters could penetrate the loosely textured iron ore, and a purification in regard to sulphur content would ensue down to the present day.

Under ordinary conditions, the higher grade the pyrite, the faster and more thoroughly it will oxidize, but there is one case at least where the opposite of this is true, and the higher grade the pyrite the more effectually it will protect itself from weathering influences. Several examples were met with, where a pyrite deposit presented an inclined surface with good drainage. In these instances, layers of finely laminated limonite form over the surface of the pyrite, protecting it from seepage and other oxidizing influences. This is found to be the case with the pyrite lenses at the Helen mine. The water seeping and percolating as shown, found an obstacle in dense massive pyrite, the outside of which only was converted into an impervious schistose layer of limonite, which prevented any further oxidation. The miners are able to take advantage of this, being warned from the structure of the iron ore of the proximity of pyrite, the shell or casing conforming to its outline. The laminated ore, which is from fifteen to twenty inches in thickness, hermetically seals the pyrite. Although the mine in a dry season, makes, judging from the appearance of the discharge, about two hundred and fifty gallons of water per minute (and this is enormously increased in wet seasons) not one drop comes off the pyrite, which as pointed out has the appearance of dry sand. In opening up a pyrite prospect, between the gossan cap and the hard ore is found a



Michipicoten Harbor.

zone, varying according to conditions, of pyritic sand, identical in appearance with the Helen mine pyrite.

In the transactions of the American Institute of Mining Engineers, Vol. XII, page 531, W. H. Adams, in an article on The Pyrites Deposits of Louisa county, Va., speaking of the Arminus mine, states: "The pyrites is found at this mine 60 feet from the surface and to the 150-foot level is generally decomposed and granular in form."

Quoting Schönichen *re* Spanish and Portuguese mines, Dingl. Journal, clxx., p. 448, Adams says: "Their shape is that of large lenticular pockets in metamorphic clay slate, from twenty to thirty-six fathoms thick and extending to a length of 170 to 200 fathoms. The whole bed is filled with pure pyrites without appreciable gangue. These beds are found in a few places at two fathoms below the surface undecomposed and in a sandy condition easily got by pit work. In other places the zone of decomposition reaches from 10 to 50 fathoms downwards." As indicated, just before chemical change occurs, the massive pyrite is broken down into a granular condition, without any appreciable less of sulphur. At this stage at the Helen mine the process was arrested by the formation of an impervious coating of laminated iron ore.

Iron Pyrites in Conmee Township

Some work has been done on a deposit (No. 22) which lies about one quarter of a mile west of Bridge 31 A, on the Canadian Northern railway, some distance below Mokoman station, on lot B in the fifth concession of the township of Conmee, Thunder Bay district.

The deposit strikes northeast near the contact of conglomerate and the Mattawin Iron range. A deep covering of bouldery gravel obscures the surface, and the deposit can only be examined where a small pit has been sunk on the bank of Beaver creek. The bottom of the test pit is five feet below the level of the creek, and about 80 tons are on the dump. The pyrite-bearing zone appears to be about thirty feet wide.

The occurrence is one of replacement, wholly and in part, of the conglomerate by pyrite, which even when massive retains that structure. The more soluble pebbles have been completely replaced by pure pyritic nodules with a roughly spherical outline. In the other portions of the conglomerate, the substitution is more or less incomplete, the pebbles of pure silica being entirely unchanged.

An average sample of ore on the dump yielded 29.20 per cent. of sulphur.

Tip-Top Copper Mine

This mine (No. 23) is situated nine miles by trail southwest of the Canadian Northern railway at Kashaboiwe station.

Following is a synopsis of the underground workings: Shaft, 200 feet deep dipping 70° to north, and four levels fifty feet apart.

1st level,	Drift to	East	80 ft. in length.
"	"	West	40 " "
2nd "	"	East	70 " "
"	"	West	40 " "
3rd "	"	East	60 " "
"	"	West	40 " "
4th "	"	East	65 " "

Cross Cuts:—

1st level to the	South	60 ft. in length.
" "	North	140 " "
4th " "	"	130 " "

Stopes:—

1st Level,	East	40 ft. long,	25 ft. high,	8 ft. wide.
"	West	30 "	15 "	10 "
2nd "	East	40 "	10 "	10 "
"	West	30 "	10 "	8 "

Shaft No. 2 about 600 feet north of east from No. 1 is fifty feet deep.
Shaft No. 3 about 500 feet east from No. 2 is twenty feet deep.

The plant consists of two boilers, one 70-h.p. return tubular, and one 30-h.p. marine boiler; one hoist, cylinders, 6 by 8 inches; one Ingersoll-Sergeant four-drill air compressor.

W. G. Miller in the Twelfth Report of the Bureau of Mines, 1903, page 102, describes the rock association as follows: "The ore body strikes approximately east and west, and lies at or near the contact of talc schist on the north and green schist on the south. Along this line of contact there has been considerable disturbance, with perhaps some faulting, and a felsite dike parallel to the ore body.

"The green schist, judging from its character at the bottom of the shaft and on the south along the edge of the ore body, appears to be an altered or squeezed quartz diabase. A short distance west of No. 1 shaft, diabase showing little alteration and containing quartz grains is exposed in places. It shows the characteristic spheroidal weathering. The quartz grains in the schist and in the diabase are often bluish in color.

"On the third level of No. 1 shaft, the felsite dike has been cut through to the north of the shaft, and ore lies on either side of it. The ore consists of copper pyrites, pyrrhotite and iron pyrites. It carries values in gold in addition to the copper. The values are found both in the schist and in felsite and quartz. What has been called chalcedony appears to be a very fine grained aphanitic felsite or quartz porphyry. To the east of the present workings and near the boundary of the location is an outcrop of gabbro."

Although the Tip-Top is essentially a copper mine, an examination was decided upon with a view of ascertaining the availability of the ore as a source of sulphuric acid, especially in view of the fact that the resulting cupreous cinder, *i. e.*, after the elimination of the sulphur, would form an admirable flux for the elimination of silica in smelting the ore of the Bruce mines and surrounding district. This expectation, however, was not realized, and although massive pyritic lenses in the mine would run upwards of 40 per cent. in sulphur, there are extensive associated bodies of leaner and very highly siliceous ore requiring a large amount of iron. The production of sulphuric acid from a large proportion of the Tip-Top ore is quite feasible, but the question is one of economics, and the alternative of utilizing the fuel value of the sulphur in the ore in pyritic smelting is one of comparative costs, and does not pertain here.

A force of ten men was in charge of mine captain Sandow.

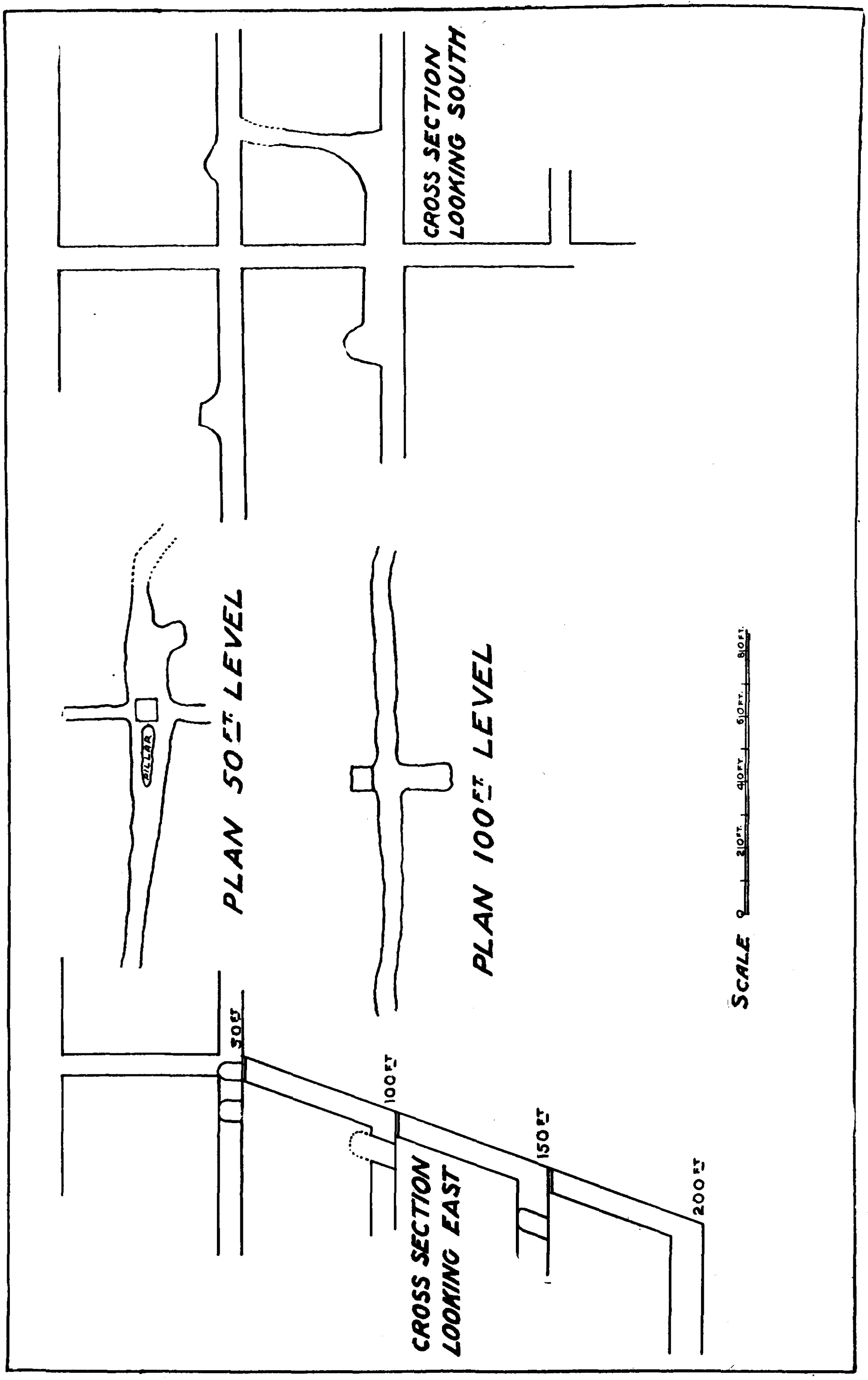
The Steep Rock Lake Deposits

This range has proven of great interest to geologists[3] and has been thoroughly prospected for iron ore. It lies north from Atikokan station on the Canadian Northern railway.

Three-quarters of a mile west from the shore of the lake the Mackenzie and Mann locations A L 461 and 462 have been prospected by four diamond drill holes. It is said that these disclosed a deposit of pyrites (No. 24), but details are not available. The country rock on the surface is interbanded silica and highly altered green schist. A peculiar graphitic calcite was observed here, similar to the occurrence of graphite in the crystalline limestone of Eastern Ontario. Along the trail is a small deposit of brown hematite six feet deep lying on the edges of the schist.

A very large deposit of iron pyrites (No. 24) has been uncovered at the southern extremity of Straw Hat lake. This is reached by a trail to the westward from the southern part of the eastern arm of Steep Rock lake. The work done comprises trenching, test pitting, and four diamond drill holes on locations 857X and 858X. The south trench shows a width of pyrite of over 140 feet, the eastern sixty feet of which would be quite high grade at shallow depth, as the only impurity was gossan. The ore showed unequal banding and nodular weathering. The eastern portion of the trench is somewhat siliceous, and would not run more than 38 to 40 per cent. of sulphur. A test

[3] Geo. Sur. Can., 1897, p. 55-56 H. Am. Jour. Sc., Vol. XIII., 3rd series, 1891, p. 317-331. Bur. Mines, 1895, p. 70-71; 96-98. Do., 1901, p. 133. Do., 1902, p. 309.



Assay map, Tiptop copper mine, Kashaboiwe, Ont.

pit 100 yards to the north near the camps shows very fine pyrites under a heavy capping of limonite and hematite. The hill on which the south trench is located is thirty feet high, and the whole gully to the west appears to be underlain with pyrite. Diamond drilling disclosed the pyrite in the form of a vast crescent, between the horns of which lies a deposit of hematite, an occurrence resembling very much that of the Helen iron mine.

The country rock to the west is an eruptive greenstone, and to the east green schist. These along the trail to Steep Rock lake show at times a curious ellipsoidal weathering.

The deposit is four miles level draw from the Canadian Northern railway to the southwest.

Other Rainy River Prospects

The sulphides of Nickel lake, of Turtle river, and of the Pipestone Lake iron range have been very little prospected, and whether several of these great gossan ranges (No. 25) are underlain with pyrite or pyrrhotite is as yet unknown. Work has been done at certain points on pyrrhotite, in the belief that it was nickeliferous, but except for diamond drilling on one location the pyrite has been ignored.

A. P. Coleman in the Report of the Bureau of Mines for 1894, page 74, states:

"Iron pyrites is found in quantities that may prove important in the future on the shores of Nickel lake between Grassy Portage and Rice bays. On 577P and 580P under a thick gossan of brown iron ore, one finds masses of solid pyrites several square yards in extent, and more than a foot in thickness. As little or no stripping has been done, one can hardly form an idea of the extent of these deposits. The mineral exists as a rather coarse granular mass in which the usual cubes may be seen. As it is common iron pyrites, and not pyrrhotite, the name Nickel lake is misleading, and it is probable that the locations were taken up there under a misapprehension."

This range extends for a considerable distance along the valley of the Little Turtle river, but as no work had been done, and the reports of timber rangers, etc., were exceedingly vague, a personal examination was not made. No prospectors of that district were met who knew the distinction between pyrite and pyrrhotite.

In the Eleventh Report of the Bureau of Mines, 1902, page 134, Dr. Coleman again refers to a deposit near Nickel lake, as follows:

"On the south side of Nickel lake in Watten township, however, a few miles farther west, the railway cuts through a considerable stretch of the Iron range, here of a somewhat unusual character consisting largely of granular silica, occasionally banded with magnetite, but more often heavily charged with sulphides, especially pyrrhotite. In places the sulphides become massive, hardly anything else being present, and one band of pyrites 15 feet thick just at the shore of Nickel lake may in the future be of importance as a source of sulphur. . . . Along with the granular silica of this narrow bulb of the iron range which strikes east and west on the south shore of Nickel lake, there are strips of black carbonaceous slate just like the black shale or slate of the Helen mine, and many other parts of the iron ranges to the east."

The Pipestone iron range was not examined, but from its similarity to the other western ranges associated deposits of iron pyrites may reasonably be expected.

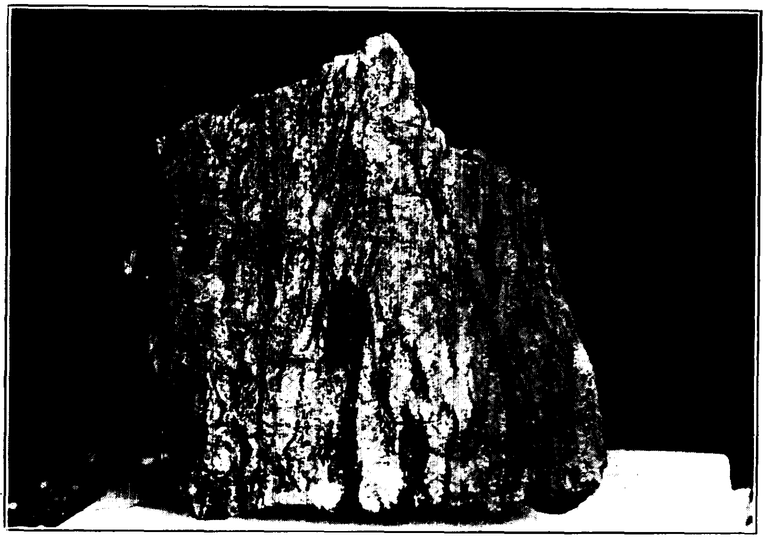
North of Riddell Siding

Locations A 274, A 257 and A 273 (No. 26) are situated about one and one-half miles north of Riddell siding on the Canadian Pacific railway. Here a heavy fahlband strikes in a northeast direction along a range of bare hills. In all the valleys and depressions along the range, high grade limonite is found. Some of this may have resulted from the decomposition of pyrites in place, but for the most part it has been derived from oxidation along the hills and subsequent deposition in the depressions. It was impossible to arrive at the depth of the limonite, but the surface area was quite extensive. No high grade gossan was observed in place on the hills, and the fahlband was in the main low grade. A small test pit, however, near the shore of a lake disclosed promising gossan and very fair pyrite. The country rock is a felsitic schist cut by numerous pegmatite dikes. It is said that a twenty foot shaft has since been sunk with good results, and that later operations have disclosed a considerable body of mixed pyrite and pyrrhotite running about 45 per cent. in sulphur.

The Michie Pyrite Mine

The Michie mine (No. 27) is situated on locations H. W. 716 and H. W. 715 at the shore of Big Vermilion lake about 35 miles northeast of Dinorwic on the Canadian Pacific railway.

The work done consists of a shaft 110 feet in depth and several test pits. A rocky ridge strikes somewhat north of east, and the deposit lies in a depression between this and the lake shore, running into the lake towards the west. The surface is obscured by a heavy blanket of boulder clay from 8 to 20 feet in depth. The only place where gossan outcropped was at the shore where the clay covering had been washed away. This gave the lake its name of Vermilion, and led to the discovery of the deposit during a prospecting trip for gold. The shaft has been sunk on the hanging wall side in country rock, but toward the bottom banded pyrite came in and a 12-foot drift to the south at



Specimen showing banded structure of vein near hanging wall, Michie mine.
Light = pyrite ; dark = schist.

the 90-foot level was all in this material. The shaft is 7 by 9 feet inside timbers, and is fairly dry, making only about five buckets of water per hour. About 75 feet south of the shaft a test pit discloses high grade pyrite. To the southwest of the shaft a prospect shaft has been sunk to a depth of thirty-five feet, the bottom of which is all in very high grade ore. At the lake front four test pits and a fifty-foot trench angle slightly across the deposit. These were said to show the same high grade ore to a width of one hundred feet. It was also stated that borings for a distance out in the lake of two hundred feet showed similar results. Although the heavy covering of clay renders it impossible to obtain exact measurements, there is here a large deposit of very pure pyrites that will run practically the theoretical percentage of sulphur. Some of the ore shows a laminated structure. The interbanded pyrite and rock near the hanging wall side, as disclosed by the shaft and cross-cut is suggestive of true vein filling, especially as some tourmaline was observed along the northern edge of the deposit. The laminated structure of the ore, however, renders it more probable that the deposit is of the replacement type, and that the banded pyrite and rock along the northern edge represents incomplete replacement of the schist. The country rock along the hanging wall side is composed of a greenish highly calciferous schist. The gangue matter of the pyrite is quartz.

The junction of the main line of the Grand Trunk Pacific railway, and its Fort William branch lies about four miles across well timbered and good agricultural country to the north.

The Fanning Prospect

This prospect (No. 28) is situated on the shore of Big Vermilion lake, eight miles west of the Michie mine. Some trenching through a blanket of boulder clay about four feet in thickness has been done at the extreme end of a point. High grade pyrite in seams from two to six feet in thickness is interbanded with graphitic shale. The deposit strikes east and west, and dips toward the shore to the north. It is said that borings in the lake out from the shore disclosed high grade pyrite to a width of twenty feet. The deposit dipping toward the shore could be very readily prospected by means of a diamond drill.

The Morley Prospect

This prospect (No. 29) is situated about three miles southeast of Schreiber on the Canadian Pacific railway, and about two miles from the north shore of lake Superior.

The work consists of a trench 36 paces long and eight feet deep, running north and south along the strike of the deposit, which lies between trap to the east and quartzite to the west. The pyrite is practically pure on the east side, but towards the west becomes mixed with pyrrhotite, and across a width of six feet is changed almost entirely to the latter mineral. Twenty-five feet to the east and farther down the hill a shaft has been sunk on a parallel lens. The shaft was filled with water, but judging from the quantity of material on the dump, would be about sixty feet in depth. The pyrite runs almost the theoretical percentage, but the major part of the dump is composed of pyrrhotite and intermixed pyrrhotite and rock. One hundred feet below, towards the bottom of the gully, a tunnel twenty feet in length has been driven into the hill to the east, with a cross-cut thirty feet in length, disclosing a very lean mixture of pyrrhotite and rock. One-quarter of a mile to the north, test pits have been sunk on some stringers of pyrite, the extent of which it was impossible to ascertain owing to the thoroughness of the weathering.

The Otisse Prospect

This location, 776 X (No. 30), lies about one and a half miles north of Schreiber at the north end of Cook lake.

A heavy fahlband strikes east and west for about a mile. The gossan capping had in several places been removed and test pits sunk. The largest of these was about twelve feet deep and twelve feet long across the strike of the deposit, which is here seen to consist of a very fine grained mixture of pyrite, pyrrhotite and silica. An average sample of the dump yielded 32.26 per cent. of sulphur.

Goudreau Lake Deposits

These extensive pyrite ranges (No. 31) lie about eighteen miles in a straight line to the southwest of Missanabie on the Canadian Pacific railway, and about three miles by trail west of the western end of Goudreau lake.

The country between Dog lake and Goudreau lake is composed of green schists cut by felsitic and greenstone intrusions. At the outlet of the more northerly lake of the Two Sisters, the formation consists of a fine grained conglomerate with pebbles the size of a small pea in a soft green cementing material. Three miles to the north this shades into a very coarse conglomerate, with light colored boulders upwards of twelve inches in diameter. Proceeding from this point up the creek flowing out of Goudreau lake, considerable disturbance has given the conglomerate a foliated structure, and the boulders are very flatly compressed, with the longer axes parallel to the schistosity. West of Goudreau lake, however, the conglomerate has shaded into a green schist.

The writer fortunately had extended to him the hospitality of Mr. E. C. Wylde, of the Lake Superior Corporation, without whose guidance it would have been impossible to find the deposits, as the trails had been obliterated by fire and subsequent growth.

For convenience the ranges will be roughly described as the North range, comprising deposits "A," "C" and the "Bear claim," and the South range, comprising deposits "B," "D" and "E;" True's trail running north of east between the ranges.

Approaching the deposits from the east, the trail passes to the south of the Bear claim and along the northern edge of two small lakes. At the western end of the second lake True's trail proceeds in a westerly direction. Another trail runs north to deposit C and another to deposit B in a southwest direction.

The prevailing formation at the lakes is a green schist. This has however been in places metamorphosed by the intrusion of greenstone to the north, to a vitreous hornstone schist. A well defined contact occurs a short distance to the north of the western end of the first lake.

Deposit C

For about four hundred paces north of True's trail, the path to deposit "C" passes over low ridges of rusty schist, and then through a depression underlain with limonite. Parallel with this, and striking east and west, runs a low ridge of pyrite with green schist to the north. A surface cross-cut here discloses a width of fifty feet of fairly high grade pyrite except for some bands of green schist, which could be easily culled out, and fine intermixed silica. The pyrite on the side of the ridge is covered with a thin scale of gossan which deepens towards the depressions. The total length of deposit "C" as disclosed by sixteen pits is about six hundred feet.

Deposit A

A short distance to the north and slightly east of "C" is deposit "A." In the vicinity of the hill on which the camps are situated, all of the depressions are underlain with limonite. Except for a few trenches, the exploratory work here took the form of diamond drilling. In the Fifteenth Report of the Bureau of Mines, 1906,[4] Dr. A. P. Coleman says:

"A section across the low hill near its west end shows green schist to the south, then limestone with some pyritous schist, 30 feet of pyrite, 12 feet of green schist 9 feet of pyrite and green schist to the north. There seems to be little continuity in the structure, however, and sections at different points vary greatly among themselves. Pyrites or gossan extends about 400 feet from east to west, with a width of about 150 feet; but it is greatly mixed with other materials, especially schist and limestone. It is stated that a diamond drill hole on "A" claim showed pyrite to a depth of 169 feet averaging about 35 per cent. sulphur."

Deposit B

Deposit "B" is reached by a trail about one-quarter of a mile long in a southwest direction from the outlet of the second lake. The central portion of this trail passes along a light colored siliceous schist studded with small broken crystals of hornblende, suggesting a sheared granite. Deposit "B" lies on the northern flank of a rocky ridge striking east and west and forming the southern shore of a small lake. Along the side hill, trenches reveal a length of 900 feet of either pyrite or gossan, and the lake bottom on that side appears to consist of limonite. The pyrite here, although somewhat interbanded with green schist, is of fair grade. On the side hill where drainage is good the

[4] Page 186.

capping is very thin and laminated, but becomes a considerable body of limonite in the lake and the depression at the eastern extremity.

Deposit D

Along the south end of a hill a short distance west of the lake is deposit "D." The exposed pyrite has here weathered in a very peculiar manner, fresh fractures showing an ore of much lower grade than the surface would indicate. This deposit is the smallest and lowest in grade of the series.

Deposit E

A short distance to the west across a small muskeg lies deposit "E." The following is quoted from Dr. A. P. Coleman's description of the Goudreau Lake pyrites deposits in the Report of the Bureau of Mines, 1906[5]. His account of the north trail which was not taken by the writer is also quoted:

"The first outcrop toward the west named "E" by the prospectors who explored it, runs east and west for about 100 feet, and in cross section shows from south to north.

Pyrite with some green schist	8 paces
Limestone (mostly hidden by debris)	6 "
Pyrite	4 "
Green schist (strike 100°, dip 60° S.)	33 "
Pyrite with some cellular silica	29 "
Very rusty banded silica (dip 25° S.)	19 "
Width of section	98 paces

"Just to the west of the hill top on which the section was measured, the limestone and much of the pyrites have been dissolved out as a narrow ravine, and here a shaft 25 feet deep has been sunk. The materials on the dump are mainly limestone, but with some bands and knots of green schist and many masses of pyrite—sometimes interbanded with the limestone."

"The limestone is exactly like that of the Grenville series, but the silica at the north end of the section is unmistakably Iron formation, though with little interbanded magnetite. The pyrites often has a porphyritic look, large crystals being embedded in a finer ground mass."

"A short distance to the north of this lake along the path from outcrop "E" a nearly straight band of crystalline limestone was followed for 410 paces. In some places it is thirty feet wide, though generally less than that, and parallel to it on the north runs a long depression sometimes showing gossan on its north side and perhaps representing a band of pyrites. The limestone is white or gray, and dips about 80° to the south with a strike nearly east and west. After the 410 paces diorite seems to cut off the limestone, but 160 paces to the east there are two sink holes running east and west as narrow trenches. The largest is 15 feet long and 8 or 10 feet deep, with six feet of partly decomposed pyrite at the bottom."

Bear Claim

As the writer did not have an opportunity of examining the Bear Claim, Dr. Coleman's description of it is also quoted:[6]

"The most easterly deposit, called the Bear claim, displays many interesting features, and has the largest extent of all the outcrops seen, with a length from east to west of 1200 feet and a width of nearly 300. To the west there is low peaty ground with small pools containing a foot or more of ochre or bog ore probably leached from the deposit, and much of the deposit itself is gossan covered or hidden beneath drift.

"A stripping near the middle shows gossan or pyrite at several points across the strike over a width of 150 feet, but no stripping crosses the full width. Towards the east walls of green schist or schistose hornblende porphyrite, rise on both sides, and at the east end of the deposit the appearance is that of an amphitheatre with walls 50 or 75 feet high. Here pyrites seems to dip in all directions under the hornblende porphyrite, as if it was a dome with the top removed. The pyrites has weathered out near the top of the wall of the amphitheatre, leaving the schist projecting over it like an eave. Whether the valley was formed by the destruction of pyrites is uncertain,

[5] Pp. 184-5.

[6] Fifteenth Rep. Bur. Min., 1906, p. 186.

but the arrangement suggests this. The pyrites of the Bear Claim seems more mixed with rock matter than in most of the deposits, but it covers a far larger area than any of the others."

The above descriptions show the very considerable pyrite-bearing area, and indicate the meagre amount of the exploratory work in proportion to that necessary for arriving at any adequate estimate of quantity and grade of available ore. A large extent of gossan and bog-ore covered depressions has not as yet been prospected. It is not unreasonable to expect that in some of these, deposits of pyrite, higher in grade than those of the hilly outcrops, may be found. Deposits "B" and "C" are higher in grade than the others, and, with very little culling, their product should run approximately 40 per cent. in sulphur. In the other ore bodies workable lenses of 40 per cent. ore, doubtless occur. The remaining material running between 25 and 35 per cent. in sulphur could readily be concentrated to a 48 or 50 per cent. product. The plant is quite simple, and the operating cost in a country replete with water power, should not exceed 60 cents per ton. The over burden of limonite is by no means insignificant economically, and will repay removal, especially if taken away before it becomes contaminated during the mining of the pyrite.

Some of the deposits are associated with outliers of the Iron formation, but the proximity of the eruptive greenstone to the north is suggestive of some of the Eastern Ontario occurrences.

Pyrites South of Chelmsford

The Clark pyrite deposit (No. 32) is situated on lot nine in the sixth concession of the township of Creighton, Algoma district. The strike is easterly. A trench fifty feet long, and three to twelve feet deep across the strike, shows gossan all the way. The gossan towards the north has clearly been formed by seepage from the deposit, which appears to lie along the side of a rocky ridge. Owing to the small amount of work done and the rapid oxidation, no pyrite could be observed in place, but some pieces in the dump were very high in grade.

The country rock to the south is a mottled crystalline schist, quite massive in structure.

The adjoining lot to the west, locally called the Craig and Hamilton property, has been prospected for copper. The work consists of several trenches, test pits and a sixty-foot shaft which has been sunk through interbanded iron pyrites, chalcopyrite, bornite schist and graphitic shale; the last being present in large quantity. The appearance of the dump indicates that if properly culled, the ore would grade high enough in sulphur content to be available for acid-making purposes.

These prospects are seven miles by good wagon road from Chelmsford station on the Canadian Pacific railway, and four miles across level country from the track.

North of the Height of Land

On an island portage on the Mattagami river, between its junctions with the Kakozhisk and Kapuskasing rivers, is an iron pyrites deposit (No. 33) referred to by A. G. Burrows in Report of the Survey and Exploration of Northern Ontario, 1900, page 66, as follows:

"The first of these (*i.e.* rapids) is passed by a portage over the island on the west side, and the second requires a lift out. At the former was observed a vein of quartz stained with iron oxide. The quartz is impregnated with pyrite and garnets. This vein is thirty feet wide and showed for forty feet. A sample of the vein material, nearly all iron pyrites, showed on assay $1.40 a ton of gold."

Referring to the same deposit, E. L. Fraleck on page 77 of the same Report states: "A band of highly oxidized ferruginous matter and pyritiferous quartz runs with the strike of gneiss, south 20 degrees west."

There is at this place, undoubtedly, a deposit of iron pyrites, but as no trenching has been done it is impossible to state definitely the quantity or grade.

In the Report of the Bureau of Mines, 1895, page 255, E. B. Borron quotes John Driver's description of a large pyrite deposit (No. 34) on Big river, a tributary of the Opazatika river. From this the following interesting extracts are reprinted.

John Driver starting out from Brunswick Post states:

"We followed the Missinaibi down to the Opazatika portage, which is in a straight line northeast 40 miles, and thence crossed over to Opazatika lake, which is 3½ miles south of Missinaibi river. From the west end of Opazatika lake to the junction of the Big river is 42 miles northeast, so that the distance over all in a straight line from the southwest end of Missinaibi lake is 91 miles, including 5¼ miles up the Big river to the pyrites bed or vein. Having looked over the vein, which I had no trouble to find, the next work was to cut out a path or road on the south bank down to the camp, a distance of 1¼ miles. . . . We uncovered the rock along the south bank the full width of the bed of pyrites, which is thirty-five feet from wall to wall. I put in two shots, which broke up the vein rock two feet deep, from which I got specimens. I then uncovered the rock 100 feet back from the bank, and found the vein covered over with a foot of sandy loam. My men uncovered the vein from wall to wall, and I found it to be 35 feet wide. The course is northwest 20° west, and at an angle of 65° east. In tracing the vein south I found it to be deeply covered with soil. The rock gradually rises in going back from the river, and at 300 yards is about 20 feet above water level of the river.

"When Mr. Borron explored Big river in 1886 he thought that the rock in the river was a boulder from which he got his specimen, but I found it to be part of the vein, 15 feet wide and 2 feet above the water. It crosses one-third of the river on the south side about 200 yards up stream. The river here takes a bend to the south, and comes back on itself, so that in following the course of the vein on the north side, it cuts across this point of land, which is a drift soil. . . . However, in following up the course, I found the vein to crop out at the foot of the rapid on the south side of the west branch of the forks of the river, half a mile northwest from the place where I had been working. Here the rock is deeply covered with stiff clay. I got the men to clean off the part of the vein, and took what specimens I could break off with my pick hammer. From the surface, the pyrites at this place does not look as good as at the lower place, although I am quite sure it is the same vein. The rock is so deeply covered with a clay soil that I could not follow it any farther, but no doubt it continues on for a much farther distance northward. In following up some three hundred or four hundred yards, I found that the country rock took a change, being on the west side of the vein Laurentian, while on the east side, and all the way down the river to the first rapid, it is a slate, what I take to be a Huronian."

No estimations were made of John Driver's samples for sulphur. In Report of Exploration, 1900, page 81, E. L. Fraleck states:

"At Lower Island portage on the Mattagami river there is every indication of a considerable body of iron pyrites, while Borron reports another deposit on one of the tributaries of the Opazatika river. To the north are large formations of limestone and dolomite. If it were desired to purify the pulp in that country, the raw material for the manufacture of the sulphite liquor and the elimination of the resins, is there available."

Deposits Elsewhere

In the vicinity of Rossport and Jackfish on the Canadian Pacific railway, north of lake Superior, locations have been taken up for gold, that seem to carry pyrite in sufficient quantity to warrant the expectation that they may develop into pyrite mines. Not being able to obtain authentic data as to the exact localities, the writer was unable to visit all these prospects.

In other districts, especially in the Sudbury region, prospectors appear to have at times opened up deposits of pyrite which were abandoned when nickel was found to be absent.

W. G. Miller in his report[7] on the Iron Ores of Nipissing District, discovered extensive belts of pyritous formation paralleling the iron ranges. He suggests that they form with the jaspylite ranges alternate legs of an eroded anticline. It is possible that these may form a source of pyrite, so soon as the districts in which they are found are provided with transportation facilities.

[7] Tenth Rep. Bur. of Min., 1901, p. 173.

Pyrite under Hematite

Several hematite localities in Eastern Ontario are known to be underlain with pyrites deposits. These have as yet been unexplored, but in years gone by various hematite properties were worked for iron ore, until contamination from pyrite became so great as to prevent further shipments, when in every instance the property was abandoned. The workable depth for iron ore varied between 50 and 70 feet. From the bottom of the largest hematite deposit in Eastern Ontario, the writer has seen pieces of ore with an inner core of high grade pyrite upwards of a foot in diameter. In some instances the ore consists of the soft red hematite, and in others the hard dense pyrite. There seems to be no doubt that these hematite deposits were at one time the gossan capping of the sulphide ore bodies, and that metamorphism due to disturbance or igneous eruptions has changed the limonite into hematite. In only one case of this kind has development taken place, namely, at the Eldorado copper mine, where it has been shown that a hard dense hematite has resulted from the alteration of a copper and iron sulphide underneath. The depth of alteration there varied between 60 and 80 feet." In the Report of the Geological Survey of Canada, 1873-74, page 222, B. J. Harrington speaking of iron pyrites states: "At the Dalhousie mine there is none visible in the ore, but, on sinking a trial hole a short distance southwest of the present workings, instead, as was expected, of coming upon the hematite, a bed of pyrites 4 feet thick is said to have been struck—a fact suggesting that the hematite may be the result of the decomposition of pyrites." It is the opinion of the writer, that with very few exceptions, nearly every hematite ore body in Eastern Ontario at least will be found to be underlain by a sulphide deposit of some kind, if not pyrite in every instance.

Geological Relationships

The nearest distance in a straight line from the most easterly to the most westerly deposits examined is about 900 miles, and from the most southerly to the most northerly deposit about 500 miles. Owing to the crescent shaped curve of the Province of Ontario around the Great Lakes this does not by any means represent a triangle of those dimensions. In the Bureau of Mines Report for 1894, T. W. Gibson states the area of Ontario to be 200,000 square miles, 60,000 of which lie south of the French and Mattawan rivers. Allowing 20,000 square miles for the post-Cambrian formations of southwestern Ontario, and 10,000 square miles for the Devonian of the extreme northern part, leaves approximately 170,000 square miles, throughout which the pyrite deposits have been found.

Regarded from the point of view of their geological relationships, the iron pyrites occurrences can be roughly grouped in three classes:

(1) The Gneissoid, comprising the Brockville and Mattagami deposits. In both cases basic dikes are in close proximity.

(2) Those of the Iron formation, comprising the Helen, Straw Hat lake, and probably the Goudreau lake deposits; those in the crystalline limestone of Eastern Ontario are similar in origin, if not in age.

(3) The remainder are associated with the crystalline schists with, in almost every instance, an eruptive greenstone close by.

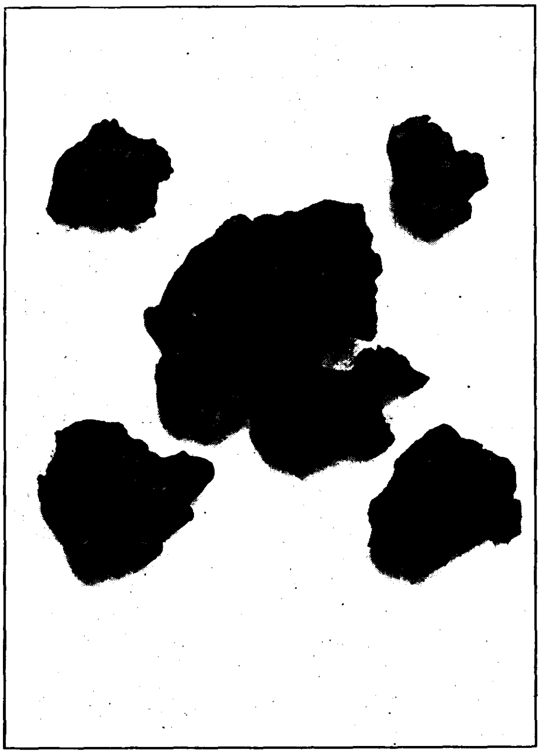
Formation of Deposits

In the case of the Bannockburn mine, as we have seen, the ore bodies are clearly due to facilities for deposition afforded by the folding of the schist. It is possible that a careful working out of the strike of the schists in other instances would reveal similar conditions. The intrusives seem to have no direct effect on the vein filling. None of the minerals produced by pneumatolytic action are found in any of the deposits. But the disturbances due to the eruption, followed by subsequent shrinkage on cooling, would necessarily cause severe zones of fracture and lines of weakness in the surrounding schist.

The pyrite lenses have pronounced dip and pitch, being very similar in these respects to ore shoots in a vein. Parallel lenses are frequent, but overlapping lenses were noted only at the Harris mine, and in that instance are certainly not caused by excessive buckling of the schist.

Graphitic shale is closely associated with many of the deposits, and this carbonaceous material may have had much to do with the deposition of the pyrite. The idea that the pyrite was sedimentary and subsequently formed in lenses by the squeezing and folding of the schist, is practically disposed of by the fact that the occurrences in metamorphic igneous schists differ in no way from those in metamorphic sedimentary schists.

Concentration at certain points in a fahlband by lateral secretion is also improbable, as the wall rocks are always altered though only for a short distance outward. Acid solutions have, however, worked through lines of weakness and fracture, and in some



Limonite deposit on mine timbers, Morley mine.

cases lateral secretion may have been an assisting factor. Whether the solutions were ascending or descending, and other features of deposition will have to wait until further light is thrown upon them by underground work being carried to greater depths.

Conditions of Oxidation

The analyses given in the foregoing pages are only intended to represent the material available for sampling at the time of inspection. It must be kept in mind that in nearly all cases oxidation had set in, but wherever possible the time of exposure to weathering has been given. This, however, cannot be taken as an exact indication of the present condition, as pyrite varies greatly in its capacity for oxidation, even in different parts of the same deposit. This capacity depends neither upon chemical analysis nor the character of the associated gangue, but the rule (not without exceptions) appears to be, the purer the pyrite, the more rapid the oxidation.

It seems, however, as if the rate of decomposition is largely governed by the density of the pyrite, *i. e.* by the closeness of its molecular cohesion. A photograph is reproduced of pieces of a deposit now forming on the rock and mine timbers at the Morley mine. This is proceeding with great rapidity, as the work was done only four years ago and on vertical surfaces such as the timbers composing the collar of the shaft the thickness is one-quarter of an inch in some places. An analysis yielded, iron 36.45 per cent., and sulphur 5.86 per cent. There are some instances, however, where pyrite will remain on the dump for years apparently without undergoing any change.

Nodular weathering has been referred to, and at Straw Hat lake a corrugated structure has been produced by different bands weathering more rapidly than others. Crystals withstand oxidation much better than the amorphous pyrite. Other things being equal, pyrite weathers inversely to the compactness with which it is laid down. The weathering out of the gangue more rapidly than the pyrite at Goudreau lake "D" and Conmee township deposits has been noted. In these instances sulphuric acid has probably attacked the soluble silicates, forming sulphates that are washed away and setting free silica, that deposits as a drusy coating in cellular cavities in the pyrite

Market Conditions

The New York Engineering and Mining Journal of January 12th, 1907, quotes the price for pyrite as follows:

Domestic Non-arsenical furnace size	per unit,	11 to 11½	cents
" " fines	"	9 to 10½	"
Imported Non-arsenical, furnace size	"	13 to 13½	"
" Arsenical, furnace size	"	12 to 12½	"
" Fines arsenical	"	8⅓ to 9	"
" " non-arsenical	"	10½ to 11	"

Pyrite prices are per unit of sulphur. An allowance of 25 cents per ton is made when delivered in lump form.

These are contract prices for pyrite, f. o. b. American mines or Atlantic Coast ports, and must be considered only approximate, as the price of pyrite varies at different mines and acid works according to the conditions of their location. The price obtainable by a shipper practically depends upon his ability to take advantage of these conditions in driving his bargain with the purchaser for the acid works. The question is nearly altogether one of freight rates, and is governed largely by the availability of the Spanish ores. That is, the price will practically be determined by the amount of the freight rate from the mine to the acid works relative to the freight rate from the Atlantic Coast ports. Acid works are located in the more northern of the Central States, which are unfavorably situated, both in regard to Spanish ores and to the American mines. There are acid works at Syracuse, Buffalo, Cleveland, Detroit, Bay City, Ashland, etc. These use ore from pyrite mines in the vicinity of DeKalb Junction, New York state; from the Davis mine in Massachusetts, and from Canadian mines, but depend mainly for their supply upon importations of Spanish ore, which of course has to be brought from the seaboard. Taking The Mining and Engineering Journal's quotation, Spanish ore at the seaboard ranges for lump ore from 12 to 13½ cents per unit, and adding to this the freight rate from American Coast ports to the acid works, a fair idea is obtained of the price Canadian ore would bring laid down at these points, a slight allowance being made for the superiority of the Spanish ore.

Prices for pyrite have been increasing slightly during the past two years, but Spanish ore has been falling off somewhat in grade, and contracts have been renewed at slightly enhanced figures. Active prospecting on the American side has failed to disclose any new important sources of supply. The policy being pursued is to re-open abandoned properties, and mine out the lower grade ore formerly passed over.

The average freight rate from the pyrite mines of Eastern Ontario to Buffalo varies from $1.10 to $1.34 per ton. In northwestern Ontario, assuming transportation were provided from the deposits to a near point on the Great Lakes, freight charges by boat to points where acid works are situated, would vary from 60 to 80 cents per ton. There is no reason why Ontario should not in the near future be able to exclusively provide the total consumption for acid works situate, not only on the Great Lakes, but also (when we consider that Spanish ore finds its way as far west as St. Louis) for those located some distance inland.

Pyrites is sold to acid works on long time contracts, extending usually from two to five years, and small quantities can only be sold at a certain loss in price. To obtain the best terms from an acid works, not only must a long time contract be made, but constant and uniform deliveries must be maintained during that period. This means that a pyrite deposit must be fairly well developed before the best advantage can be taken of the market conditions.

Requirements of Pyrite Deposits

(1) The deposit must be of sufficient size to warrant the cost of development necessary to maintain a constant supply;

(2) It must be favorably situated for transportation facilities;

(3) It must be free from any volatile impurities, such as lead, zinc, arsenic, etc. Through the development of the contract process, which necessitates washing of the gases, it is possible to utilize certain ores that formerly could only be employed for special purposes. Impure ores, however, notwithstanding high sulphur content, are heavily penalized.

(4) The ore must contain approximately at least 40 per cent. of sulphur content. The scarcity just at the present time, however, of pyrite is such that an ore grading between 35 and 40 per cent. would be saleable, especially if of good roasting quality, but at a somewhat diminished price on account of the extra material requiring to be handled.

(5) The ore must be of good roasting quality. A good burning pyrite ore will roast down to one-half per cent. of sulphur in the cinder. If the gangue consists of easily fusible silicates this percentage will be correspondingly increased. With the improvements in roasting furnaces, however, in recent years, and more care and skill being exercised in the handling of the mechanical adjustments, better results are constantly being achieved, and as much depends probably upon skilful roasting as upon the character of the ore.

Prospecting for Pyrite

When it is considered that out of the comparatively large number of prospects determined, very few were taken up as pyrite properties, that the Hungerford mine was taken up for gold, and a smelter at one time erected on the property; that the Queensboro mine was first taken up for gold and arsenic, and shipments of the ore were made to Marmora; that the Farrell, McIlwraith and other prospects, were first opened up in the search for gold; that the Helen mine is being operated for iron ore; that the

Goudreau lake deposits were located as iron properties; and that it was in prospecting for iron that the Straw Hat lake deposit and the Mackenzie and Mann locations were discovered; some remarks on prospecting for pyrite may be timely.

The distinction between the yellow iron pyrites and the magnetic variety, pyrrhotite, does not seem to be well known, and yet a simple test for magnetism will distinguish one from the other. The theoretical percentage of sulphur in pyrite is 53.2, and in pyrrhotite, 39, so that an analysis for sulphur will readily distinguish them.

Although pyrite deposits are not in every instance accompanied by a fahlband, yet this is almost invariably the case. Of course, there are thousands of fahlbands that contain no pyrite deposits, but every zone of imperfect pyritic impregnation that possesses adequate transportation facilities, should be prospected for pyrite.

A careful inspection should be made along the strike, and test pits should be sunk on any outcrops of gossan. A special scrutiny should be devoted to those portions of the fahlband in the vicinity of igneous intrusions. It is very rare to find gossan outcropping on the surface. Lumps and pieces, however, are often found in the soil, and underneath these the gossan is frequently found in place.

Test pits should be sunk on all spots where the soil is of a deep red color, although this sometimes results from leaching and deposition in depressions from a low grade portion of a fahlband. A deep red color is, however, greatly sought for by prospectors in Eastern Ontario. In a great many cases the gossan is found immediately below this soil, which becomes more and more red in color until the gossan is reached. The character and depth of the gossan depends not only on the grade of ore underneath, but, also on the position of the outcrop. Where drainage is fairly good, but yet not too rapid, the gossan will be of the character of an impure hematite, as at the Hungerford mine, where 23 feet was sunk in this material before any pyrite was encountered. On the other hand, where there are depressions that admit of concentration of surface waters, a considerable deposit of limonite is apt to be formed.

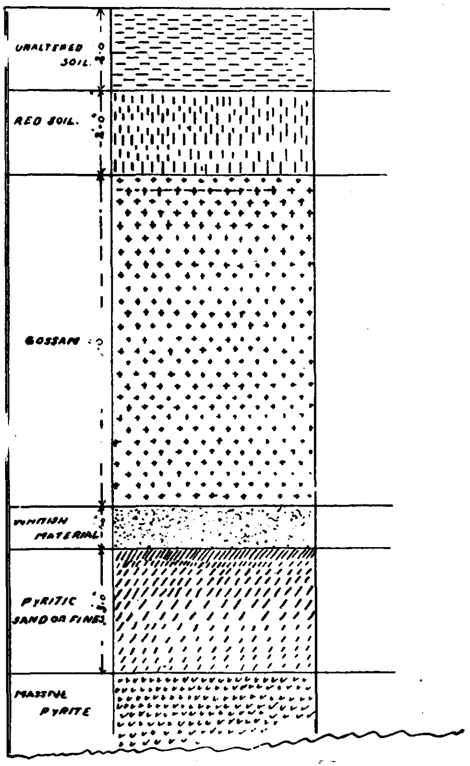
Analyses of Gossans

Analyses of gossans from various properties resulted as follows:

		Per cent.
Clark Prospect	Iron	42.70
	Sulphur	0.80
Rib Lake mine	Iron	41.30
	Sulphur	1.32
Morley prospect	Iron	36.45
	Sulphur	5.86
Ladore prospect	Iron	52.85
	Sulphur	.26
Tip-Top mine	Iron	52.19
	Sulphur	.45
Goudreau	Iron	52.56
	Sulphur	.42
Darling prospect	Iron	55.40
	Sulphur	.30

These samples are not intended to represent any average, but merely to indicate in a general way the character of the gossan. Of course, there are many instances where fairly good pyrites will yield a lower grade gossan, where surface dirt has had an opportunity to wash in and contaminate it. The depth of the gossan varies greatly according to conditions. As a rule, however, the higher grade the deposit, the higher grade will be the resulting limonite. In test pitting, the gossan tends to become darker with depth until a zone of whitish bleached material is reached. This consists of a mixture of pyritic sand, melanterite and gossan mixed with all the intermediate stages of decomposition. Underneath this there is a zone of pyritic sand usually in a moist condition, which can be shoveled out, but becoming more and more massive until the solid pyrite is reached.

The cut herewith gives an ideal section illustrating the foregoing conditions.



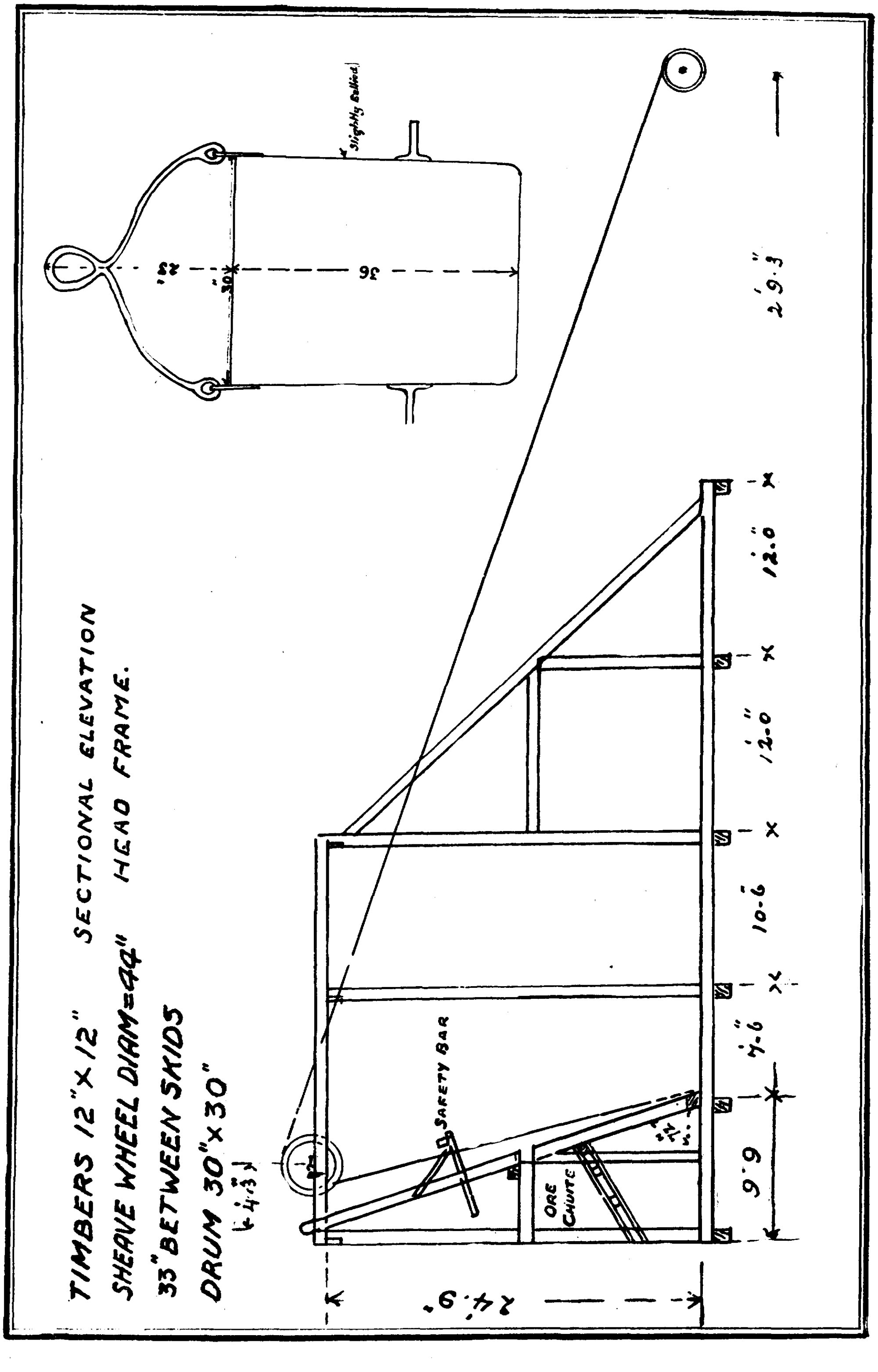
Ideal section of pyrite deposit, showing gradation upwards through decomposition products to soil covering.

Developing a Prospect

Surface trenching should be done at regular intervals until the boundaries of the lens are established. Care should be taken to ascertain the pitch of the lens along the strike before a shaft is located, or, as in the case of the Bannockburn mine, the shaft will either have to be turned at an angle to keep on the ore body, or considerable barren work done, which will increase in extent with depth as the pyrite pitches away from it.

It is a general practice to use the hand windlass for the preliminary work. A small derrick, however, is inexpensive, and a horse can be used for a straight draw up to 25 or 30 feet in depth without any inconvenience. This not only permits of more rapid work than the hand windlass, but larger loads can be handled, and there is the additional advantage of swinging the material away from the shaft, which saves re-handling. It is also a convenience in culling, as the ore and rock can be dumped in separate places. In opening a prospect ore should be carefully culled as it is taken out, and neatly piled in a separate dump. This point might be emphasized, as in very few of the prospects examined had there been any attempt at culling, but ore and rock had been thrown out together in a confused mass, rendering it very difficult to arrive at the proportions of each.

Pyrite mines are as a rule comparatively dry, but water is usually encountered before the first level is reached. This is nearly all surface water, and comes in through seams and floors in the ore. After reaching tight ground at a depth varying from forty



Bucket tripping device and bucket, Harris pyrites mine.

to eighty feet, the flow diminishes to a very small quantity. It is a usual practice to trap this water and instal a stationary pump on the first level. At the Queensboro mine, however, water came in to such an extent in the first fifty feet of the shaft, as to render further sinking impossible. A drift was made thirty feet to the east; it being the side from which most of the water was coming. The east 20 feet of this drift was excavated to a depth of five feet, and by throwing a timber across the front this constituted a sump 20 feet long, 6 feet wide, and 6 feet deep. At the entrance to the drift wall plates of 10 by 12 timbers were placed around the shaft and secured by rock bolts. On these, by means of elm plank, clay and cement a trough was constructed, which drained all the water into the water trap provided in the drift. The clay formed a cushion to prevent the cracking of the cement, rendering the drift fairly secure from the shock of the firing. A half hour's work every few days sufficed to keep the troughs in a state of repair. A stationary pump was placed at the entrance to the drift, and a piece of band iron attached to the steam valve of the pump. From this another piece of band iron fastened to a cedar float was suspended, thus enabling the pump to regulate itself as the water rose or fell.

Mining the Ore

The best mining practice consists of sinking a shaft, running levels for every hundred feet, drifting each way on the vein, timbering up mill chutes, and underhand stoping of the ore in the usual manner. Operations at the Bannockburn mine have shown the absolute impossibility of winning ore by the open pit method, or of underhand stoping, removing the whole of the lens as the work progresses. The work of the Hungerford mine, on the other hand, constitutes practically a model of the best practice.

The shafts follow the dip of the ore, and hoisting is done by either bucket or skip. In the preliminary stages of development, of course, the bucket is invariably used. Cuts are here given of an ingenious bucket tripping device, installed by Mr. Harris at the Harris mine, which saves the work of one or possibly two men at the head of the shafts.

As seen by the plans, which were kindly supplied by Mr. Harris, stout lugs attached to each side of the bucket travel on skids until they come to rest in a notch above the grizzly on which ore is to be dumped. As the lugs are set below the centre, lowering away causes the bucket to dump. The bucket is then raised a few feet, and when lowered the lugs catch a pair of curved arms, which, when inverted by lowering of the bucket, completely cover up the notches and allow the bucket to be lowered away down the shaft. It will be noted that the head frame must be within sight of the man at the hoist. The skids at the Harris mine are on an angle of 72°, and should not be any steeper for successful operation. Mr. Harris states that the reason for the safety bar, which prevents the bucket turning backward and discharging down the shaft, is in case a bucket is sent up nearly empty and loaded on one side; but if the buckets are loaded one-quarter full, or more, no care need be taken to have the load even.

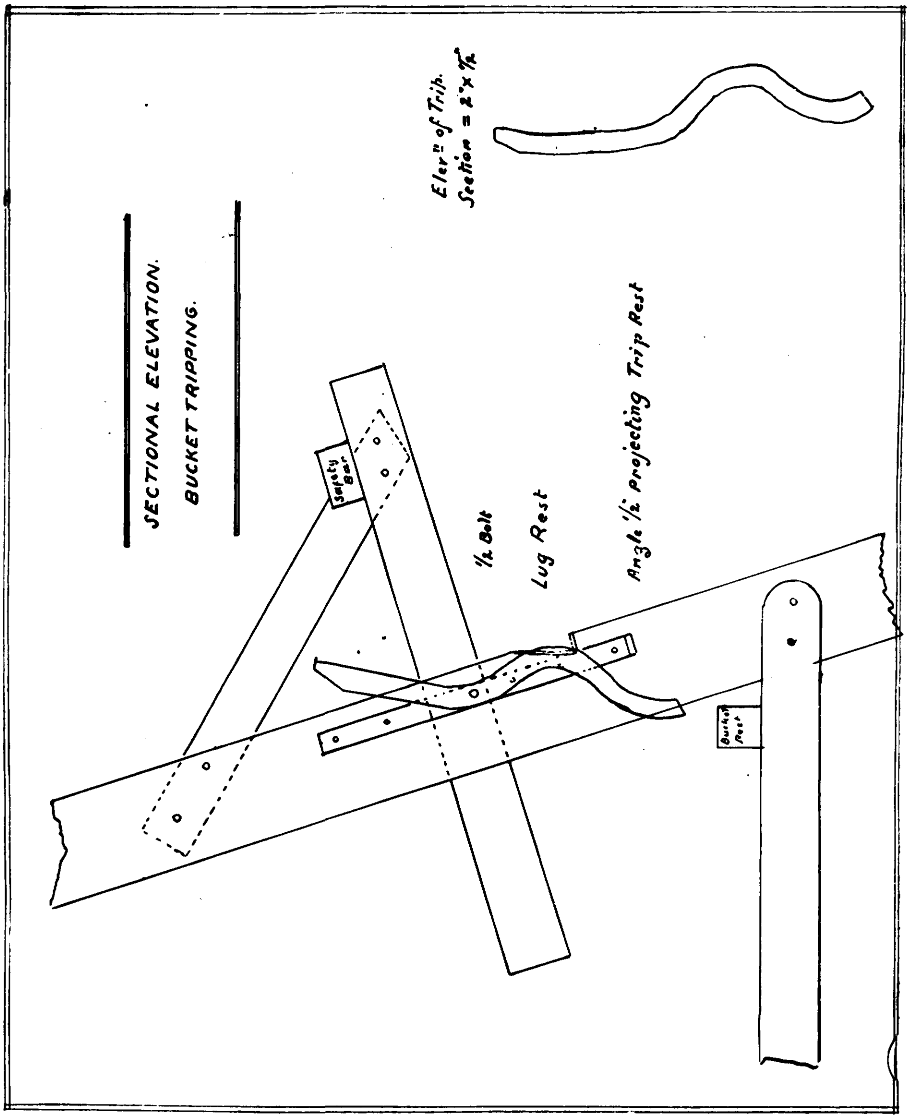
In Eastern Ontario, contracts for shaft sinking are let at prices varying from $14 to $16 per foot, the contractor supplying his own powder, caps, light, etc., the company bearing all the expenses on the surface. The total expense of shaft sinking would range from $25 to $30 per foot, and in watery ground from $40 to $50 per foot. Drifting under the same conditions is contracted for at prices ranging from $6 to $8 per foot.

The scale of wages paid in Eastern Ontario is: foremen, $2.50 per day; expert drill runners, $1.75 to $2.00 per day; blacksmiths, $2.00 to $2.25 per day; boilermen, $1.50 to $1.75 per day; laborers, muckers, helpers, etc., $1.50 per day. Board is obtainable at $3.00 to $3.15 per week. The total cost of mining and preparing the ore for shipment in Eastern Ontario under ordinary conditions ranges between $1.10 and $1.30 per ton.

In Northern Ontario prices are fixed by the Cobalt camp at $2.50 to $2.75 for drill runners; $2.75 to $3 for blacksmiths, and $1.75 to $2 for muckers. In this case the companies provide the men with board. In Northwestern Ontario labor prices are somewhat lower.

Pyrite in other Countries

According to Robert B. Brinsmade in the Engineering and Mining Journal, October 28th, 1905, the pyrite deposits of St. Lawrence county, New York, lie in, and



Details of bucket trip, Harris mine.

are conformable to metamorphic schists of the Oswegatchie series of the Cambrian. The properties produce some lump ore, but the main portions of the deposits require to be concentrated, and in the mining of Ontario pyrite, it will eventually be found profitable to concentrate the low grade material composing the cull lumps. A brief description of the method in vogue in St. Lawrence county, taken from Mr. Brinsmade's article is here given.

The concentrator of the Cole mine is the best equipped on the range. The ore is fed to two 14 by 18 inch Blake crushers, and then goes to a set of 12 by 24 inch Cornish rolls. Water is fed to both crusher and rolls. From the rolls the material is delivered to a trommel 36 inches in diameter and 6 feet length, with 3/16-inch round holes. This is set at 1:20 slope, and is connected to its driving pulley by a flexible joint. The resulting oversize is recrushed in 14 by 19 inch rolls, and fed back to the trommel head.

The trommel undersize, 3/16-inch particles and less, descends to four Hartz jigs, alike in form and adjustment. Each jig has three (24 by 32 inch) beds, with four-mesh No. 16 wire screens. Each bed is 4 inches deep at the lower and 5½ inches at the upper end, below the parting weirs. The concentrate from both the screen and the hutch is delivered by the flume and elevator to the storage bins.

Mr. Brinsmade states that the raw ore contains usually 20 to 30 per cent. sulphur, and the concentrate goes 40 to 50 per cent. in sulphur.

He gives the cost of mining for a production of 110 tons of raw ore, which produced 55 tons of concentrate as follows:

Mining, two shifts of 10 hours each :	
1 pit boss	$2.50
4 Italian muckers	6.00
2 American muckers	3.50
One shift	$12 00
Two shifts	$24.06
2 Rock drills, day shift, on contract at 7 cents per ft.—140 ft. average	9.80
Total mine labor	$33.80
Per ton raw ore	.307
Per ton concentrate	.614

The cost of milling this ore is stated to be 37 cents per ton of raw ore, and 74 cents per ton of concentrate.

The Stella mine, upon which mining operations have been recently resumed, has five parallel veins on the property. A new concentrator is being built to replace the old one which burned down in 1900, and when a branch railroad is built in 2½ miles from DeKalb Junction, the Stella will be the largest producer on the range.

The High F. lls mine is also being operated, and is equipped with a concentrator comprising two jigs with crusher and trommel in a manner somewhat similar to the Cole mine.

The production from these properties has gone mainly to acid works in that locality, especially those situate in Syracuse. It is expected that a considerable market may be found in the sulphite pulp industry of the Adirondacks.

The Davis Pyrite Mine

This deposit is described by J. J. Rutledge in The New York Engineering and Mining Journal, October 13th, 1906, from which the following notes have been selected:

The mine is located in the northwest part of Franklin county, Massachusetts. The foot wall of the deposit is of mica schist, and the hanging wall of quartz schist or quartzite. Intrusions of igneous rocks are common in the immediate vicinity.

Deposits have been opened up along the strike for about 450 feet, and down the dip for about 1,200 feet. Here, as at the Hungerford mine in Ontario, the ore is broken by hand. The undersize from the grizzlies, however, passes through a trommel, having an inside perforated plate with holes three-quarters of an inch in diameter, and an outside plate of three-eighths of an inch perforations. The fines from the trommel are then ready for shipment, but the undersize or "nut ore" is sent to the concentrating mill for crushing and jigging, after first going through a double trommel with inside perforations ⅜-inch, and outside 5/16-inch diameter. The undersize from this trommel goes direct to Hartz jigs. The oversize is recrushed, re-trommeled, and is then sent to the jigs. The average of the concentrate from the jigging grades from 44 to 46 per cent. of sulphur. The total output of lump ore in concentrate averages 3,000 tons per month. This ore finds its way west as far as Detroit, but most of it is consumed in Boston and the surrounding neighborhood.

Deposits in Virginia

These are described by Robert K. Painter in The Mineral Industry, 1905, page 522. The following notes have been taken from this article.

The lenses are of varying size; in the Louisa mines, lenses several hundred feet long, and at points as thick as eighty feet, have been worked. In the Cabin Branch mine near Dumfries 10 feet may be taken as the maximum thickness. The larger part of the output of the Louisa mines consists of fines. One mine turns all its ore into fines. At this mine the skip dumps upon a grizzly of railroad iron with bars set 3 inches apart. The slate is picked and forked from the two sizes, which go to their respective crushers at the head of the mill. By successive crushing with breakers and rolls, and screening by trommels, ore is here reduced to jig size and fed by a distributor to the Hartz jigs. Jigging through a bed of cast iron balls is employed, and the hutches discharge upon a belt conveyer of ascending grade, which delivers to the stock piles where the ore soon drains.

Assuming all the veins to have an average thickness of 5 feet with capacity of 4,000 tons per month, mining is stated to average $1.03 per ton; ore dressing 47 cents, which with general expenses of 10 cents, makes a total cost of $1.60 per ton at the mine. Mr. Painter further states that unless a mine be favorably situated with regard to shipping facilities, or contains ore bodies of large size, it should produce ore running not less than 50 to 60 per cent. pyrite to be attractive.

The ore from this locality is almost entirely consumed locally in the large fertilizer industries of the South.

From the foregoing, comparisons may be instituted between these productive points in the United States and the localities described in Ontario.

A certain amount of ore is mined at Pilley's Island, and on the mainland of Newfoundland, which is consumed at the acid works on the Atlantic Coast. These works, however, draw their main supply from the Spanish mines, such as the Rio Tinto.

The Rio Tinto deposits are of enormous magnitude, and occur at the junction of porphyritic rocks and Devonian clay slate. The more important Spanish deposits are located in the Province of Huelva.

Portugal possesses some important mines in the Province of Alemtejo.

A deposit at one time important as a source of pyrite is located in the Avoca district of the county of Wicklow, Ireland. It is associated with metamorphic slates and schists, which have been cut by pyroxenic and felspathic intrusions. At one point carbon is present in the form of graphitic shale. This is another instance of pyrite deposits which have been extensively mined for iron ore before the pyrite was encountered.

France possesses a deposit at St. Julien de Valgalques near Alars, at a contact between Lias shales and Oolitic limestone. Another deposit of similar nature occurs at Soyons.

In Norway are important pyrite deposits at Stordoen and Undal. These contain as high as 2.6 per cent. of carbon, and are black in color from this intermixture. Vigsnaes mine near Stavenger lies in highly folded schists near intrusive saussurite gabbros.

Importance of Ontario Deposits

The Ontario prospects give promise of comparing favorably in extent and grade with any which have yet been found, except the larger Spanish occurrences. The latter, however, which have been mined since the time of the Romans, show signs of exhaustion at some period in the future, and the average output is slightly but steadily decreasing in the percentage of sulphur content. As has been seen, very little real prospecting for pyrite has yet been done in Ontario, and the whole industry is still in the prospecting stage; our deepest mine not being down over 300 feet. Nevertheless, the total amount of available ore at the present time will run up into the millions of tons, and there is a large and constantly increasing market near at hand to the south of the Great Lakes. When, however, the importance to a country of large and inexpensive supplies of sulphuric acid, and its far-reaching effects upon a whole series of large and important chemical industries, is considered, the energies of the people of this country should certainly be directed toward conserving these enormous resources to the Province, and working them out as far as possible in our own country into a state available for final consumption.

Sulphuric Acid : Manufacture and Use

It has been often stated that the amount of a country's production and consumption of sulphuric acid is an index of its progress in civilization. This remark is in a general sense true, as the chemical industry above all others requires the greatest amount of technical education and skill; and as nearly every chemical industry in the world uses as a base, or depends upon, sulphuric acid as one of its main ingredients, it will be seen how important it is to a country to possess large amounts of the raw material necessary for this industry.

The largest amount of sulphuric acid consumed in the Province of Ontario is used in the refining of petroleum. In the purification of the distillates, ordinary sulphuric acid of 66° Beaumé is generally used, fuming sulphuric acid being employed in rare cases for varieties of oil difficult to purify. In a treatise on petroleum by W. T. Braunt, page 309, it is stated that the distillates from Canadian oil, for instance, required much more acid and time than distillates from Pennsylvania oil, and that "for purifying American distillates 2 to 3½ , and even 4 per cent. (sulphuric acid) is required, the quantity increasing with the yield of crude distillate, since the heavier oils require more acid."

According to W. H. Adams in The Mineral Industry, 1899, page 649, it takes one pound of sulphuric acid 66° Be. to produce a gallon of commercial petroleum (kerosene).

The next most important industry on the list is the manufacture of fertilizers.

It takes a ton of chamber strength sulphuric acid to decompose or dissolve a ton of rock in the manufacture of acid phosphate or fertilizer. For over twenty-five years The Standard Fertilizer and Chemical Company[8] have been in existence at Smith's Falls. Their raw materials are mainly native phosphate and ammonium sulphate from Germany. They make their own sulphuric acid in a small chamber plant from Sicilian brimstone. The resulting fertilizer is mainly sold in the Eastern townships of Quebec; a few local market gardeners and some Niagara fruit growers are also supplied. Considerable quantities of sulphuric acid are also used by fertilizer works in the vicinity of Toronto, using bone phosphate and waste products from the packing houses. Their product is all sold to fruit growers in the Niagara district.

An ever increasing demand for sulphuric acid is found in the nitro-glycerine dynamite and dualin industry. The acid in making nitro-glycerine is first mixed with nitric acid in the proportion of three parts of nitric to five parts of sulphuric. The sulphuric acid used must be chemically pure, and of the highest possible concentration. Dynamite works in Ontario consume about one-half ton of concentrated sulphuric acid per day.

Sulphuric acid is also used in Ontario in the manufacture of acetic acid. Calcium acetate obtained from the destructive distillation of wood is placed with sulphuric acid in huge iron retorts. Upon the application of heat acetic acid distils over. This industry consumes over a ton of sulphuric acid per day.

[8]Rep. Roy. Com. Min. Res. Ont., 1890, pp. 169 and 179.

A considerable quantity of sulphuric acid is also consumed in the galvanizing industry. It is used as a bath in which the wires and utensils are dipped for cleansing purposes. It is employed, too, in the tanning industry, and in the manufacture of aniline dyes, alums and other sulphates, wet cell storage batteries, nitric acid, hydrochloric acid, etc.

Roasting the Pyrite

Pyrite kilns or burners are of special design, and roughly speaking, of two main types; one for lump ore and one for fines. On this continent the old hand method of burning is largely discarded in favor of mechanical roasters, and furnaces of the McDougall type are finding favor in the old country. In former times it was considered impossible to roast the small stuff or fines, and hence it was that enormous quantities of granular pyrite were discarded as waste, until the introduction of the Spence furnace by W. H. Adams in 1883, rendering possible the use of this material. In Mineral Resources of the United States for 1897-1898, page 575, the statement is made that "It is now possible to construct a mechanical furnace at a cost of $1,500.00, which will perfectly roast 7,000 pounds of granular ore in twenty-four hours. Such furnaces require but little attention, and no extra cost for labor, thus meeting many objections put forward by chemical manufacturers for the past twenty years. Larger furnaces, which will roast 25,000 pounds American ores daily are constructed at a cost of $3,000." In the Mineral Industry, 1894, page 111, Mr. W. H. Adams states that the cost of roasting by means of the Spence furnace, including labor, fuel, repairs, etc., varies from thirty to seventy-five cents per ton of pyrites.

The Spence furnace, however, is being superseded by others of more recent design, the most popular of which is the Herreshoff. This consists of a series of concentric shelves and rabbles set one above the other. The ore is fed in from the top, and automatically works its way down, discharging at the bottom. The Herreshoff furnace is air cooled, whereas the Frasch furnace has a water cooling attachment. In the Falding Furnace there is a dead air space, which keeps the walls cool, and supplies hot air for concentration pans, etc. The Edwards furnace is finding great favor just now as a desulphurizing equipment in many metallurgical works, and it will be interesting to note the degree of success that furnaces of this type may meet with if their use is attempted in connection with acid plants.

The Chamber Process

Sulphuric acid in times past has been largely produced by the chamber process, which was introduced about 1810. During the last five years, however, this process has had to meet a formidable competitor in the recently developed contact process.

In the old chamber process brimstone, until largely displaced by pyrite, was roasted in specially designed furnaces. The resulting gases in these furnaces pass through a flue into a nitre oven, where meeting with a surface of nitrate of soda (which had been placed there in pots) they are decomposed, and the mixed vapors given off travel on and are passed through a Glover tower. This tower usually consists of a column lined with sheet lead, and filled with fragments of silica, through which the gases percolate. The object of this tower is to de-nitrate the nitrous acid from the Gay-Lussac tower, and to concentrate the acid on its way down. The Gay-Lussac tower is constructed on similar principles to the Glover tower, but is made considerably higher. In this the liquors obtained from the base of the Glover tower meet the ascending gases, absorb the nitrous acid, and are returned. The gases from the top of the Glover tower pass on through flues into chambers constructed of sheet lead connected to each other by leaden flues. Steam jets are introduced into the chambers by which the sulphuric acid is condensed; the nitrous acid gases passing to the Gay-Lussac tower to be recovered as described. The resulting chamber acid varies in specific gravity from 45 to 55° Be.

For a great many purposes, such as the superphosphate industry, and the manufacture of alums, this strength is sufficient. For ordinary purposes, however, the acid is usually sold at a strength of 60 or 66° Be., and for many other purposes such as dynamite, alizarine industries, etc., the acid requires to be of the greatest possible strength. To effect this concentration, it is necessary to heat the acid to such a point as to drive off the water. This is effected by means of platinum stills.

Contact Process

The contact process was first perfected by the Badische Anilin und Soda Fabrik at Ludwigshafen on the Rhine, after many years of research and expensive experiments.

The process depends upon the catalytic action of platinized asbestos upon a mixture of air and gases from the burners, converting the sulphur dioxide into sulphuric anhydride. One of the great difficulties met with in the successful operation of the process lay in the fact that the operation was seriously interfered with by the presence of any impurities in the burner gases, arsenic being exceptionally deleterious. It was found possible to completely purify the gases by an extended series of washing and filtration. The gases after washing are passed through a series of vertical tubes filled with platinized asbestos in such a manner as to form a contact with every portion of the gas, and yet not offer too much resistance to their passage. The resultant sulphuric anhydride is rapidly absorbed by water, forming a concentrated sulphuric acid.

Many advantages of this process over the old chamber system are apparent. In the Twelfth Census of the United States on Selected Industries, page 536, these advantages are set out as follows:

"First; No expense of construction and maintenance of the entire chamber system, including the Gay-Lussac and Glover towers and the steam and nitre plant. Second; No expense for nitre and for the sulphuric acid used therewith; although the resulting nitre cake can be utilized, it is rarely a desirable product. Third; The acid used is pure, strong oil of vitriol, requiring no concentration for sale or use. Concentration of chamber acid to high strengths, requires the use of platinum stills, which thereby lose in weight, the dissolved platinum being irrevocably lost. The rate of loss is much reduced by previous purification of the acid, but is always a considerable item of cost. Fourth; The contact acid is also free from arsenic, lead, or iron salts. The fundamental difference in the character of the reactions in the chamber process and those in contact method indicates the possibility of substantial improvements in the methods of roasting. Fifth; Although the 50° acid as it comes from the chambers, is desirable for many purposes—for example in making superphosphates—it is held by some authorities that it can be made more cheaply by diluting the strong acid with the needed proportion of cold water, than by introducing this water into the chambers in the form of steam. This, however, is denied by others, and it is probable that the chamber process will continue to exist, though in a more restricted field."

The success of this process and the extent of its introduction in the past six or eight years, has caused a great many reforms to be introduced in the old chamber system, some of which have proven their desirability.

Shroeder-Grillo and Mannheim Processes

Again, as platinum is a very expensive article, of considerable more value than gold, experiments were actively conducted in an endeavor to find a cheaper contact material. This has led to the perfecting of two other systems of the contact process, the value of which has been demonstrated.

In the Shroeder-Grillo process, by means of soluble salts, the contact substance is restored with very little loss of platinum. By 1901, the inventors of the process claimed that the platinum consumption was reduced to one-eighth.

The Verein Chemischer Fabriken in Mannheim have worked out a process in which ferric oxide (the cinder resulting from the burning of the pyrite) is the main ingredient of the contact mass.

Many contact plants have been erected in the United States during the past seven years, the Schroeder-Grillo being the most popular, and have proven their ability to compete against the old chamber process, even when using the raw material, impure pyrite ores, and also zinc blendes as at the Mineral Point Zinc Works, which are described in the Engineering and Mining Journal, September 1st, 1906. At this plant the Shroeder-Grillo process is used, The washed gases are heated to 400° C., and exposed to the catalytic action of finely divided platinum distributed on particles of magnesium sulphate.

A description of the Mannheim Contact Process by William Wilke is given in the Engineering and Mining Journal of April 21st, 1906. He summarizes the process as follows:

"1. The utilization of the heat of the ordinary roasting process for carrying on the catalytic action of the oxide of iron upon the sulphurous acid.

"2. The purification of the burner gases is a dry process. In all other processes the gases are washed and have to be dried again.

"3. The conversion or catalytic oxidation of that part of the sulphurous acid which passes through the iron contact but has not been converted, is brought about by means of platinum and reheated to the proper temperature by means of the waste heat of the burner gases.

"4. The whole process is carried on by moving the gases by means of exhausters only."

The first plant of this kind in the United States was erected in 1903 at Buffalo, N.Y., and had a capacity of about 1,600 tons of iron pyrites per month which has since been quadrupled. It is also stated that four other firms in the United States have adopted this process. One difficulty in the inception of the process was the fact that the catalytic action of ferric oxide was somewhat imperfect. This has been overcome in two ways; either by the use of platinum later on, or operating in connection with the chamber plant, in which the waste gases could be finally recovered.

The contact process has certainly come to stay. The revolutionizing of the sulphuric acid industry by its means is proceeding slowly and uniformly; the advantages though great, not being sufficient to warrant the scrapping of the chamber plants already in existence.

Some cinder, especially that obtained from the roasting of Rio Tinto ores, is low enough in sulphur to admit of being used along with iron ore in blast furnace work. The cinder, however, resulting from native ores is largely waste product, but, certain amounts are used in connection with the mineral paint industry.[9] The cinder is ground and then heated in retorts until the exact degree of oxidation is effected to obtain the desired color. This is largely used in the manufacture of paper, where a red color is desired, and also as an adulterant in paint manufacture.

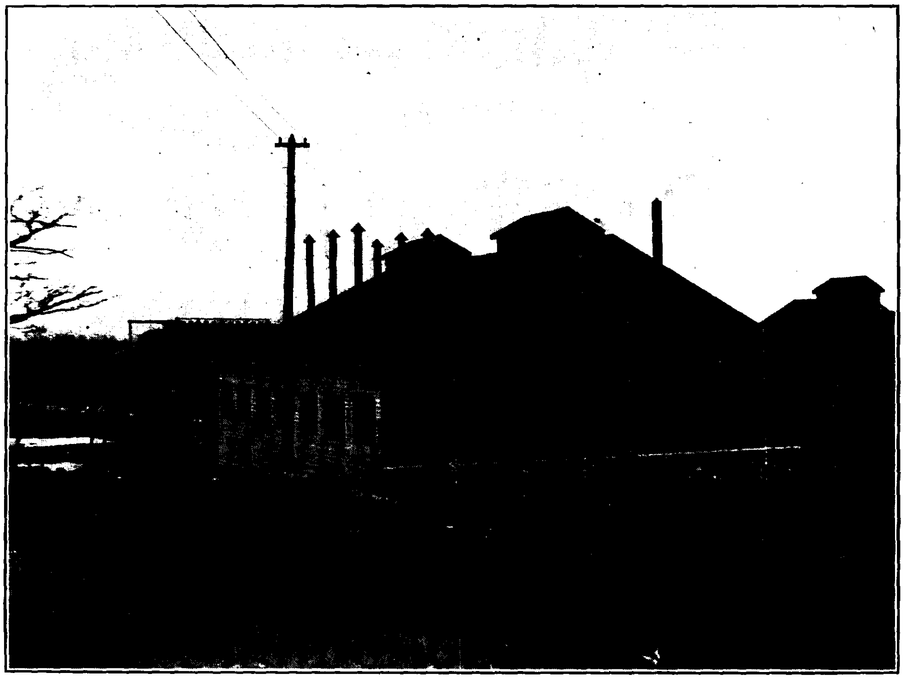
A New Industry for Ontario

Although references are frequent in the Geology of Canada and the Reports of the Bureau of Mines, to the uses of sulphuric acid, and the value of this industry to a country, no move along those lines until recently has been made in Ontario since the days of the old Brockville failure. In The Journal of the Canadian Mining Institute, 1902, page 148, Dr. W. L. Goodwin states: "We have some of the largest and best deposits of pyrite to be found anywhere in the world. One of these is now being worked, and the raw pyrite is shipped to the United States for the manufacture of sulphuric acid, etc. We import the acid for the manufacture of nitro-glycerine, etc. The pyrite is worth $3.00 or $4.00 a ton. Each ton will about make 1¼ tons of acid, worth $40.00. It would certainly be of great advantage to make our own acid, and even make it for

[9] Journal of The Canadian Mining Institute, 1903; C. A. Meissner on the Manufacture of Sulphuric Acid at Sydney, C.B.

export. If this were once begun, it would be the basis for a dozen other chemical manufactures, in which sulphuric and sulphurous acids are used."

In the fall of 1906, however, The Nichols Chemical Company of Canada, operating the Hungerford mine, commenced the building of a large acid plant, which they have located on a level piece of ground lying between the mine and the Canadian Pacific railway. Some idea of the large extent of the building operations can be formed from the illustrations. The works have since then been completed and put in operation. Some five carloads of pyrites per day are used in the manufacture of sulphuric, nitric and mixed acids. These products are shipped to all parts of Ontario and Quebec in the company's own tank cars. The contact process of manufacture is employed, the installation of which is made expensive by the large quantity of platinum required. The employees in the works and mine number over 150, the monthly pay-list being upwards of $6,000. The works are situated at the new station of Sulphide, where a thriving village is springing up composed almost entirely of the company's employees.



Burning room, Nichols Chemical Coy., Sulphide.

Uses for the Acid

The oil production of Western Ontario is constantly increasing, and the importations of crude oil also must continue to increase with increase in our population and the consuming capacity of our people.

The extension of our railroads, and the construction of large public works, canals, etc., require an ever increasing consumption of dynamite, etc., and steadily growing demand may be looked for.

The continuous expansion of the fruit and canning industries inevitably cause a more extensive use of fertilizers; also when we consider that farming lands in the older portions of Ontario have been steadily cropped for over eighty years. notwithstanding the increase of mixed farming due to the cheese and dairy industry there is no question

Nichols Chemical Company's acid works, Sulphide.

Acid Storage tanks. Nitric acid plant. Power House. Contact plant. Chambers. Sulphur burners. Mine shaft.

that the use of fertilizer in this Province could be widely extended. It is to a large degree a matter of education as to its value. Although in the United States the tobacco and cotton industry produce the largest demand for fertilizer, yet in the eastern section of that country, its use is practically universal. This has been due largely to the campaign of education instituted by the Federal and State governments, and by the fertilizer interests. It is reasonable to suppose that the same causes would produce an extensive demand for fertilzer in this Province, especially when it is considered that we have high grade phosphate and pyrite deposits, constituting the two main raw materials, almost along side of each other. An analysis of other sources of consumption in this Province indicates that no falling off in the demand may be anticipated, but on the other hand, there is bound to be a continuous increase in the consumption of sulphuric acid. By importing anthracene (a by-product of the coking of Nova Scotia and British Columbia coal) there is no reason why the aniline dye and other allied manufactures could not eventually be undertaken in this Province.

The alum industry is one deserving of attention, and to produce neutral or basic sulphate of alumina, 1,250 lb. of bauxite are used to 2,800 lb. of sulphuric acid of 50° Be.

The most promising field, however, for the use of iron pyrites within the Province is in connection with the sulphite pulp industry. Extensive plants of this kind are situated at Ottawa, Hawkesbury, in the Niagara peninsula, at Sturgeon Falls, Spanish River, etc. These companies manufacture their own by-sulphite liquor, using brimstone as the raw material. This brimstone is imported from Sicily, and costs on an average from $25 to $26 per ton laid down at the works. Roughly speaking, an average of 160 lb. of sulphur is required per hundred thousand pounds of sulphite pulp. Other plants, which are able to obtain their sulphur (on account of less freight rate) much more cheaply than the Ontario plants, are finding it more economical to use iron pyrites instead of brimstone. Eight years ago The Partington Paper Pulp Company of Dartford on the Kent equipped its Norwegian mill with pyrite burner apparatus. and many other European mills have since that time followed its example. In 1901 one sulphite mill in the United States was using pyrite, and since that time several others have followed suit, especially in the New England States. It is estimated by F. J. Falding that suitable pyrite for wood pulp manufacture would induce an economy of 75 cents to $1.00 per ton of pulp produced, and the farther from the seaboard the works were situated, the greater would be the saving. Take the example of a mill located in Eastern Ontario, which is now using 12 tons of sulphur per day in the midst of a pyrite-producing district. At the price of $25 per ton, sulphur is now costing them $300 per day. Equivalent to that amount of sulphur in a 40 per cent. ore would be 2½ tons of pyrite per ton of sulphur, or 30 tons per day. This could be laid down at the works say at $6 a ton or $180 per day,thus effecting a saving at this one plant alone of $120 per day by using pyrite instead of brimstone. Nothing is allowed for the little remnant of sulphur that will remain in the cinder, or for the slightly increased cost of handling, because these items would be more than compensated by the sale of the cinder.

No apprehension need be felt that sulphur production might increase to such an extent as to drive pyrite out of the market. The whole tendency of the two trades has been in the opposite direction. During the past twenty years a certain amount of sulphur each year, especially on this continent, has been replaced by pyrite. Brimstone cannot possibly compete with pyrite until it is laid down at points of consumption at $14 a ton, and there is no prospect that crude sulphur will ever be any cheaper than it now is. For many years the sulphur industry was dominated by the Anglo-Sicilian Corporation. In the last couple of years, however, Florida not only became a factor in the market, but is practically able to dictate terms, especially as far as the United States is concerned. This condition of affairs has been rendered possible by the success of the ingenious Frasch process. By this a well is drilled and then cased with an iron

? Louisiana

pipe 10 inches in diameter. This enters the rock overlying the sulphur a distance of ten feet. Inside is a pipe 6 inches in diameter, and inside of that one 3 inches in diameter, and inside of this again one of 1 inch diameter. The well is carried down to the bottom of the sulphur pit, and the small pipes dropped nearly to the bottom of the hole. Water heated to 320° F. is forced down the 10-inch and 6-inch pipes and compressed air down the 1-inch pipe. A column of sulphur rises with great rapidity. The success of this process caused such a state of alarm in its competitor that the Anglo-Sicilian Corporation has been practically disbanded, and the regulation of the Sicilian sulphur industry taken over by the Italian government.

Of the sulphuric acid works in Canada, one at Sydney, C. B., uses Newfoundland iron pyrites; one at Capeltown, Que., uses cupreous iron pyrites from that locality; and one at Vancouver, B.C., uses Japanese sulphur, which doubtless acid plants along the Pacific Coast will find it advantageous to use as raw material in the absence of pyrite deposits close at hand. Brimstone is still being used in small amounts in Ontario, at Smith's Falls and London, and to a considerable amount in the sulphite pulp industry, but notwithstanding the price to which brimstone at some future time might possibly be reduced, freight rates will always be a prohibitive economic factor in its competition with Ontario pyrite.

Availability of Pyrrhotite

Several years ago in the United States W. H. Adams foresaw that by exhaustion of pyrite deposits, pyrrhotite would have to be called in as a source of sulphur. One of the pioneers in this movement was The Lake Superior Corporation at Sault Ste. Marie, Ont. As no roaster had ever been designed for pyrrhotite, the Herreshoff furnace was changed to meet the differing conditions. The main alteration was in the regulation of the draft, so that the requisite amount of oxygen, and no more, might be supplied to the roasting hearths. It is stated by E. A. Sjostedt in the Journal of the Canadian Mining Institute, 1904, page 486, that a pyrrhotite ore as low as 20 to 25 per cent. in sulphur was found to be free-burning in the roaster used, and cinder produced as low as .20 to .75 per cent. in sulphur without obtaining a weak gas, but generally the amount was from 1 to 3 per cent. sulphur when not producing a good gas. Since this time the use of pyrrhotite in the southeastern States has become quite extensive.

The occurrences of pyrrhotite in Ontario, as given by W. G. Miller in the Report of the Bureau of Mines for 1900, page 207, are: "Dalhousie, lot 22, con. 2; lot 18, con. 3; Elizabethtown, lot 19, con. 2; Galway; Monteagle; Madoc, lot 10, con, 2; Olden; Wollaston, lot 15, con. 2, lot 22, con. 9." Other deposits are situated in Frontenac county near Mountain Grove; in Hastings county near Turriff and along the Hastings road above Millbridge, and in Haliburton county, more particularly in the townships of Galway and Glamorgan. From an economic standpoint, these deposits being non-nickeliferous, their only possible use is in the acid industry.

The day, however, is far distant when recourse to pyrrhotite will be necessary on account of the exhaustion of the iron pyrites deposits of Ontario. Owing to the vast extent of undeveloped and even unexplored territory, and the comparative slowness in providing transportation facilities, it is highly probable that the acid industry will draw from large well situated pyrrhotite deposits, while many remote pyrite deposits remain untouched. It is also probable, that with the ever increasing demand in the country for sulphuric acid, the problem of saving the roast heap gases of the nickel industry will be successfully solved, and an obnoxious waste converted into a financial asset for the companies interested and the whole Province.

Production of Pyrite in Ontario

The Reports of the Bureau of Mines give the production of iron pyrites, 1901 to 1906, as follows:

Year	Tons	Value
1901	7,000	$17,500
1902	4,371	14,993
1903	7,469	21,693
1904	13,451	43,716
1905	7,325	21,885
1906	11,090	40,583

The production for 1901 consisted largely of ore won from the open pit at the Bannockburn mine. The falling off in 1902 is to be attributed to development, the result of which is seen in the increased production of 1903. The robbing of the Bannockburn mine and the opening up of the Hungerford were responsible for the further increase in 1904. The decrease in the following year was due to the suspension of operations at the Hungerford mine, while the production of 1906 included output from the Helen mine and Rib lake deposits as well as those in Hastings county.

Although the coming years will undoubtedly show a steady increase in production, much time for systematic development of the deposits on the one hand, and transportation facilities on the other, will have to elapse before the output approaches anything like the amount justified by the character and extent of the Province's resources.

While it is true that the ordinary mining property presents some risk in the prospective stage, it is also true that the quality and grade of a pyrite deposit can be definitely ascertained, the cost of production, transportation and price of the ore accurately predicated, and the possibility of failure practically eliminated. The allurement for the general public of the mining of the precious metals is such that other and safer forms of mining investment are apt to be overlooked. The statement that none but countries rise to great material prosperity where the balance between mining and agriculture is evenly maintained, is only true if the products mined form the raw material for great metallurgical and manufacturing industries. This is the condition which should obtain in Ontario, and the capital which will enlist the best engineering skill in winning and working up these latent supplies of raw material, will not only reap a sure reward, but greatly contribute to the welfare of the Province as a whole.

The writer desires to extend his thanks to the many mine owners and superintendents for kindly hospitality extended, and also gratefully acknowledges assistance from many others in the preparation of this report.

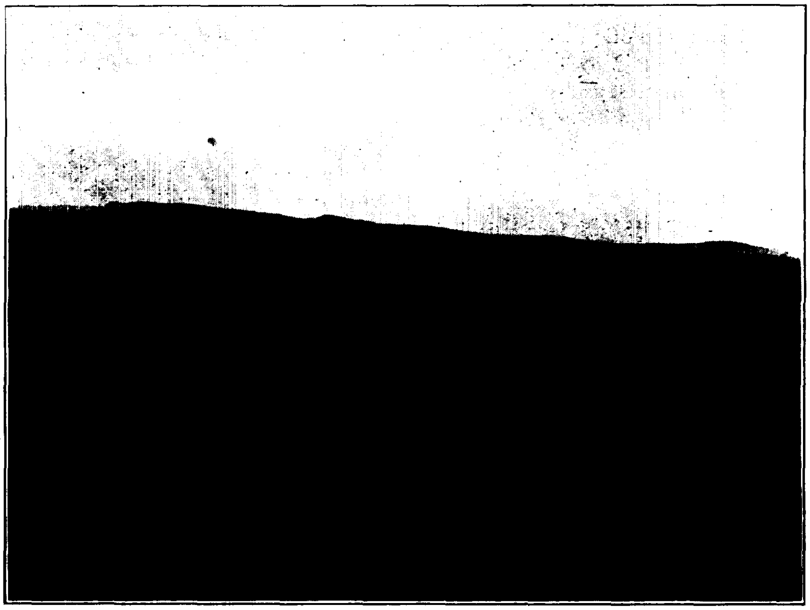
THE LARDER LAKE DISTRICT

BY R W BROCK

NOTE.—This report is based on field work which occupied about two weeks' time. The rocks have not yet been subjected to microscopical or laboratory examination. Consequently, the report must be considered tentative and subject to revision.—R.W.B.

Situation and Means of Access

Larder lake lies about 34 miles north of the head of lake Temiskaming, two and a half to three and a half miles west of the inter-Provincial Boundary Line between Ontario and Quebec, and a few miles south of the height of land separating the Ottawa and St. Lawrence waters from those flowing northward to James Bay. The location of the corner posts of the townships of McGarry, McFadden, Hearst and McVittie would fall in the main body of the lake near the north shore, so that the northeast arm lies in McGarry, the southeast in McFadden and most of the western part of the lake in Hearst.



Typical view of country about Larder lake. The hills in the background form the divide between Larder lake and Raven lake.

Access to the lake may be had by several routes. Those most frequently followed are via Tomstown, on the Blanche river, which may be reached from Haileybury and New Liskeard either by steamer up the Blanche river, a twice-a-day service, or by daily train to Heaslip, a station on the Temiskaming and Northern Ontario railway, two and three-quarter miles by wagon road from Tomstown.

From Tomstown a canoe route or a wagon road may be taken. The river from Tomstown to Wendigo lake on the east or Abitibi branch of the Blanche is swift, and three portages are necessary, the last one being a mile and a half long, so that the best part of a day is taken in covering this distance. As it is only about seven miles by wagon road to Wendigo, this is usually made the starting point for the canoe journey. This canoe route leads northeastward through the Wendigo lakes and a connected chain of eight small lakes to Raven lake, across the south end of Raven lake to Larder creek and up the creek to Larder lake. This route can be easily followed and the portages are short and light. The only portages of any length are the one into Raven lake and the one from Raven lake, round the falls of Larder creek. These two are each about one-third of a mile long. The trip from Wendigo to Larder can be made in a day, and at present this forms the best summer route for travellers and supplies.

There is also a wagon road from Wendigo to Larder lake. A little beyond the half-way house this road forks, the west branch followed by the telephone line running to Spoon's bay, and the east branch connecting with Fitzpatrick's bay, about sixteen or seventeen miles from Wendigo.

While a good route in winter, and not too difficult for foot passengers at any time, the wagon road is next to impassable for horses at the Larder lake end except during the winter season. A trail runs from Boston on the Temiskaming and Northern Ontario railway to Larder Lake city, a distance of about twenty miles. A good wagon road is now under construction by the Government between these two points, which when completed will afford the readiest means of transportation into Larder lake.

The first exploration of Larder lake was by Prof. W. G. Miller, now Provincial Geologist, who in 1901 made a reconnaissance survey of the Blanche river, in search of iron ore formations. He ascended the Abitibi branch and crossed Larder lake or Present lake, as it was then called. In his report, published in the Report of the Bureau of Mines, 1902, he called the attention of prospectors to the mineral possibilities of the region.

In 1904, after the discoveries at Cobalt, W. A. Parks made a geological survey of this portion of the country for the Geological Survey of Canada. His report was published in the Summary Report of the Geological Survey for 1904. The main object of this survey was the delimitation, north of lake Temiskaming, of the rock formation which at Cobalt had been proved to be silver bearing. He notes the discovery of gold during the summer, along the chain of lakes between Wendigo and Raven lakes, and expresses the opinion that this region is worth prospecting for gold.

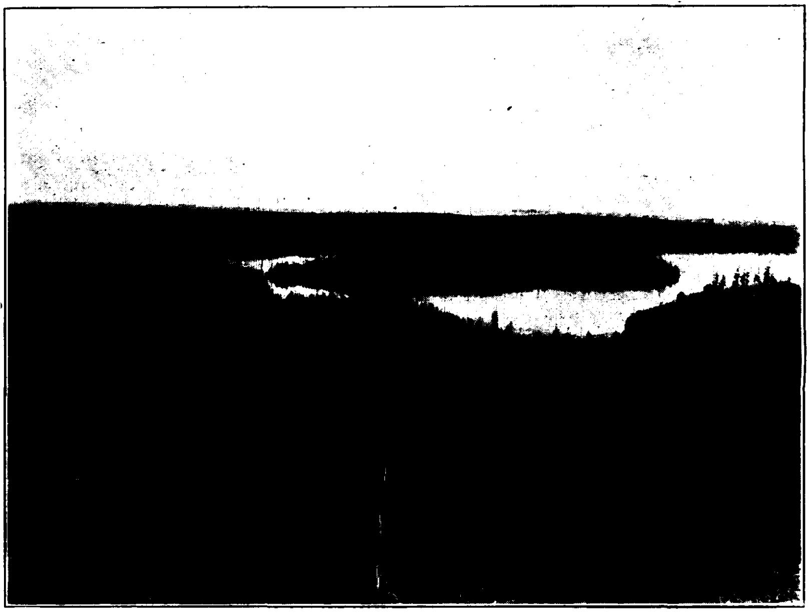
Discovery of Gold

During the summer of 1906, the great demand for mining property in northern Ontario, created by the Cobalt boom, caused prospectors to extend their operations far beyond the limits of the Cobalt field, and a number of parties found their way into Larder lake. It is said that gold had long been known to occur at Larder lake by an Indian, Tonene, in whose hunting ground the lake lies, and that when prospectors began to approach his territory he located the first claim, thereby attracting their attention to this as a gold district. The writer has not verified this story. Before the end of the season a number of prospectors had staked claims on the lake which furnished good specimens of free gold. The samples which they brought down at the end of the season caused a winter stampede to Larder lake, and practically all the ground in its vicinity and for some miles north was speedily staked. Something like four thousand claims were recorded. Necessarily a large number of them were snow-stakings of doubtful value. Companies were formed during the winter, to prospect and develop Larder lake claims, but only a portion of the necessary supplies reached Larder lake before the break up of the winter road, and since then it has been impossible to get them in so that little development work that would prove the value of a property has been done or may be done this season.

Topography

The country about Larder lake is on the whole of low relief, having the typical glaciated form of the Laurentian peneplain. Its surface is uneven, being broken by depressions occupied by lakes and muskegs, by knolls of sand or gravel, and by protruding knees or elbows of rocks. The skyline, viewed from the higher hills, is very regular and even, but is occasionally notched by a valley or by a monadnock hill of more resistant rock. Along the southeast and east of the lake, a range of hills rising 500 or 600 feet above the lake, separates Raven lake valley from that of Larder lake. At the north end of this range, cut off from it by a pass, is an isolated, mesa-like hill, called Shiminis.[1] This hill has an elevation of about 750 feet above Larder lake, and is about three miles from the head of the northeast arm. It forms the most striking object in the topography of this region.

The lake in many respects resembles Temagami on a small scale, with its arms and numerous islands. As a rule the shores are rocky, often steep, and in a few places rise abruptly as cliffs. High cliff faces, both round the lake and on the hills away from the lake, are almost invariably formed by vertical joint planes in the conglomerate formation, which will usually be found on the higher elevations. The average of barometer readings for June gives an elevation of about 1,100 feet for the lake. The shores reach an extreme height, at the head of Fitzpatrick's bay, of 200 feet above the lake. The



Larder lake, looking north from Fitzpatrick's bay.

depth of the basin occupied by the lake could not be determined, as there was no means of estimating the extent to which it had been filled with silt. The deepest sounding obtained was in the narrows where the depth was 94 feet. Other soundings are shown on the accompanying map.

Geology

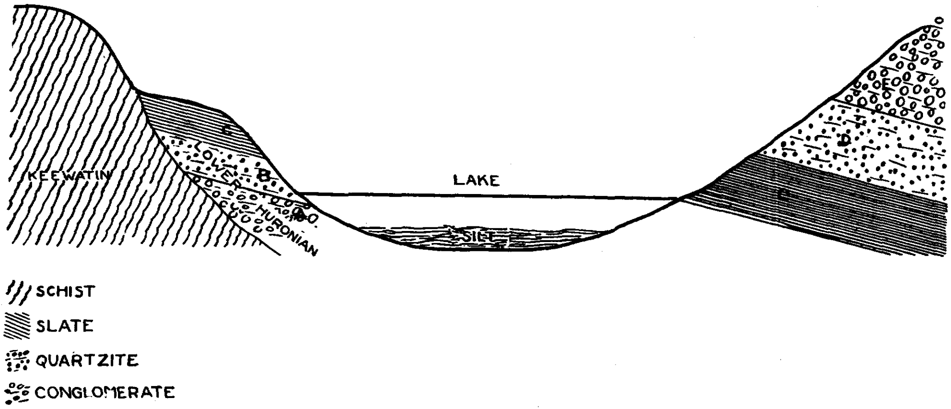
The rocks of the district present considerable variety. While a good deal of the territory is covered with drift—and contacts between the various rocks are particularly liable to be covered with this recent, unconsolidated material—the relationships between the chief groups of rocks may be determined with considerable certainty. An inspection of their general characteristics without consideration of the relationships exhibited

[1]See 11th Rep. Bur. Min., 1901, pp. 218, 219.

leads naturally to a subdivision of the rocks into several formations. A similar subdivision into the same groups is arrived at by classifying them according to their relationships to one another.

West and north of the lake is a complex, consisting of phyllites, schists, cherts, ferruginous dolomites and greenstones, cut by igneous rocks. These rocks as a rule are lying on edge and are characterized by the disturbances and metamorphism to which they have been subjected. Cutting them at various points about the lake are pegmatite and quartz porphyry dikes, evidently connected with a granite intrusion. From the number of granite boulders scattered over the surface, it is evident that not very far away the granite is exposed. While later than the rocks of the complex, the rocks of the granite family are undoubtedly older than the sedimentary rocks mentioned below as overlying the old complex, since these sedimentaries contain fragments of the granites.

Lying unconformably upon the preceding complex is a series of sedimentary rocks consisting of slates, quartzites and conglomerates. These are for the most part undisturbed, with gentle dips, except in the immediate vicinity of a later igneous intrusion, where they may show considerable local metamorphism. In such cases differentiation from the earlier complex may be somewhat difficult, but the undisturbed condition of these rocks affords the readiest criterion for their recognition. This series is exposed on most of the islands of the main body of the lake, on the north shore near the narrows, and on the east shore of the lake.



Ideal section showing relationship of rocks on Northeast Arm of Larder Lake.

Later than and intrusive in the rocks above mentioned, is an igneous rock which in places presents a gabbro facies, and in others a diabase, and also a series of usually small, basic, mica dikes.

The rocks of the basal complex correspond perfectly, in position and in lithological character, in their disturbed and metamorphosed condition, to the oldest formation in the lake Superior and lake Huron districts, which the International Committee on Geological Nomenclature recommended should be called Keewatin. The rocks of the granite family correspond to the Laurentian as defined by this Committee, and the sedimentary series to the Lower Huronian. As no rocks newer than the diabase or gabbro were seen, it can be classified only as Post-Lower Huronian.

Above the solid formations are glacial and post-glacial deposits of clay, sand and gravel. There are, then, in descending order the following formations:

Name.	Rocks.
Post-Glacial	Clays, sands, gravels.
Glacial	Boulder clay.
Great Unconformity.	
Post-Lower Huronian	Diabase, gabbro, mica lamprophyres.
Igneous Unconformity.	
Lower Huronian	Conglomerate, quartzite, slate.
Unconformity.	
Laurentian	Granite, pegmatite, porphyry.
Igneous Unconformity.	
Keewatin	Greenstone, lime silicate rocks, schists, dolomites, cherts, etc.

It will be noted that the rocks here bear a strong resemblance to those at Cobalt, the chief differences being that none of the upper members of the Huronian are represented, but on the other hand the Keewatin contains a more varied assemblage of rocks.

Keewatin "greenstone," which may represent altered limestone. The dark portions are green lime-silicate minerals; the light are calcite. Pancake creek trail.

It is interesting to find at such widely separated points as lake Superior, lake Huron, Cobalt, and the Height of Land, the same rocks, showing the same relationships, falling into the same scheme of classification; thus confirming the idea that the rocks as grouped represent great and widespread systems, separated by profound alterations of geological conditions during great time intervals.

Keewatin

The Keewatin, as above noted, consists of a complex group of rocks of both igneous and sedimentary origin, highly disturbed and metamorphosed. Possibly the commonest rock is a green chlorite schist, which probably represents an old, squeezed, eruptive rock. Sometimes this is thinly fissile, and sometimes rather massive. Hornblende schists are rather common. A soft grayish-weathering schist with green chloritic seams is also of frequent occurrence. These schists are often charged with pyrite in well formed cubic crystals.

Bands of soft micaceous schists, phyllites or slaty rocks, and a rusty weathering dolomite (?) are in places conspicuous members of the series. With the latter rock on Pancake creek is a thinly banded chert, like the jasper bands of the Iron ore formation. A banded green and white cherty rock on the east shore of Fitzpatrick's bay, also bears a strong resemblance to Keewatin Iron ore formation, a resemblance strengthened by the folding and faulting to which it had been subjected. From the number of its boulders in the Huronian conglomerate, typical banded red jasper and magnetite iron ore must occur near here, possibly buried under the Huronian. It is exposed in the township of Boston to the west.

Greenstones, some highly altered, and some showing original textures, cut the older rocks of the system. These greenstones often exhibit the typical spheroidal markings, torsion cracks, quartz and calcite seams that characterize the Keewatin in the Cobalt and lake Superior districts. On the southeast corner of Fitzpatrick's bay, near the point west of the Golden Thorn, and on Haycock hill where Brunné's trail to Boston turns west round the bend of Pancake creek, is a rock consisting of boulder-like masses of green, calcium-magnesium-iron silicate, cemented by crystalline calcite. All stages from this pseudo-conglomerate to massive green-silicate rock with seams of calcite occupying gashes like torsion cracks, are to be found. The green silicate rocks present the characteristics of typical Keewatin greenstone. Where the rock consists of boulder-like masses of silicate in calcite, it bears a strong resemblance to a limestone partially altered to green silicate rock by contact metamorphism, and the massive greenstone to the more completely altered limestone. The numerous old intrusive rocks in the Keewatin would account for the metamorphism.

While it would require more detailed work to establish the truth of this hypothesis, there are several facts which make it quite possible that some of the Keewatin "greenstones" may have had this origin, although the majority of the greenstones, without doubt are altered eruptive rocks. The Keewatin certainly contains a considerable amount of sedimentary material which must have been metamorphosed by the extraordinarily numerous intrusions of igneous rocks. Limestones or ferriferous dolomites are included in these sedimentaries, and would be expected to be altered to green silicates. This would explain the remarkable richness in lime-carbonate which some of the Keewatin "greenstone" has been shown to possess.

The Gold-bearing Rock

The most interesting rock from an economic standpoint near Larder lake is the rusty weathering dolomite(?). About 60 per cent. of the rock consists of lime-magnesia-iron carbonate, the remainder of quartz and a soft green talcose silicate, probably serpentine. The origin of the rock is as yet a little uncertain. Certain dikes, when squeezed and altered, produce a rock which bears a strong resemblance to it, but its occurrence with slates and phyllites and with the cherts—undoubted sedimentary rocks—as a conformable band with them, over a wide stretch of country, and its apparent composition, render it much more probable that it is an altered, stratified, ferriferous dolomite, probably forming a member of the Iron Ore formation. This rock, especially where cut by the porphyry or pegmatite mentioned in the Laurentian on a later page, is traversed by innumerable stringers of quartz which in places are gold-bearing. This rock was seen northeast of Reddick's at the head of the Northeast arm, extending southwest, about parallel to the arm, to about the Proprietary Company, where it gets back a short distance from the lake, past Bear and Tonene lakes, Pancake creek, Bluebell and Maxwell claims, north of Larder City and around Pancake lake. A similar band seems to occur south of Spoon's bay, and at one or two points on Fitzpatrick's bay. The Keewatin rocks are folded, contorted and faulted. They are generally on edge. That this represents the true dip, and not merely schistosity, is shown by the succession of sedimentary bands on going across the strike.

The Keewatin rocks form the oldest and most disturbed formation at present recognized. These rocks were formed during a very extended portion of geological time and under changing geological conditions. It is more than probable that this series should be subdivided into several formations, for some of the rocks are very much newer than others and have been subjected to much less alteration. Some disturbed and squeezed conglomerates intimately related to the Keewatin, as on the west shore of the main lake about a mile below the narrows, seem to belong to this formation, and if so mark unconformities which might be utilized to subdivide the Keewatin. The subdivision is rendered difficult, however, by the degree of metamorphism, and the disturbances through igneous intrusions.

Serpentinized and silicified dolomite (?), dissected by quartz stringers. Bluebell claim.

The Keewatin is not only cut by eruptives belonging to this period, but by later intrusions as well. As will be shown below, mineralization on an extensive scale took place during Keewatin times.

A long time interval elapsed between the Keewatin and Lower Huronian during which the Keewatin was a land surface subjected to heavy erosion. This erosion produced a topography not unlike that of this country at the present day. Some of the old Keewatin valleys are now present-day valleys, as the northeast arm of Larder lake, which, as the contact between the Keewatin and Lower Huronian shows, was a valley at the close of the Keewatin. Erosion and transportation must then have greatly exceeded atmospheric weathering, for the Keewatin surfaces and hills were swept bare of rotted rock before the Huronian was deposited on them.

Keewatin greenstone with torsion-like cracks, left by the weathering out of calcite. Pancake creek trail.

Spheroidal markings on metamorphosed Keewatin near Golden Thorn, north shore of Larder lake.

Laurentian

Included in this formation are the pre-Huronian granites, and related rocks, which are intrusive in and therefore later than the Keewatin, but which antedate the Huronian. In many places in Ontario these rocks cover large areas. Often they have been mashed to gneisses. Around Larder lake, in the areas examined by the writer, the only possible representatives of this formation are the pegmatites and quartz porphyries that cut the Keewatin more or less frequently wherever it is exposed. Erratic boulders of granite are, however, abundant, and similar boulders are held in the Huronian conglomerate, so that it is reasonably certain that pre-Huronian granite occurs in the neighborhood.

The pegmatite dikes are numerous in the Keewatin. The quartz is apt to be segregated, and to contain more or less "mineral" such as pyrite and specularite. The country rock in the neighborhood is apt to be somewhat silicified and mineralized, and occasionally gold is found as in the Gold Hill claim. The pegmatite becomes porphyritic in places, and passes insensibly into porphyry.

Glacial erratic of Huronian conglomerate on the polished upturned edges of Keewatin schist near the narrows, Larder lake.

The porphyries are quartz-bearing rocks with distinct phenocrysts of feldspar. Sometimes the base is reddish and sometimes gray. These porphyries are also associated with mineralization of the neighboring country rock. At the Peerless Mining Company's claims on Fitzpatrick's bay the gray porphyry is mineralized with pyrite, and occurs as fragments in a quartz vein.

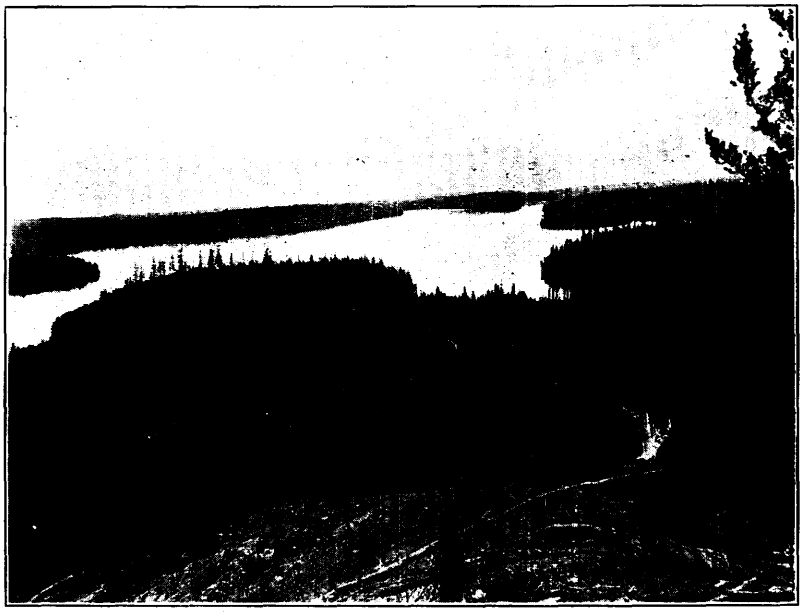
The dikes of porphyry are numerous in the Keewatin.

There were extensive disturbances following the Laurentian and previous to the deposition of the Huronian, and the former rocks were eroded extensively before the formation of the latter.

Lower Huronian

On the upturned edges of the Keewatin and Laurentian, eroded into hill and valley, the Lower Huronian rocks were laid down. The actual contact between the Huronian and the Keewatin is usually concealed by drift. At certain points at least, the basal member of the Lower Huronian appears to be a breccia-conglomerate, carrying angular fragments of the Keewatin rock immediately underlying it, as seen on island CC,[2] on the small patches of conglomerate left on Gold Hill, and along the shore near the Reddick claims. This rock does not appear to have any considerable thickness. It is succeeded by a thin band of quartzite, and the latter by a considerable thickness of slate. This is again succeeded by quartzite, which becomes coarser and contains a few boulders near its top, and is succeeded by a thick coarse breccia-conglomerate. The thickness of the various members of this group varies at different places. The slates must have a maximum thickness of at least several hundred feet, the quartzites one hundred and twenty-five, and the conglomerate several hundred feet.

The boulders of the conglomerate are rounded to angular, and vary in size from small pebbles to masses 10 or 12 feet in diameter. The great majority are under a foot in diameter. They include all the Keewatin and Laurentian rocks recognized in the district, besides numerous boulders of red and of gray granite, jasper, and finely banded jasper-magnetite—Iron Ore formation.



Fitzpatrick's bay, Larder lake.

Boulders of the Keewatin containing mineralized quartz veins cut off sharply at the edge of the boulder are not infrequent. These veins are mineralized by pyrite, galena, specularite, etc., just as the veins now found in the Keewatin. Boulders of the rusty weathering dolomite (?) with mineralized quartz stringers are among these Keewatin boulders, showing that some of the mineralization of this district dates back to pre-Huronian times.

Certain beds of the conglomerate are apt to be rich in boulders of one kind of rock, and adjoining beds rich in another. The supply of boulders evidently came from alternating sources.

The conditions under which the conglomerate was laid down have not been deciphered. The most obvious explanation is that it is of glacial origin. In this case the basal conglomerate sometimes found, made up of fragments from the immediately

[2] See map of Larder lake.

underlying Keewatin, would represent uneroded and untransported remnants of the earlier Huronian beds, while the slates, quartzites, and upper conglomerate would represent more or less sorted glacial debris.

Some striated boulders of the conglomerate at Cobalt, found by A. P. Coleman,[3] have been taken by him as proof of the glacial origin of the Lower Huronian. The latter evidence, as pointed out by W. G. Miller, is not conclusive, as the rocks at Cobalt have been much disturbed, and some, if not all, of the striations to be seen on the boulders are to be accounted for by these movements, which have slickensided the boulders. Referring to the origin of the Cobalt conglomerate, Miller says,[4] "In the present state of our knowledge we have little warrant for claiming that the granite boulders, often two or three feet or more in diameter, and distant a couple of miles from exposures of the rock, indicate glacial conditions during Lower Huronian times, although we have no proof to the contrary."

Proprietary Company's camp on Northeast Arm.

The thickness and widespread extent of the conglomerate in northern Ontario, where its general characteristics seem to remain constant throughout, the clean-swept and often rounded surfaces of the older rocks on which it is frequently laid down, and the extraordinary variation in the size of the boulders—these and other facts stated above regarding the conglomerate of Larder lake, furnish the strongest evidence yet found, for a glacial origin. But there are still difficulties in the way of its acceptance. The deposits cannot be said to have the appearance of glacial deposits. There has been no boulder-clay recognized—the material has at least been re-sorted.

Many of the boulders have re-entrants; when polished they have often the form of boulders worn by river sand.

The Huronian is for the most part undisturbed and almost flat-lying. The slates might be expected to contain fossil remains, if animals with hard parts existed in the waters in which these muds were deposited. None, however, were discovered. Where examined, the Huronian rocks appeared to be barren of all trace of mineralization

[3] 19th Annual Meeting, Geological Society of America, New York, Dec. 1906.

[4] Rep. Bur. Min., 1905, Part II. See also Canada Mining Journal, No. 1, Vol. I.

except in places disturbed by later eruptions, where some quartz veins were occasionally developed. In the Cobalt district, however, the Lower Huronian is probably the chief mineral-bearing horizon.

Post-Lower Huronian

At a few points, cutting the older rocks and the Lower Huronian, is an igneous rock which is in places a gabbro, in others a diabase. It is exposed on the north side of "A.A." island; on a reef near the east shore north of this island; on the east shore east of "R" islands[5]; and at the head of Fitzpatrick's bay. In places it is a coarse feldspar-pyroxene or hornblende rock with red feldspar segregations like the diabase near Cobalt. At other places it is fine grained, with small lath-shaped feldspars and a pronounced ophitic structure. At the head of the southeast bay, at the south end of Fitzpatrick's bay, behind the cabin, its contact with the Lower Huronian conglomerate can be traced. The line of contact is irregular, the conglomerate is somewhat altered

Quartz stringers in serpentinized and silicified dolomite (?). Harris-Maxwell group.

along it, while the diabase is finer grained, frozen tightly to the conglomerate, and in places becomes more basic with biotite distinctly developed. Its relationship here suggests a sheet of diabase intrusive between the conglomerate and the Keewatin. In other places it probably breaks up through the Huronian. On the little reef near the east shore north of Island "A.A." the diabase contains a segregation of epidote with a little quartz, calcite and copper pyrites.

Cutting the Keewatin and porphyry are dikes of a basic rock, in which biotite, chlorite and hornblende are now prominent. It has little aplite stringers through it, which, however, may be segregations from its own magma.

Later than these dikes and cutting the Keewatin and Huronian, are dikes of a basic rock which probably represents a biotite-lamprophyre. The basic edge of the diabase resembles them somewhat, and they might possibly be intrusions of the diabase magma.

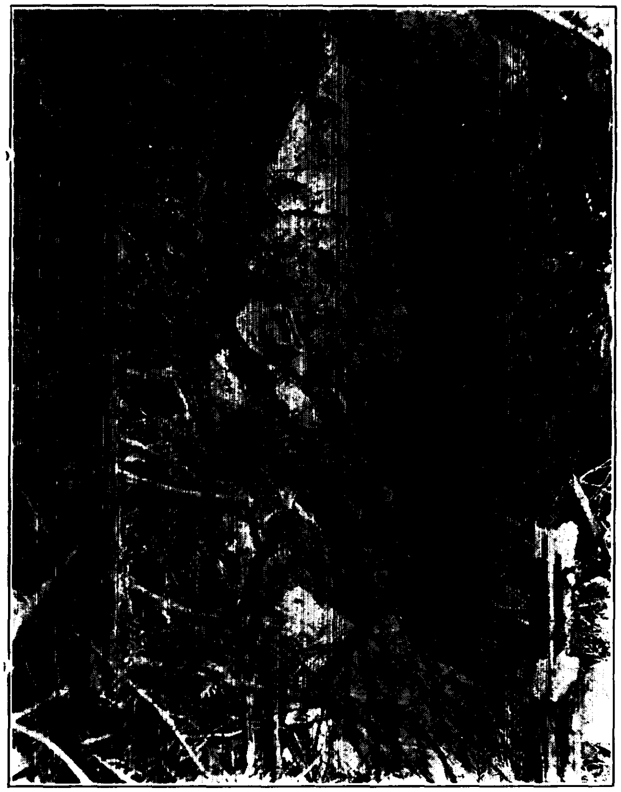
A line of disturbance of some kind extends northward from Larder City. The strike of the rocks differs on either side of this line, and the conglomerate at Larder

[5] See Map.

City, which contains similar boulders to the ordinary Huronian conglomerate is squeezed almost to a schist. The boulders are drawn out and flattened. The dikes which cut it also show signs of pressure. This probably is a fault line, but as most of the ground about here is drift-covered and muskeg, the exact cause of this disturbance was not ascertained.

Glacial

The exposed rock surfaces are usually rounded, polished, fluted and striated, furnishing evidence of extensive glaciation. Glacial erratics, some very large, are scattered round. The direction of ice movement as recorded by striations averages about 169° astronomic. The local variations from this are very slight. The erratic boulders are



Quartz vein (white) in Keewatin greenstone. The quartz contains a little scattered chalcopyrite, galena, specularite, etc. West side of Fitzpatrick's bay.

much more numerous in hollows and protected places, while those still left on the rock surfaces are generally large, suggesting that these surfaces have since been wave swept. Further evidence of this is afforded by the deposits of sand and gravel which cover large areas, and by deposits of Saugeen clay—a well stratified interbanded sand and clay in one-half-inch to one-inch bands.

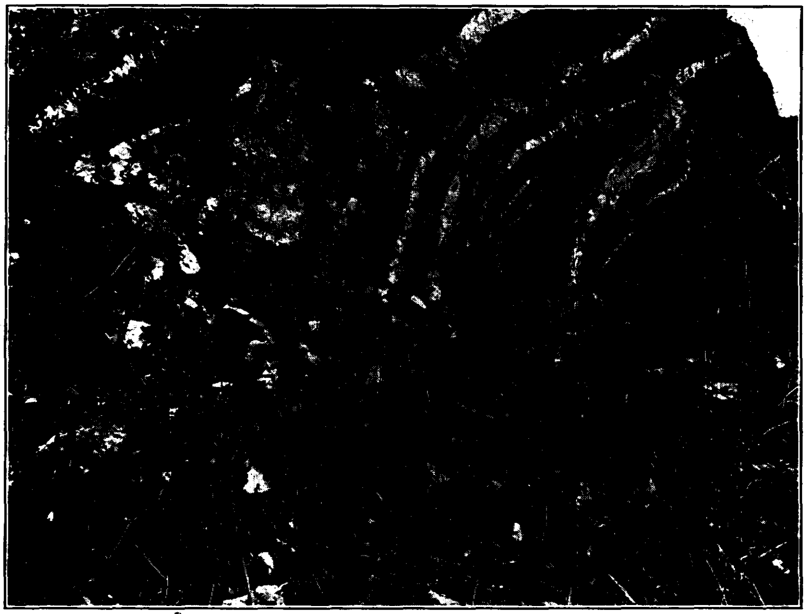
The glaciation has cut away the weathered and rotted rock surfaces and scoured the pre-glacial valleys, sweeping away any of the old sands and gravels.

Boulder clay has for the most part been removed by the later water-action, but at one or two protected points a little was believed to occur.

Ores

In the limited time spent in the field only some of the claims could be visited. The claims which were considered locally to give the most promise, and to be typical of the camp were, however, seen. Most of the "showings" occur in the band of rusty-weathering "dolomite," (?) where seamed with quartz stringers, which is often the case near pegmatite or porphyry dikes, or in the Keewatin greenstone where mineralized with quartz near similar dikes. There are some well defined veins carrying a little pyrite or chalcopyrite, a few specks of galena, and perhaps zinc blende, and in places a good deal of specularite. Sometimes the latter is in rosetted form. Some of the quartz veins are several feet wide swelling out in places to large masses 10 or 12 feet in diameter. The quartz veins seen by the writer looked very lean, and where sampled ran nothing but a trace, except in picked specimens rich in sulphides, which might go a few dollars per ton in gold and silver. Mr. N. L. Bowen, who is continuing the geological mapping reports, however, that since the writer's departure a well defined quartz vein has been found on one of the claims of the Chesterville group, which furnishes good specimens of free gold.

On the Gold Hill claim, which has yielded some fine specimens showing free gold, the country rock is diorite (field name) cut by pegmatite. Stringers of quartz, with some feldspar, from six inches down, in width, traverse the greenstone in the neighborhood. The quartz is rather watery in appearance and holds a little copper pyrite, specularite and silicified inclusions of the country rock. A little pyrite is developed in the country rock near by, but very little in the quartz itself. Free gold occurs in places in the quartz, in the silicified inclusions of country rock and in the country rock near the stringers of quartz.



Gold-bearing quartz stringers in serpentinized and silicified dolomite (?). Reddick group.

The claims on the silicified band of rusty weathering "dolomite" (?) that show values, have much the same characteristics. The "dolomite" (?) with its peculiar green serpentine mineral developed in bands, is seamed with reticulating quartz stringers from a few inches in width to microscopical dimensions. Some carbonate is often interbedded in the quartz or forms parallel bands with it. The country rock between stringers is frequently silicified to a quartzite-like material. The quartz contains a little pyrite and chalcopyrite, a few specks of galena and perhaps a little specularite. The quartz stringers are sometimes predominantly parallel to the strike, sometimes predominantly across it, and sometimes quite irregularly distributed. While somewhat rusted on the surface, the oxidation does not usually extend an inch in depth, where the clear unoxidized quartz is encountered. It is sometimes milky white and sometimes somewhat rosy and watery. Through it in places is sprinkled free gold, usually in fine particles, but sometimes in grains the size of a pea or in little plate-like masses.

At the bottom of the two pits on the Knott claim of the Reddick group, about 14 feet below the surface, the gold seems to be as abundant in the fresh quartz in the bottom as near or on the surface. The gold has a fine color and is evidently of a high degree of purity. On the Harris-Maxwell claim a small branching dike of black trap-like material cuts the quartz. The gold occurs in the quartz particularly round galena and near the little black dike. It is also found near the quartz stringers in the silicified country rock.

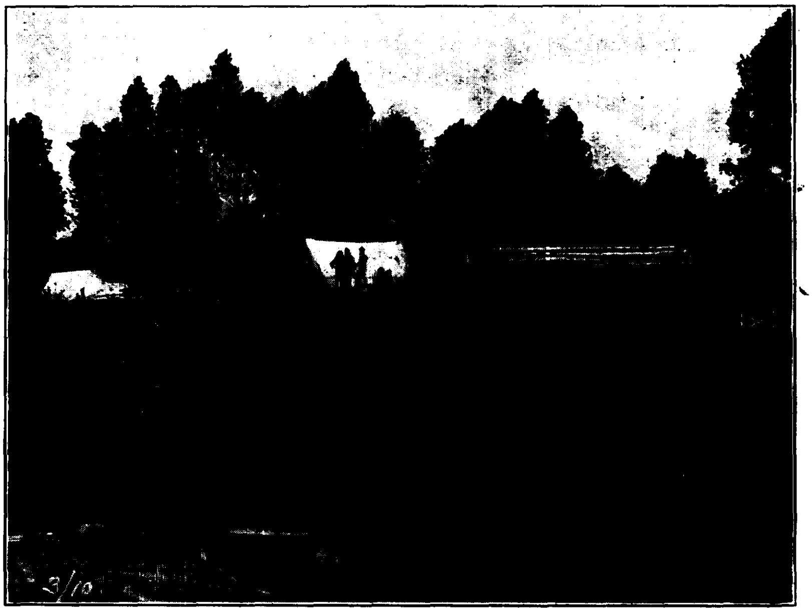
Open cut on the Maxwell, from which a shipment of 1,500 lb. was made to the School of Mining mill at Kingston, which yielded returns of $13.20 per ton.

On the Reddick claim two sets of quartz stringers occur running for the most part across the strike. The older set dips about 60° east, and consists of a blue watery barren quartz. The others which have a vertical or slightly westward dip, are of white milky quartz which carries some free gold. They are later than and cut the former set of stringers. These stringers end rather abruptly at the edge of this band against a soft grayish schist. The width of the band of silicified and veined dolomitic rock is not easily determined, as edges are rarely exposed. On the Knott claim at least 100 feet in width is exposed, all veined in much the same way, and, it is claimed, showing gold values for the whole distance. On the Harris-Maxwell the width exposed is still greater, and gold may be obtained at points scattered over this whole exposure.

A shipment from the Harris Maxwell of 1,500 pounds was sent during the winter to the mill at the School of Mining, Kingston. It returned $13.20 per ton. The hole from which this rock was said to have been taken was 6 or 8 feet across. It is claimed that the greenish silicified rock between the quartz stringers gave assay returns of $8.00 per ton.

Possibilities

Very little development work has been done, the two fourteen-foot holes in the Knott claim representing the most extensive development in the camp. It has not yet been proved what "run of mine" might be expected from any place. Some of the stringers are quite rich, but they seem to be too small and irregular to be mined by themselves, and it would appear that the whole rock would have to be taken. Over what area such material could profitably be mined and what it would run, can only be satisfactorily determined by mill tests. Several of the companies have ordered small stamp mills, and parts of some of them reached the camp before the spring break-up. Since then it has been impossible to get the complete plants in or to send out trial shipments, so that no such tests have yet been possible. One small mill on the lake run on a custom basis, could probably furnish all the companies the information necessary regarding what might be pay ground, the probable values to be expected, and whether it is desirable to erect a mill on their own properties.



Beginning operations. Clearing for a camp, and building cabins on the Chesterville group, at head of Northeast Arm.

In many places this band of "dolomite" (?) rock contains very few quartz stringers, and often even when well-cut up by them and otherwise apparently quite promising, samples fairly taken will not yield values sufficiently high to warrant further attention. This rock, however, forms a long continuous band, a little north of the lake, and is exposed at several other places, so that there is a considerable area over which values might be found. On a few claims very fine samples of free gold, nicely disseminated through a considerable extent of rock, have been found. Further prospecting may increase the number of gold "showings." From the character of the quartz and gold, fourteen feet below the surface, it looks as if gold might continue to exist in a free state for some depth. Though the stringers with gold are small and irregular, and therefore make a rich workable ore uncertain, there seems to be a reasonable chance that at some points by mining the whole rock, a large tonnage of low grade ore may be developed, with perhaps occasional rich bunches. If further work and mill tests prove this to be the case, a few dollars per ton in easily won gold (as the gold here so far seems to be), would constitute good pay ore. With a sufficient tonnage and perfect transportation facilities even three dollars per ton might be made to pay. There are some claims therefore that are worth exploitation along these lines.

As might be expected from the number of "snow-stakings" the majority of the claims have little present or prospective value.

The gold occurrence bears some resemblance to the Lake of the Woods and Rainy River, but here the stringers are for the most part independent of the schistosity, while in Northwest Ontario, the quartz lay between the bands of rock.

It will be noticed that the "showings" so far discovered are all in the Keewatin rocks, and that the main mineralization has been accomplished in pre-Huronian times. The undisturbed Lower Huronian is here, so far as could be seen, absolutely barren. Its only chance would seem to be for an old Huronian placer deposit in the conglomerate, which the mineralized fragments of Keewatin in the conglomerate might seem to suggest as possible. The fact that waste by erosion exceeded atmospheric weathering prior to the deposition of the Huronian, lessens the possibility of such concentration, and the uncertainty regarding the origin of the conglomerate makes it impossible to give a definite answer to the question.

Where the Lower Huronian is disturbed by faulting and large intrusions of the later diabase, it might be mineralized. These are the conditions at Cobalt. The intrusions seen at Larder lake are small and the effects extremely local, but a small amount of mineralization has resulted. It is interesting to find cobalt bloom in a calcite stringer on one of the Chesterville claims at the head of the northeast arm. On Wendigo lake to the south of Larder lake, cobalt has also been found.

There is very little possibility of modern placers being encountered. The loose material and rotted rock surfaces have been removed by the heavy glaciation and scattered somewhere south. Since glacial times very little weathering and consequently very little concentration of gold in sands and gravels, has taken place.

North of Larder lake to Abitibi, the geological conditions appear to be much the same. Gold has been found at Abitibi, and at points between these two lakes, so that a very large extent of territory exists in which to prospect for gold, with fair chance for success.

LAKE ABITIBI GOLD DEPOSITS

BY WILLET G MILLER

There are three areas in northeastern Ontario which have attracted the attention of prospectors for gold during the last two seasons. These are Larder lake, Abitibi lakes and Night Hawk lake. It seems well to have a brief account of the latter two tc accompany the report of Prof. Brock on Larder lake.

The writer has not visited Night Hawk lake, but among the specimens shown him, from a small island, known as Golden Island, in the northeast part, by Mr. A. A. Cole, M.E., who examined the deposits for the Temiskaming and Northern Ontario Railway, it is evident that the deposit there being worked for gold is similar to that described by Prof. Brock on some of the mining claims in the vicinity of Larder lake. This material consists of what appears to be a silicified limestone carrying iron pyrites. Associated with the limestone is the somewhat striking green material which Prof. Brock describes as being probably serpentine.

The Abitibi Lakes.

The deposits on the shores and islands of the Lower and Upper Abitibi lakes visited by the writer in August last are different from those described by Prof. Brock and Mr. Cole on Larder and Night Hawk lakes respectively. The chief point of resemblance is that the same green mineral is found in some of the deposits at Abitibi as that in the deposits of the other two lakes.

Mosher Bros. and others did considerable prospecting on the Abitibi lakes in 1906. During last winter a shaft 75 feet in depth was sunk on a vein on a small island, which lies five or six miles north of the north end of the narrows which connects Lower Abitibi lake with the Upper Abitibi lake. The work on this vein in Lower Abitibi lake is the most systematic which has thus far been done on any of the deposits in the vicinity of the lakes. A little work has been done on a deposit in the south bay of the same lake and at a few points elsewhere.

The little island referred to is known as Shaft island, B.C. 173, the head frame of the shaft being visible for some distance. The property is equipped with a fifteen or twenty horse power boiler, a hoist and steam drill. Shaft island is separated by a narrow channel from a somewhat larger island, B.C. 174, which lies to the northward, and on which there is a boarding and sleeping camp, storehouse and an assay office.

The types of gold deposits seen on the Abitibi lakes by the writer are essentially of two kinds: (1) That of Shaft island in Lower Lake Abitibi; (2) Those of the south shore and the islands of Upper Lake Abitibi, from the bay on the south shore on the Quebec side, just east of the Boundary point, to the islands in a bay about four miles S 70° W. of Boundary point on the Ontario side.

The auriferous quartz vein on Shaft island varies in width from about four feet to a few inches. It has a vertical dip with strike east and west and cuts a massive igneous rock which may be called diabase. This rock has a somewhat fresh appearance, and seems to belong to the newer series of eruptives similar to that of the post-Middle-Huronian diabase of the Cobalt area. This Abitibi diabase, like that of Cobalt, carries quartz as a characteristic constituent. Iron pyrites, together with a little copper pyrites and a dark-colored zinc blende occur in the quartz vein. Fine gold is frequently visible in the quartz. The vein cuts across the island for a distance of over 200 feet and disappears into the water on both shores. Our sampling was not very systematic, but it would appear that the vein is workable at a profit with a small plant under good management.

The other deposits visited on lakes Abitibi are different in character from the vein on Shaft island. As already stated, these deposits are found at various points, from the bay on the Quebec side, immediately east of Boundary point, westward along the south shore of the Upper lake. The half dozen deposits examined occur in rocks of

Keewatin age. These rocks here consist essentially of green schists, which are cut by dikes of fine-grained granite or porphyry, varying in width from a few inches to fifteen feet or more. They have been shattered, narrow cracks running across them characteristically transversely from wall to wall. These cracks are filled with quartz, and there are also at times lenses and irregular masses of quartz replacing the dike material or enclosed between it and the wall rock. Fragments of the dikes are frequently cemented by the quartz, forming a breccia. The dike material is, at times, changed to sericite schist. The dikes have been impregnated with iron pyrites, which is now altered, to a considerable extent, to iron oxide. The pyrites appears to be the gold bearer. "Colors" can be obtained by panning the dikes, but the highest fire assays from samples taken by us gave only $3.40 per ton. Copper pyrites is at times associated with the iron pyrites.

The Abitibi lakes lie 35 or 40 miles north of Larder, while Night Hawk lake lies about 50 miles, a little south of west of Abitibi. It is thus seen that gold has been found over a large area in this part of the Province.

The shortest canoe route to Abitibi is now by way of McDougall Chute station on the Temiskaming and Northern Ontario railway, thence down the Black river to its junction with the Abitibi river, and up the latter to Lower Lake Abitibi. The canoe trip from McDougall Chute to Shaft island can be made in a day and a half. A road is now being cut out from a point south of McDougall Chute to the lake. Supplies for the Transcontinental railway will be taken over it.

On our trip to Abitibi we went across the wagon road from North Temiskaming to Klock's Depot, thence by canoe up the water route on the Quebec side which runs approximately parallel with the interprovincial boundary. Two main series of rocks are seen along this route. From Klock's northward to Island lake just north of the height of land, granite and gneiss outcrops are prominent. On Island lake and northward towards Abitibi, the rocks consist essentially of what apears to be volcanic fragmental material which may be classed as Keewatin. On Upper Lake Abitibi the spheroidal structure so characteristic of Keewatin greenstones was seen well-developed.

Night Hawk Lake

Mr. Cole gives the following notes as the result of his observations:

"Topography: The country surrounding this lake is uniformly low lying, 40 to 50 feet above the lake level being a maximum. There is a heavy clay overburden, and rock exposures are infrequent, and almost always along the water's edge. The bush is green, so that practically all the prospecting done is along the water fronts.

"Geology: The formation is Keewatin, and the rocks are mostly greenstones and old diabase.

"The only location in this section on which much work has been done is on a small island, known as Golden island, situated in the northeast part of the lake. Good cabins are being erected here, two shafts being sunk, and preparations are being made for continuous development during the winter. When I visited this property (6th October, 1907), the working force consisted of thirteen men.

"On this island streaks of white quartz run through a brownish rock resembling a quartzite, but often high in lime in many places, running into bands of calcite usually of a bright green color. These rocks appear to have been derived by alteration from very impure Keewatin limestones. Similar rocks are found in connection with the auriferous deposits of Larder lake. Some pockets rich in gold have been located on this island, and the enclosing rocks show at least a trace of gold.

"The same rock formation that is found on Golden island occurs on the adjacent mainland.

"On account of the heavy clay overburden it will take years to thoroughly prospect this district."

GRENVILLE-HASTINGS UNCONFORMITY

and the

Probable Identity in Age of the Grenville Limestone with the Keewatin Iron Formation of the Lake Superior Region

BY WILLET G. MILLER and CYRIL W. KNIGHT

NOTE.—Since Prof. Brock's paper on the ore deposits of Larder Lake shows that the crystalline limestone or "dolomite," pages 205-207, is such an important rock in that locality in connection with the occurrence of gold, it has been thought well to publish with his paper, the results of some recently completed work in Southeastern Ontario, which was done chiefly during a few days in November of the present year.

In the Larder Lake area the crystalline limestone is so intermingled with the Keewatin greenstone, owing to the disturbances to which the rocks have been subjected, that it has not been found possible to prove their true relationship. Similar interminglings of carbonate rocks and iron formation with the Keewatin eruptives have been described at various points in Northern Ontario and in the Lake Superior region proper. The writers believe that they have determined by their recent work in Southeastern Ontario the true relationship of the Grenville limestone to the Keewatin, and that this limestone is of similar age to the limestone of Larder Lake and to the limestones and iron ore formation associated with the Keewatin of the Lake Superior region. Owing to the proof of Prof. Brock's paper being in page form before this is written, it is impossible for the writers, without delaying the printers, to give more than an outline of the results of their recent work on the Grenville and associated rocks. A paper containing more details will be published at some later date.

The crystalline limestones and associated pre-Cambrian sedimentary rocks of southeastern Ontario and the adjacent parts of the Province of Quebec, to which Logan and his colleagues long ago gave the names of Grenville and Hastings series, have never been satisfactorily classified as regards their age. In the earlier years of the Canadian Geological Survey the discovery of the supposed remains of an organism, the so-called "eozoon," induced the Survey to place the limestone containing this supposed organism in an arbitrary position. Later workers in re-mapping parts of the area have been no more successful in determining the relationship of these rocks. During the last decade, for instance, the opinion has been emphasized that the Hastings series represented the Grenville in a less highly altered form. Such being the views held by the workers in the field, it is not suprising to find that the International Committee representing the Geological Surveys of the United States and Canada, which made a necessarily hurried trip through the district in 1906, should be unable to arrive at any definite or satisfactory age classification of the rocks of the region under review.[1]

Conclusions of Committee of 1906

Concerning the relation of the Hastings series to the Grenville, the Committee say "The term 'Hastings series' in the opinion of the committee should be abandoned as a serial name, seeing that the development to which this name was applied by Logan is merely the Grenville series in a less altered form, as Logan in giving the name had conjectured was probably the case. The committee, however, think that it may in some cases be advantageously employed as a qualifying term to designate the less highly altered phase of the Grenville series, which may thus be referred to as the 'Hastings phase' of the Grenville series."

The Committee say further "The committee consider that it is inadvisable in the present state of our knowledge to attempt any correlation of the Grenville series with the Huronian or Keewatin, so extensively developed in the region of the Great Lakes. The Grenville series has not as yet been found in contact with either of these, and until this has been done and the relations of the several series have been carefully studied, their relative stratigraphical position must remain a mere matter of conjecture."

Referring to the relation of the crystalline limestones and the associated conglomerate, the Committee say "it is, however, still a matter of uncertainty as to whether the conglomerate here developed marks the base of an overlying, infolded, unconform-

[1] Report of a special Committee on the correlation of the pre-Cambrian Rocks of the Adirondack Mountains, the 'Original Laurentian Area' of Canada and Eastern Ontario. Jour. Geol., April-May, 1907.

able series or not." In their classification of the pre-Cambrian rocks of the region, they say "the following succession in this region is therefore recognized and adopted :

"Grenville series

(Intrusive Contact).

"Laurentian."

It will thus be seen that the Committee were able to recognize only two great unconformable series in the region, namely, the sedimentary Grenville and the igneous Laurentian.

The Authors' Conclusions in 1907

Some years ago the present writers, while studying the gold and other deposits of Eastern Ontario, had their attention attracted to the association of the crystalline limestones and the conglomerates (which were frequently found to contain pebbles of limestone) and felt that a brief search would prove the conglomerates to form an unconformable series with the limestones. Pressing work in another region during the last four years has prevented their investigating the problem. A few days in the field during the late autumn of the present year (1907) has, however, made the relationship of these sedimentary series quite plain, and has also shown that an old greenstone series, with associated acidic igneous rocks, similar to that of the Keewatin of the Lake Superior region, is widely developed. They have proved that much, at least, of what has been called the Hastings ser es, consisting of limestones, conglomerates and other fragmental rocks, is much younger than, and forms a well-defined unconformable series with, the typical crystalline limestones and associated fragmental rocks of what has been called the Grenville series proper. The view that the Grenville and Hastings constitute one series, the former being a more highly altered phase of the latter, is no longer tenable.

Floor of the Grenville

It has also been proved by the present writers that the Keewatin here is the oldest series in the region. The limestones are found to have been deposited on the surface of the Keewatin. An ancient Keewatin lava has, in places, been subjected to little denudation before the deposition of the Grenville limestone, which fills the cracks and openings in the ropy surface of the lava. Unconformably above the Grenville limestones and Keewatin lavas or greenstones rest the conglomerates and other sedimentary rocks, including limestones, which the present writers class as Huronian. These conglomerates contain not only ordinary fragments of the Grenville limestones but "eozoon"-like boulders as well, thus showing that the limestone is much older than the conglomerate. Moreover the "pebbles of cherty and ferruginous rocks resembling those found in the iron ranges of Lake Superior" in the conglomerate of Eastern Ontario are found by the writers to have been derived from layers or bands of this material in the Grenville limestone.

Pre-Cambrian Classification

To sum up briefly, the writers find the Keewatin series of the Lake Superior region represented in southeastern Ontario by ancient rocks of like character. The Grenville limestones have been deposited on the surface of the Keewatin. These latter rocks, limestones, are classed as regards age with the Keewatin iron formation of Lake Superior, which it has not been found possible in that region to separate from the greenstones.

The writers classify the pre-Cambrian conglomerate and associated sedimentary rocks overlying, unconformably, the Grenville limestone in Eastern Ontario as Huronian. The crystalline limestones of the adjoining region in Quebec and the Adirondacks appear to be similar in age to those of southeastern Ontario.

The following table show (1) the classification prepared by the International Committee of 1906 for the rocks of Eastern Ontario, Southwestern Quebec and the Adirondacks. (2) The classification adopted by the International Committee of 1904 for the rocks of the Lake Superior Region[2], and (3) the writers' classification in 1907, for the rocks of southeastern Ontario.

1.	2.	3.
		(Miller & Knight, 1907.)
	Keweenawan.	Keweenawan? (basic dikes.)
	Huronian.	Huronian.
Grenville.		Grenville.
	Keewatin with iron formation.	Keewatin.
Laurentian.	Laurentian.	Laurentian.

In (1) the Laurentian intrudes the Grenville.

In (2) the Laurentian makes an igneous contact with the Keewatin. In (3) the Laurentian intrudes both the Keewatin and Grenville.

The Huronian in our classification of the rocks of southeastern Ontario stands essentially for what heretofore has been called the Hastings series.

[2] Report of the Special Committee on the Lake Superior Region. Jour. Geol., Feb.-March, 1905.

INDEX

END OF PART I.

1 м

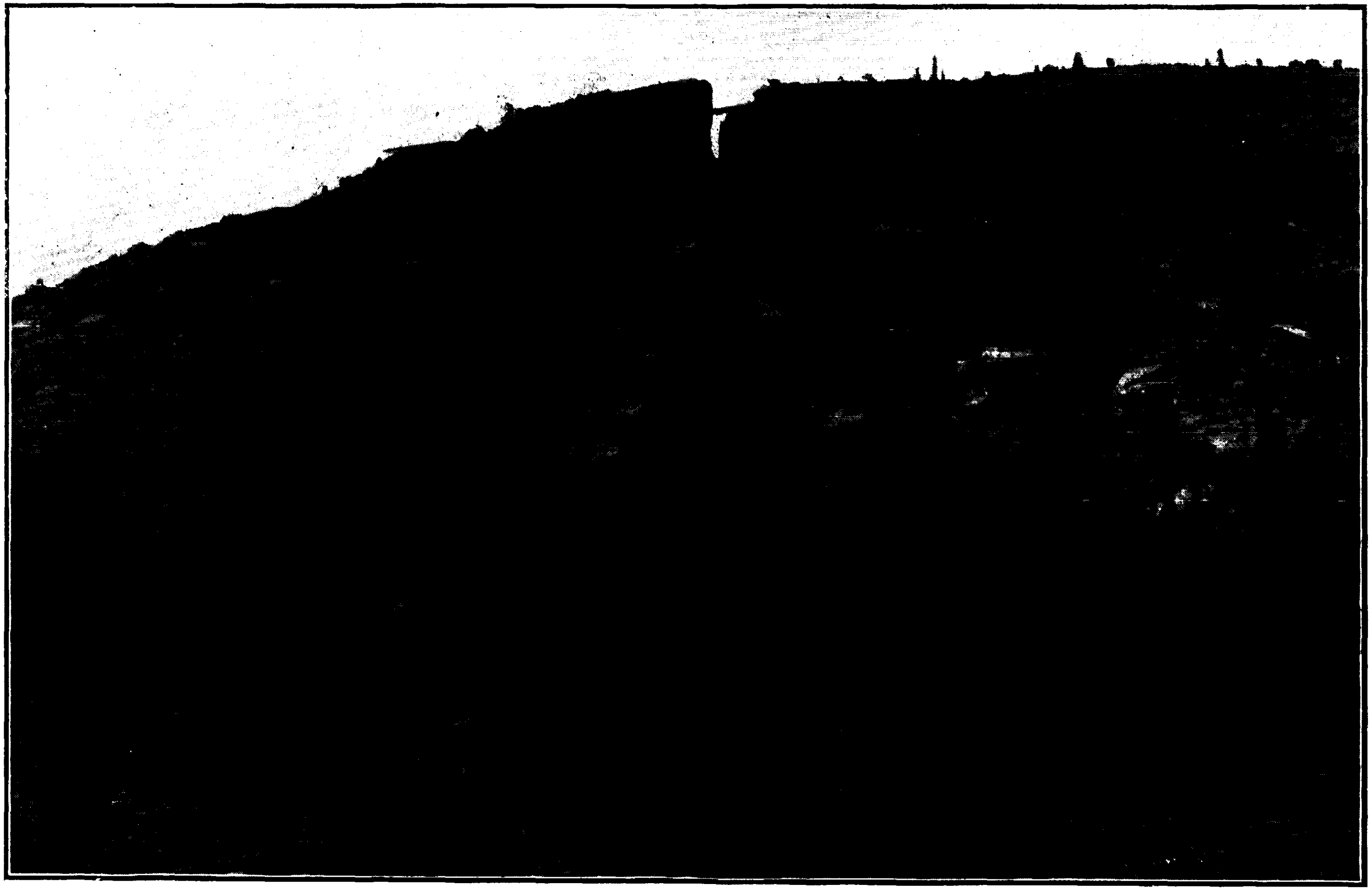
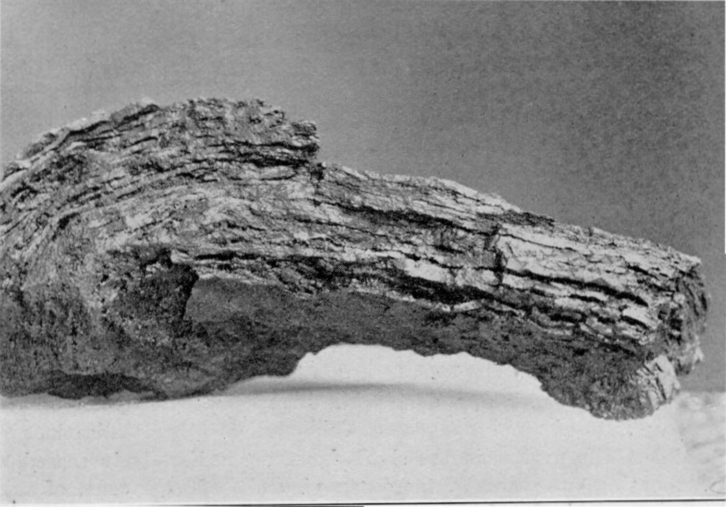
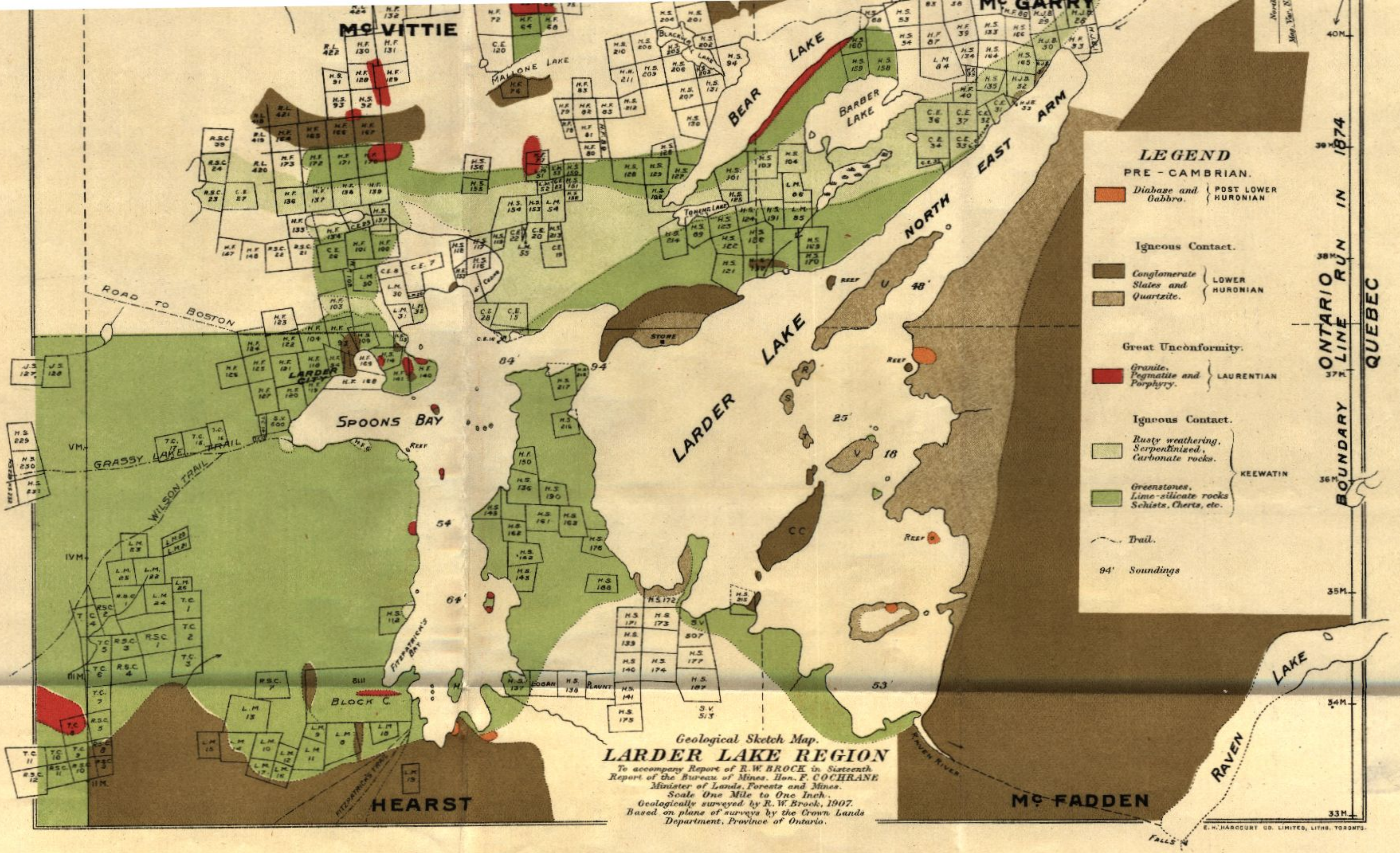
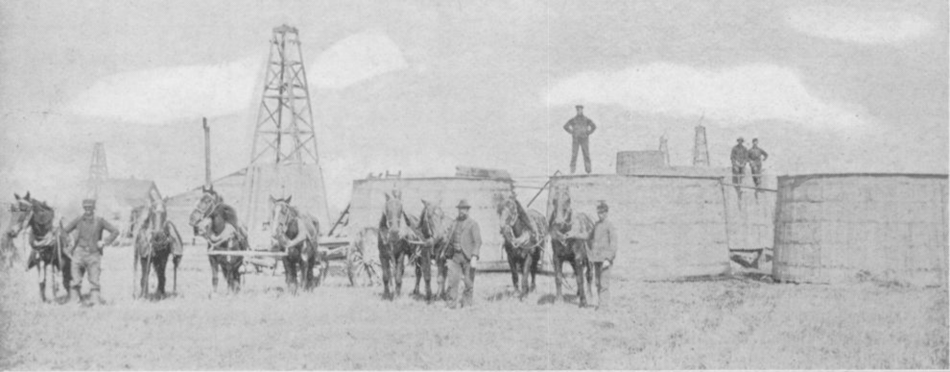
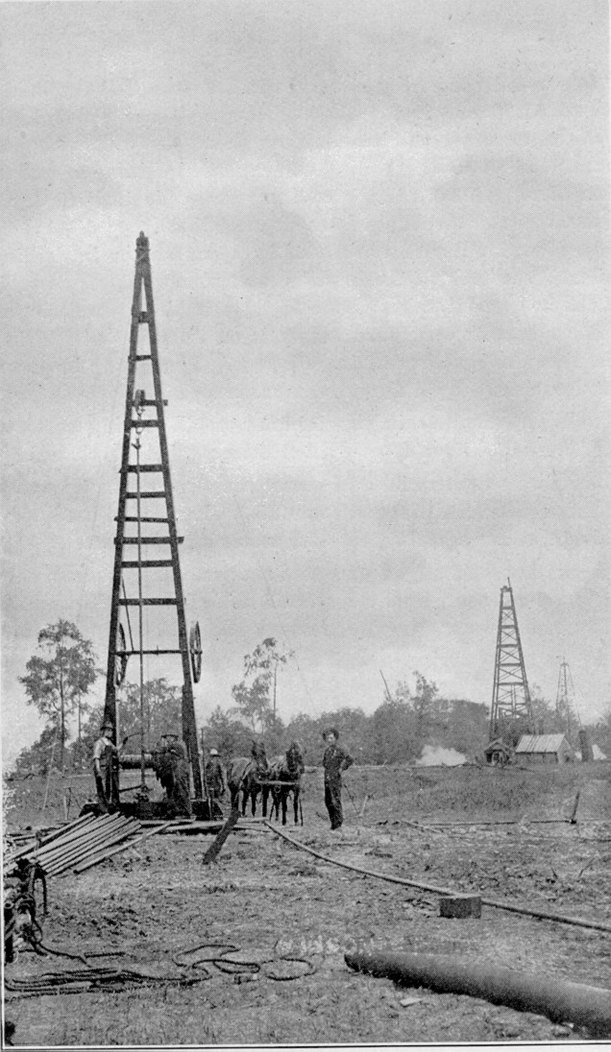


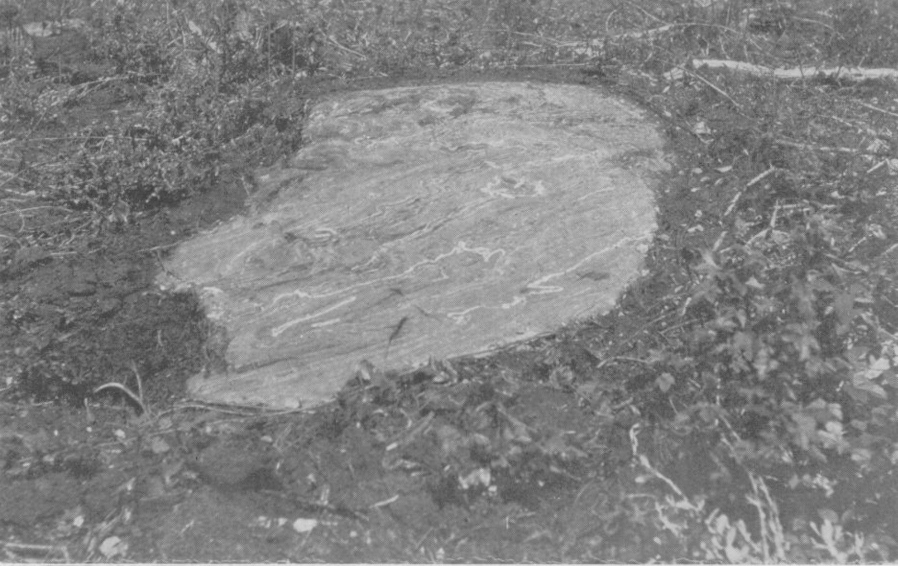
FIG. 1. The Little Silver Vein, southwest corner of location R. L. 404. The cliff is about 70 feet in height, and is composed of almost horizontally lying Lower Huronian rocks. At the bottom are about 15 or 20 feet of well banded greywacké slate. This is followed by about the same thickness of feldspathic quartzite overlying which, at the top of the cliff, is a coarse conglomerate. The greatest thickness of the vein, as originally

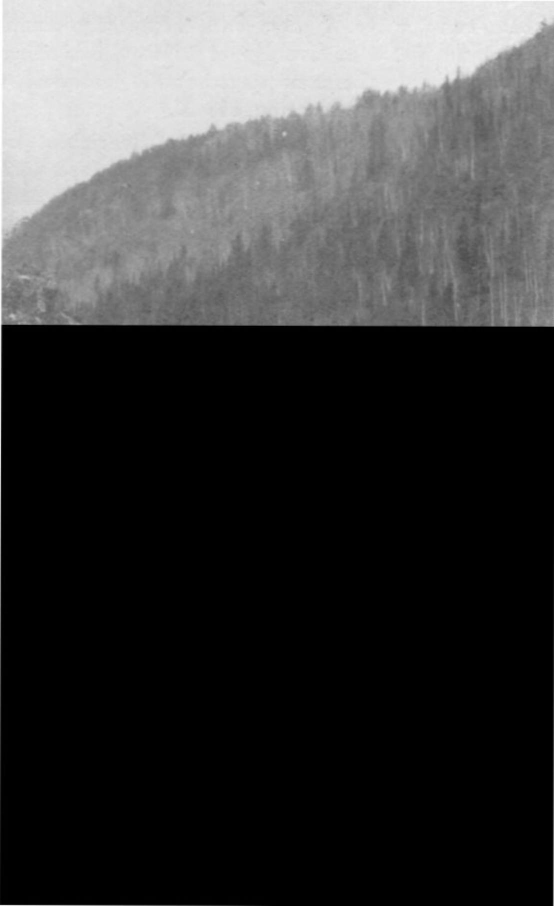



Geological Sketch Map.
LARDER LAKE REGION
To accompany Report of R. W. BROCK in Sixteenth Report of the Bureau of Mines. Hon. F. COCHRANE Minister of Lands, Forests and Mines.
Scale One Mile to One Inch.
Geologically surveyed by R. W. Brock, 1907.
Based on plans of surveys by the Crown Lands Department, Province of Ontario.
LEGEND
PRE-CAMBRIAN.
Diabase and Gabbro. POST LOWER HURONIAN
Igneous Contact.
Conglomerate Slates and Quartzite. LOWER HURONIAN
Great Unconformity.
Granite, Pegmatite and Porphyry. LAURENTIAN
Igneous Contact.
Rusty weathering, Serpentinized, Carbonate rocks.
Greenstones, Lime-silicate rocks Schists, Cherts, etc.
KEEWATIN
Trail.
94' Soundings
Mc VITTIE
Mc GARRY
HEARST
Mc FADDEN
LARDER LAKE
NORTH EAST ARM
BEAR LAKE
BARBER LAKE
MALLONE LAKE
SPOONS BAY
FITZPATRICK'S BAY
LARDER CITY
BLOCK C.
RAVEN LAKE
RAVEN RIVER
FALLS
ROAD TO BOSTON
GRASSY LAKE TRAIL
WILSON TRAIL
STORE
REEF
ONTARIO QUEBEC
BOUNDARY LINE RUN IN 1874
E. H. HARCOURT CO. LIMITED, LITHS. TORONTO.









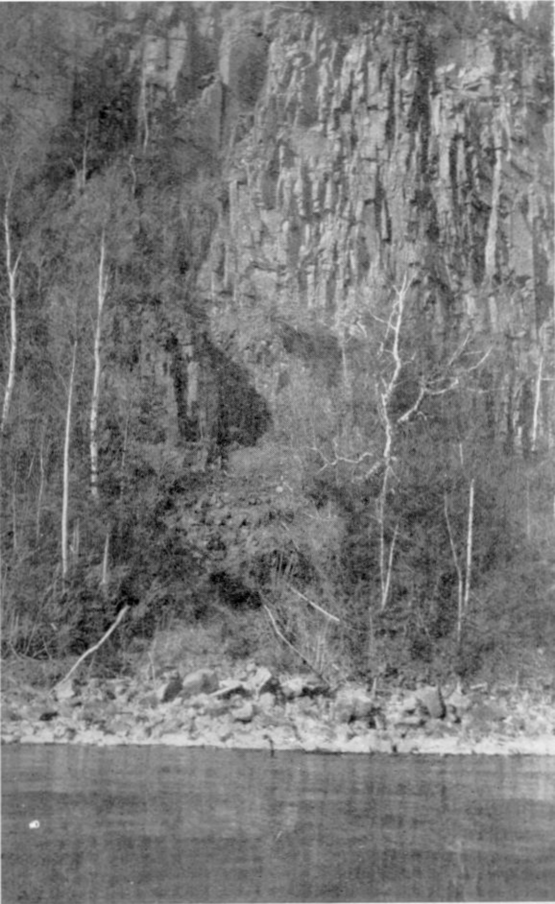
Problem Page
The original page in this document had a problem when scanned and as a result was unable to convert to Portable Document Format (PDF).

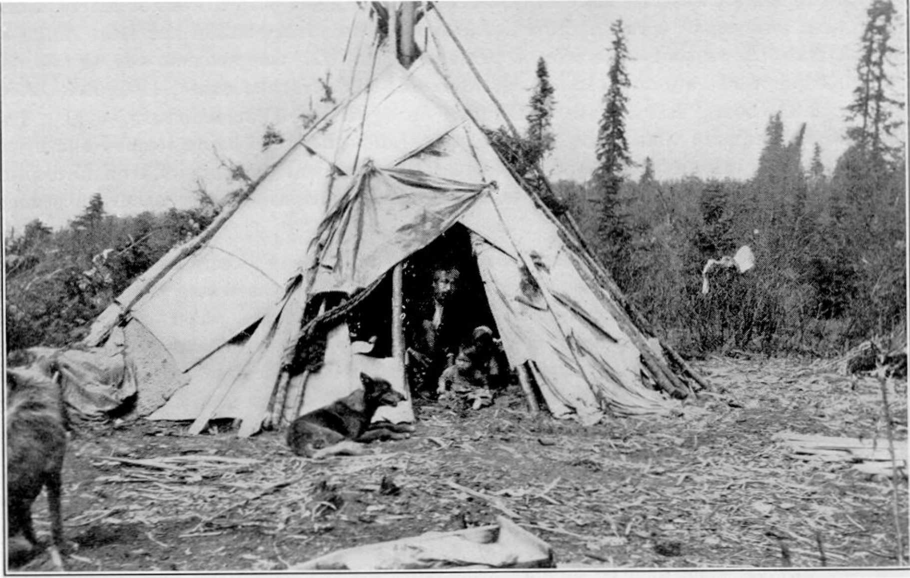
We apologize for the inconvenience.

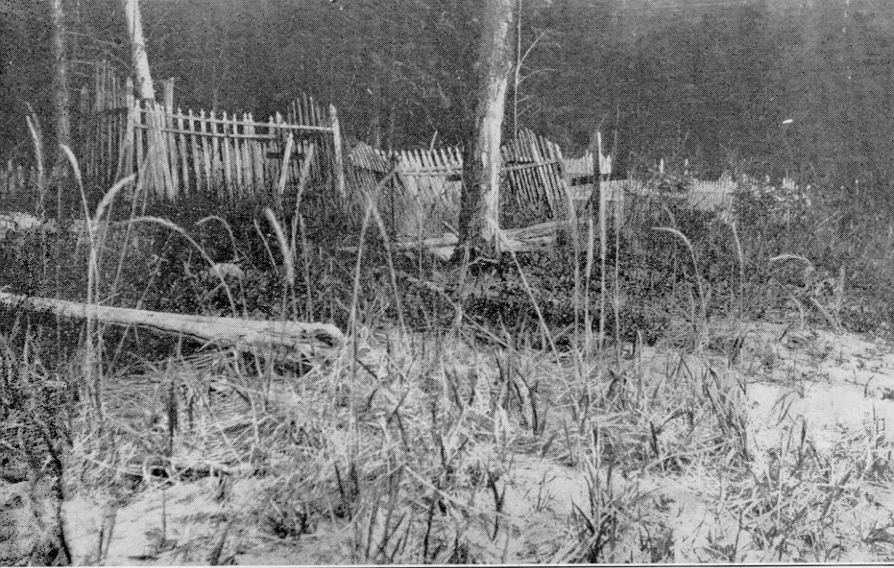
Problème de conversion de page
Un problème est survenu au moment de balayer la page originale dans ce document. La page n'a donc pu être convertie en format PDF.

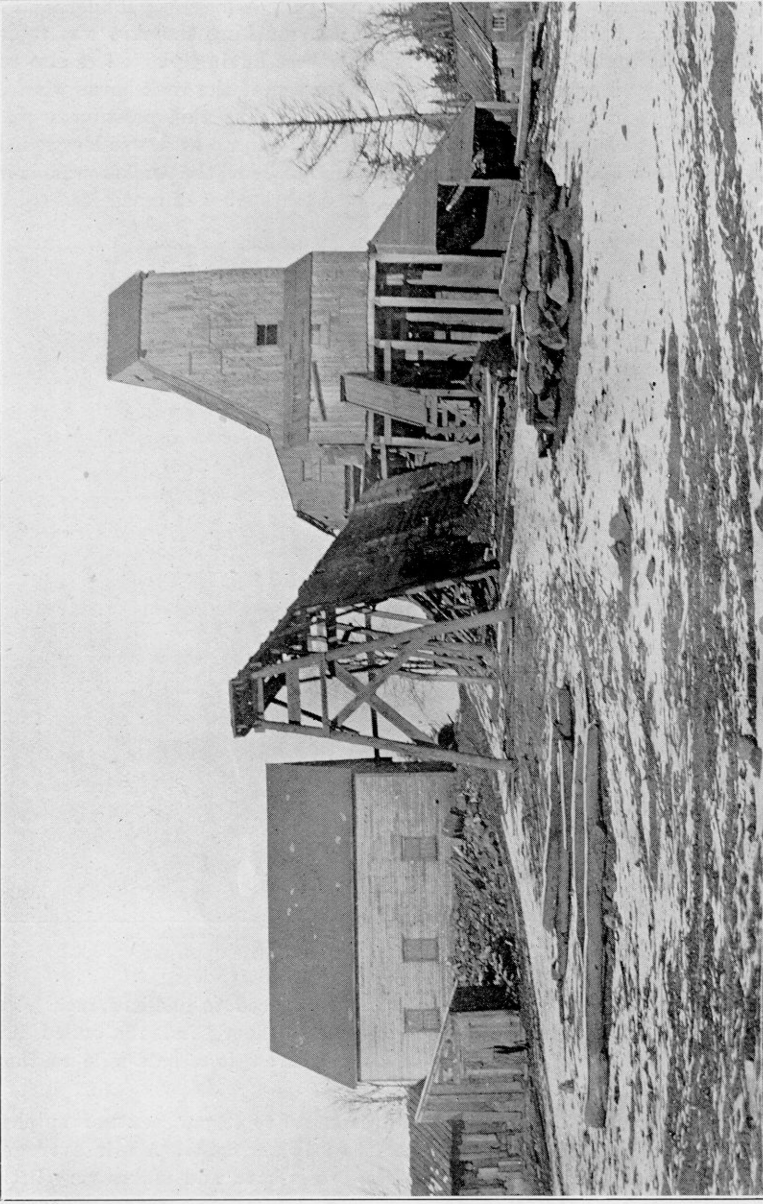
Nous regrettons tout inconvénient occasionné par ce problème.

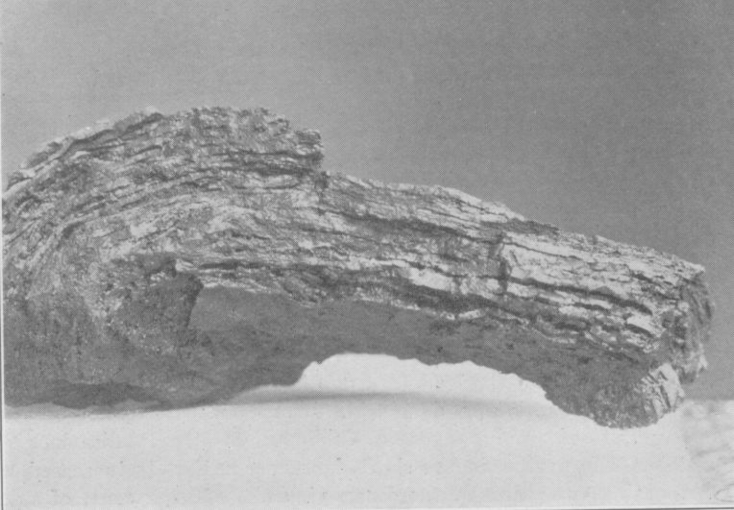
TIF_JPG_Conversion_Failure_Bad_Header_MNDM111x1

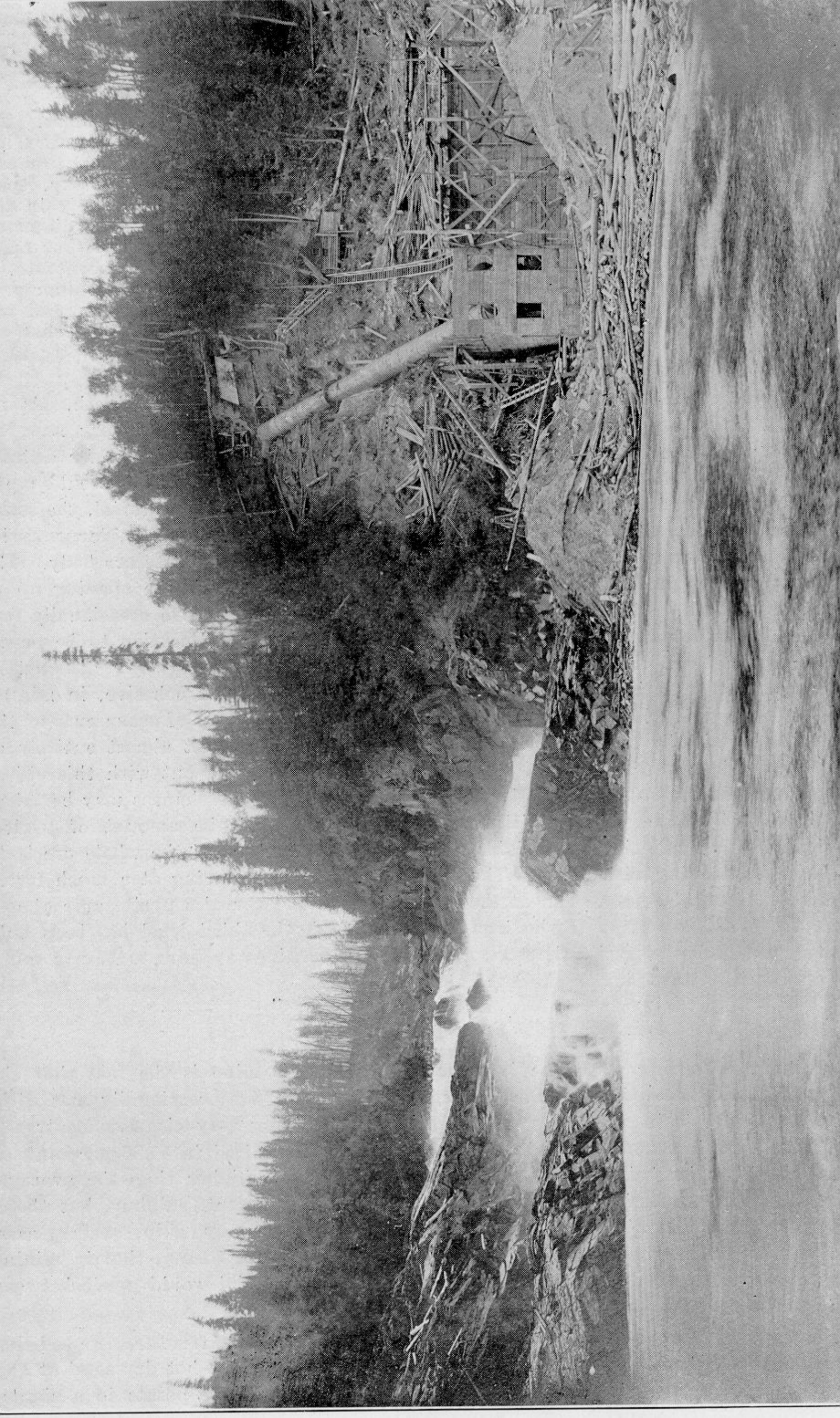


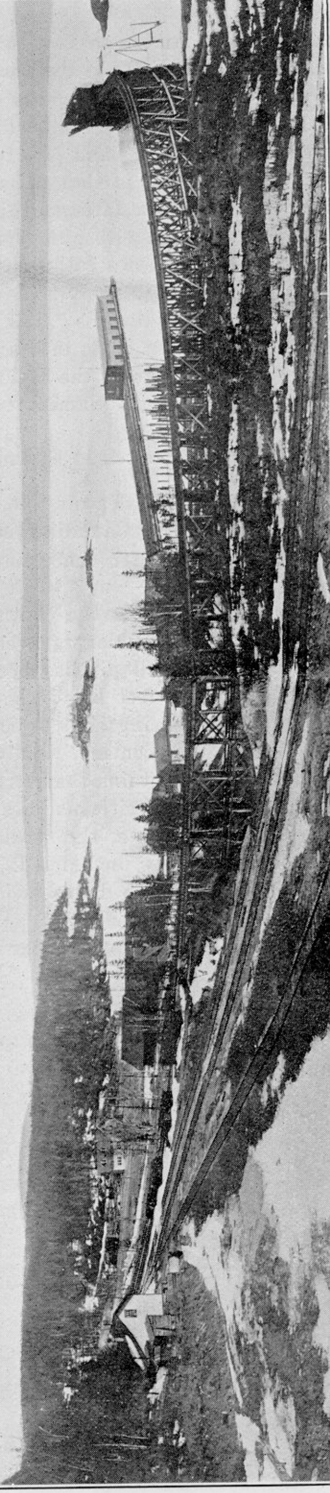


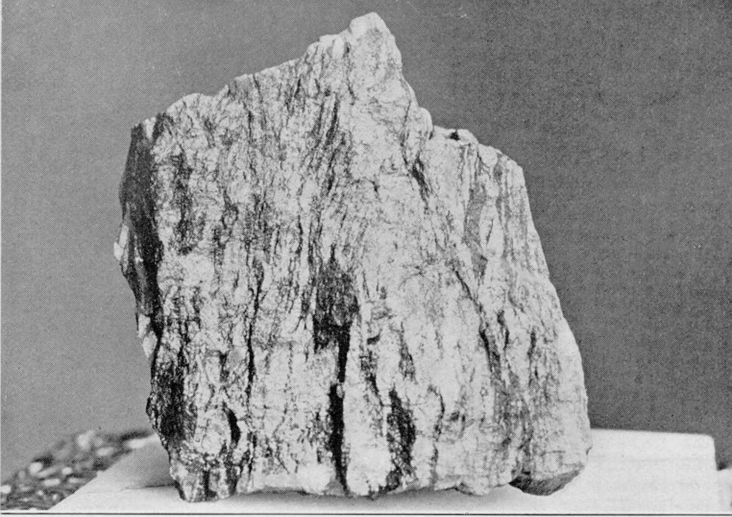


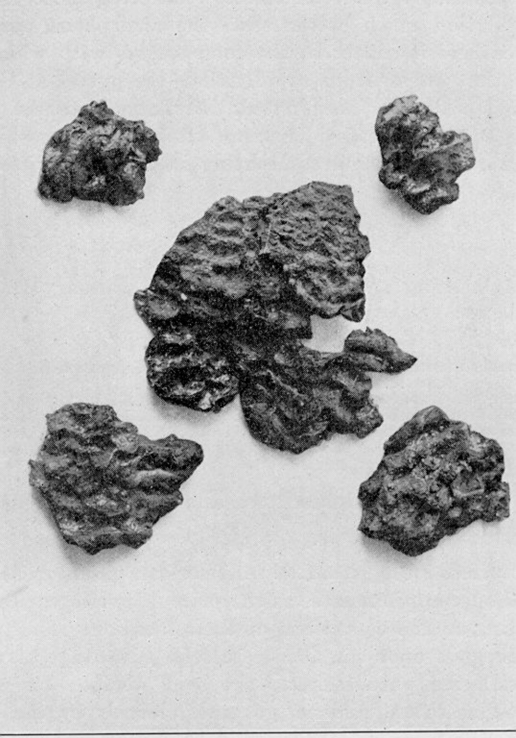




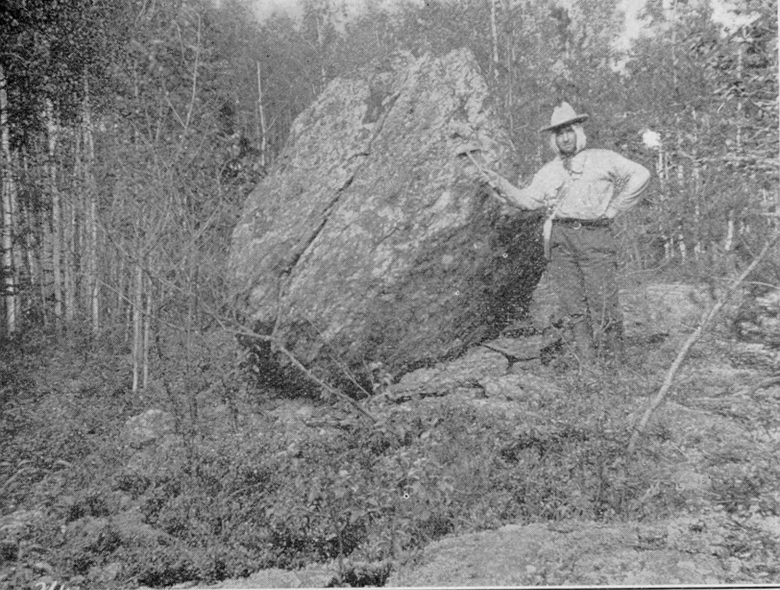


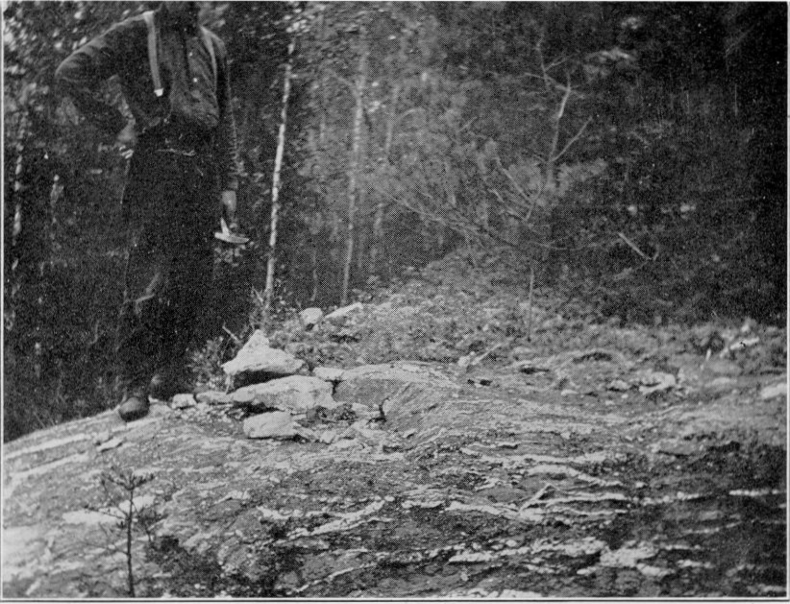




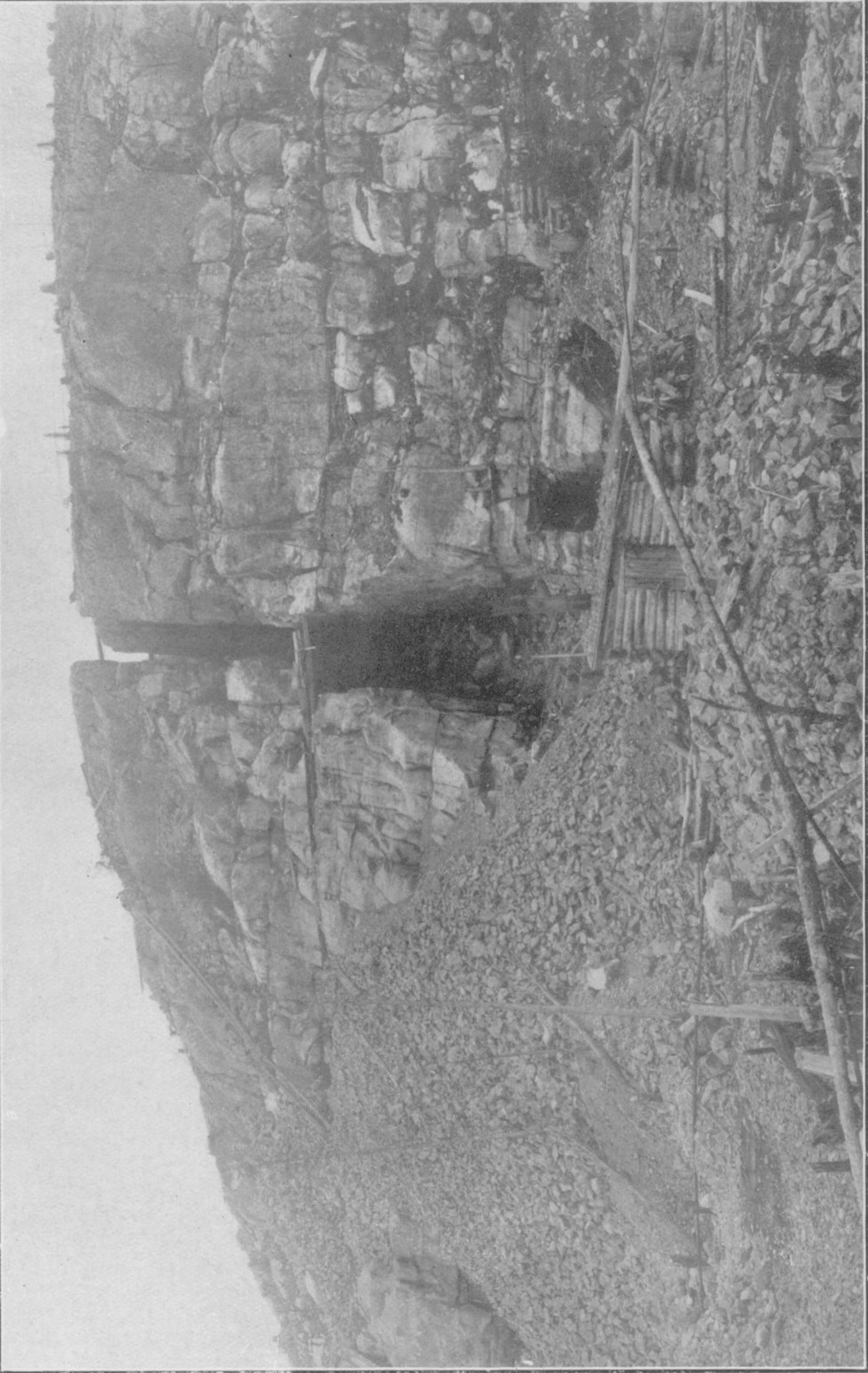


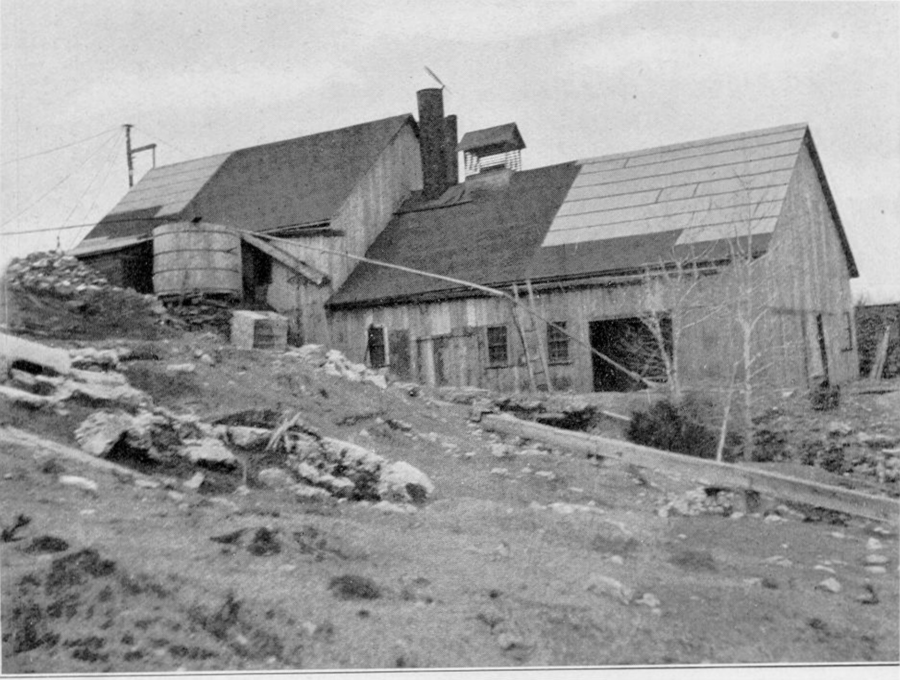

3/3.



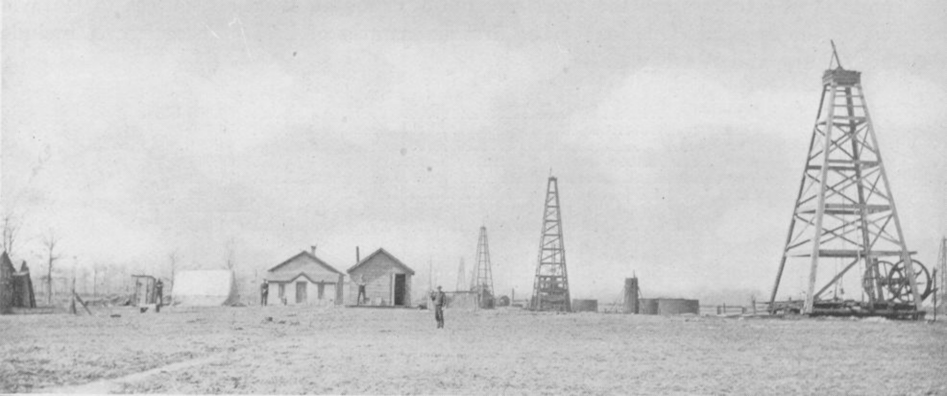



3/10






CORUNDUM MILL
CRAIGMOUNT
ONT.



REPORT OF
THE BUREAU OF MINES, 1907

VOL. XVI. PART II.

THOS. W. GIBSON,
Deputy Minister of Mines.

THE COBALT-NICKEL ARSENIDES AND SILVER DEPOSITS OF TEMISKAMING

(THIRD EDITION)

BY

WILLET G. MILLER, Provincial Geologist.

With an Appendix on—I. List of Mining Companies Incorporated, 1904-8.
II. "Early History of the Cobalt Industry in Saxony," translated by Geo. R. Mickle.

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO.

TORONTO:
Printed and Published by L. K. CAMERON, Printer to the King's Most Excellent Majesty.
1908.

" The detection of a small portion of cobalt in association with these metals upon the shores of Lake Huron, should lead us to look for deposits ot this rare and valuable material."—T. Sterry Hunt in Report of Geological Survey of Canada for 1848-9.

CONTENTS

Maps.

PREFACE TO THE THIRD EDITION

It is now over two years since the second edition of this Report was published. Since then great changes have taken place in the Cobalt mineral area. Ontario has become one of the leading producers of silver, and practically controls the world's market for cobalt. The arsenic contained in the ores now shipped from the Cobalt camp equals about half of the world's production of this substance. In the process of refining the Cobalt ores much of this arsenic is, however, not saved as yet. Next to Sudbury and New Caledonia, Cobalt is the world's largest producer of nickel but little of this metal from Cobalt is refined.

In the preface to the second edition, which is reprinted with this Report, the public was warned against a period of stock-jobbing and mining on paper, which the writer felt was approaching. It is, however, difficult to protect people from themselves. The boom, which came on in Cobalt in the latter half of 1906, was, to say the least, injurious to the mineral industry. It avails nothing to sermonize on gambling in mining stocks. The writer wishes simply to make one point, which is, that losses through stock gambling should not be charged up against the mineral industry. Mining is as legitimate as any other industry. If people who buy so called mining stock will not take ordinary precautions, the industry is not to blame. The record of the Cobalt camp has been seldom surpassed as regards the relation of dividends to output. As shown on a following page, the output to the end of 1907 was over $10,000,000, and over 50 per cent. of this output was distributed as dividends. This record is, however, tarnished by the absurd stock gambling which has taken place in connection with many of the properties.

It is to be hoped that the period of stock-jobbing will soon be over and that the field will be developed on a more legitimate basis. In the preface to the second edition of this Report, published before the boom began, it was pointed out that "it takes little capital at Cobalt to prove the quality of most claims." It may be added that the owners of developed claims or mines should know their value at least as well as any one else. Hence, if such claims or mines are put on the stock market there is good reason to believe that the owners think they can make more money by "mining the public" than by mining the ore. The fact is, however, that most people who buy mining stocks during the height of a boom care little about the value of the properties. They do not buy for permanent investment but hope to get the stock on the rise and sell out before the crash comes.

The policy of leasing small tracts of land, on a royalty basis, coupled with stringent working conditions, has been introduced in the camp. It is to be hoped that this system will be widely followed. It will give the man of small means a fair opportunity to invest his capital, and the camp will tend to develop more rapidly than it has during the stock-jobbing era of the past.

Additions in this Edition

We have not found it necessary to make any fundamental changes in the description of the geology or of the ore deposits, based on our first year's work in 1904, and published from time to time since then. Our views concerning the relationship of the rocks, the character and nature of the veins and of the economic problems of the camp remain practically the same. Much work has been done, but no new type of ore body has been discovered, with the possible exception of the ore associated with the aplite of the Montreal river area (pages 124-5). While both the silver-cobalt ores associated with the aplite of the Montreal river area and those in the veins in the Cobalt area proper are believed to have been derived from the diabase magma, the former, or aplite ores, appear to have come more directly from the magma and can be classed as being of aqueo-igneous origin, the ores of the Cobalt area being of aqueous origin.

A few minerals in addition to those described in the First Report have been discovered in the ore deposits. These are mentioned on succeeding pages. More details are given concerning the distribution and character, especially of the microscopic characteristics, of the rocks of the various systems. Mr. Cyril W. Knight, Assistant Provincial Geologist, has described pretty fully the minute characteristics of various members of the Keewatin and of the diabase of the post-Middle Huronian.

Origin of Ores

At the time the second edition was published it could not be very definitely decided as to what was the source of the silver in the veins, that is, whether it came from the diabase magma or whether it had been leached out of the Keewatin greenstones or some other rocks. At that time the occurrence of cobalt throughout a large region in association with the diabase, which is characteristic of the Cobalt area proper, was considered sufficient evidence to prove that the cobalt-nickel arsenides originated in the diabase magma.

In the Wendigo lake area, 30 miles north of Cobalt, cobalt-nickel arsenides were found in the diabase but not in the accompanying Huronian fragmental rocks. A somewhat similar condition prevailed in other surrounding areas, silver being absent. Since all the rock systems characteristic of Cobalt were not present in these outlying areas, it was felt that the evidence as to the source and origin of silver was not conclusive. Since then, however, the widely distributed veins and veinlets in the diabase of the Montreal River and Temagami Forest Reserve areas have, it seems to the writer, proved conclusively that we must look to the diabase magma as being not only the source of the cobalt-nickel minerals but of the silver as well.

Older Fragmental Rocks

In the first and second editions of the report attention was drawn to the fact that certain pebbles and boulders in the Lower Huronian conglomerate appeared to be themselves fragments of a conglomerate formation, thus giving evidence of a conglomerate series older than the Lower Huronian. It has been found, however, that there are certain pseudo-conglomerates in the Keewatin. These are in the form of dikes, the conglomeratic appearance being produced by the absorption of fragments of the wall rock by the dikes. That there is sedimentary material older than the Lower Huronian is shown by the occurrence of iron ore bands in the Keewatin. The writer and Mr. Knight have shown, in a recent paper on the Hastings-Grenville unconformity, that this ore formation, which has heretofore been grouped with the Keewatin, represents the Grenville system of southeastern Ontario.

Maps and Illustrations

This edition is accompanied by the previously published geological map on the scale of one mile to the inch, together with an uncolored plan showing the names of the properties and the position of the important cobalt-silver veins. Since the publication of the last edition, we have prepared a geological map of the important part of the productive area. This map, which accompanies this report, is on the scale of 400 feet to the inch, with contour intervals of ten feet. It thus shows the geology in considerable detail, together with the location and strike of the veins.

Geological maps of the areas surrounding Cobalt proper, in which cobalt or silver has been found, namely, Montreal River and Temagami Forest Reserve, Casey township, Wendigo lake, Portage bay, and the area south of the township of Lorrain are published herewith.

The Report is illustrated with about 100 geological plans and reproductions from photographs.

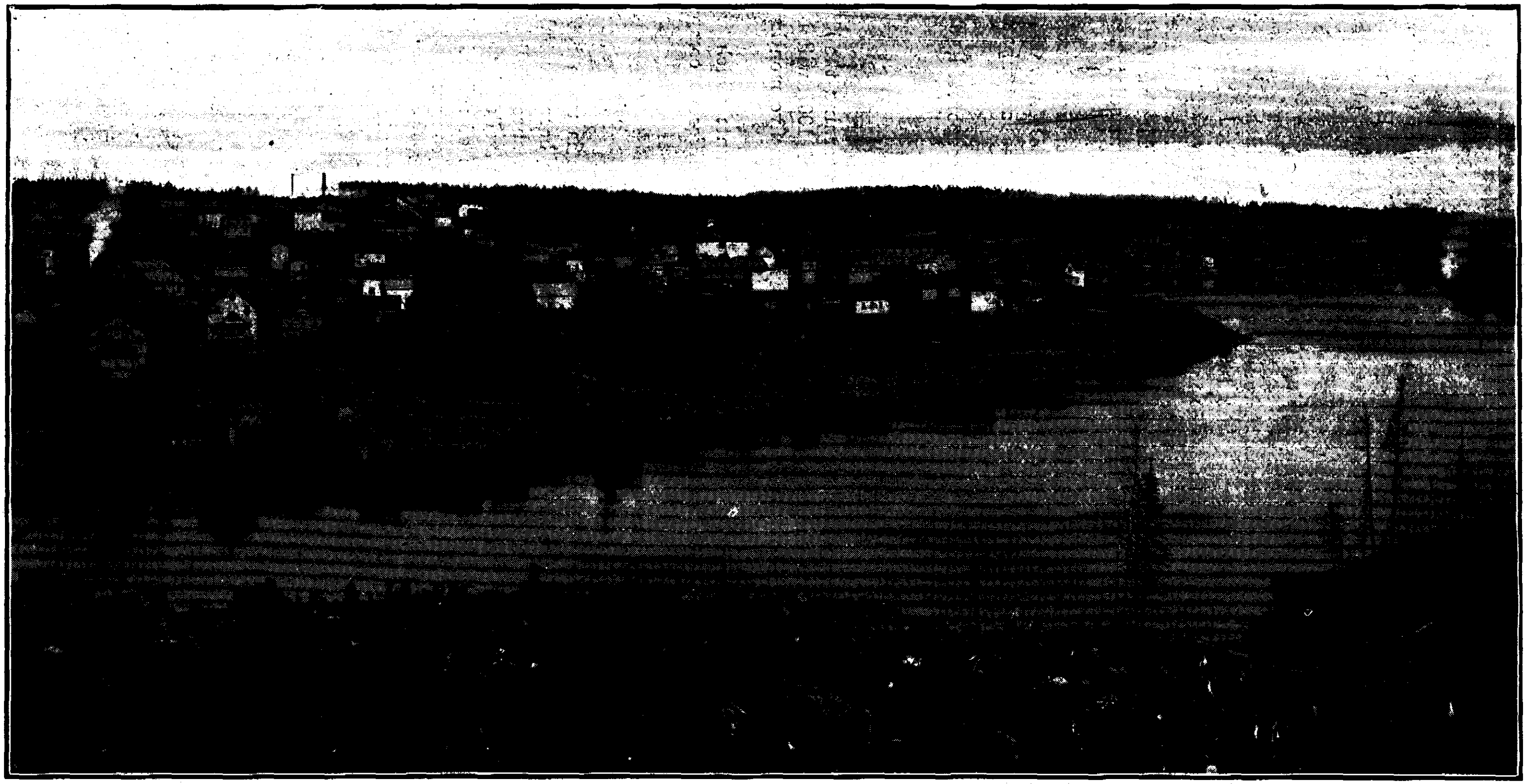


Fig 1A. Cobalt in 1907, with Cobalt lake in the foreground

Working Mines

In Chapter II Mr. E. T. Corkhill, Inspector of Mines, describes the mines which were working at the time of his visit during the first half of 1908. His report is very fully illustrated with reproductions from photographs of the various plants and mine buildings.

Other Temiskaming-Cobalt Areas

In Chapter III a number of areas surrounding Cobalt, in which silver or cobalt veins have been discovered during the last two years, are described. Mr. Cyril W. Knight describes the Montreal River and Temagami Forest Reserve area. His report is accompanied by a colored geological map, on the scale of one mile to the inch.

A brief description, accompanied by a map, is also given by Messrs. Knight and Burrows of the recently discovered silver-cobalt area which lies immediately south of the township of Lorrain.

The geology and ore deposits of the township of Casey and Wendigo lake, Portage bay and Bloom lake are described by Messrs. R. E. Hore, J. S. DeLury and W. R. Rogers respectively. A plan showing the geology of these areas accompanies each report.

In Appendix I is given a list of the mining companies incorporated, chiefly in connection with Cobalt, during the last three years.

Shipments and Dividends

As complete statistics as possible are given in the Report concerning the shipments which have been made from the camp. Those up to the end of 1907 will be found on page 15 and following. The tons of ore shipped during the first five months of 1908 are given on page 116.

A list of the dividend paying mines together with the amounts which were distributed, up to the end of 1907, among stock holders by the different companies is given on page 19.

Markets and Refining

The position of the camp with regard to the market for ores is much better than formerly. There are now in the Province three plants which have been erected for the treatment of silver-cobalt ores. That at Copper Cliff has been run successfully for some time. During the last half year the plant at Deloro, which is controlled by the owners of the O'Brien mine, has been treating these ores, and shipments of refined silver are being constantly made. In May, 1908, the plant of the Coniagas company at Thorold, Ont., began operations. It would seem that hereafter the mine owners will not have to hunt a market for their product. Times have changed—representatives of smelters are beginning to visit the camp in order to purchase ore.

Toronto, May, 1908. W. G. M.

PREFACE TO THE SECOND EDITION

(REPRINTED)

Owing to the wide interest which has been taken in the Cobalt mineral deposits, not only in Canada but throughout North America, and in parts of Europe, the first edition of 6,000 copies, published in November last, is now nearly exhausted. Since it is necessary to issue the present edition at an earlier date than was expected there has been little opportunity to revise either the text or the accompanying colored geological map. The first edition of the map consisting of 6,000 copies was published in April, 1905, in time for the prospectors who were then entering the field. It was thought that another edition might not be required until the heavily wooded and moss-covered surface was sufficiently cleared so as to enable the geology to be worked out in greater detail than was possible during our examination of the area in 1904. It is evident, however, from the exhaustion of the edition that the map has served most of the needs of prospectors. As the number of men in the field, all of whom will need maps, seems likely to be greatly increased during 1906, it has been thought best to issue a slightly revised edition without waiting until more field work has been done.

On account of the variety and relationship of the rocks outcropping in the area it is not possible to prepare an approximately perfect map without very detailed work. This is especially true of the localities in which outcrops of Keewatin and Lower Huronian are associated. The latter group is derived largely from the former, and the two are frequently so intimately connected that a very large scale map would be needed to represent them accurately. Frequently exposures of Lower Huronian, only a few feet in diameter, overlie the Keewatin. On the other hand small exposures of the Keewatin project through the Huronian. Again, the slaty members of the Lower Huronian resemble, especially when they have been metamorphosed by intrusion of diabase, the more characteristic phases of the Keewatin, rendering it almost impossible to distinguish certain facies of the one from the other in the field. If, however, the prospector reads carefully the marginal notes on the geological map and visits the typical outcrops of the Keewatin and Lower Huronian, there mentioned, it is believed he will have little difficulty in most cases in distinguishing the one group of rocks from the other. Prospecting during the coming season will be carried on miles outside of the boundaries of the geological map, but if the prospector on first entering the field visits and studies some of the more typical outcrops of rocks in the Cobalt area proper, he will be able to recognize, in most cases, similar rocks which cover a large territory in this part of Ontario.

Post-Middle Huronian basic rocks, of the composition of diabase, of at least two and possibly more ages, are known in the field. It is desirable, since important cobalt-silver veins occur at two or three points in the diabase, that these should be studied more carefully than they have been up to the present time.

Origin of Ores

The writer has little to add concerning the source of the ores to what was said in the first edition. Whether the ore minerals were carried from great depths by the heated, impure waters associated with—following—the diabase eruption, or whether they were leached from the Keewatin greenstones, is a problem which in all likelihood may never be conclusively solved. As stated on a following page, analyses of specimens of Keewatin and later diabase give no clue as to the source of the metals. Diabase in the surrounding region, as for example in the township of Dymond, ten miles north of Cobalt station, and in the township of Ingram, thirty miles to the north, has been found to contain cobalt in veinlets, with little or no silver. The diabase here is of

Huronian age. Hence one might conclude that the lack of silver in these veinlets was due to the absence of the Keewatin. That this conclusion would not be correct is seen from the fact that the Keewatin in the vicinity of Trout like, and eastward south of Bay lake on the Montreal river, contains at a number of points considerable cobalt, but, in so far as the writer knows, little or no silver is here associated with the cobalt. Since the diabase and Keewatin cobalt deposits so far discovered outside of the Cobalt area proper do not contain silver in paying quantities, must we look to another rock as the source of this metal? The Laurentian granite of the township of Lorrain, outcrops of which are not known much nearer than two miles from Cobalt station, would be the only other source. It scarcely appears, however, that this granite is closely enough associated with the ore bodies to be the source of the silver. Masses of granite may, on the other hand, be buried beneath the Huronian sediment in the immediate vicinity of the productive silver area surrounding Cobalt. On succeeding pages attention is drawn to three old and now practically exhausted mineral areas of Europe, the veins in all three of which resembled very closely those of Cobalt, Ont., especially as regards their width, all being very narrow, and their mineral contents. In the case of one of these localities, at least, that of the Chalanches, it has been suggested by an eminent authority, who has studied the veins, that the cobalt and nickel were derived from the basic rocks and that the silver probably came from the leaching of deep-seated granite. In the case of the other two localities, Annaberg and Joachimsthal, it has been thought that the ores are genetically connected with the granite.

A plan showing the striking relationship which the three isolated areas—those of Rabbit lake, to the south, Cobalt lake, in the centre, and Wendigo lake, to the north—have to the great northeast-southwest lines of weakness in the area is given (Fig. 15).

Depth of Veins

Little can be said in addition to what has been stated in the first edition concerning the depth to which the values in silver, cobalt and nickel will continue. At the La Rose mine, which is on the most important vein yet exploited, it has been proved that native silver exists at the depth of about 200 feet from the surface. The maximum depth to which veins on other properties have been tested is only about eighty feet. Judging from the experience of other districts, which contain veins with a similar assemblage of ores, native silver will be found in larger quantity in the upper workings than in those at a greater depth. This was the case at Silver Islet on Lake Superior, at the Clalanches, at Annaberg and Joachimsthal, and in other localities, where native silver has been worked. It seems pretty clear that in most veins the native silver is a secondary product, formed by the decomposition of the sulphide and other compounds. While silver in the free state will probably become less abundant as the veins are worked to a greater depth, the reverse will likely be true of its compopnds. At Silver Islet, which was worked to a depth of about 1,200 feet, the chief production came from the first four levels. At the Chalanches it was not found profitable to work the veins to a great depth. At Annaberg and Joachimsthal, on the other hand, narrow veins similar in width and mineral contents to those of Cobalt, have been worked profitably to a depth of between 1,500 and 2,000 feet. The writer, on general principles, would not expect the values in the veins at Cobalt, except as regards their content in metallic silver, to change materially so long as the veins continue in one series of rocks. That is, if a vein is worked in Lower Huronian rocks, as the majority of them are, its values should not change materially until the bottom of the basin in which these rocks lie is reached. Or if a vein is followed from the surface in diabase, its values should continue not only in this rock but also, from what one can say at present, into the Lower Huronian as well, if it underlies the diabase, as it does in many parts of the field. The horizontal extent of any vein, if it can be determined, should form some criterion as to the depth to which the vein can be followed.

Markets and Refining

During the last two or three months, although more ore has been mined than during a similar period heretofore, less has been marketed. This is owing to the difficulty experienced by the company, which was practically the only buyer of the ores, in treating the material so as to extract all the valuable contents. Recently ore has been sold for its silver content alone, nothing being received for the cobalt, nickel or arsenic, thus entailing great loss on the mine owners. This state of things cannot long continue. Similar ores have long been successfully treated elsewhere, and although the processes employed in the extraction of the metallic contents are kept more or less secret, the difficulties in making use of them or in employing others are not unsurmountable.

The statistics of production are not complete owing to the fact that comparatively little ore has been shipped during the last two or three months, on account of the state of the markets. Adding together the value of what has been shipped with that now stored at the mines, the output can be estimated at approximately $2,000,000 during the year just closed.

Changes in Text and Figures

A few illustrations have been added to this edition. Some additions have been made to the text. The quantity and value of the shipments of cobalt-silver ores during 1905 is given.

An interesting account of the "Early History of the Cobalt Industry in Saxony," summarized by Prof. Geo R. Mickle from a German publication, will be found in the appendix.

Reviews

A number of mining and geological journals have published reviews of the first edition. Among these reviews are those in the Engineering and Mining Journal of New York, Mining World of Chicago, Canadian Mining Review of Ottawa, and in the recently founded journal of Economic Geology of South Bethlehem, Pa. The last mentioned review is by Dr. C. K. Leith, of the University of Wisconsin, who has made a special study in several fields of the group of rocks found in the neighborhood of Cobalt, where he has also spent some time.

Benefits and Injuries

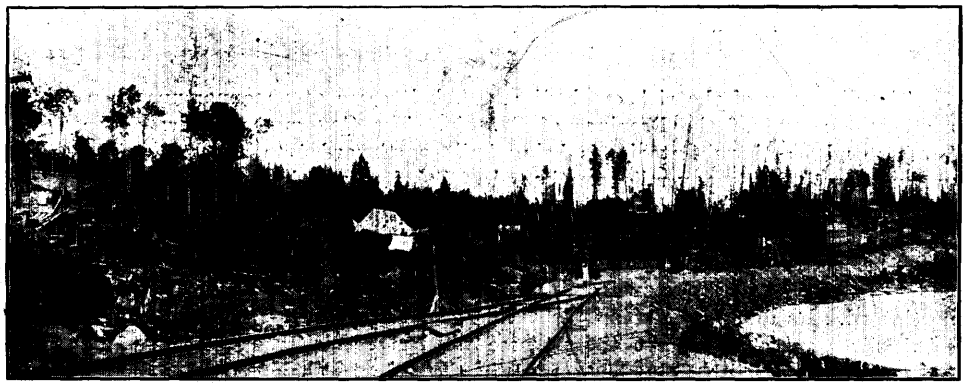
The discovery of the rich ore bodies at Cobalt came at an opportune time for the northeastern part of the Province of Ontario. The Government railway, the Temiskaming and Northern Ontario, is being built northward into a vast territory which needs settlers. Not many miles northward of Cobalt the rocky region, traversed by the railway for the first hundred miles of its course, gives place to a promising agricultural district. Farther north, over the height of land, the railway taps the great clay belt which has been estimated to contain 16,000,000 acres of fertile lands. Cobalt has served, and will serve, as the lodestone to this great region in the vicinity of Temiskaming and northward. Its discovery during the building of the railway was thus fortunate. The cobalt-silver veins here serve the purpose which the auriferous placers of Australia, California and British Columbia served in their day. They attract not only miners but all classes of people, and will thus bring about the settlement of the region much earlier than would the stable yet comparatively prosaic industries of farming and lumbering.

Cobalt has convinced the public that Ontario has deposits of ore richer than are those known in most parts of the world. The discovery in northern Ontario of economic minerals of any grade of richness will not be doubted in the future. It will be different from the history of Cobalt, which although described in both the daily press and in technical journals, shortly after its discovery, received little attention from the public for nearly eighteen months. If the ore bodies had been in some remote region difficult of access its history as regards recognition would likely have been otherwise. There would have been a stampede to it.

Although the Province of Ontario has thus far benefited greatly by the discovery of Cobalt, both as regards the attention which it has directed to our minerals and the advertisement which it has been for the undeveloped resources in general of our north country, it is to be feared that another period of stock-jobbing may be ushered in. The ignorance, credulity and superstition of many people is vast concerning mining enterprises. A few rich ore bodies are discovered in a district, hundreds of worthlss claims are represented as being promising, and a "boom" is launched. People buy so-called mining stocks, and forever after are cynical concerning the mineral industry. That a boom has baneful effects on the mineral industry is patent to all mining men in this country. Since the collapse of the boom which began in the 90's it has been almost impossible to raise capital on mining enterprises no matter how promising they can be proved to be. It is to be feared that a similar state of affairs will exist in two or three years if a boom is now started in connection with the Cobalt area. As regards this field one thing should be remembered. It is this,—that while certain claims have been passed by the inspectors, there is no evidence, in many cases, that these properties will ever become dividend payers. It should also be remembered that it takes little capital at Cobalt to prove the quality of most claims, and that a majority of those staked will prove barren. Companies do not need to be capitalized at high figures. No part of the world to-day offers better opportunities for legitimate mining enterprises than does Ontario and Canada in general. It is to be hoped that the industry will not receive another set-back through mining on paper.

W. G. M.

TORONTO, February, 1906.



Cobalt Station, June, 1905.

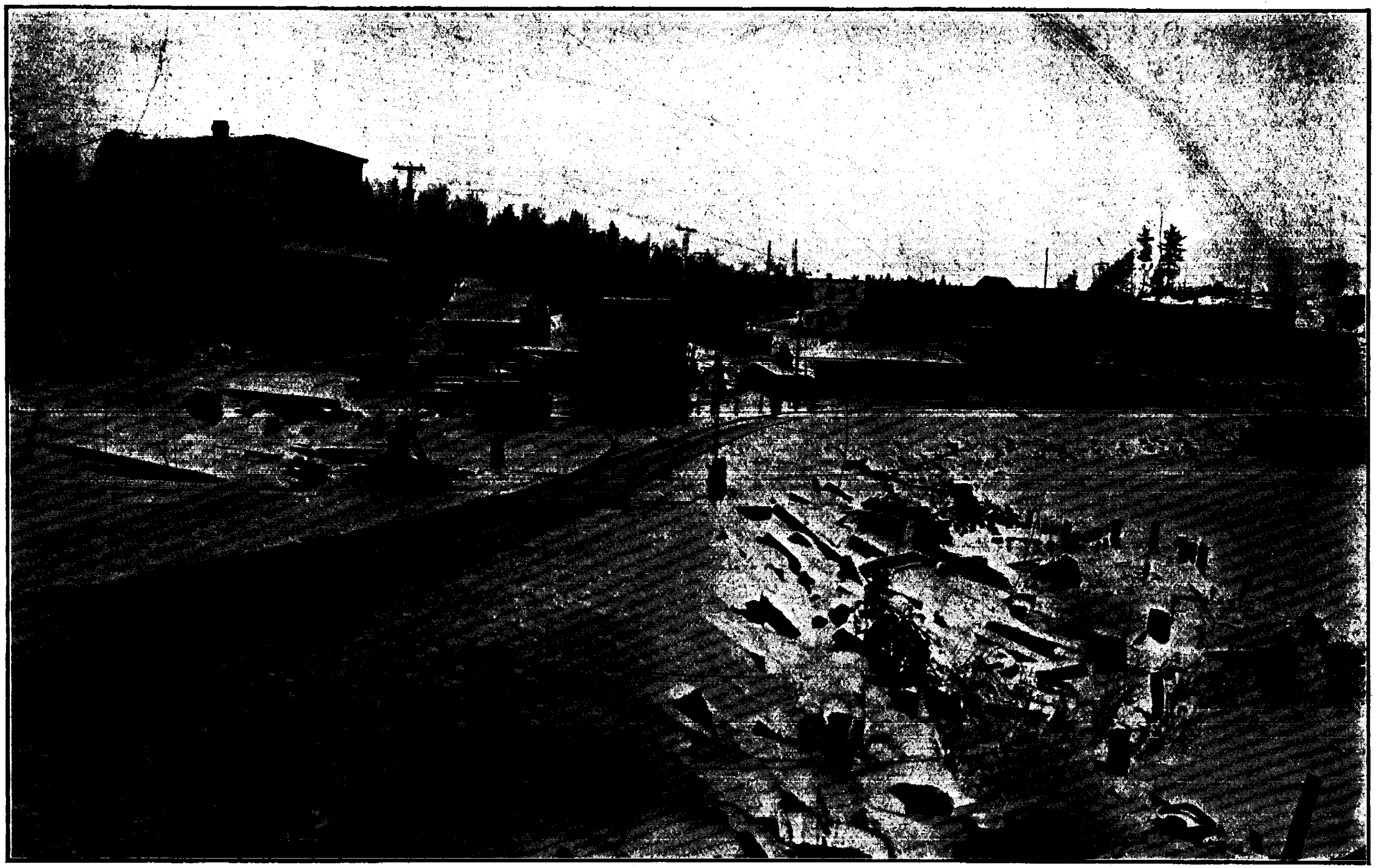


Fig. 1B. View of part of Cobalt, showing railway station and hotel, December, 1905.

Cobalt-Nickel Arsenides and Silver

By WILLET G. MILLER

CHAPTER I

Introduction

What is known as the Archean protaxis, or that rugged, rocky region which stretches away from the St. Lawrence river, expanding to the northwestward, and occupying a large part of northern Ontario, has produced and is constantly producing, a group of what may be called unique, or at least comparatively rare, economic minerals. Probably as great a variey of minerals is produced here in proportion to the number of inhabitants as is derived from any other country. Among these economic deposits are:

The nickel mines of Sudbury, which is one of the two important nickel producing localities of the world, with the bye-products, platinum and palladium;

The corundum deposits of north Hastings, south Renfrew and other areas in eastern Ontario, which now supplies by far the greater part of the corundum consumed in the world;

The unsurpassed feldspar and mica deposits of Frontenac and adjoining counties and the apatite, graphite, pyrite, talc, gold, copper, zinc, lead, fluorite and barite of the same district;

The iron ranges, which extend over a great territory in northern and northwestern Ontario, but which, up to the present, have not been developed to a great extent.

In addition to these, it may be said that a few years ago north Hastings possessed the only arsenic plant in North America. More recently the auriferous-arsenic ores of Temagami were made known, and lastly a discovery has been made of the series of Cobalt-Nickel Arsenides and Silver, which are unique, so far as known, on this continent, and are paralled by deposits only in Saxony and adjacent regions of continental Europe.

The eastern part of this region is also noted for certain minerals which can scarcely be said to be of economic value, but are of great scientific interest. The largest and finest crystals of the mineral zircon in the museums of the world come from eastern Ontario, as do also sphenes, pyroxenes, scapolites and other crystals. Sodalite, marble and other decorative materials are also found here.

Situation and Discovery

A brief description of the character and modes of occurrence of the Cobalt-Silver ores of the area examined during 1904 is given, as marginal notes, on the colored geological map which accompanies this report. For practical purposes, it is not necessary to add much to these. In the report which was published in the Thirteenth annual volume of the Bureau of Mines an account of the discovery and location of the ore bodies was given. It may be well to repeat briefly some of this information.

These ore bodies which carry values in silver, cobalt, nickel and arsenic, were discovered during the building of the Temiskaming and Northern Ontario Railway. In fact, it may be said that the railway discovered the deposits, as it runs almost over the top of what is probably the most important vein yet found.[1] The finding of such rich

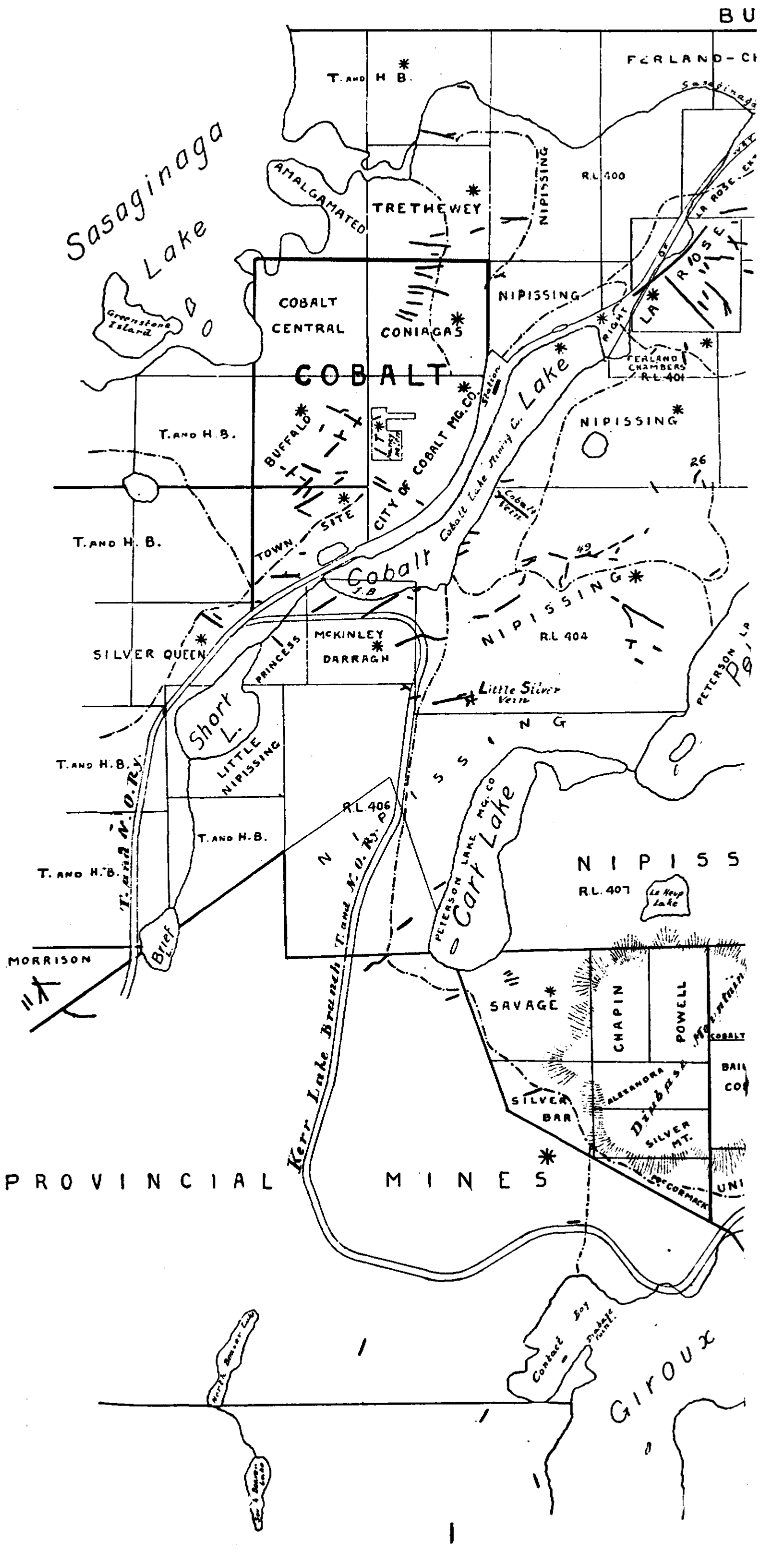
[1] It may be added that the Canadian Pacific railway virtually discovered the Sudbury nickel deposits, 90 miles to the southwest of Cobalt. It can thus be said that each of the two railways, thus far built in this part of Ontario brought to light an important and little dreamed of mineral field.

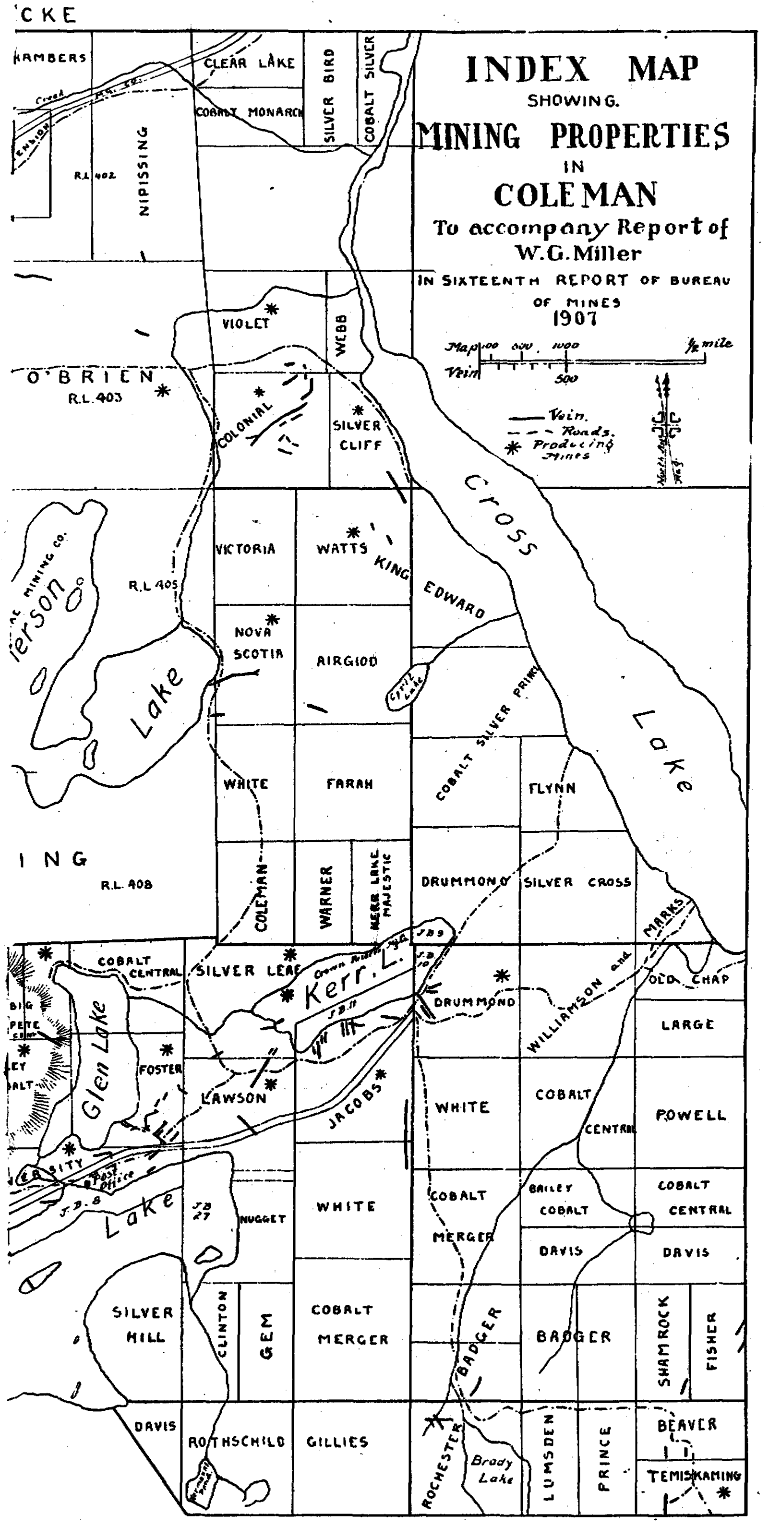
A FORECAST.

It may be interesting to note that the writer made the following comment on the mineral possibilities of the district in a report over two years before the discovery of the cobalt deposits—

"It will be seen from what has been stated on preceding pages that the district examined contains as great a variety of rocks as probably any part of the Province of equal area. . . .

"Although few discoveries of economic minerals have been made in this territory, it may reasonably be expected, judging from the character and the variety of the rocks, that deposits of value will be found when the district is more carefully prospected, as it will be in a short time, owing to the rapid settlement which is now taking place. . . . It would seem that at least some of the conditions of the Sudbury district are repeated in this more eastern field." (Report on "Lake Temiskaming to the Height of Land" in the Eleventh Report of the Bureau of Mines, page 229.) This report gives an account of the rocks and of the canoe routes from Lake Temiskaming northward to the Height of Land, and may now be found to be of service to prospectors.


BU
FERLAND-C
T. AND H. B.
Sasaginaga Lake
AMALGAMATED
TRETHEWEY
NIPISSING
R.L. 400
LA ROSE
Greenstone Island
COBALT CENTRAL
CONIAGAS
NIPISSING
RIGHT OF WAY
LA ROSE
COBALT
FERLAND CHAMBERS R.L. 401
T. AND H. B.
BUFFALO
CITY OF COBALT MG. CO.
Station
Cobalt Lake
Cobalt Lake Mining Co.
NIPISSING
26
T. AND H. B.
TOWN SITE
Cobalt Vein
49
J.B
NIPISSING
SILVER QUEEN
McKINLEY DARRAGH
PRINCESS
R.L. 404
Little Silver Vein
PETERSON LA
Short L.
LITTLE NIPISSING
T. AND H. B.
T. AND H. B.
T. and N. O. Ry.
R.L. 406
NIPISSING
PETERSON LAKE MG. CO
Cart Lake
NIPISS
R.L. 407
Le Heup Lake
MORRISON
Brief L.
Kerr Lake Branch T. and N. O. Ry.
SAVAGE
CHAPIN
POWELL
COBALT
SILVER BAR
ALEXANDRA
Diabase Mountain
SILVER MT.
McCORMACK
PROVINCIAL MINES
Contact Bay
Giroux


INDEX MAP
SHOWING
MINING PROPERTIES
IN
COLEMAN
To accompany Report of
W. G. Miller
IN SIXTEENTH REPORT OF BUREAU
OF MINES
1907
Vein
Roads
Producing Mines
CLEAR LAKE
COBALT MONARCH
SILVER BIRD
COBALT SILVER
NIPISSING
R.L. 402
VIOLET
WEBB
O'BRIEN
R.L. 403
COLONIAL
SILVER CLIFF
Cross Lake
VICTORIA
WATTS
KING EDWARD
R.L. 405
NOVA SCOTIA
AIRGIOD
Lake
WHITE
FARAH
COBALT SILVER PRINCE
FLYNN
R.L. 408
COLEMAN
WARNER
KERR LAKE MAJESTIC
DRUMMOND
SILVER CROSS
MARKS
COBALT CENTRAL
SILVER LEAF
Kerr L.
DRUMMOND
WILLIAMSON and
OLD CHAP
LARGE
Glen Lake
FOSTER
LAWSON
JACOBS
WHITE
COBALT CENTRAL
POWELL
Post Office
Lake
NUGGET
WHITE
COBALT MERGER
BAILEY COBALT
COBALT CENTRAL
DAVIS
DAVIS
SILVER HILL
CLINTON
GEM
COBALT MERGER
BADGER
BADGER
SHAMROCK
FISHER
DAVIS
ROTHSCHILD
GILLIES
ROCHESTER
Brady Lake
LUMSDEN
PRINCE
BEAVER
TEMISKAMING

ore within so short a distance of the shore of lake Temiskaming, a stretch of water which has been a well-travelled route to the north by white men for 200 years or more, and the deposits being only about four miles from the town of Haileybury, show the possibilities there are for the discovery of important mineral-bearing areas in the vast hinterland of Ontario, much of which is little known. The first of these ore bodies to be worked lies within half a mile of what is now known as Cobalt station, distant by rail 103 miles from North Bay junction on the transcontinental line of the Canadian Pacific, and 330 miles almost north of the city of Toronto.[2]. It may also be added that one of the oldest known ore bodies in North America, the argentiferous galena on the east side of lake Temiskaming, is distant only 8 or 9 miles from Cobalt station. This galena deposit was apparently discovered by voyageurs 150 years ago. A map of the lake published in 1744 has a bay marked on it with the name "Ance à la Mine," thus showing that the deposit was known at least at that date, and probably much earlier, owing to the fact that the ore outcrops at the water's edge and is of such a character as to attract attention (Fig. 2).

Some of these veins in the vicinity of Cobalt station were apparently noticed by the men employed in railway construction in the spring of 1903, but, there being no miners or prospectors among them, little interest was aroused and nothing was heard of the discovery by prospectors till October of the same year. At that time Mr. T. W. Gibson, Director of the Bureau of Mines, then in that part of the Province, was given a sample of niccolite which the donor thought was copper ore, the color of this mineral being like that of copper as the German name, kupfer-nickel, indicates. Mr. Gibson, however, recognized the value of the sample and forwarded it to the writer, who was then in the eastern part of the Province, and asked him to make a report on the occurrence as soon as possible. The writer, although he knew the specimen represented high class ore, hardly expected to find ores of the character and in the quantity which he saw on his arrival.[3] This mineral, niccolite, had been found

[2] The name Cobalt appears to come from the German *Kobold*, meaning goblin or house spirit. The metal was so called by the miners because its ore, being arsenious, was poisonous and difficult to treat. The writer felt, however, when he suggested the name for the town, that in this age such a name would not be considered unlucky.

THE CHRISTENING OF THE TOWN OF COBALT.

Fearing that the name "Long Lake," which had been in use for the construction camp, would be retained for the station which it had been decided to place at this point on the railway, the writer endeavored to select a name which would be in keeping with the locality. As an experiment he put up a post, in the first week of June, 1904, on the railway near the lake and wrote on a piece of board attached to the post, "Cobalt Station, T. & N. O. Ry." The name took at once, as was seen when the writer visited Haileybury a few days afterwards. The workmen and others from Long Lake who had registered at the hotel in the meantime had all given their address as "Cobalt."

On the 7th of June, 1904, the writer wrote to Mr. T. W. Gibson, Director of the Bureau of Mines, concerning the name of the station.

EXTRACT FROM LETTER FROM W. G. MILLER TO T. W. GIBSON.

"I wish you would suggest to the Commissioners of the T. & N. O. Ry., or whoever has the naming of the stations along the line that they call this station at Long Lake, Cobalt Station." "There will be a post office here in time—there are enough people here for one already—and there is now a Long Lake post office in Frontenac County. The name "Cobalt" would be unique. It would serve to advertise the place and miners and others would not get mixed in their stopping off place, as they might if the station is simply called 'Long Lake.'"

On June 11th, Mr. Gibson wrote to the Secretary of the Railway Commission, Mr. P. A. Ryan, concerning the calling of the station "Cobalt" Two days afterwards on June 13th, Mr. Ryan wrote as follows to Mr. Gibson:

"I beg to acknowledge receipt of your favor of the 11th inst, suggesting that the station which will probably be established at Long Lake, south of the Township of Bucke, be called "Cobalt." The suggestion which you make strikes me as being a good one, and I shall have pleasure in bringing your letter before the Commission at the proper time."

Shortly after the receipt of Mr. Ryan's letter the Commissioners met and accepted the name "Cobalt" for the station, which is now known, probably, at least as widely as Dawson City and the Klondike

[3] At the time of the writer's arrival in the district, in November 1903, 4 veins, all of which were very rich, had been found. Three of these were within sight of the railway and the fourth was a short distance to the southeast. The blackened, tarnished silver had up to that time attracted little or no attention, although it occurred in profusion in two or three of the weathered outcrops. At the present time over 100 veins and stringers, the majority of which can be worked at a profit, have been found. Although the writer's first report of his examination of this cobalt-silver area was published in November, 1903, the public evinced little interest in the field until about eighteen months afterwards, when reports were made of shipments from various properties. The lack of interest was apparently due to the fact that the evil effects of the mining boom of a few years ago had not died out, and the public were more or less sceptical of reports on mining, no matter from what source they might emanate. By June, 1905, interest was aroused in the district throughout North America, and the rush to Cobalt has been greater than has been seen before in the mining fields of Ontario.

The following extracts from letters written in the autumn of 1903 by Mr. T. W. Gibson, Director of the Bureau of Mines, may now have some historical interest.

some years before in association with the lower grade nickel ores of some of the Sudbury deposits, but no great quantity of it has up to the present been discovered in the Sudbury field, the town of which name lies about 90 miles southwest of Cobalt station. It may, however, be stated that the Sudbury ore deposits are quite different in character and in origin from those at Cobalt, although the metal nickel is an economic constituent in each. The Sudbury deposits have received a great deal of attention from geologists during the last fifteen years or more, and two important reports have recently been published by them. These are by Dr. A. E. Barlow, of the Geological Survey, and by Professor A. P. Coleman, of this Bureau. Nearly all the writers agree that the ores are essentially of igneous origin,—that is, that the nickeliferous magnetic pyrites or pyrrhotite and copper pyrites have separated from a molten mass of rock. The deposits at Cobalt, on the other hand, occupy narrow, practically vertical fissures or joints which cut through a series of usually slightly inclined metamorphosed fragmental rocks of Lower Huronian age (Fig. 1). A few veins, of similar form, have also been found in the adjacent diabase. While there are a number of occurrences of ore in the Keewatin the two most productive veins in this series are probably vein 26 on the Nipissing and that on the Temiskaming, which is shown in the southeast corner of our large scale geological map. The former vein lies near the edge of Peterson lake and close to the western edge of the diabase sill, while the latter lies between the diabase and granite. The Keewatin when not near a diabase contact has not been proved to be productive.

There are examples of veins which run from the Huronian conglomerate into the underlying Keewatin, and there are veins, *e. g.*, one on the Lawson property, which runs horizontally from the Keewatin into the diabase, and, *e. g.*, the Nova Scotia vein which runs downward from the Keewatin into the underlying diabase.

The material in these veins has, in all likelihood, been deposited from highly heated and impure waters which circulated through the cracks and fissures of the crust and were probably associated with—followed—the post-Middle Huronian diabase eruption.[4] It is rather difficult to predicate the original source of the metals—silver,

(Extract from letter from T. W. Gibson to W. G. Miller, then inspecting mineral properties in the vicinity of Perth, Ontario.)

"Bureau of Mines. Toronto, Oct. 26th, 1903.

"I am enclosing herewith a fragment of a larger sample of what I take to be kupfer-nickel found along the line of the Temiskaming & Northern Ontario Railroad. The locality of the deposit is in the unsurveyed territory immediately south of the township of Bucke. I have not learned anything as to the extent of the discovery, but if the deposit is of any considerable size it will be a valuable one on account of the high percentage of nickel which this mineral contains. I think it will be almost worth your while to pay a visit to the locality of the discovery before navigation closes. I am under the impression that the find was made while making the cutting for the railway. Mr. Ferland, of Haileybury, showed me a sample of the mineral when I was there, but he did not appear to recognize it or know its value, deeming it a compound of copper. It would be rather remarkable should our nickel deposits turn out to have a wider range than has hitherto been supposed, and especially if the new outcrop should be a large one containing ore of so high a grade."

(Extract from letter from T. W. Gibson to W. G. Miller, addressed to Haileybury.)

"Bureau of Mines, Toronto, Nov. 13th, 1903.

"I duly received your letters of the 6th and 9th inst., respecting the progress you are making in looking up the really wonderful finds which appear to have been made in the locality where you are. I hope you will be able to procure a first-class set of samples for the Bureau from all the discoveries, and am waiting with some degree of anxiety your report on the western deposit, namely, the one at Loon Lake."

On November 16th, 1903, the Toronto "Globe" had a half-column article, based on letters of W. G. Miller to the Bureau of Mines. The following sentences indicate the tenor of the article: "Rich discoveries along government railway. . . . Exceeding rich in nickel. . . . Silver, cobalt and arsenic also found. . . . One specimen of silver obtained by Mr. Miller was about the size of his hand, and half an inch thick.

On November 20th, another half column article, an interview with W. G. Miller, appeared, in which are these sentences, "Temiskaming minerals . . . Prof. Miller returned with samples. Says there is no doubt as to the importance of the find. . . . One large piece of silver weighs about ten pounds."

Interviews of this date also appeared in several other Toronto newspapers.

[4]The waters are said to be associated or connected with the diabase eruption in the sense that they probably represented the end product of the eruption. In many volcanic regions hot springs are present long after the rocks have solidified. In the Cobalt area the fissures and joints now occupied by the ores were probably produced by the gradual shrinkage in cooling of the diabase, the ores being deposited by the waters which represented the last stage of vulcanicity.

The widespread occurrence of cobalt veins in the diabase, shown by discoveries during the last two years, appears to be pretty conclusive proof that the cobalt and diabase have come from one and the same magma. The cobalt veins in the diabase near Wendigo lake, about 25 miles north of cobalt and in the Montreal river area about the same distance to the west, are described in Chapter IV. of this report In both of these areas no veins are found in the Huronian conglomerate, and, as will be seen from the geological maps, the Keewatin series is doubtfully present near Lake Wendigo and occurs in very small volume in the Montreal river area.

The origin of the ores of the Cobalt area, is dealt with in an important paper by President C. R. Van Hise, in the Journal of the Canadian Mining Institute, 1907, pages, 46-61.

cobalt, nickel, arsenic and others—now found in these veins. They may have come up from a considerable depth with the waters or they may have been leached out of what are now the folded and disturbed greenstones and other rocks of the Keewatin. Analyses of various rocks of the area have not given a clue as to the origin of the ores. As these ore bodies in the vicinity of Cobalt station may be said to be unique among those known in North America, we have no chance of instituting comparisons on this continent. Some European veins, however, such as those of Annaberg, Joachimsthal and other localities which will be again referred to, show a similar association of minerals. The origin of these has been explained by most authors by the supposition that the metals were leached from the surrounding rocks. The writer has found, however, from the descriptions which have been published of most of these European occurrences, that there are usually basic dikes in the vicinity of the veins. These dikes appear to have in some cases, the same relation to the ore bodies that those of diabase and gabbro have in the Ontario cobalt region. (*See* preface to third edition concerning origin).

Ores and Minerals.

The more important ores in the veins under consideration are native silver,—associated with which is usually some dyscrasite, argentite, pyrargyrite and other compounds of the metal—smaltite, niccolite and related minerals. Many of the minerals occur mixed in the ores, and for this reason some of them have not been clearly identified. Another character of the minerals which renders their identification difficult, is the fact that most of them occur in the massive form. Crystals when present are small, being almost microscopic in size. The writer has, however, identified the following minerals, which can be conveniently classed under the headings:

I.—Native Elements:
Native silver, native bismuth, graphite.

II.—Arsenides:
Niccolite, or arsenide of nickel, $NiAs$; chloanthite, or diarsenide of nickel, $NiAs_2$; smaltite, or diarsenide of cobalt, $CoAs_2$.

III.—Arsenates:
Erythrite, or cobalt bloom, $Co_3 As_2 O_8+8H_2O$; and annabergite, or nickel bloom, $Ni_3 As_2 O_8+8H_2O$.

IV.—Sulphides:
Argentite, or silver sulphide, Ag_2S; millerite, or nickel sulphide, NiS.

V.—Sulph-arsenides:
Mispickel, or sulph-arsenide of iron, $FeAsS$; cobaltite, or sulph-arsenide of cobalt, $CoAsS$.

VI.—Antimonide:
Dyscrasite, or silver antimonide, Ag_6Sb.

VII.—Sulph-antimonides:
Pyrargyrite, or dark red silver ore, $Ag_3 SbS_3$; proustite, or light red silver ore, $Ag_3 AsS_3$; tetrahedrite, or sulph-antimonide of copper, $Cu_8Sb_2S_7$.

In addition to the above minerals there are a number of secondary or decomposition products with rather indefinite characteristics, such as asbolite, which may be called a much weathered form of cobalt bloom. It consists essentially of the oxides of cobalt, manganese, etc. The cobalt bloom and annabergite occur intermixed, at times, in proportions such that the red color of the former counteracts the green color of the latter, a white clay-like substance being the result. There are occasionally other sulphides present than those mentioned, especially in the wall rock. These consist of copper pyrites and bornite, which are the sulphides of copper and iron; galena, the sulphide of lead; and iron pyrites, the disulphide of iron. Zinc blende is found occasionally. These minerals in the wall rock were probably deposited before the vein materials.

One is struck with the great variety of these comparatively rare minerals, some of which occur in a high percentage in the deposits. The number of metals is also large.[5]

[5] In the Summary Report of the Geological Survey of Canada for 1907, pages 96-97, Mr. R. A. A. Johnston states that stromeyerite, $Ag_2S.Cu_2S$, and argyropyrite, a sulphide of silver and iron, have been recognised in specimens from the Foster mine, and that freibergite, a silver-bearing tetrahedrite, is found in quartz at the Silver Queen mine.

A characteristic of the group is the subordinate part which sulphur plays in comparison with arsenic. Antimony, which is not abundant, is found in some compounds where we would expect to find arsenic, since the latter is so much more abundant. For instance, while we have both native silver and arsenides in abundance the only compound of arsenic and silver yet recognized is proustite which occurs in two or three of the mines in small quantity. Then one would also expect to find some compounds of bismuth since this metal occurs in the free state in considerable quantities in some parts of the deposits. It might also be expected that native arsenic would occur at times.

It will be seen from a following page that nearly all the chemical groups of minerals found in the celebrated Joachimsthal deposits of Bohemia are present in the Temiskaming ores. The most important exception is uraninite or pitchblende, which came into prominence a few years ago on account of its being the chief source of the element radium. The Austrian Government finding they had a practical monopoly of pitchblende are reported to have prohibited its export.

The Bohemian deposits appear never to have been so rich in silver, cobalt, nickel or arsenic as are those of Ontario.

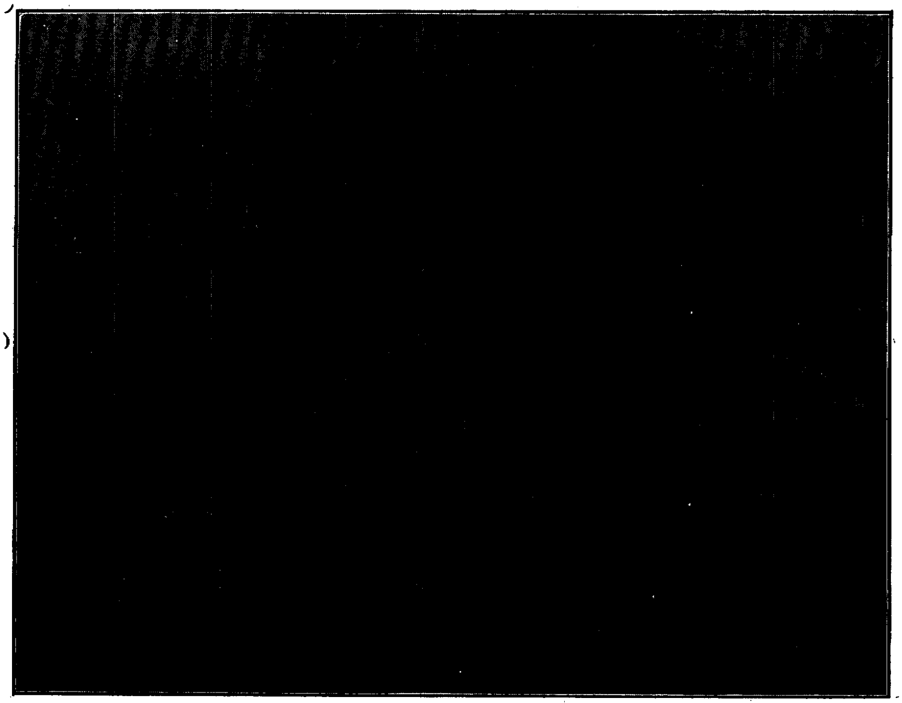


Fig. 1c. Prospectors at Cobalt, May, 1904.

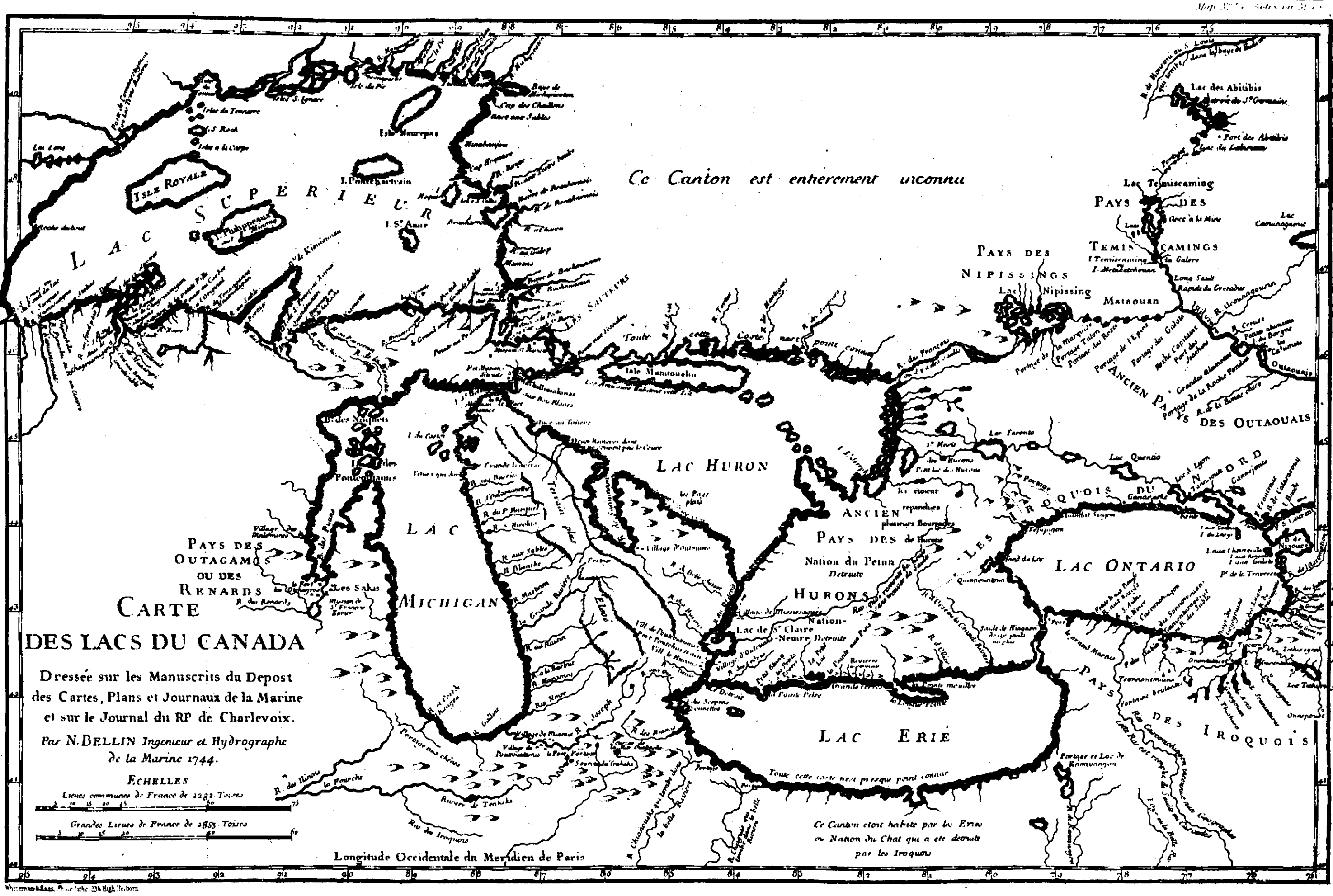


Fig. 2. Map published in 1744 showing that the argentiferous galena deposit on the east side of Lake Temiskaming (Ance à la Mine) was known at that date.

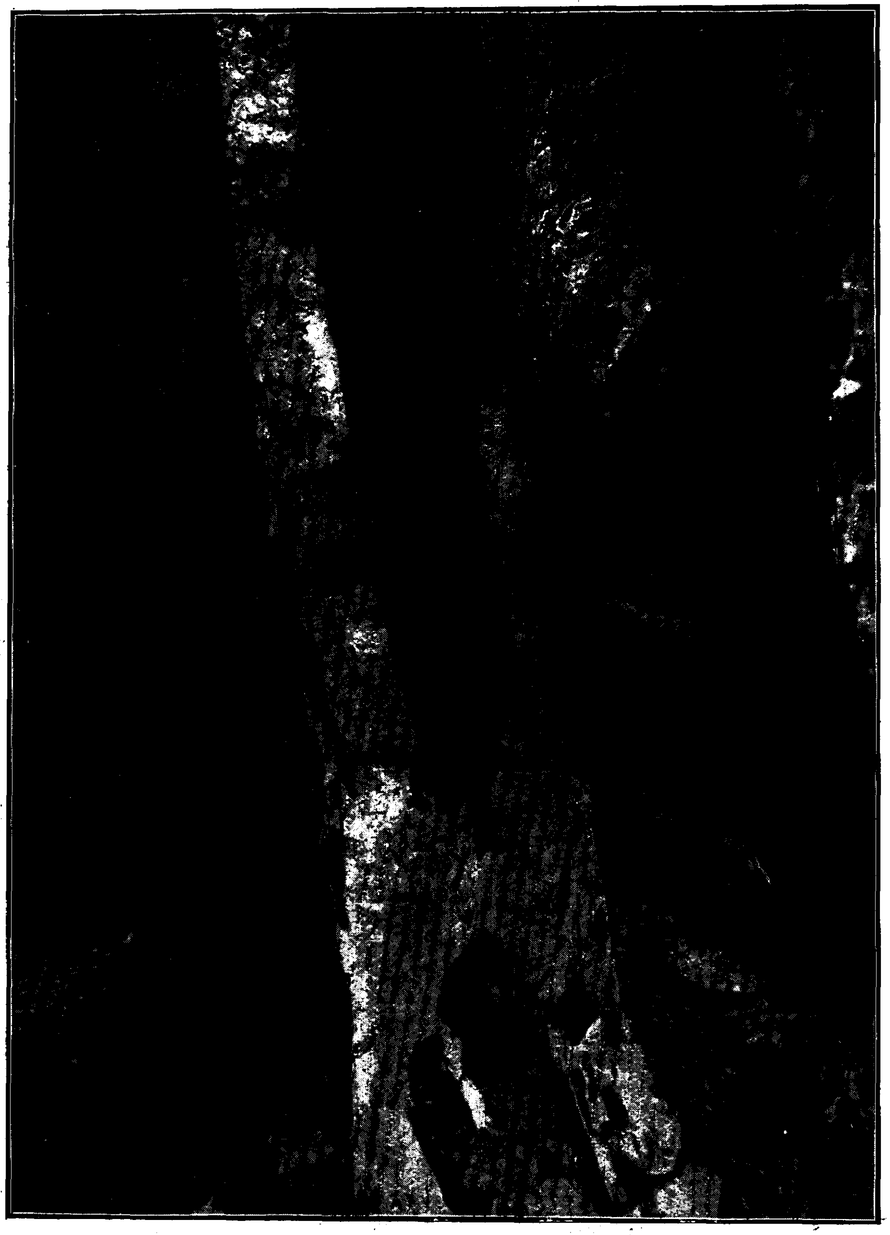


Fig 3. Crown Reserve vein, on Kerr lake.

NOTES ON MINERALS

The 5 or 6 veins ,with one exception, which were the first to be worked, all carry high values in silver, as do most of those discovered more recently. The outcrop of the non-silver bearing vein is about 14 inches in width of practically solid ore, which had a gray color and was not unlike mispickel in appearance (Fig 5). Very little veinstone, such as calcite, or quartz, was present. When examined carefully in hand specimens, this apparently massive, uniform, gray ore is found to contain two constituents. Set through the gray ground mass are grains of the copper colored niccolite, the ground mass itself being smaltite. Occasionally this ore in tiny vugs shows crystals large enough to be recognized. Minute crystals of smaltite also occur in the wall rock. No crystals of the niccolite have been recognized. There are probably some other closely related arsenides of cobalt in addition to smaltite in this ore. The diarsenide of nickel, chloanthite, is also present. At times some massive tetrahedrite is seen, and it is usually associated with copper pyrites, which helps one to identify it. It is, however, usually readily recognizable by its black color and bright appearance.

Much of the surface of this ore shows the decomposition product, cobalt bloom, the arsenide having been changed by atmospheric agencies to the arsenate, the oxidized form. There is at times some green decomposition material, which is the arsenate of nickel, known as annabergite. Occasionally the cobalt bloom shows a crystalline structure, being in the form of delicate rosettes. The bloom, which is of a delicate pink color, can be easily recognized, if one has any difficulty in distinguishing it from certain shades of red oxide of iron, by heating it gently, when it will take on a blue color. This is characteristic of all hydrated salts of cobalt. They are pink or, if in dilute solutions, almost colorless. Sympathetic ink, for instance, is a dilute solution of cobalt salt. If a pen be dipped into it and used for writing on paper, the writing is invisible until the paper is heated, driving off the water and dehydrating the salt, which then takes on a distinct blue color.

In most of the veins where silver is found in important amounts, a uniform massive structure like that of the vein just referred to is not exhibited. There is more or less calcite present, and at times a little quartz. The veins sometimes show a crudely banded structure. The writer is, however, unable to say that there is any special arrangement of the ores in these veins.

The ores are frequently grown together. Arsenides of cobalt and nickel, for example, have native silver intimately mixed with them; at other times there is almost massive smaltite or niccolite. Some of the veinlets which form junctions with the larger veins contain much silver in various forms. The chloanthite occurs characteristically in small spheroidal masses in calcite.

The native silver is in masses and also occurs in films, flakes, sheets and wire-like forms, especially in calcite. On analysis it is found to contain, usually, some antimony and occasionally bismuth. The dyscrasite is usually closely associated with native silver. Pyrargyrite is not very abundant, and only one slab or angular piece of ore which the writer examined contained crystals of this mineral. These were of sufficient size to be examined with a reflecting goniometer. Fig. 4 represents one of these crystals which has been kindly measured by Professor Goldschmidt, of the University of Heidelberg. The pyrargyrite is rather easily recognized by the color of its streak. Argentite occurs in a number of the veins, and is easily recognized by its softness, cutting like lead, from which metal it may be distinguished by its black color.

Only one sample containing the delicate needles or hair-like forms of the sulphide of nickel, millerite, was found, although it is likely this mineral occurs in most of the deposits. Being so delicate, the crystals are easily destroyed.

Native bismuth has been found in nearly all of the deposits worked. On freshly broken surfaces it has almost the color of native silver, and is not readily recognized unless it is cut. Being softer than silver, it is rather easily determined, its color distinguishing it from argentite. Native bismuth, however, soon tarnishes on exposure to the air, and takes on a rather striking, yellowish color, something like that of pyrite or bornite.

The following anaylses will give some idea of the characteristics of the minerals and of the value of the shipments which have been made from a number of the deposits, the material in one vein being similar to that in most of the others.

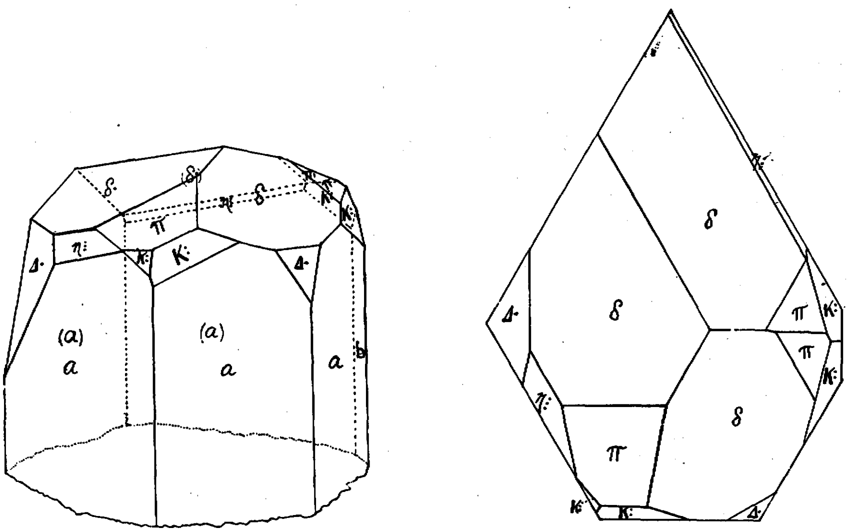


Fig. 4.

The following note on the pyrargyrite crystals from the La Rose mine is by Prof. Nicol:

"The crystals occur as an incrustation on the surfaces of chinks or cracks in the country rock intimately associated with argentite or silver glance.

"The crystals are more or less well developed hexagonal prisms, terminated in some cases by rhombohedrons and scalenhedrons. The crystal reproduced in the drawings shows a somewhat peculiar development—only five faces of the prism of the first order *a* are present; the sixth face *b* is a single representative of the prism of the second order."

White Bloom

Associated with the cobalt bloom in the weathered parts of the La Rose and other veins there is a white, clay-like material, which resembles in form the moist cobalt bloom. The writer suspected that the white color of this material was due to the intermixture of tho green nickel arsenate, annabergite, sometimes known as nickel bloom, with the pink cobalt bloom. An analysis by Mr. Burrows confirmed this opinion. It is a rather interesting occurrence. In pottery the blue cobalt compounds are used in small amounts to destroy the delicate reddish tinge due to iron in the ware. In this white bloom we see one color destroyed by another in nature.

	Per cent.
Nickel oxide	29.30
Cobalt oxide	6.43
Arsenic pentoxide	38.31
Lime	.84
Magnesia	1.12
Iron	.30
Water	24.04
Total	100.34

Mr. Burrows says: "In evaporating the solution of the metals I had a very interesting result. The solution was quite concentrated, and on cooling, green acicular crystals of the nickel compound separated out, while the solution above and around them was quite pink. The original solution before the crystallizing out of the nickel compound was quite blue."

Mixed Dark Mineral

There is a mineral, or mixture of minerals, of fairly common occurrence in some of the narrow stringers which run off from the main La Rose vein and elsewhere. Some of this was sent to Mr. Burrows for anaylsis. He has, however, not been able to get a sample which he considers represents a single mineral. From one specimen sent to him by the writer he obtained the following percentages:

	Per cent.
Silver	57.40
Sulphur	15.94
Antimony	7.92
Iron	3.88
Arsenic	.52

Mr. Burrows afterwards analysed other samples but with unsatisfactory results. For instance, he found the following percentages of silver: 47.24, 47.38, 64.29, 62,56, 63. He also proved the presence of lead in samples examined later. In one case he got 9 per cent. of lead, and in another only about 1.8. He found these samples to show considerable free silver, which no doubt accounts for the varying percentages of this metal, and that the mineral did not look the same in all parts, some of it being of a dull lustre and other parts bright.

Chloanthite

A sample of chloanthite, in nodular form, from the La Rose mine, J S 14, was found to have the following composition:

	Per cent.
Nickel	23.24
Cobalt	4.11
Silver	2.78
Sulphur	2.18
Arsenic	67.17
Antimony	none
Total	99.48

Niccolite

A sample from the La Rose mine, consisting essentially of niccolite, was found to contain 5.02 oz. of silver to the ton, and nickel 26.64, cobalt 6.16, arsenic 45.64 per cent.

Tetrahedrite

Mr. Burrows found a specimen of the tatrahedrite, which occurs massive, to possess the following composition:

	Per cent.
Copper	36.04
Sulphur	22.86
Antimony	21.86
Zinc	8.14
Iron	9.84
Cobalt	none
Nickel	none
Lead	not det.
Total	98.74

Tetrahedrite is frequently met with in the Trethewey mine, J B 7. Native bismuth has been found in practically all the veins which have been opened up.

Native Bismuth

	Per cent.
Bismuth	99.20
Cobalt	distinct trace
Nickel	trace
Iron	.40
Silver	trace
Arsenic	trace
Antimony	none
Total	99.60

This analysis represents a sample from the Cobalt Hill vein.

Mispickel and Cobaltite

Mispickel is not so common in the deposits as one might expect it to be. In some of the veins first discovered on what is now known as the Buffalo mine, in the town plot of Cobalt, mispickel seems to be a characteristic mineral.

	(1)	(2)	(3)
Iron	34.4	26.76	28.83
Arsenic	46.	41.76	40.08
Sulphur	19.6	17.63	19.25
Cobalt	......	3.21	4.83
Nickel	......	.76	......
Silver	......	......	306.1 oz. per ton.

No. 1 analysis shows the theoretical composition of mispickel; Nos. 2 and 3 are analyses of mispickel from the south vein (of the two discovered in 1904) on the Buffalo mine. This ore occurs in the Lower Huronian not far from the contact with the Keewatin.

In connection with these the following analyses, Nos. 1 and 2, of samples of mispickel from the Big Dan and Little Dan claims near Temagami will be of interest.

	(1)	(2)	(3)	(4)
Iron	29.68	29.84	not det.	4.55
Arsenic	36.24	36.81	41.65	44.55
Sulphur	18.99	18.77	17.8	20.73
Insoluble	13.52	13.02	not det.	
Water	.72	.79	not det.	
Cobalt	......	......	32.42	29.10
Nickel	......	......	......	.97
Total				99.90

No. 1 represents selected particles from a sample taken at the Little Dan claim. In addition to the components shown, the sample carried $4.00 worth of gold and 59 cents worth of silver per ton. No. 2 represents selected particles from the Big Dan claim. This ore showed values per ton of $3.20 in gold and 54 cents in silver. The deposits are in the Keewatin. No. 3, cobaltite ore from the Temiskaming Cobalt mine, carries $5.20 a ton in gold. No. 4, crystals of cobaltite from the Columbus claim, analyzed by Mr. J. S. De Lury.

Dyscrasite

A sample of the dyscrasite from the La Rose mine was found by Mr. Burrows to have on analysis the formula Ag_6 Sb. The more common variety of this material in other districts has the formula Ag_3 Sb.

Calcite

A sample of the calcite veinstone from the Violet mine, which lies at the northwest corner of Cross lake, was taken by the writer and analyzed by Mr. Burrows. The vein here is in diabase. The calcite as shown by the following is remarkably pure. The absence of magnesia in calcite is rare.

	Per cent.
Lime	55.72
Magnesia	none
Iron and alumina	.12
Carbon dioxide	43.74
Insoluble residue	none
Total	99.58

Cobalt Hill Ore

The deposit known as the Cobalt Hill vein, in the northwest corner of R L 404, was described on page 99 of the Thirteenth Report of the Bureau. For comparative purposes it will be well to again refer to it. The description is intended to show the character of the more massive cobalt-nickel ore of the area and of one of the important veins containing this class of ore. The workings at this vein can be seen from the railway track on the west side of Cobalt lake. The vein was one of the four which had been discovered at the time of my visit to the district in November, 1903. The ore is unlike that of some of the other important veins in the vicinity in that it does not carry silver in paying quantities, the values being in cobalt, nickel, and arsenic. From a glance at the plan it will be seen that the strike of the vein is northwest and southeast. Moreover, this vein contains little calcite or other gangue. It is believed that the calcite, which is found in considerable quantity in the other veins, is, for the most part, later in age than the cobalt-nickel minerals, and that it is older than most of tho silver at least. The silver frequently occupies cracks in the calcite.

The more or less well banded slaty greywacké, through which the Cobalt Hill vein cuts perpendicularly, dips westward towards Cobalt lake at an angle of 20 or 30 degrees in the direction in which the vein strikes. The rock is slightly arched over the vein, thus producing a gentle anticline, which pitches towards the lake (Figs. 1, 5). The vein, where originally exposed, is at a height of 100 feet above the lake.

At the points where it was originally exposed, the vein showed a width of 14 inches of massive ore, and vugs two feet or more in the wall rock from the edge of the vein contained cobalt bloom. It may be added that in certain of the other veins the wall rock is impregnated with native silver, which is found even in the centre of boulders of granite in the conglomerate.

The ore has a rather dark-gray color. When closely examined it is seen to be composed of a grey mineral, which is chiefly smaltite, set through which are grains of a reddish mineral, niccolite. Smaltite and the corresponding arsenide of nickel, chloanthite, are said by most authors to pass into one another by the substitution of cobalt for nickel and *vice versa*. Niccolite, in the analyses quoted by Dana and others, carries only a small percentage of cobalt and iron, while smaltite frequently contains a considerable percentage of nickel and iron. In the ore under consideration the cobalt and nickel appear to be, for the most part, in distinct compounds. In the analysis (No. 1) if we consider the 7 per cent. of nickel to exist as niccolite, and the percentages of iron and cobalt, 6.3 and 16.8 respectively, to represent smaltite, the theoretical percentage of arsenic in the ore should be 68.47 instead of 69, as found by analysis. The percentage of niccolite by weight would be 15.94, or about one-seventh part of the whole by volume, since niccolite has a somewhat higher specific gravity than smaltite.[6] Specimens of this ore, when examined with the magnifying glass, appear to agree with this.

Constituent.	1	2	3	4	5
Cobalt	16.8	16.7	16.76	19.80	} 21.70
Nickel	7.0	6.8	6.24	4.56	
Iron	6.3	7.5	....	6.20	8.89
Arsenic	} 69.0	62.0	66.60	60.30	63.55
Sulphur		7.0	3.37	4.09	5.38
Insol. silica, etc	0.9	....	....	2.40	0.60
Water	....	....	....	2.00	....
Totals	100.0	100.0	....	99.35	100.12

Of the above analyses, Nos. 1 and 2 were made by Mr. O. S. James. The former represents a hand specimen from near the surface, and the latter a specimen from a

Fig 5. Cobalt Hill vein, northwest corner of location R L 404, Nipissing mines. The photograph shows the fractured character of the rock and a gentle anticline. The vein is seen to be in step-like forms as if it had been affected by horizontal faults, but the ore is not brecciated.

depth of about 20 feet; 3 and 4 are of average samples collected by the writer, the former from the uppermost opening on the hill, and the latter from the middle or main opening, the analyst being Mr. A. G. Burrows. Sample 3 contained considerable cobalt bloom. Analysis 5 is by Dr. J. Waddell. It represents a specimen collected by Prof. Nicol. This specimen was not taken, like 3 and 4, with the object of determining the average composition of the vein. Prof. Nicol states that a qualitative analysis

[6] Specific gravities: niccolite 7.33-7.67, smaltite 6.4-6.6, native silver 10.1-11.1. It may be added that a determination of the specific gravity of a number of samples of ore from one of the Cobalt-silver veins showed it to average 4.85.

showed the presence of small amounts of copper and lead, and the absence of antimony, bismuth and zinc.

Minute, brilliant, silver-white, or tin-white, crystals, occur sparingly, imbedded in the wall-rock and in the ore. The crystals are cubes and combinations of this form, with the rhombic dodecahedron, and octahedron. Prof. Nicol, who has measured some of them on the goniometer, has found them to be smaltite, (Fig. 6). The white or gray colored arsenides show a tendency to form globular or spheroidal masses, with a radiated structure. Some of these masses in calcite have a diameter of over half an inch.

The ore is at times somewhat porous, spaces being left between the globules, which are tarnished almost black on their surfaces. Where the surface of the ore has been exposed to the action of water and ice, it has a dark color not unlike that of the wall rock, bloom, the product of decomposition, having been carried away. The fresh ore is coated with a fraction of an inch of the dark decomposed material.

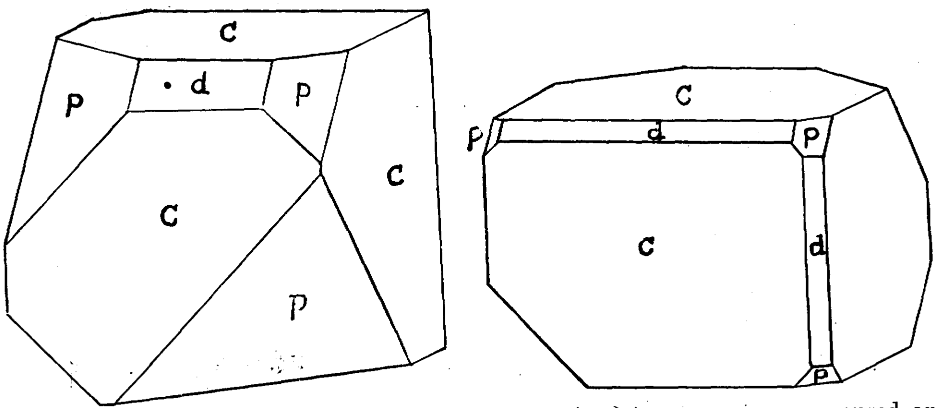


Fig. 6. Smaltite crystals from the Cobalt Hill vein, Nipissing mines, measured and drawn by Prof. William Nicol of the Kingston School of Mining. C=cube, P=octahedron, d=rhombic dodecahedron.

Small grains of quartz are found sparingly in the ore.

The proportion of nickel to cobalt in this vein is less than that in the main La Rose vein, particularly.

Copper pyrites, with which is usually associated gray copper ore, tetrahedrite, is found in the deposit. Native bismuth is also of frequent occurrence.

Veinlets at Lake Shore

Two veinlets, at the time the camp was discovered, were to be seen near the water level on the east side of Cobalt lake, not far from the point where the north boundary of location R L 404 meets the shore. A sample was taken from these veinlets and was found to have the following composition, showing that it is much like the massive ore of the vein in the northwest corner of R L 404:

	Per cent.
Cobalt	17.84
Nickel	4.16
Arsenic	56.10
Sulphur	5.98
Iron	9.22
Insoluble	4.32
Bismuth	No indications
Silver	"
Antimony	"
Water	Not determined

Sample shows cobalt bloom.

Exhibit of Cobalt-Silver Ores

Through the Bureau of Mines, arrangements were made for securing a collection of the cobalt-silver ores for exhibition at the Louisiana Purchase Exposition, held at St. Louis in 1904. These were obtained at the request of Mr. William Hutchison, Dominion Exhibition Commissioner, who has since purchased the samples exhibited with the object of keeping them as a permanent exhibit. They were afterwards sent to the Liege Exhibition, Belgium.

The following notes given to the writer by Mr. W. E. H. Carter, late Provincial Inspector of Mines, show the composition and character of the exhibit. While the exhibit was at St. Louis it was sampled by Mr. Carter, who has this to say of the various specimens: "The niccolite contains silver not only disseminated but in pure stringers and nuggets as well. These nuggets and stringers were not included in the sample taken for analysis, but should be considered as very considerably adding to the value of ore represented by my sample.

"I. Cobalt-Silver Ore, Sample from R L 404:

(a) 50 lb. decomposed material with silver, containing by estimate 30 p. c. silver, which amounts to 218 oz., and at 55c. per oz. $119 90

(a) 14 pieces, wall rock with silver .... } 75 pieces weighing
(b) 61 pieces cobalt ore .... } 6.510 lb.

This 6,510 lb. contains by assay—

Silver, 2.58 oz., per ton, at 55c.	$ 4 62
Cobalt, 18.04 p. c.,—1,174.4 lb., at 65c	763 36
Nickel, 5.52 p. c.,—359.35 lb., at 15c.	53 90
Arsenic, 39.56 p. c.,—791.2 lb., at 1c.	7 91
Total value of sample	$949 69

(a) From Little Silver vein, southwest corner of location R L 404.
(b) From Cobalt Hill vein, in northwest corner of the same location.

"II. Niccolite-Silver Ore, from La Rose mine, Location J S 14 on map:

Containing by assay.	Value per ton.
Silver, 7.944 p. c.—2,317 oz., per ton, at 55c.	$1,274 35
Cobalt, 8.93 p. c.,—178.6 lb., at 65c.	116 09
Nickel, 15.67 p. c.,—313.4 lb., at 15c.	47 01
Arsenic, 39.56 p. c.,—791.2 lb., at 1c.	7 91
Total per ton	$1,445 36
There are about three tons in the sample	$4,336 08

"III. Trethewey's Cobalt-Silver Ore, Location J B 7 on map:

145 lb. in all. Of this, 15 lb. is by estimate pure silver—212 oz.—and at 55c.	$116 60
And 130 lb. is cobalt ore containing silver, and valued at $1.50 per lb.	195 00
Total value	$311 60

"In valuing the above ores I have taken the prices paid by the dealers at New York for the crude ore, which are as follows for the several metals:

Silver	Market value.
Cobalt	65c. per lb.
Nickel	15c. per lb.
Arsenic	1c. per lb."

The value of these samples of ore, which are to be kept for exhibition purposes, is approximately as follows:

(1) Sample of cobalt-silver ore from R L 404, weight 6,560 lb., value	\$949 69
(2) Niccolite-silver ore from La Rose mine, exact weight not given, but if it is three tons, as stated, the value of the sample is	4,336 08
(3) Trethewey cobalt-silver ore, 145 lb. in all, value	311 60
Total value of collection	\$5,597 37

The cobalt is contained essentially in the mineral smaltite, which is a diarsenide of this metal. Most of the nickel in the samples occurs as the arsenide, niccolite, but

Fig. 7. Slabs of silver from the Trethewey Mine, location J B 7. The slab standing upright is the 79-pound specimen referred to in the text.

some of the metal is in the diarsenide form, chloanthite. The greater part of the silver is in the native form, although the sulphide, argentite, the sulph-antimonide, pyrargyrite, and other compounds of the metal are found in the deposits.

Sample from Trethewey Mine

Through the courtesy of Mr. W. G. Trethewey, the Bureau of Mines obtained a sample, for preservation in its collection, of the richer ore from his vein on location J B 7. This sample weighs 79 lb. (Fig. 7). Drillings, obtained by boring into the sample, show it to have the following composition. The calcium and magnesium carbonate represent the veinstone. The cobalt and nickel exist as arsenides and the silver is essentially in the metallic form. Some of the iron shown in the analysis may have come from the drill.

	Per cent.
Silver	66.67
Cobalt	2.15
Nickel	.41
Iron	1.60
Arsenic	7.03
Antimony	9.67
Sulphur	.22
Calcium carbonate	6.72
Magnesium carbonate	1.23
Insoluble	3.29

The va'ue of the silver in this 79-lb. sample, at 64c. an ounce Troy, the present market price, is $491.55, which represents an increase of $40.39 in value since the sample was purchased by the Bureau of Mines.

SHIPMENTS AND ANALYSES

The production for the first quarter year ending March 31st, 1905, during which shipments were made, was 354.05 tons of ore valued at $293,552. The ore thus averaged $829 a ton. The average percentage of the metals in the ore was as follows:

	Per cent.
Silver	4.802
Cobalt	8.264
Nickel	4.739
Arsenic	34.606

The 4.802 per cent. of silver represents 1,406.27 ounces a ton. The cobalt, nickel and arsenic in one car load are not included, no returns having been made.

During the second quarter, March 31st to June 30th, 1905, the shipments were 537 tons, valued at $394,552, or an average of $734 a ton.

The average percentage of the metals in the ore for this quarter was:

	Per cent.
Silver	4.158
Cobalt	6.890
Nickel	3.091
Arsenic	30.912

The metals in the ore were sold at approximately the following prices: Silver, 55 to 60 cents an oz. Troy for 90 per cent. of the contents, cobalt, 65 cents, nickel, 12 to 15 cents, and arsenic about 1 cent a pound.

During the first quarter there were four companies or individuals who made shipments, namely, Messrs. Timmins, Dunlap and McMartin, of the La Rose mine, or J S 14, Mr. W. G. Trethewey, of the New Ontario mine, or J B 7, Messrs. R. Gorman and Co., of the McKinley and Darragh mine, or J B 1, and the Nipissing Mining Company, who worked the Cobalt Hill and Little Silver veins in the northwest and southwest corner of R L 404 respectively. During the second quarter small shipments were made from one or two other properties.

Total Shipments for 1905

The companies shipping ore during the third and fourth quarters of the year 1905, in addition to those mentioned above, were the Kerr Lake Mining Company, Victoria Mining Company, Buffalo Mining Company, Trethewey & Leonard, Lawson Mine, White Silver Company, Glendenning-Blair and Kerr, Watts & Allen, Temiskaming &

Hudson Bay Company, Violet Mine, Drummond Mines, Ltd,. O'Brien. One or two other properties had a small production. The total number of producers was seventeen.

During the second half of the year, owing to there being no plants in America adapted to extracting all the constituents of the ores, the mine owners received, in some cases, no pay for the cobalt, nickel and arsenic contents, the purchasers allowing for the silver only. For this reason the statistics of production received by the Bureau of Mines are incomplete, complete analyses not having been made of some shipments. In compiling the following table the average of the cobalt, nickel and arsenic contents in the shipments analyzed has been taken, and proportionate percentages, based on the silver, in the shipments of which complete analyses were made, has been added to those which were incompletely analyzed.

Owing to their receiving nothing for some of the metallic contents of the ores, if sold during the latter half of the year, the producers had stored at their mines on

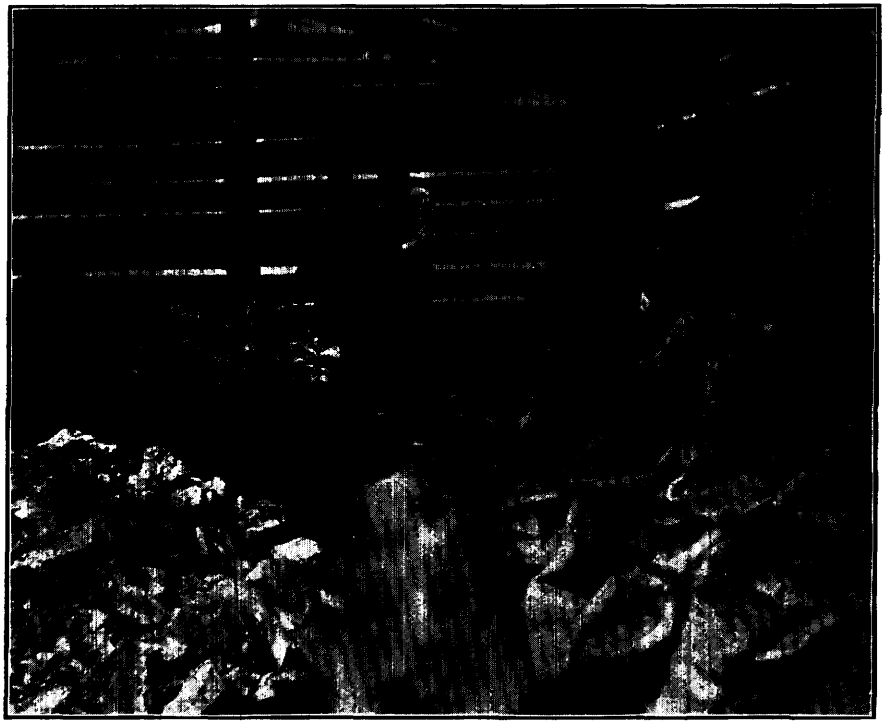


Fig. 7A. Cobbing and sacking ore at the La Rose mine, November, 1904.

December 31st, 1905, the end of the year represented by the statistics, a considerable quantity of ore. In two or three cases the quantity in storage represented a value of $100,000 or more. The following table, therefore, does not represent the total production for 1905, but merely the shipments:

	Quantity.	Value.
Tons of ore shipped	2,144	
Silver, ounces	2,441,421	$1,355,306
Cobalt, tons	118	100,000
Nickel, tons	75	10,525
Arsenic, tons	549	2,693

The 2,144 tons of ore shipped during the year had therefore a percentage composition of: silver 3.90; cobalt 5.50; nickel 3.49; arsenic 25.60. A percentage of silver of 3.90 represents 1,138.72 ounces a ton, or at 64 cents an ounce, the then price of silver, a value of $728.78 a ton of ore throughout the year. It is needless to say that the average value of the ore shipped from few mining camps can equal this. The average value of the total metallic contents per ton of ore shipped throughout the year 1905, at the prices received, was $684.94. It should be noted that most of the ore mined during the year came from near the surface. Hence the percentage of cobalt, nickel and arsenic is lower than it will be when greater depth is reached, the metals being leached out by surface agencies.

The ore shipped till near the end of 1907 was sorted by hand. In his account of the working mines on following pages Mr. Corkill describes the concentrators which are now in operation at the Coniagas, Big Pete and Buffalo mines. Other concentrators in the camp are nearing completion. Much ore that would be considered high grade in most mining camps has accumulated on the dumps. This will no doubt be milled in the not distant future and will add materially to the output. Further reference is made under the heading of Veins, to the value of shipments.

It will be of interest to add the following to the shipments of 1905, 158 tons being shipped in 1904.

Cobalt Output in 1904

Silver, ounces	206,875	$111,887
Cobalt, tons	16	19,960
Nickel, tons	14	3,467
Arsenic, tons	72	904
Total		$136,218
Ore shipped, tons		158

The uses made of cobalt and a table showing the production of the metal in various countries are given on following pages. The uses of arsenic are also mentioned.

The following table summarizes the output of the Cobalt camp since it was opened up:

Production of Cobalt Mines, 1904-1907.

Year.	Ore shipped.	Nickel.		Cobalt.		Arsenic		Silver.		Total value.
	Tons.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Ounces.	Value.	
			$		$		$		$	$
1904	158	14	3,467	16	19,960	72	903	206,875	111,887	136,218
1905	2,144	75	10,000	118	100,000	549	2,693	2,451,356	1,360,503	1,473,196
1906	5,335	160	....	321	80,704	1,440	15,858	5,401,766	3,667,551	3,764,113
1907	14,788	370	1,174	739	104,426	2,958	40,104	10,023,311	6,155,391	6,301,095
Total	22,425	619	14,641	1,194	305,090	5,019	59,558	18,083,308	11,295,332	11,674,621

The average value of the ore shipped during the three years was $704 per ton. For the first year, when only very rich material left the camp, the ore averaged $862 per ton; in 1905, when a large quantity of low-grade gravel was included in the shipments, it fell to $687 per ton; while in 1906, the average went up to $705 per ton, practically identical with the average for the whole period. A considerable proportion of the consignments in 1906 was also of second or third class quality, but on the other hand there were many carloads of unusual richness. The percentage of low grade ore in 1907 shows an increase, but concentration plants which are now being installed at some of the mines will enable much of this grade of material to be treated in the camp. The minimum limit of ore which can be profitably shipped is about 100 ounces of silver per ton, and owing to the fact that in many of the mines free silver in films and thin sheets is found extending from the veins into the walls for a considerable distance, the quantity of concentrating rock or ore will no doubt in the aggregate prove to be large.

The following table sets forth the course of silver mining in the Province for the last five years; in examining it the fact should be borne in mind that in 1903 the Lake Superior mines ceased work, and in 1904 those of Cobalt began. The difference between the figures for 1902-3 and for 1904-6 is sufficiently striking.

Silver Mining, 1902 to 1906.

Schedule.	1902.	1903.	1904.	1905.	1906.
Ore raised .... tons	6,250	3,400	158	3,144	9,456
Ore stamped .... "	6,250	3,360	....	....	1,500
Ore shipped .... "	....	....	158	2,144	5,335
Silver product .... oz.	96,666	16,688	206,875	2,473,452	5,433,984
Value of silver .... $	58,000	8,949	111,887	1,372,577	3,689,286
Men above ground .... No.	25	12	29	289	471
Men under .... "	25	20	28	186	586
Wages paid .... $	36,000	8,000	12,300	191,582	581,253

It will be observed from the statistics in the foregoing tables that the cobalt, nickel and arsenic contents of the Cobalt ores are at present of very little value to the mine-owners. As a matter of fact, they are of so little importance to them that in most cases no assays are made for anything but silver, everything else being regarded as waste. The sole exception is cobalt, which in the silver-bearing ores is paid for if in excess of 6 per cent.; in non-silver ores, of which there are some veins, it brings 60 cents per pound when the ore runs over 16 per cent. cobalt, lower percentages being settled for nearly in proportion. These rates are paid by manufacturers of cobalt oxide in Great Britain, who advance 75 per cent. of the value upon shipment, and settle for the balance on umpire assay in Britain. Nickel and arsenic bring practically no return to the sellers of ore, the figures of value set opposite the latter being for the refined white arsenic produced at the Copper Cliff reduction works, where about 1,000 tons of ore from Cobalt were treated during the year.

The producing mines of the Cobalt camp in 1906 were the following: Nipissing, LaRose, Coniagas, Kerr Lake (Jacobs), Drummond, Buffalo, O'Brien, University, Trethewey, Cobalt Silver Queen, Right-of-Way, McKinley-Darragh-Savage, Foster, Temiscaming and Hudson Bay, and Nova Scotia. A small quantity of ore was also taken from the Violet. Outside of the Cobalt region the only sources of silver were the West End Silver Mountain mine, west of Port Arthur, operated by the Hanson Consolidated Mining and Milling Company, and the Bessemer mattes refined for the Canadian Copper Company at the Orford Works, New Jersey. The total production of silver was 5,433,984 ounces, worth $3,689,286, of which the Cobalt mines yielded 5,401,766 ounces.

In 1907 the producing mines were those given in the preceding paragraph, together with others shown on the plan on a preceding page, and the Green-Meehan, Temiskaming Cobalt and one or two small producers which lie outside of the area covered by the plan.

DIVIDENDS PAID BY COBALT SILVER MINES.

Name of Company.	Date of Incorporation.	Amount of Capital Stock Authorized	Amount of Capital Stock Issued.	Par Value of Share.	Total Dividends and Bonuses declared up to 31st December, 1906.	Dividends and Bonuses declared in 1907.	When last dividend or bonus declared, in 1907.	Rate of last dividend per cent.	Rate of last Bonus per cent.
		$	$	$	$	$			
The Buffalo Mines, Limited	May 10, '06	1,000,000	900,000	1	54,000	108,000 00	Dec. 6, '07	3	
The Coniagas Mines, Limited	Nov. 24, '06	4,000,000	4,000,000	5	none	440,000 00	Dec. 26, '07	2	1
Cobalt Silver Queen, Limited	April 6, '06	1,500,000	1,500,000	1	none	120,000 00	Jan. 15, '07	8	
Foster Cobalt Mining Company, Limited.	Feb. 14, '06	1,000,000	915,588	1	50,000	none	Dec. 31, '06	5	
McKinley - Darragh - Savage Mines of Cobalt, Limited	April 17, '06	2,500,000	2,246,937	1	none	133,948 44	Dec. 13, '07	4	
The Nipissing Mining Company, Limited.	Dec. 16, '04	250,000	250,000	100	950,000	760,000 00	Dec. 20, '07	72	
The Right of Way Mining Company, Limited	July 13, '06	500,000	499,518	1	none	69,889 75	July 31, '07	7	
Temiskaming and Hudson Bay Mining Company, Limited	July 29, '03	25,000	7,746	1	712,632	23,238 00	July 23, '07	300	
Trethewey Silver Cobalt Mine, Limited	May 30, '06	1,000,000	945,450	1	37,818	37,818 00	Mar. 31, '07	4	
Kerr Lake Mining Company	Aug. 9, '05	3,000,000	3,000,000	5	150,000	240,000 00	Oct. 1, '07	2	1
					$1,954,450	$1,892,894 19			

The foregoing table does not include several companies or concerns which are practically close corporations, and whose stock or properties are owned or controlled by a few individuals in each case. Under this category fall the La Rose Mining Company, Drummond Mines, Limited, and the O'Brien mine. Adding the profits divided among the shareholders of these companies or owners of the min s to the total of dividends and bonuses paid out as above, the net returns from the active mines of the Cobalt camp will be found to be over five millions of dollars up to the end of 1907. From a preceding table it will be seen that the value of the output from the camp since the beginning is over $10,000,000. The profit therefore represents approximately 50 per cent. of the output. The capitalization given for the Nipissing is that of the Ontario charter.

The following table, showing the tons of ore shipped from the various mines in the Cobalt camp since mining began, is taken from the valuable report of Mr. A. A. Cole, who is the mining engineer of the Temiskaming and Northern Ontario Railway, the government railway, from whose station the ore is shipped.[7]

Mine.	1904.	1905.	1906.	1907.	Total.
Bailey	....	....	30.00	....	30 00
Buffalo	....	200.80	992.80	1,241.54	2,435.14
City of Cobalt	....	....	....	50.61	50.61
Cobalt Central	....	....	....	77.33	77.33
Cobalt Townsite	....	....	....	143.22	143.22
Colonial	....	....	15.00	40.38	55.38
Coniagas	....	30.60	422.02	2,447.37	2,899.99
Drummond	.50	32.15	274.70	104.13	411.48
Foster	....	83.85	117.00	312.13	512.98
Green-Meehan	....	....	37.03	98.39	135.42
Imperial Cobalt	....	....	....	14.61	14.61
Kerr Lake	....	54.95	158.35	319.76	533.06
King Edward	....	†19.00	....	31.12	50.12
La Rose	90.05	607.86	854.61	2,815.45	4,367.97
Lawson	....	14.61	....	61.12	75.73
McKinley-Darragh	24.00	447.09	80.45	742.42	1,293.96
Nancy Helen	....	....	....	30.10	30.10
Nipissing	57.00	486.02	2,125.08	2,538.26	5,206.36
Nova Scotia	....	....	43 95	272.21	316.16
O'Brien	....	26.32	114.18	1,491.61	1,632.11
Princess	....	....	....	3.93	3.93
Red Rock	....	....	....	45.71	45.71
Right of Way	....	....	46.25	129.37	175.62
Silver Leaf	....	9.00	....	46.36	55.36
Silver Queen	....	*44.73	130.94	478.57	654.24
Temiskaming (Temiscamingue)	....	....	....	204.32	204.32
Temiskaming Cobalt	....	....	20.47	67.98	88.45
Temiskaming and H.B.	....	....	....	149.53	149.53
Trethewey	20.00	218.58	198.48	833.58	1,270.64
University	....	16 00	155.28	60.23	231.51
Violet	....	16.00	20.00	....	36.00
White Silver Mining Co.	....	28.45	....	....	28.45
Totals	191.55	2,336.01	5,836.59	14,851.34	23,215.49

NOTES—†Shipped from the Watts.
*Shipped by Temiskaming and Hudson Bay Company.
Tons of 2,000 pounds. Shipments for first five months of 1908 are given on page 116.

The tonnage given by Mr. Cole for the various years is somewhat in excess of that given in the Bureau of Mines reports. This is accounted for by the fact that the tonnage given in the Bureau reports is based on returns from smelters and refiners after the ore has been carefully weighed and deduction made for the moisture contained in the ore. The weights given by the railway are necessarily not made so carefully and no deduction is made for moisture in the ore.

Prices Paid for Ores from Cobalt

The following notes on the prices paid for ores from the Cobalt camp in the latter part of 1907 are also taken from Mr. Cole's report. The Deloro works did not receive shipments till towards the end of the year.

Tho output for 1907 was distributed for treatment as follows:

	Tons.	Per cent.
Canada	2,585.05	17.40
England	167.34	1.13
United States	12,098.95	81.47
Totals	14,851.34	100.00

[7]Report on Cobalt District for 1907, by Arthur A. Cole, Mining Engineer, Temiskaming and Northern Ontario Railway, 21 pages, Toronto, 1908.

Canada

The Orford Copper Company

The Orford Copper Company's smelter at Copper Cliff took almost all the ore that was shipped to Canadian smelters. At the end of the year the following was the purchase schedule and terms of settlement of the Orford Copper Company for silver and cobalt in arsenical silver-cobalt ores:

Purchaser to make payment for:

94% of silver per ton of ore (2,000 lbs.)	when same assays	4,000	ozs. and over.
93%	do	1,200	do
92%	do	800	do
90%	do	500	do
85%	do	300	do
80%	do	150	do

Purchaser to make payment of:

$30.00 per ton of ore (2,000 lbs.)	when same contains	12%	cobalt and over.
$20.00	do	8%	do
$10.00	do	6%	do

No payment will be made for cobalt in ores containing less than 6% cobalt, nor in which the nickel contents are higher than the cobalt contents.

Further, the right is reserved to return, at shipper's expense, any such ores (*i. e.*, nickel contents higher than cobalt contents) received at Copper Cliff.

Ore is to be delivered by seller to the Canadian Copper Co., f.o.b. cars, Copper Cliff, Ont., ore to be at shipper's risk until sampling is undertaken, as purchaser can assume no responsibility for the same until the ore has been taken into its sampler.

Purchaser to sample at its expense, purchaser's and seller's representatives to be present. Assays to be made by Ledoux & Co., of New York, at seller's expense, which assays are to govern in settlement.

Payment for 50% of the silver returnable to the seller, as per the above scale, to be made at the New York official price for silver on the first settlement date, which shall be 45 days after the date on which sampling of the ore is completed, the remaining 50% to be paid 45 days later. The purchaser, however, reserves the right to deliver on either or both of the settlement dates above specified, in lieu of cash, at its option, such silver bullion (commercial bar silver) as is due the seller in settlement upon these dates. Such delivery to be made in New York city.

Payment for cobalt will be made as per the above scale when the cobalt contents of the ore comes within the specifications mentioned, settlement to be made 50% on each of the two due dates for silver, namely, 50% in 45 days and 50% in 90 days after the completion of sampling the ore.

All purchases of these ores are made strictly subject to the following *force majeure* agreement:

If, by reason of the acts of God, strikes or other causes beyond the control of either parties hereto, which may be legally called *force majeure*, either of them will be unable to carry out the conditions of agreement as to shipment, receipt or treatment of consignments, this agreement shall be suspended as long as this condition shall continue, and the terms of this agreement shall be then extended for such a period as shall be equivalent to the times of delay or interruption.

Further, this clause shall also cover unavoidable and extraordinary delays should they occur when the speiss or silver bullion resultant from the smelting and treatment of these ores are in transit between the Copper Cliff and Camden plants of the purchaser, and between either of the above plants and the silver refinery of the Balbach Smelting & Refining Company at Newark, New Jersey.

Purchaser does not guarantee date when ore will be sampled, but undertakes to complete same promptly after the ore reaches its turn for sampling.

The freight rate on ore from Cobalt to Copper Cliff is $5.20 per ton.

The Deloro Smelting and Reduction Company

The Deloro Smelting and Reduction Company, with works at Deloro, Ontario, is just starting operations on Cobalt ores and is offering the following prices for them:

Deloro Schedule.

Silver.—Ore containing	100 to 200	ozs.	per ton	pay	85%
"	200 " 500	"	"		90%
"	500 " 800	"	"		91%
"	800 " 1,000	"	"		93%
"	1,000 " 2,000	"	"		94%
"	2,000 and over	"	"		95%

At New York quotations 30 days after agreement of assays.

Arsenic.—Ore containing not less than 10% arsenic pay for all arsenic contained:

10% to 30%.—1 cent per pound arsenic.

30% and over.—1½ cents per pound arsenic.

Cobalt.—Ore containing not less than 6% cobalt.

6% to 10% cobalt pay $10.00 per ton ore.

10% and over cobalt pay $20.00 per ton ore.

Treatment charges in all cases $10.00 per ton (2,000 lbs.) ore.

No charge for sampling.

No penalties for "insoluble matter."

Ore to be delivered in carload lots f.o.b. Marmora station, Central Ontario Railway.

This tariff is subject to change without notice.

The freight rates on ore from Cobalt to Marmora station is $7.00 per ton.

Thorold

The refinery of the Coniagas company at Thorold, Ont., is expected to begin the treatment of Cobalt ores in May. A few shipments have already been made to these works.

England

The Anglo-French Nickel Company of Swansea, Wales, was the only European Company that bought ores from the Cobalt camp.

This Company wished ores solely for their cobalt contents, and paid nothing for the silver.

The following is the schedule of average prices paid for Cobalt ores during 1907, by the Anglo French Nickel Company, but before the end of the year these prices were cancelled:

8 to 10%	cobalt	30	cents per pound for metallic cobalt.
10.1 to 12%	"	35	" " "
12.1 to 14%	"	40	" " "
14.1 to 16%	"	45	" " "
16% and over	"	50	" " "

The freight rate on ore from Cobalt to Swansea, Wales, is $13.98 per ton.

United States

American Smelting and Refining Co

Eighty per cent. of the camp's output went to the United States and most of this was taken by the American Smelting and Refining Co., at their works at Perth Amboy, N. J.

The following is the schedule of prices offered by this company at the end of the year for silver-cobalt ores:

For ores assaying under 1,500 ozs. per ton.

Silver.—Pay for 93% of the silver contents at the New York quotations as given by Messrs. Handy and Harman to Western Union Telegraph Company, on the 30th day after agreement of assays.

Working Charge.—$9 per ton of 2,000 pounds dry weight, plus one-half cent per ton of each ounce of silver contained.

Arsenic.—Should arsenic be contained in excess of 5%, an addition to the working charge will be made at the rate of 25 cents per dry ton for each per cent. of arsenic in excess of 5%.

Insoluble Matter.—An addition to the working charge will be made at the rate of 7 cents per dry ton for each per cent. of insoluble matter contained in excess of iron.

Payments of net proceeds of shipments will be made on the thirtieth day after date of agreement of assays.

Ores assaying 1,500 ounces per ton or over.

These ores will be treated at the Perth Amboy plant by the cupelling process, separately from any other ores, in the presence of the shipper's rpresentative, making payment immediately on production, for all of the silver recovered in silver bars at the New York quotation prevailing on date of production of bars, as given by Messrs. Handy & Harman to Western Union Telegraph Company.

All by-products recovered during the process, such as slags, test bottoms, etc., will be sampled in the presence of the seller's representative, and 98% of the silver contents of same will be paid for on the basis of assays arrived at by averaging the smelter's results with those of the seller's representative, providing the differences are not unusual; payment being made on the thirtieth day after date of agreement of assay, and at the quotation prevailing on that date; any unusual differences in assays to be adjusted by umpiring in the usual manner.

Working Charge.—$125.00 per ton of 2,000 pounds of ore dry weight plus one per cent. per ounce of silver paid for.

On ores running under 1,500 and above 400 ounces per ton the shipper is advised to consign through Messrs. Ledoux & Company's works at Bergen Junction, with privilege of sampling in transit. At any sampling or other operations at Perth Amboy plant the seller is entitled to have a representative present.

The freight rate on ore from Cobalt to Perth Amboy, N.J., is $10.20 per ton.

Denver

Some of the comparatively low grade ores proved suitable for mixing with certain western ores, and for this reason towards the end of the year a considerable tonnage of these ores was shipped to the American Smelting and Refining Company's works at Denver, Colorado. A reduction was made in the smelting charge to offset the increase in freight rates.

The following companies were also occasional buyers of silver-cobalt ores during the year:—

Balbach Smelting and Refining Company, works at Newark, N.J.

United States Smelting, Refining and Mining Co., Chrome, N.J.

Pennsylvania Smelting Co., Carnegie, Pa.

Annual Average Prices of Silver

(From "Mining World," February 22nd, 1908.)

In the following table an attempt has been made to show the fluctuations in the annual average price of silver and the world's output during the last 40 years, as nearly as can be calculated from official sources; the New York price is per fine ounce and London per standard ounce (0.925 fine):

Year.	World's Production. Fine ounces.	New York.	London. Pence.
1868	43,051,583	$1.326	$60\frac{1}{2}$
1869	43,051,583	1.325	$60\frac{7}{16}$
1870	43,051,583	1.328	$60\frac{9}{16}$
1871	63,317,014	1.326	$60\frac{1}{2}$
1872	63,317,014	1.322	$60\frac{5}{16}$
1873	63,267,187	1.298	$59\frac{1}{4}$
1874	55,300,781	1.278	$58\frac{5}{16}$
1875	62,261,719	1.246	$56\frac{7}{8}$
1876	67,753,125	1.156	$52\frac{3}{4}$
1877	62,679,916	1.201	$54\frac{13}{16}$
1878	73,385,451	1.152	$52\frac{9}{16}$
1879	74,383,495	1.123	$51\frac{1}{4}$
1880	74,795,273	1.145	$52\frac{1}{4}$
1881	79,020,872	1.138	$51\frac{11}{16}$
1882	86,472,091	1.136	$51\frac{5}{8}$
1883	89,175,023	1.110	$50\frac{9}{16}$
1884	81,567,801	1.113	$50\frac{5}{8}$
1885	91,609,959	1.064	$48\frac{5}{8}$
1886	93,297,290	0.995	$45\frac{3}{8}$
1887	96,123.586	0.978	$44\frac{5}{8}$
1888	108,827,606	0.940	$42\frac{7}{8}$
1889	120,213,611	0.935	$42\frac{11}{16}$
1890	126,095,062	1.046	$47\frac{11}{16}$
1891	137,170,919	0.988	$45\frac{1}{16}$
1892	153,151,762	0.871	$39\frac{13}{16}$
1893	165,472,621	0.780	$35\frac{5}{8}$
1894	164,610,394	0.635	$28\frac{15}{16}$
1895	167,500,960	0.655	$29\frac{7}{8}$
1896	157,061,370	0.674	$30\frac{3}{4}$
1897	160,421,082	0.604	$27\frac{9}{16}$
1898	169,055,253	0.582	$26\frac{15}{16}$
1899	168,337,453	0.596	$27\frac{7}{16}$
1900	173,591,364	0.613	$28\frac{1}{4}$
1901	173,011,283	0.589	$27\frac{3}{16}$
1902	162,763,483	0.522	$24\frac{1}{16}$
1903	167,689,322	0.536	$24\frac{3}{4}$
1904	168,390,238	0.572	$26\frac{3}{8}$
1905	157,339,962	0.604	$27\frac{13}{16}$
1906	158,313,445	0.665	$30\frac{7}{8}$
1907	159,456,333	0.653	$30\frac{3}{16}$

THE COBALT-SILVER VEINS

It is not considered necessary to give a detailed description of a number of veins in the Cobalt area, the character of one being usually so much like that of another. The distribution and strike of those found up to about August, 1907, are shown on the plan which accompanies this report. A few veins have since been discovered. Most of those first worked were developed in the form of open cuts. The vein first discovered on the La Rose claim, J S 14, on which several others have since been found, has been developed systematically. The first level on the LaRose main vein, at a depth of 65 feet is, together with its extension on the Right of Way property, now nearly 1,000 feet in length. Systematic development of veins on other properties has taken place, especially during the last year, and open-cut work is being less favored.

To give an idea of the character of the ore of one of the other veins it may be said that an open cut, about 50 feet long and 25 feet deep, on the Trethewey vein, location J B 7, produced approximately $200,000 worth of ore, the maximum width of the vein

Fig. 8. An underground view in La Rose, showing parallel veins.

being not more than 8 inches. The amount received for one car load of 30 tons of ore from this mine, at the prices for the contained metals mentioned elsewhere in this report, was between $75,000 and $80,000. A shipment of 50 tons of the ore gave on analysis approximately the following percentages of metals: Arsenic, 38; cobalt, 12; nickel, 3.5; and 190,000 ounces of silver. Pay was received for cobalt and silver only.

An interesting account of the "Richness of Cobalt Ores" is given by Dr. A. R. Ledoux, in the Journal of the Canadian Mining Institute, pages 72-73, 1907. Dr. Ledoux states that the highest lot sampled at his works ran 7,402 ounces in silver, the next in order being 6,909, 6,413, 6,163 and 5,948 ounces to the ton. The average percentages of other metals in the 366 carload lots sampled by his firm were, cobalt, 5.99, nickel 3.66, and arsenic 27.12.

Most of the cobalt-silver veins occur in what is called on the map which accompanies this Report the Lower Huronian. Several have been found in the diabase, and in the Keewatin. The Keewatin greenstones and other rocks are tougher and do not fracture with the same ease as the overlying series of the Lower Huronian. Hence the solutions have not had the same freedom of movement in the former as in the latter. In so far as the precipitation effects which the rocks of either series may have on solutions working through fissures in them there seems to be little difference between the two. Many of the pebbles and boulders, and much of the cement material in the Lower Huronian have been derived from the underlying Keewatin. Hence one would think they would have about the same influence in precipitating substances from solution as the rocks of the latter formation. The distribution of the Lower Huronian, as will be seen from the accompanying geological maps, is irregular. At one time, in all likelihood, it formed a complete layer or mantle over the uneven surface of the older rocks. This has been removed to a considerable extent by erosion, leaving the rocks now in more or less isolated belts and patches.

The more important veins so far found in the Lower Huronian lie in what may be called two parallel belts. Those first discovered are in a belt which runs about parallel

Fig. 9. A typical silver-cobalt vein, outcrop on the Coniagas. The head of the hammer shows the width.

with the railway in the vicinity of Cobalt lake. A second belt stretches from Giroux lake to the southeast end of Cross lake, in which important deposits occur. Although these two belts have a strike approximately in a northeast and southwest direction, the strike of the veins is not uniform, as will be seen from the plan. Those on the Trethewey and Coniagas strike east and west. The main veins on the La Rose and McKinley-Darragh strike approximately northeast and southwest, while that in the northwest corner of R L 404 strikes northwest and southeast. The vein in the southwest corner of this location strikes east and west, which is the direction of strike of the majority of the veins.

Dimensions

None of the veins are wide. The ore in the Trethewey vein on J B 7, for instance, had a maximum width of about 8 inches, while the vein in the northwest corner of R L 404 had 14 inches of ore. The first level on the La Rose main vein follows more properly what may be called a system of veins, three or four roughly parallel veins being at times exposed in the level (Fig. 8). Numerous small, nearly horizontal faults are found in the veins, which are frequently thrown into the walls of the level. Where the whole vein system is exposed the total width or ore in the veins of the level averages slightly over one foot. A plan of the level shows a number of veins branching off from the main vein system. One of the side veins, No. 3, which runs at nearly right angles to the main vein system has ben traced on the surface for about 900 feet. Some veins in the camp which have been traced 100 feet, or over, average not more than one inch in width (Figs, 1, 3, 5, 9, 10).

The surface, being uneven and more or less covered with loose deposits and, when the camp was discovered, with green timber, does not afford an opportunity of tracing the outcrops of the veins any great distance, and it is not known definitely how long most of the outcrops would prove to be if the material referred to were removed from the surface of the solid rock.

Fig. 10. Vein showing on the wall of a pit at the La Rose mine, November, 1904. The width of the vein is equal to the space between the head of the hammer and the man's hand on the handle.

It is also impossible to give much definite information concerning the depths to which these veins will reach. As already said, most of them do not appear to cut through the older Keewatin series which forms an uneven surface below the Lower Huronian. In the vicinity of Cobalt station the latter rocks are found on hill-tops which stand about 500 feet above the low water level of Temiskaming, where similar outcrops are found. We have reason for saying, therefore, that the Lower Huronian conglomerates and other rocks associated with them may in some places have a thickness of at least 500 feet. In other places this series is entirely wanting, outcrops of the older Keewatin and later diabase forming the surface. It may be added that the greatest depth which mine workings have thus far reached in the Huronian of the Cobalt area is approximately 265 feet. At this depth the shaft referred to is still in the Huronian.

The depth to which a vein in the Lower Huronian may reach depends, therefore, on whether it descends into an old valley of the older rocks or whether it lies above a former hilltop. No one can tell this, of course, without diamond drilling or sinking a shaft. Evidence of the probable thickness of the Huronian or vein-bearing formation can, however, be determined by noting the outcrops of the Keewatin or the intrusive diabases. An exposure of Keewatin surrounded by the Lower Huronian represents an old hilltop. It is therefore evident that a vein which strikes toward this outcrop is likely to have a less depth near the outcrop than some distance away from it. Similarly, if a diabase dike or mass cuts through the Lower Huronian in a vertical direction we have evidence of a greater depth in an adjacent vein than if the diabase cut through the Huronian at a lower angle. In the latter case the vein may be disconnected or cut through by the diabase at no great depth from the surface. It is likely that in some cases, at least, a vein passing downward through Lower Huronian conglomerate or slate

Fig. 11. The hammer is on two veins or branches of a vein on the face of a pit at the La Rose mine, November, 1904.

will penetrate sheets or sills of diabase which it may encounter. Similarly veins starting at the surface in a diabase sheet or sill will likely penetrate underlying conglomerate or slate, judging from what we know of the veins of the Port Arthur district, where the diabase bears a similar relation to the fragmental series. At the Nova Scotia mine we have an example of a vein running downward from the Keewatin into the diabase and becoming much more productive, in silver, in the latter.

Across the railway track from the La Rose main vein, and only a short distance from it, there is an exposure of diabase. This diabase dike, however, shows a vertical face and therefore is seen not to affect the vein. The diabase in some parts of the field has a laccolithic or sill-like structure, overlying the conglomerate and slate, as for example on the western edge of Diabase Mount east of Peterson lake, and on the shores of this lake. The relationship is seen to better advantage in the vicinity of Wendigo lake to the northward. The sheet or sill of diabase overlying the conglomerate and slate is of varying thickness.

At the Nova Scotia mine and at the Watt's and Colonial, the Keewatin overlies the later diabase. The colored cross-sections accompanying the large scale geological map show this relationship and that of the Huronian to the Keewatin and later diabase in other parts of the field.

Distribution of Veins

The veins in the vicinity of Cobalt, are indicated on the index map by the sign — and on the large scale, colored map by short red lines, the direction of the lines showing the strike. There is another area on or near lots 14 and 15, concession 1 of Bucke, not far from the shore of Lake Temiskaming, which has been a producer. The Green-

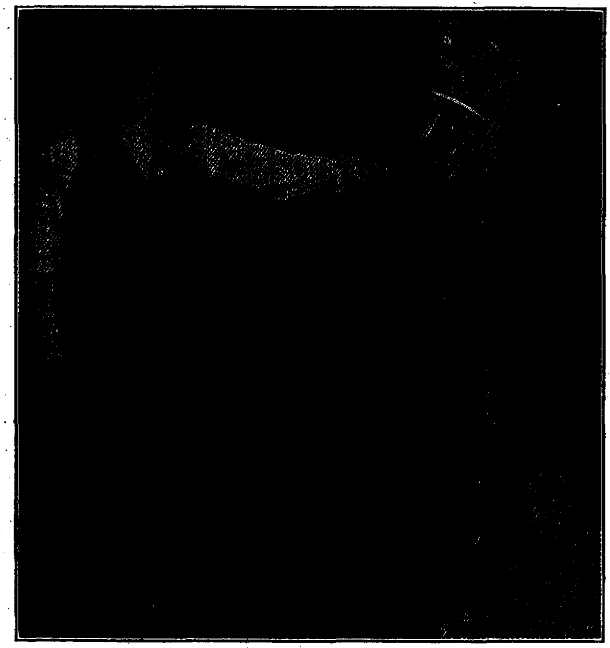


Fig. 12. A Cobalt pioneer and his vein.

Meehan, Temiskaming Cobalt, Red Rock and other properties are situated in it. This area is shown on the small scale, one mile to the inch, geological map, but not on the index map or on the large scale geological map.

Ores in Diabase

In the Cobalt area proper there are some important veins in the diabase, *e. g.*, the vein in the southeast corner of the Jacob's or Kerr Lake location, the Big Pete or Cobalt Central, King Edward, Silver Cliff, and one of the recently developed veins on the O'Brien. Reference has already been made to the vein in the diabase beneath the Keewatin on the Nova Scotia.

On the north end of lot 2 in the third concession of the township of Dymond and on the south end of the lot across the road to the north, cobalt bloom has been found in the diabase. This knoll of diabase is, however, overlain around its base by Lower Huronian rocks, which have at one time undoubtedly covered the whole of the diabase mass. It is likely that veins at one time occurred in the overlying series which has been removed.

Several veins carrying cobalt have also been found in the diabase area between Loon lake and Portage bay, which lies to the west of Cobalt, and in the diabase to the southwest of Cobalt in the vicinity of Gillies station.

On lots 9 and 10 in the sixth concession of the township of Ingram, and elsewhere in the vicinity, 30 miles north of Cobalt station, quartz veinlets in diabase contain bloom and smaltite. This area is described by Mr. Hore on following pages.

The occurrence of cobalt-silver veins in the diabase of the Montreal river area is described by Mr. Knight in this volume.

The wide association of cobalt with diabase would seem to indicate that the cobalt was a constituent of the original diabase magma.

Distribution of Ores

A peculiar occurrence of cobalt and nickel with gold was discovered in 1905 on Rabbit lake east of Temagami and about 30 miles south of Cobalt station. The outcrop was at the water's edge. The rocks here have been more disturbed and are much more highly metamorphosed than are those in the vicinity of Cobalt station. They appear, however, to belong to the Lower Huronian conglomerate—greywacké series. The ore body, about 18 inches wide, is in a zone of fracture. Through the chlorite schist which occupies this disturbed zone is a reddish felsitic material, which, under the microscope, is seen to belong to the fragmental series. Veinlets and impregnations of a gray cobalt-nickel ore occur sparingly in both the chloritic and felsitic material. An analysis of some of the more highly mineralized material gave the following results:

	Per cent.
Arsenic	22.53
Cobalt	8.76
Nickel	6.56
Gold	$8.80 a ton.
Silver	1.10 "

This unique deposit is of interest since it shows that cobalt-nickel ores are to be looked for so far south of Cobalt station. The Rabbit lake occurrence is about the same distance south of Cobalt station as those of the township of Ingram are north of it, thus showing that the cobalt-nickel ores are distributed over a distance of at least 60 miles in a north and south direction. It may be added that more recently cobalt-silver veins have been found in the area immediately south of the township of Lorrain, a few miles northeast of Rabbit lake.

A tract of country 75 miles or more in length, stretching from the vicinity of lake Temagami northward to the height of land and beyond, contains outcrops similar to those which are shown on the map of the area under consideration. As our geological maps show, the outcrops form a patchwork-like structure. In some parts of the area the conglomerate outcrops are much larger than they are in others. In a few of the areas the conglomerate and other members of the Lower Huronian have been practically all removed by erosion, leaving the surface composed of the Keewatin, Laurentian or later diabase. Areas of considerable size are occupied by the arkose and quartzite of what we have called the Middle Huronian, in which no veins have been found. In any area containing conglomerate and graywacké slate of the Lower Huronian, it is possible that cobalt-silver veins, similar to those in the vicinity of Cobalt station, may be discovered. The wide distribution of these ores in the diabase is shown above.

ORES OF THE KEEWATIN

Associated with the greenstones or schists of the much disturbed Keewatin are characteristic ores.

These rocks are found in numerous localities in northern Ontario between the western boundary of Quebec and the eastern boundary of Manitoba. In many places they are iron-bearing, the typical iron formation being composed of interbanded magnetite or hematite with jasper or some other closely related silicious material.

These outcrops of the iron formation, or iron ranges as they are called, have attracted the attention of many writers. Some of the most important of them are the following: those of lake Temagami; that in the township of Hutton; the Michipicoten iron range; and farther west the Mattawin and the Atikokan. In fact, all of the iron ranges of the northern part of the Province, with the exception of those in the Animikie or Upper Huronian series in the vicinity of Port Arthur, and the titaniferous iron ores which are found in a number of places, belong to the Keewatin. There are two or three interesting occurrences in the area under review which show that this Keewatin iron formation has at one time been well developed here. Immediately south of Sharp's Landing, near the shore of Temiskaming, there is an outcrop of the interbanded material which is only about 25 feet in length. No other rocks of the Keewatin are here exposed, the Lower Huronion being distributed over the rest of the surface in the locality. The rocks consist of conglomerate and greywacké slate. The pebbles in these show numerous representatives of the iron formation.

A Buried Iron Range

It is thus seen that we have here a portion of a buried iron range. The strike of the interbanded material in the exposure is somewhat north of west. In the outcrops of conglomerate which are shown on the map in the township of Hudson are found large blocks of this iron formation in the direction from the outcrop at Sharp's Landing represented by the strike of the interbanded material at the Landing. We have thus good evidence that the iron range or formation lies at no great distance from the surface in this part of Hudson. Between these outcrops of conglomerate and Sharp's Landing the range is cut through by diabase and it is overlain by Niagara limestone and recent clay deposits in addition to the Lower Huronian. This iron range no doubt extends farther west than Hudson. It has been covered up since Lower Huronian times, as shown by the fact that it is overlain by rocks of this series, and has therefore not been subjected to glaciation, which is supposed to have produced injurious effects on the iron deposits of Ontario, it having been held by some writers, for instance, that the soft ores in these deposits have been gouged out and carried to the southward. Near the southwest corner of Cross lake in the township of Coleman there is a small exposure on the shore which also carries large angular blocks of the iron formation. There is, in all probability, a portion of a buried iron range in this vicinity. We have found the iron formation in place, in the area which we have mapped as Keewatin, a short distance northeast of the Drummond mine. Much of the conglomerate in various parts of the area contains jasper pebbles and other material derived from the iron formation.

In addition to the iron ranges which are found in the vicinity of lake Temagami, 25 miles to the south of Cobalt, there are outcrops of similar material in the township of Boston to the northward.

Iron Pyrites

The iron pyrites deposits of this part of Ontario also belong to the Keewatin. One of these is shown on the map near the Montreal river, south of the township of Coleman. Others have been worked still farther to the southward between this point and lake Temagami. Copper pyrites has attracted attention at numerous places in this series, but, so far as the writer knows, no large deposits of this mineral have as yet been found.

Arsenic

Near the railway track a short distance north of lake Temagami, two deposits of auriferous mispickel have been worked in the Keewatin. These are known as the "Big Dan" and "Little Dan" prospects, respectively. Mispickel is the sulph-arsenide of iron. It seems strange that it should be gold-bearing while 25 miles to the north the arsenides of the metals cobalt and nickel, which are closely related to iron, are silver-bearing. Arsenic occurs, therefore, in this district in considerable abundance. It may also be added that the pyrite, especially in the vicinity of lake Temagami, practically always carries some gold, frequently from one to two dollars per ton. Gold has also been found in Lower Huronian ore. That of the Temiskaming Cobalt mine, lot 15 in the first concession of Bucke, showed $5.20 to the ton in one sample, the ore being cobaltite, a compound related to mispickel, and that from Rabbit lake is also gold-bearing. The presence of a sulph-arsenide, either mispickel or cobaltite, in an ore from this district is an indication that the ore carries more or less gold.

It would appear, from what is known of the cobalt-nickel-silver ores of Cobalt and of the auriferous mispickel ores near Temagami and in Hastings county, that Ontario has a greater supply of arsenic than has been found in any other country.

Arsenic is marketed in the form known as "white arsenic," As_2O_3. This oxide is produced by roasting various minerals containing the metal. These minerals contain a much lower percentage of arsenic than do ores from most of the Temiskaming cobalt-silver deposits.

Up to a few years ago the only arsenic plant in North America was that at Deloro, Hastings county, Ontario. Here the ore is a gold-bearing mispickel, similar to that of Temagami. More recently an arsenic plant has been erected in the state of Washington and another in Virginia. The production of these plants has not been large. At the present two plants in Ontario are refining arsenic from Cobalt ores, viz.: the plant at Copper Cliff and the one at Deloro. That at Thorold is expected to be soon in operation.

White arsenic contains theoretically 75.8 per cent. of arsenic and 24.2 of oxygen. One pound of arsenic in an ore, if roasted, will therefore produce, theoretically, about one and one-quarter pounds of white arsenic.

During former years white arsenic was worth about $60.00 a ton or three cents a pound. In the year 1903 the United States imported $256,097 worth of white arsenic, metallic arsenic and arsenic sulphide. White arsenic was quoted at over $100 a ton in the beginning of 1906, and in the beginning of 1908 it was quoted at 6¼ to 6¾ cents a pound.

The greater part of the white arsenic formerly produced at the Deloro works was consumed in the plate glass industry of the United States. It is said that if the glass manufacturers were assured of a constant supply at satisfactory prices they would use white arsenic in place of the oxide of antimony, which they commonly employ as an oxidizer.

Other uses of white arsenic are in Paris green and various paints, in sheep dips, insecticides, aniline dye works, etc.

An instructive paper, by Mr. J. Walter Wells, on the manufacture and uses of arsenical compounds is published in the Eleventh Report of this Bureau, pages 101 to 122. Papers by Messrs. Kirkegaard and Wright are to be found in the transactions of the Canadian Mining Institute, vol. 2, 1897, and vol. 4, 1901-2.

Silver-Cobalt Ores in the Keewatin

The two most important veins which have been discovered in the Keewatin are probably vein 26 on the Nipissing and that on the Temiskaming, which is shown in the southeast corner of our large scale geological map. It will be seen from the map that both of these veins are not far from the contact of the Keewatin with the diabase. All the Keewatin veins in which silver has been found occur under similar conditions, *i. e.*, they are in proximity to a diabase contact. Veins in the Keewatin in the vicinity of Cobalt lake and the railway, west of the western edge of the diabase, have not been found to be productive in silver. In this part of the area certain veins have been followed downward from the Huronian conglomerate into the underlying Keewatin and while the cobalt-nickel minerals are present in the vein in the Keewatin the silver dies out. Some of these veins show little change in width in their passage from the Huronian into the Keewatin. Others split up into stringers where the Keewatin is reached and certain veins end abruptly at the Keewatin contact.

The fact that veins are much fewer in the Keewatin than in the Huronian fragmental series is due to the Keewatin rocks being tougher and fracturing much less readily than the Huronian conglomerate and slate.

In the case of a vein which passes from the Huronian into the Keewatin and carries high silver values in the former and not in the latter, the variation in values is to be accounted for by the fact that there have been two periods of deposition of the ore minerals. The first minerals to be deposited after the cracks were formed were essentially the cobalt-nickel arsenides. After these minerals were deposited there was a slight disturbance of the rocks and the veins were slightly fractured and opened, giving an opportunity for the deposition of the silver minerals which were then percolating through the rocks. The Huronian conglomerate and slate being not highly metamorphosed and lying on the Keewatin or in contact with the diabase was affected by the secondary disturbance while the great mass of tough Keewatin rock for the most part escaped the disturbance and the veins in it where not fractured so as to give access to the silver solutions. Where Keewatin veins lie near a diabase contact they were not only in a better position to be affected by the secondary disturbance, which was probably due to the concentration of the diabase in cooling, but they were also nearer the source of the solutions which appear to have come from the diabase magma.

In the notes which accompanied the first edition of our map of the Cobalt area we advised prospectors to pay special attention to the conglomerate areas. This was owing to the fact that the veins then known, with the exception of one or two in the diabase, occur in the conglomerate. Moreover, we believed that the Keewatin being a tougher rock, fewer fractures would be found in it. The edition of the map was published in the spring of 1905, in time for the prospectors who were then entering the field. Much of the area then open for prospecting contained conglomerate. Our advice to the prospectors has been verified, as the great majority of the veins since discovered in the Cobalt area are in the conglomerate. Of course after the conglomerate areas had all been staked the less promising Keewatin and diabase areas became more worthy of attention.

It may be added that when mining began in some of the veins in the conglomerate the writer told the operators that he thought the veins would hold their silver values until the underlying Keewatin was reached, but that he did not think the veins would be productive in the Keewatin. As shown above this has proved to be the case. It cost some of the operators considerable money to convince themselves of this fact. On reaching the Keewatin they sank and drifted in a vain search for more rich ore. During the time of the "boom" the theory that the Keewatin is less promising than the conglomerate was especially unpopular.

LIMESTONE

It will be seen from the map (scale 1 mile to the inch), that the Niagara limestone forms some large outcrops on the islands and in the vicinity of the shore near the northwest corner of lake Temiskaming. This limestone affords stone suitable for building and for the production of lime, and on this account should be of considerable value in the years to come, since limestone is a somewhat rare material in most of this northern part of Ontario. The district to the west and north is being rapidly settled and will soon contain a large population which will need much material for building purposes. The following is an analysis of a sample of limestone taken from Farr's quarry, Haileybury:

	Per cent.
Insoluble residue	1.60
Ferric oxide and alumina	.66
Lime	29.50
Magnesia	21.59
Carbon dioxide	46.84
Sulphur trioxide	.70
	100.89

This limestone formation extends northward, although overlain by clay and similar deposits in many places, and has been observed by the writer along the south branch of the Blanche river below what is known as the Mountain portage.

Considerable attention has been paid to the limestone area, Sir William Logan having first described it years ago. It has been shown that the series here is more closely related to the Niagara of Southern Ontario than it is to the Niagara areas to the north and west.

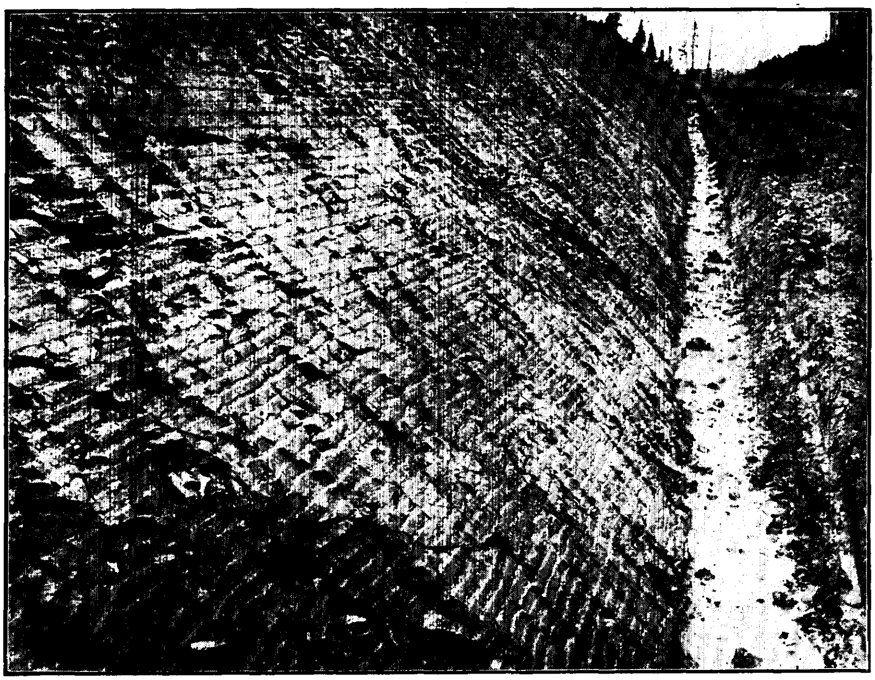


Fig. 13. Bedded clay in railway cut between Haileybury and New Liskeard.

CLAY

A couple of miles northward of Cobalt station the agricultural region of this part of northern Ontario is met with. The soil is essentially a well banded clay (Figs. 13, 14). Between this point and the height of land, or watershed, between the Hudson Bay and Ottawa river waters, the clay does not form a continuous mantle, but there are large areas of tillable land which is being rapidly settled. Outcrops of solid rock, in many cases representing hill tops, which project through the clays, are seen. North of the height of land, however, is a large agricultural area, estimated at 16,000,000 acres, and known as the "great clay belt," in which exposures of solid rock are few in number. The clay on both sides of the height of land is pretty uniform in character. Following is an analysis of the clay in a cut on the railway between Haileybury and New Liskeard. It will be seen that the lime and magnesia are rather high. This is owing to alternate bands containing considerable marl. The clay effervesces strongly in acid.

	Per cent.
Silica	52.00
Alumina	16.11
Ferric oxide	4.69
Lime	8.26
Magnesia	4.10
Potash	1.74
Soda	2.76
Sulphur trioxide	.09
Loss on ignition	9.64
Total	99.39

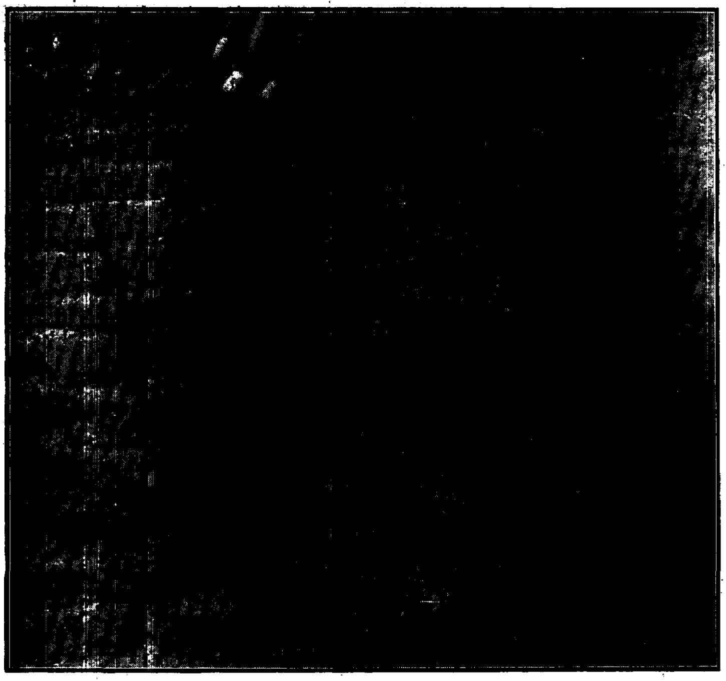


Fig. 14. A part of the face of the cut shown in Fig. 13 enlarged.

The clay used in the manufacture of brick in the vicinity of New Liskeard is described by Mr. M. B. Baker in the 15th Report of the Bureau of Mines, Clay and Clay Industry of Ontario, pages 83 and 84.

REGIONAL DISTURBANCES

From the geological maps and the plan, showing the distribution of the veins, which accompany this report, it will be seen that while the belts of the fragmentary rocks, of what we have called the Lower Huronian, strike approximately northeast and southwest, as for example the belt along the railway at Cobalt and the Glen and Kerr lake belt, the majority of the veins have a strike different from this. It would also appear that the strike of the veins in this area has little connection with the disturbance or disturbances which caused the great majority of the larger rivers and chains of lakes in the district to follow one or other of two well' defined directions.

A glance at a general map, such as the "Map of Part of the District of Nipissing," published by the Department of Lands and Mines of Ontario, will convince the reader that the system of water courses in the district is a truly remarkable one (Fig. 15). The Nipissing and Temiskaming map sheets published by the Geological Survey, Ottawa, show the system to hold over a still larger district. The chief water courses, as the maps show, follow either a northeast and southwest, or a northwest and southeast direction. While both of these courses are indicated clearly on the maps, the latter is the more prominent.

N.W.--S.E. Water System

The Temiskaming and Northern Ontario Railway from lake Temiskaming to North Bay junction, on the main line of the Canadian Pacific railway, has naturally been constructed along the line of least resistance, or in other words, it has been built for the most part along a line of depression in order to avoid costly rock cuts. The map shows that this road practically parallels, running in a northwesterly direction, the Ottawa river and lake Temiskaming for the first 90 miles or more of its course, to the crossing of the Montreal river at Latchford station, the railway being 15 or 20 miles to the westward of the Ottawa. At Latchford the railway turns northeastward and runs for 12 or 14 miles, parallel with the second great system of water courses, to Haileybury on lake Temiskaming. The direction followed by the railway for the first 90 miles of its course proves that there is a line of depression here, parallel with the Ottawa river and lake Temiskaming, although it is not indicated by water courses on the map along the greater part of the route.

Continuing northwestward from Wabi bay, the northwest corner of lake Temiskaming, and in line with the direction followed by the main body of this lake and the Ottawa river for about 75 miles, there is a water course, Wabi creek, which flows southeast for about 15 miles. In line northwestward from this point on Wabi creek the map of Nipissing does not show any prominent water course in a direction northwest and southeast for about 15 miles, although two branches of the Blanche river cross this space on the map in a direction northeast and southwest, parallel with the other great system of water courses. Fifteen miles in line northwestward of that part of Wabi creek referred to, the lake Temiskaming-Ottawa river line is continued northwestward by what is here known as the south branch of the Blanche river. For 15 miles northwestward here the river is represented by lake expanses, Long and Kinogami lakes, and for 15 miles above the upper of these lakes, the river is ascended in a northwest direction to the limits of the map of Nipissing, to which reference has been made.

The length of the line followed northwestward from Mattawa by the series of water courses mentioned—Ottawa river, lake Temiskaming, Wabi creek, Long and Kinogami lakes and the upper part of the south branch of the Blanche river—is approximately 135 miles.

It will be seen, however, that there is a bend in lake Temiskaming near the point where the Montreal river enters it. The lower part of the lake and Ottawa river are therefore more in line with the Montreal river than with Wabi creek.

The Blanche river enters the northeastern expansion of lake Temiskaming and the main stream and Round lake branch of this river follow a northwest line for a distance of 35 or 40 miles. This northwest axis of the Blanche lies parallel with the Wabi creek-lake Temiskaming axis, and 9 or 10 miles to the northeast of it.

A third water course which shows a striking parallelism to the two described is that of the Montreal river, which lies 10 or 11 miles southwest of the northwest axis of the Ottawa river. From the railway crossing at Latchford station northwestward through Bay lake and the townships of Auld, Barber, James, to the edge of the

Nipissing map, the line of the river holds its northwestward course for over 50 miles. Southeastward from Latchford station the line of weakness, if we can so call it, is continued through Straight, Johnny and Rib lakes for 9 or 10 miles. It will be seen that in the township of Barber and immediately below Latchford station, for example, the river changes its course for 3 or 4 miles, here following the direction of the other great system of water courses, that is the northeast and southwest one, but it gets back again into its normal northwest and southeast course.

Immediately east of the cobalt-silver area there is a chain of small lakes,—Cross, Kirk, Chown and Goodwin—with connecting streams, which follows a clearly defined northwest and southeast direction, parallel with the shore of Temiskaming, distant 3 miles to the eastward.

N.E.—S.W. System

The water courses and lake axes which lie in a northeast and southwest line are not so prominent on the maps as are the northwest-southeast ones just described; still they form a not indistinct system, and, as indicated by fig. 15, they seem to have an important, but as yet little understood, relationship to the cobalt deposits of not only Cobalt proper but of those of Rabbit lake 30 miles to the south and of Wendigo lake 30 miles to the north. If a line be drawn on the map from near the mouth of the Quinze river, at the northeast extremity of lake Temiskaming, southwestward to Latchford station on the Montreal river, a distance of 22 or 23 miles, and beyond, it will be seen that it follows the main axis of the large northeast bay of lake Temiskaming, and that the longer axis of Cobalt lake lies parallel to it. Several other small lakes,—Short, Pickerel and Bass—lie approximately on this line, as does also that part of the Montreal river between Latchford station and the Sandy portage. Farther southward it will be seen that one long narrow arm of lake Temagami and adjacent bodies of water follow a northeast and southwest line for over 20 miles. Rabbit lake, east of Temagami, has one arm 5 or 6 miles in length running in the same direction and another whose axis follows a northwest-southeast line. The two arms of Obabika lake, to the west of Temagami, show a similar relationship, one to the other.

The most striking water course following a northeast-southwest line is, however, the northeast or what is sometimes called the Abitibi branch of the Blanche river. There is a string of eleven lakes here between Windigo lake, north of the township of Ingram, and the Quebec boundary, a distance of 15 miles. To the southwestward in the townships of Armstrong and Henwood the south branch of the Blanche follows about the same direction. Otter and Wright creeks which run from the Quebec boundary into the Blanche river, between the head of Temiskaming and Tomstown, flow in a southwest direction.

The plan, Fig. 15, shows that the three occurrences of cobalt ores, viz.: at Cobalt, near Paulson's bay on lake Temiskaming and those at Animanipissing, are on one northeast-southwest line. The occurrence at Rabbit lake and in the area south of the township of Lorrain are on a similar line. Further, the deposits at Anvil lake are approximately in line with those at Wendigo. Believing that the occurrence of ore is in some way connected with the northeast-southwest lines of weakness the writer advised prospectors to search for deposits in the vicinity of Animanipissing. This resulted in the first finds of cobalt there.

At points where the two systems of water courses join a number of striking V-like turns are shown in lakes and rivers, as for example, those formed by (1) the two arms of Rabbit lake, (2) the northeast arm of Temagami with the main body of the lake, (3) the turns in the Montreal river at Latchford station and at the Sandy portage, (4) the longer axis of Wabi bay with that of Paulson's bay at the head of lake Temiskaming. The angles thus formed appear to be slightly less than a right angle and the V in all but one of the cases mentioned points southward. The axes of the two arms of Obabika lake form an angle greater than a right angle, which points eastward.

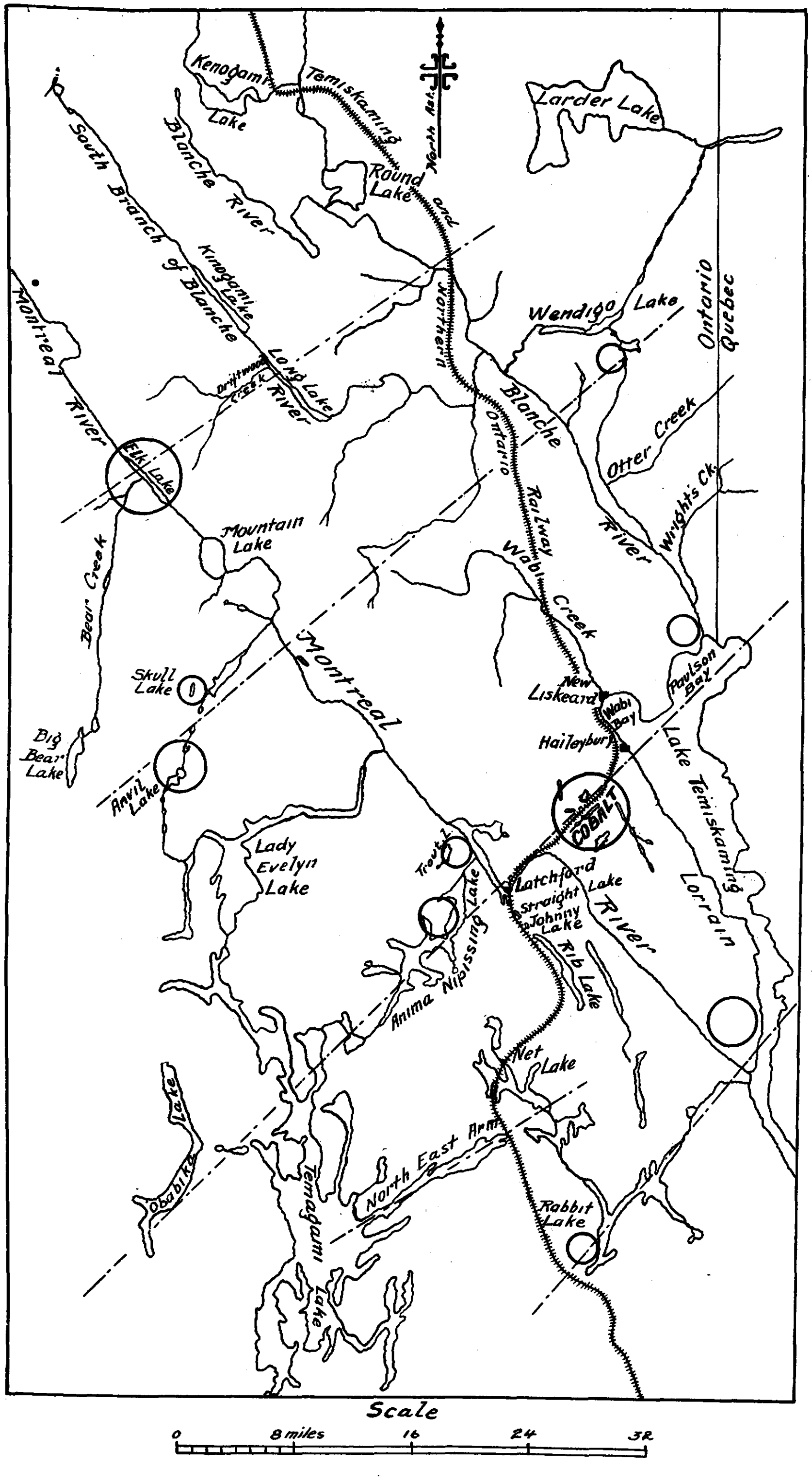


Fig. 15. Relations of N.E.—S.W. Lines of Regional Disturbance to the Cobalt-Silver Deposits. Rabbit Lake—South of Lorrain; Animanipissing—Cobalt; Anvil Lake—Wendigo Lake.

Considering the great variety of rocks cut through by the water courses of the two systems, the regularity of their courses over such a large district is remarkable. A few lakes and streams have their longer axis lying in a north and south or in an east and west direction, but they do not form a system comparable to either of the other two.

Origin of the Systems

Concerning the origin of the two great systems of water courses little can be said at present. It is impossible to say whether the courses follow fault lines or simply folds. They are doubtless due to regional disturbance in post-Middle Huronian times. Much of the surface of the country is covered by recent and glacial deposits, and the rocks where exposed present such a complex of igneous and metamorphosed fragmental matrial, with minor faults and folds, that is will be difficult to prove the existence of what may be called regional faults or folds. It can be proved that slight faulting, at least, has taken place in post-Glacial times.

At Cobalt lake, which has its longer axis parallel with one of these regional axes, if we may so call them, the beds of the Lower Huronian greywacké-slate and conglomerate dip towards the lake, as shown at the veins on the Coniagas property and on Cobalt hill, on the Nipissing, location R L 404. The lake, judging from the dip of these rocks, occupies the axis of a syncline. The hills where the dip was observed lie at an elevation, on both locations, of about 100 feet above the railway track at Cobalt station. At the powder house vein, however, on the La Rose, near the foot of Cobalt lake, the slate is seen to be practically horizontal. The vein here referred to is at the base of a cliff, which rises to a height similar to that of the hills across the railway track to the westward on the southern part of R L 400. In the former case, the hill is composed entirely of the greywacké-slate, while on R L 400 the rock is conglomerate of the same series. It would thus appear that the railway here follows approximately a line of fault, especially as the main shaft on the La Rose penetrates conglomerate, similar to that in the hills on R L 400, at a depth from the surface of 80 feet or more. There may thus be a fault here parallel with the main axis of the synclinal fold and Cobalt like. The strike of the main vein of the La Rose mine, J S 14, near the foot of Cobalt lake and that of the McKinley and Darragh vein at the head of the lake are approximately parallel with the main axis of the lake. The outcrop of diabase across the railway track opposite the La Rose main vein appears to be in the form of a dike. This diabase outcrop seems to indicate a line of weakness parallel with the lake and the railway.

Numerous small faults, with throw of a few feet at most, are found in some of the veins. These have been studied the most carefully in the La Rose main vein. The throw is nearly horizontal and, where observed, the faults are to be classed as being of the "reverse" type.

CHARACTER AND STRIKE OF VEINS

The accompanying index map of the veins shows that the strike of few of them conforms to the directions or lines of weakness followed by either of the two great systems of water courses, which have been described. It would appear that there is more uniformity in strike among the veins which lie to the westward of Cobalt lake than in any other part of the area. The vein on which the Trethewey mine is situated has a strike of about N. 85° W. A narrow stringer immediately north of this has a similar strike, as have also the seven veins on the Coniagas. On the Buffalo mine, immediately southwest of the Coniagas, two narrow veins have a strike similar to that mentioned, as have also other veins on the properties to the southwest. The strike of these veins, on the Coniagas, at least, is parallel with the dip of the enclosing rocks. The dip can be determined here in but few places. On the Coniagas at one point it was seen to be about 20° to the eastward. (*See* Index Map).

"It is not always possible, in a shattered rock, to discriminate between joints and those lines of division to which the term fissure is more usually restricted. Many so called fissures may be merely enlarged joints."[8] This holds true in the cobalt-silver area. While the openings occupied by some veins, or part of a vein, can be called fissures, there are many more to which the writer is inclined to apply the term joint. The openings in the greywacké and conglomerate are in many cases connected with columnar jointing in these rocks. A vein may occupy a distinct fissure-like opening for some distance, then it may split up, the stringers thus formed running around columns out of the former course of the vein and coming back some feet ahead into the line first followed. The columnar jointing is well shown in the rock cut along the railway a short distance south of Cobalt station. Several of the trenches, 20 feet or more in depth, from which ore has been extracted, illustrate the same phenemenon.

Fig. 16. Columnar jointing perpendicular to the planes of bedding in greywacké-slate. The structure is due to the effects of intrusive diabase on the slate. A section of a small column is on top of the larger one. Lot 15 in the first concession of Bucke.

The well banded greywacké-slate on the north part of lot 15 in the first concession of Bucke, has this columnar structure very perfectly developed in it (Fig 16). The columns here have a much smaller diameter than those just mentioned. They are developed at right angles to the bedding of the slate which is almost flat-lying, and they are nearly as perfect in form as those specimens found in basalt. On this lot in Bucke the columns are developed at the contact of the slate with intrusive diabase. That columnar structures of this kind are not uncommon in fragmental rocks is seen from the following statement: "Contact with eruptive rocks has frequently produced a prismatic structure in the contiguous masses. Conspicuous illustrations of this change

[8] Geikie, Text Book of Geology, p. 688.

are displayed in sandstones through which dykes have risen. Independently of the lines of stratification, polygonal prisms, six inches or more in diameter, and several feet in length, starting from the face of the dyke, have been developed in the sandstone."[9]

Whether we call the openings occupied by the cobalt-silver veins and stringers fissures or joints, it seems likely that they have been produced by the diabase which intruded the Lower Huronian rocks in which most of the veins are found. The diabase formed sheets or sills, in many cases, which appear to have had a great horizontal expansion. Owing to denudation, diabase outliers are now found at many points overlying the older fragmental rocks. The sills here appear to be comparable with those in the vicinity of Port Arthur, on the north shore of lake Superior. As previously shown, a few good cobalt-silver veins have been found in the diabase. Silver veins in the Port Arthur area also cut both the Huronian and diabase, many of them passing from one rock into the other. (Fig. 17).

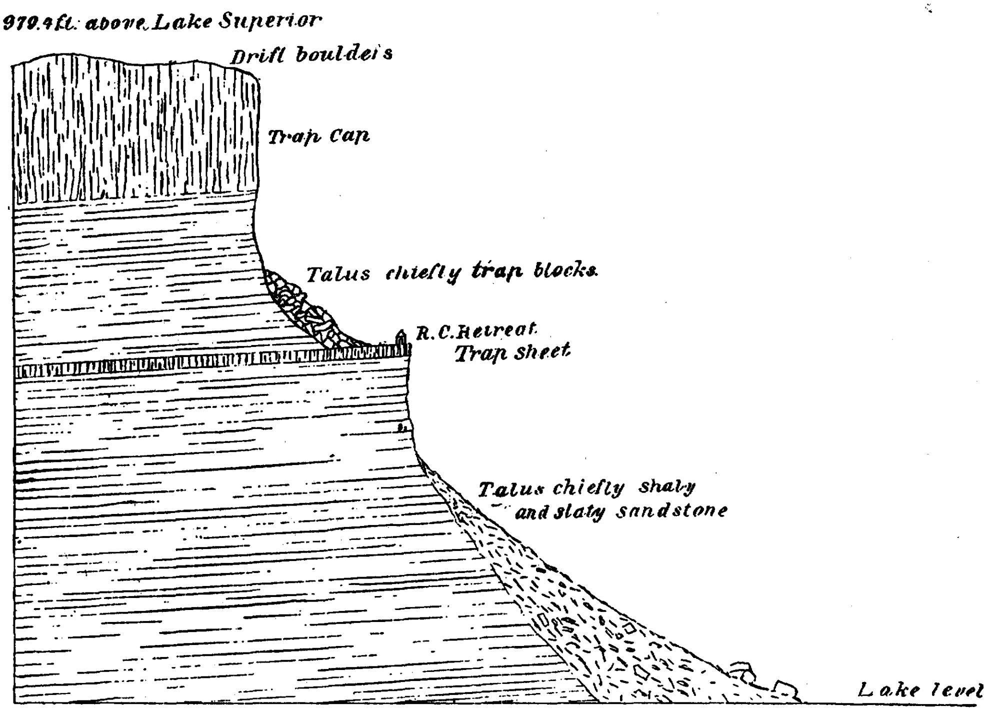


Fig.17. Section through Mt. McKay near Fort William, Ont. The trap here bears a similar relationship to the slaty series to that which it has in the Cobalt area. Some silver veins in the Port Arthur area cut both the trap and slate. (After Dr. A. C. Lawson.)

In the Cobalt area, as shown on a preceding page, there are examples of veins passing from one rock into another, *e.g.*, the Nova Scotia vein passes from the overlying Keewatin into the underlying diabase. One of the veins in the Lawson passes from the Keewatin horizontally into the diabase. Certain veins are known to pass vertically from the Huronian conglomerate into the underlying Keewatin, but are not productive in silver in the latter.

[9] Geikie, Text Book of Geology, p. 769.

METAMORPHISM OF SILVER AREA

As already shown, there is a similar assemblage of rocks, to that surrounding Cobalt station, over an area which is at least 75 miles in length from north to south. The question then arises as to why deposits as rich in silver as those near Cobalt have not been found here and there all over this large area. The only answer to this question which the writer can give at the present time is that the Huronian fragmental rocks in the vicinity of Cobalt station appear to have been less disturbed and less highly metamorphosed by the regional disturbances than have those in the surrounding areas. For instance, while much of the Lower Huronian in the productive area lies in horizontal beds or in those which dip at a low angle, similar rocks a few miles north, near Sharp's Landing, dip at angles of 60° or more. In the vicinity of Temagami and Rabbit lakes to the southward similar rocks have been rendered schistose. South of Wendigo lake, 30 miles to the north of Cobalt station, the conglomerate and greywacké-slate, while frequently lying almost horizontally, appear to have been baked and hardened much more than those in the productive area. Quartz stringers appear to be characteristic of the more disturbed areas (Fig. 17A).

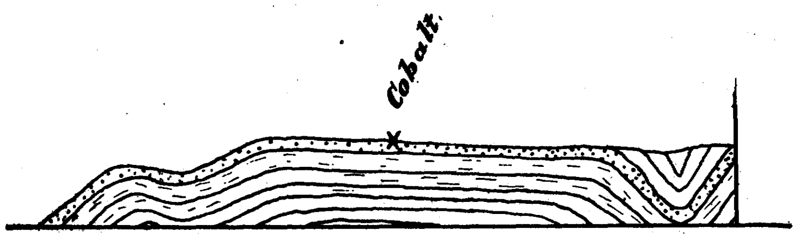


Fig. 17A. Ideal vertical section to show the less disturbance to which the Lower Huronian rocks at Cobalt have been subjected than have the rocks of the same age in the surrounding area.

It would appear then that the fragmental Huronian rocks in the productive area had escaped the greater disturbances and metamorphism to which those in surrounding areas have been subjected. This left them in the right physical condition to be readily jointed and fissured by the contraction of the diabase. After the deposition of the cobalt-nickel arsenides, which seem to be among the first minerals deposited, the veins appear to have been slightly disturbed, giving rise to cracks and openings in which the silver and later minerals were deposited. Veins which escaped this later, slight disturbance contain little or no silver.

Of course the post-Middle Huronian diabase has not been influenced by the metamorphism to which the Huronian fragmental series was subjected and may be fractured as readily in one area as in another. It is not surprising, therefore, that veins have been found in the diabase in James township and elsewhere in the district, while the adjacent Huronian slate and conglomerate is barren.

There may be other differences between the productive areas and those which surround them. Intrusions of rocks later in age than the diabase and gabbro may have played some part in the formation of the ores. Only one such intrusion has been observed in the field. This is the Cross lake basalt and diabase, referred to on another page. It is very difficult, in most cases, to distinguish these basic rocks of different periods of eruption. Even Keewatin diabases may be mistaken for those of later age, and *vice versa* unless a very careful examination is made.

THE ROCKS OF THE AREA

Owing to the fact that the surface was at first covered with green timber and there is much drift material, contacts and good exposures were difficult to find in places. Facilities for mapping have been much better during the last couple of years, as mining has progressed and the timber has been removed.

From the colored maps which accompany this Report it will be seen that there is a considerable variety in the pre-Cambrian series. The Niagara of the Silurian system also shows prominent outcrops. Between the Niagara and the Pleistocene or glacial there are no formations represented in the district. The pre-Cambrian has been separated into the following series by the writer. It is possible, however, that unconformities exist which have not been located as yet.

In preparing the original geological map on a scale of one mile to the inch, in 1904, I had the valuable assistance of Messrs. Cyril W. Knight and R. Anson-Cartwright. This map has gone through three editions. In 1906 Mr. Knight took charge of the work of preparing a detailed map of the more productive part of the area. This map is on a scale of 400 feet to the inch, with contour intervals of 10 feet over the more important part of the area. It was published at the end of 1907 and accompanies this third edition of the report.

Keewatin and Laurentian: The oldest series in the district consists of an igneous complex which contains diabases, and related rocks of different periods of eruption, together with granite-porphyry and other igneous material. Sediments are represented by the jasper-iron ores. The basic rocks or greenstones occur in much larger volume than do those of a more acid character. The name Keewatin is applied to this series. It has been subjected to folding and other disturbances, and is cut through by medium to coarse-grained granite, especially in the township of Lorrain, to which the name Laurentian is applied. The Keewatin rocks, however, have been folded before the intrusion of the Laurentian.

Huronian: After the Laurentian intrusion the surface was subjected to erosion, and these rocks, together with the Keewatin, were worn down. This period of erosion was a long one, and the surface was rendered very uneven, being cut into hills and vallys somewhat like those of the present surface. The oldest fragmental material which lies directly on the eroded Keewatin and Laurentian surface consists of conglomerates, greywacké-slate and impure quartzites. These rocks contain fragments of the granite, greenstone and other representatives of the older series, and their relationship to the latter is quite easily proved by contacts in a number of localities. This older, or, as it is called on the map, Lower Huronian, is of special interest since it contains most of the cobalt-silver veins.

The association of the members of the Lower Huronian is somewhat variable. There is usually a little coarser material, conglomerate, at the base. This is frequently followed by a considerable thickness of well banded greywacké-slate. The slate in many cases passes gradually upwards into a feldspathic or impure quartzite which is succeeded by a coarse conglomerate. The greater part of the conglomerate is undoubtedly younger than the more slaty members. The relationship of these members of the Lower Huronian is well seen in the Little Silver vein cliff in the southwest corner of R L 404, a part of the Nipissing. (Frontispiece).

The veins cut through all these series, but the most productive part of the veins are usually in the rocks which contain more or less coarse fragments. It is believed that the fissures now occupied by these veins were produced at the time of the eruption of the younger, post-Middle Huronian, diabases which will be referred to again.

This Lower Huronian series has at one time had a greater thickness than it has at present. Being laid down on an uneven surface, it is impossible to say what the thickness of the series is at any one point; it may be a few feet or it may be a few hundred feet. In some places it is entirely absent, the older series or floor on which the Lower Huronian is laid being exposed at the surface. The hills near Cobalt station, however, where these conglomerates and other members of the series outcrop, are 500 feet above the water level at the shore of lake Temiskaming, where similar outcrops are found. It would thus seem that the Lower Huronian may in some cases have a thickness of at least 500 feet. The greatest depth to which a shaft has been sunk in the Lower Huronian is about 265 feet, the bottom of the shaft being in the series.

Middle Huronian: The series of arkoses, or what have been called by some writers sea-green quartzites, together with conglomerates and quartzites of the township of Lorrain, form another series in the Huronian, the present writer having found that they are unconformable to the Lower Huronian. This series in the eastern part of the area has been derived chiefly from the erosion of the Lorrain granite, and much of the area, between Chown and Goodwin lakes on the west and Paradis bay on the east, contains small patches and outliers of this series. It is impossible to represent these on the map, the passage from granite into the decomposition products being so gradual. On lot 4, in the twelfth concession of Lorrain, a striking contact between the Lower Huronian and Middle Huronian is seen, fragments of slate of the former being cemented in the arkose of the latter. Fig. 22 shows a specimen from this contact.

On the eastern shore of Temiskaming the two series, so far as seen, appear to be conformable.[10]

There is no reason so far as the writer knows, why this Middle Huronian should not contain veins as well as the Lower Huronian, since it is also cut by the diabase and has been subjected to similar disturbances. The intrusive nature of the diabase as regards the Middle Huronian is seen on the shore of Temiskaming just south of Devil's rock.

Post-Middle Huronian Diabase: It will be seen from the geological maps that these rocks occupy a considerable part of the surface of the area under review. In most cases, where associated with the Huronian, they seem to be in the form of sheets or sills spreading between or over the layers of the rocks through which they cut. They show no evidence, such as amygdaloidal texture, of being surface flows. These rocks are much fresher in appearance and coarser in grain than those of a similar composition which occur in the Keewatin, and can thus usually be readily distinguished in the field from the latter. After the eruption of these diabases, whose exact age is not known, that is, whether they belong to the Upper Huronian or the Keweenawan, erosion of the

[10] Sir William Logan (then Mr. Logan) explored Lake Temiskaming in 1845–6. The account of his trip, published in the report of the Geological Survey for those years, pages 60-70, is of interest.

"Ascending Lake Temiscamang, the slates come in upon the gneiss about three miles below the mouths of the Montreal and Metabecchuan Rivers, on the west bank, and about three miles above them on the east; and they occupy both sides to within two and a half miles of the Hudson Bay Company's Post. In this distance they may have a direct breadth of about seven miles in which they are effected by at least one undulation, and probably more, and constitute hills of 300 or 400 feet. As gathered from the map of D, Taylor's exploratory journey from Lake Huron to the Ottawa by Lakes Nipissing, Temagamang and Temiscamang, the slates in a westerly direction run forty miles in a line about S. 40° W., from the latter Lake to Bass Lake, on the Sturgeon River, which discharges into Lake Nipissing on the north side, and it appears probable they will come upon some part of the north shore of Lake Huron. On Lake Temiscamang they are followed by the sandstones, which cross the lake with a strike of N. 60° E., and dipping northward at a very small angle, after having been piled up into a range of about the same elevation as the slate hills, they reach the Company's Post, where, nearly flat, they run under a narrow gravel hill, 130 feet in height; emerging beyond, they continue to a distance of about half a mile above the Post, and there become interrupted on both sides of the lake by a mass of syenite. This syenite does not possess the gneissoid arrangement of the rock lower down the river, but it appears to be nearly similar in other respects, being composed of reddish feldspar white or colorless quartz and a sparing quantity of green hornblende. The breadth of this syenite band is pretty nearly three miles on both sides of the lake. On the west it is succeeded by the sandstones, which run along the coast for a distance of four miles, nearly in the strike of the measures, dipping towards the water at a small angle, and are followed by the slates, which come from behind them, and continue in a straight line for nine miles to the western bay at the head of the Lake, forming high, perpendicular cliffs for part of the way, and rounded hills for the remainder. On the east side, the syenite gives place to the slates, which there present the porphyritic appearance already mentioned. The sandstones come upon them on the south side of the southern large island, and the mainland near, dipping a little to the west of north at an angle of three degrees; and both they and the slates, with their associated conglomerates, make their appearance at occasional points along the coast, wherever denuded of the overlaying limestones, the basset edge of which thinly covers them, to the island at the entrance of the eastern or Moose Bay. Beyond this the sandstones, gently dipping south, are seen in a projecting point to the east of the island. The slates are met with at the mouth, and at the first, second and third Portages of the Riviere des Quinze, or Moose River and their associated conglomerates in the bay to the west of the Blanche.

"The limestones constitute the two large islands north of the Company's Post, the two smaller ones between them, the island already mentioned planted at the entrance of the eastern bay, and a very small one on the west coast, as well as the promontory which separates the east bay from the west. The strata lie in the form of a shallow trough, based sometimes on the sandstones and sometimes on the slates, occupying the breadth of the lake,—from five to six miles—and extending from the south side of the southern great island to some unknown distance northward, being probably a projecting point or an outlier of some more extended calcareous area nearer Hudson's Bay."

surface again took place for a long period of time, and all the series now exposed in the field, with the exception of the younger Niagara, were worn down.

In the earlier editions of this Report and on the maps the term "diabase and gabbro" was used, owing to the fact that the post-Middle Huronian basic igneous material was often rather coarse in grain and was difficult to determine in the field. Microscopic examination by Mr. Knight has, however, shown that all the samples taken by him are diabase, most of which contain primary quartz and hence may be called quartz-diabase. Hence the name "gabbro" is dropped.

Diabases representing several periods of eruption, Keewatin to post-Middle Huronian, are found and care is necessary to distinguish them in the field. On the south shore of Cross lake the diabase which contained cobalt-silver veins is cut by a younger basalt, which grades into an olivine diabase.

Niagara: This Silurian series consists of similar rocks and fossils to those which are found in the districts to the south. It is composed especially of limestones which contain a little conglomerate and sandstone at their base. The region has been subjected to little disturbance since the deposition of these Niagara rocks.

Fig. 18. Torsion cracks in Keewatin greenstone, lot 15 in the second concession of Bucke.

Glacial and Recent: Much of the surface of the area covered by the geological maps is occupied by boulder clay and loose bedded deposits. The character of some of this material is shown in Figs. 13 and 14. The distribution of the glacial and recent deposits is shown on the large scale map.

Keewatin

The folding which has been produced in the Keewatin is well shown by torsion cracks in Figs. 18, 19. The photographs which these represent were taken at the contact of the Keewatin with the Lower Huronian, at the shore of Temiskaming, on lot 15 in the second concession of the township of Bucke. This contact is shown on the map.

It is an important one owing to the fact that it is easily reached from the town of Haileybury, either by water or by land. The Keewatin greenstone also frequently shows ellipsoidal parting similar to that which has been described in the Vermilion district of Minnesota.

Mr. M. B. Baker who examined, microscopically, specimens of the Keewatin greenstone from near the contact on the lot above mentioned says that the rock has a very fine grained trap-like appearance. The two important constituents are green hornblende and plagioclase. The former mineral occurs in angular grains and blade-like pieces, which show a frayed structure, and is altered to chlorite. Much of the plagioclase is changed to kaolin and occurs in lath-like forms. Some sections show a well defined ophitic structure, so that the rock can now be called a fine-grained hornblende diabase. Other specimens of the Keewatin greenstone examined by the writer from the railway cuts near Pickerel lake and elsewhere are similar in character.

Fig. 19. Part of rock surface in Fig. 18 enlarged.

At the immediate point of junction or contact of the Lower Huronian with the Keewatin on the lot to which reference has been made, the greenstone of the latter is cut through by a dike of porphyry of pre-Huronian age. This porphyry shows similar cracks to those presented by the Keewatin, but its porphyritic texture serves as a good means of identification. It frequently is difficult to distinguish the more or less metamorphosed greenstones of the Keewatin from some of the slaty-greywacké phases of the overlying Lower Huronian. These greywackés are simply the recomposed greenstones, or in other words after the greenstones have broken down into fine material this has been resolidified into slate-like rocks. But at the contact referred to we find pebbles and boulders of the Keewatin porphyry dike in the overlying Huronian, and there is no mistaking these pebbles and angular fragments for something else. (Figs. 20, 21). In many other outcrops one has not his attention drawn to the unconformity at once. There is a well defined contact in a light colored knoll which lies some distance east of Farr creek on the northeast corner of lot 13 in the first concession of Bucke.

This hill is in the bush but can be seen on looking southward from the road. Northward from the road here there are also contacts. The location of these is shown on the map (scale 1 mile to an inch).

Previous to 1904, maps of this district showed as one series the Keewatin, Lower Huronian and Middle Huronian, thus bringing out the fact already illustrated that it is somewhat difficult at times to distinguish some phases of the Lower Huronian from the Keewatin. Those who mapped the series in this way considered that the boulders and other fragments in the Lower Huronian represented pyroclastic rocks practically contemporaneous with the greenstones of the Keewatin, which were also deemed to be of sedimentary character.

Keewatin pseudo-Conglomerates. Certain Keewatin dikes contain rounded inclusions of the rocks through which they have cut and are apt to be mistaken for conglomerates by untrained observers, more especially if boulders or pebbles of these dikes are seen in the Huronian or later formations. Lamprophyre dikes on the Nipissing just west of

Fig. 20. Lower Huronian breccia-conglomerate formed *in situ* from Keewatin porphyry. The finger is on the latter rock. Lot 15 in the second concession of Bucke.

Peterson lake, where the surface has been cleaned by the hydraulic plant, contain numerous inclusions and are good examples of pseudo-conglomerates. It should also be remembered that there is a certain amount of volcanic fragmental material in the Keewatin, which may be mistaken for Huronian, although it is more angular than the latter.

Surrounding Sharp's Landing there are some interesting exposures. The Keewatin is here represented by an outcrop of iron formation which is only about 25 feet in length. Surrounding this or overlying it are slates and conglomerates of the Lower Huronian, which here dip at a higher angle than they usually do in the vicinity of Cobalt station. Near this Landing and along the shore, the Huronian is probably folded into anticlines and synclines, as there seems to be a repetition of certain beds. The most interesting point in connection with these outcrops is, however, the fact that we found fragments of the Keewatin iron formation in the overlying series.

The Keewatin rocks which outcrop around the shores and islands of Sasaginaga and Clear lakes are seen to be of at least two ages. The older rocks are light colored and fine grained and are often much fissured. They contain numerous stringers of quartz, especially near the north end of lake Sasaginaga. It is difficult to say what much of this light colored rock has been originally, although, from thin sections examined microscopically, it appears to have been a fine grained volcanic type. It is cut through by a later series which is somewhat like other exposures of the Keewatin seen in the district. A similar assemblage of rocks to those found at this lake occurs in the township of Boston to the northward. Usually the Keewatin is represented by darker colored rocks than those of most of the exposures around Sasaginaga.

The folding, shown by small cracks or torsion figures, which are present in many of the Keewatin outcrops, assists in their recognition. Many of these cracks are now filled with white calcite, and although on the whole the rocks look like slates of the Lower Huronian, these calcite fissures distinguish them. There are some good exposures of this kind in the railroad cuts between Pickerel lake and Bass lake, two or three miles south of Cobalt station. Other smaller exposures of the rock in the railroad cuttings may be seen about opposite Short lake, just south of Cobalt lake, and certain outcrops occur not far east of the railway and south of Cobalt lake. Then we have shown areas just west, north and east of Peterson lake. It may be said that if the slaty phases of the Lower Huronian have been metamorphosed, as they sometimes are in the vicinity of diabase intrusions, it becomes doubly difficult to distinguish them from the Keewatin. We have also shown Keewatin areas along the Montreal river between Hound Chute and Sandy portage. This area is probably much larger than shown on the map, as no attempt was made to trace it out in detail. Similar rocks are found around lake New.

Contact of Keewatin and Laurentian

Although the Laurentian granite covers an area of considerable extent on the map, we found only one good contact where the granite plays the part of an intrusive rock. This was near the northwest corner of what we have called Kirk lake. The granite here comes in contact with greenstone and sends out small dikes and stringers into it. This greenstone appears to be a variety of the Keewatin of the district. It is certainly older than the granite. A microscopic description of the greenstone is given on a following page. The rock appears to be volcanic fragmental in origin, but it is now much metamorphosed.

The granite of the district is commonly rather coarse in grain and of a deep flesh-red color, the feldspar predominating. The ferro-magnesian constituent is biotite, which is usually converted to chlorite and occurs in small quantity. The predominant feldspar is generally microcline, and other acid varieties of plagioclase are abundant. The larger quartz grains frequently show a rounded outline.

It would have been a source of satisfaction if we had been able to find more contacts of the granite with the Keewatin greenstones, but the writer thinks that the relationship which is shown by the legend on the map to exist between the rocks of this region is correct for the following reasons: (1) The Keewatin throughout the field has been much disturbed and now contains torsion cracks and other evidence of disturbance, while the Laurentian granite does not show any traces of such disturbance. (2) The granite, as has just been said, cuts through the greenstone at the northwest corner of Kirk lake. (3) Boulders and other fragments of granite, similar to that which makes up the mass of the rock in Lorrain, are found in the Lower Huronian in many places, thus giving evidence, even if we had no contact between the granite and the Keewatin, that the Lower Huronian is younger than the granite. The writer has never seen any contact between the granite and the Lower Huronian in the Cobalt area proper, but, as shown on a following page by Mr. Knight, good contacts of these rocks occur in the Montreal river area. (4) The Middle Huronian is seen in contact with the Laurentian granite in numerous places in the township of Lorrain. In fact it is difficult to draw a line between the two series, the recomposed Middle Huronian material often resembling very closely the Laurentian granite from which it has been derived. A similar relationship between these series was described by Dr. Barlow in his Report of the region some years ago, the outcrops studied by him being on the Quebec side of Temiskaming in the vicinity of Ville Marie. At that time it was thought, however, that the granite was the oldest rock in the district, that is, older than the Keewatin, Lower Huronian and Upper Huronian, the three being put into one series.

Fig. 21. Contact on shore of Temiskaming between the Keewatin and Lower Huronian. The Huronian breccia rests on the Keewatin rock from which it was derived. The Keewatin is light in color and the illustration shows the Huronian breccia to be composed of angular fragments of this rock set in a dark ground mass. Lot 15 in the second concession of Bucke.

In two or three instances pebbles in the Lower Huronian appeared to be conglomerate, that is, they seemed to indicate that there had been a conglomerate series before the Lower Huronian was laid down. It would appear, however, that these pebbles and boulders come from the pseudo-conglomerates, viz.: Keewatin dikes, which hold partly dissolved, rounded fragments of rocks through which they have cut. Such pseudo-conglomerates have been described on a preceding page. It is well, however, to consider the possibility of a fragmental series in the district older than what is here called the Lower Huronian. The Keewatin undoubtedly contains some sedimentary material, shown by the jasper-magnetite bands. The writer believes that these sedimentary bands should be classed with the Grenville series, which is found in much greater volume in southeastern Ontario. He would place the Grenville sedimentary series between the Keewatin and Lower Huronian in age.

The breccia and conglomerate of the Lower Huronian are what were called by Logan and others slate-conglomerate, a name which well describes the varieties possessing a slate-like base through which are set pebbles and boulders. At times the fragments are angular in form. These rocks show great variety in composition, the conglomerate frequently containing pebbles of many kinds and of various sizes, the material being representative both of the Keewatin complex and of the Laurentian. Pebbles represent several diabases and porphyries of the Keewatin together with those of granite and other pre-Huronian rocks. In other cases the Lower Huronian fragmental rocks contain material of only one or two kinds, representative of an underlying or adjacent mass. Thus the slaty-greywacké members frequently represent the recomposed material of the Keewatin which was consolidated almost *in situ.* It is often difficult to distinguish the recomposed rock from that through whose decomposition it was formed.

Further Notes on the Keewatin

The complex group of rocks to which the name of Keewatin is given are the oldest rocks recognized in the Lake Superior, Northern and Northwestern Ontario region. They consist essentially of igneous, volcanic, types of different periods of eruption. Some of these rocks appear to have been surface flows, while others now exposed at the surface, through denudation, seem to have had a more deep-seated origin. Moreover, certain types occur as dikes *e. g.*, in the Cobalt area we have dikes of lamprophyre and granite-porphyry. Associated with the massive volcanic rocks there is more or less volcanic fragmental material, varying in size from ash-like material to coarse blocks, representing ejectamenta from volcanoes contemporaneous with the lava flows.

Frequently the Keewatin rocks, in the region referred to are so altered through metamorphic agencies that their original character is difficult, if not impossible to determine. The rocks of basic and intermediate composition have been changed in many cases to green schists which give little evidence of the original character of the rocks. Diamond drill cores from a depth of a few hundred feet in the Keewatin prove that the rocks at this depth are practically as much decomposed as they are near the surface. This leads to the assumption that decomposition was probably brought about through the agency of magmatic waters.

Description of Type Specimens of Keewatin

From the following descriptions by Mr. Cyril W. Knight of type specimens of Keewatin rocks from various parts of the Cobalt area, it will be seen that the igneous material erupted at this early period of the earth's history shows as great a variety in composition as do the Tertiary and more recent eruptives of the Rocky Mountain region. We have in the Cobalt area, as Mr. Knight shows, basalts (and probably andesites), diabases, diorites, pyroxenites, mica and hornblende lamprophyres, granite and quartz porphyries together with volcanic fragmental material of various kinds. The jasper-iron ore bands represent sedimentary material which has heretofore been included in the Keewatin. The writer believes, however, that this sedimentary material represents the Grenville series which is developed in much greater volume in the southeastern part of Ontario and the adjacent part of Quebec.[11]

The prevailing green color of the Keewatin is due chiefly to chlorite and other secondary minerals such as serpentine and epidote. The color causes the series as a whole to be known as greenstones.

[11] The Grenville-Hastings Unconformity, pages 221-223, Sixteenth Report of the Bureau of Mines, 1907.

As shown on preceding pages the Keewatin contains numerous torsion cracks which are filled with calcite. The veinlets of calcite serve as a means of readily distinguishing the Keewatin greenstones from certain members of the Huronian which bear otherwise a close resemblance to them in the field. Such Huronian fragmental material is formed from the consolidation of fine grained Keewatin debris.

(a) *Area west of the Trethewey and Coniagas Mines*

A specimen from the centre of the lot due west of the Trethewey mine shows the rock to be an altered diabase. A green, slightly pleochroic hornblende is now the main constituent. Some of it occurs in grains ¼ inch in diameter; much is in the fibrous form, some grains terminating in fine drawn out threads. Considerable amounts of epidote are present, no doubt secondary after the plagioclase or pyroxene; a few grains of zoisite are found. The plagioclase has been completely altered to saussurite. Much of the rock consists of a confused mixture of hornblende, serpentine, chlorite, epidote and zoisite. The ilmenite has changed to leucoxene. Traces of a distinct ophitic texture still remain, rods of plagioclase (now altered to saussurite) being embedded in the hornblende. Much of the section is, however, lacking in any of the textures found in igneous rocks, and consists largely, as already stated, of a confused mixture of hornblende, chlorite, epidote, zoisite, etc.

Another specimen taken from the same lot as the above a little farther east, is also on microscopic examination seen to be an altered diabase. It consists now essentially of plagioclase and hornblende, together with the secondary minerals chlorite, epidote, leucoxone, etc. The plagioclase occurs in rods and stouter prisms mostly altered to saussurite. The albite twinning lamellae may sometimes be seen, in which case the maximum extinction in sections normal to the lamellae is 20 degrees, indicating that it is probably a basic andesine. The hornblende is the common green variety, partly in distinct or irregular grains, partly in confused fibrous areas, associated with chlorite and epidote. The ophitic texture can readily be made out.

The rock at the head of Sasaginaga creek (south shore) is more altered than the other two sections just described. Much of it consists of a confused mass—lacking any igneous texture—of chlorite, epidote, quartz, leucoxene, calcite, serpentine, etc. Rods and stout prisms of plagioclase (andesine) can be made out; it is, however, badly altered to saussurite. Hornblende occurs in allotriomorphic grains (usually fibrous) largely altered to chlorite, calcite, etc. The rock appears to have been originally a diorite.

The western edge of the Trethewey mining company's property is Keewatin. A thin section shows it to have the following composition: plagioclase, orthoclase, hornblende, titanite, ilmenite and pyrite. The plagioclase is andesine usually cloudy, due to secondary products. Some untwinned feldspar occurs. The hornblende is the common green variety in rods and fibrous masses; it has crystallized out partly at least, before the plagioclase. Much has altered to chlorite. No traces of an ophitic texture are seen and the rock is classed as a diorite.

A thin section of a diamond drill core on the Trethewey at 661 feet consists, probably almost wholly, of secondary minerals of which calcite is by far the most abundant. Epidote and sericite also occur. A few plagioclase rods are seen in this groundmass, some of them largely decomposed. The presence of these plogioclase rods seems to indicate that the rock was probably igneous. A section from the drill core at 765 feet is seen under the microscope to be about similar to that at 661 feet. The hole was drilled at an angle of 62 degrees.

The greenstone immediately west of the Coniagas is typical of many of the Keewatin rocks around Cobalt. It is a light greenish colored rock with numerous very fine stringers of different shades of greenish material irregularly ramifying through it. The iron sulphides are also present. The grain is too fine to allow the component minerals to be distinguished. Under the microscope, however, it is seen to consist essentially of a very fine grained ground-mass. This is made up of a confused mass of chlorite, epidote, hornblende, plagioclase rods, and other similar material difficult to distinguish on account of the fine grain. In it are irregularly set a few larger rods of plagioclase. Cutting through this structureless material are numerous tiny veinlets consisting of chlorite, epidote, hornblende, calcite and sulphide of iron; these are the veinlets referred to in the above description. If the rock was originally an igneous representative it has now entirely lost its original texture.

The Keewatin at the southwest corner of the Buffalo mine is a much altered diabase The freshest material present is hornblende, but much of this is altered to chlorite. The feldspar is generally completely gone to secondary products; a few rods do show albite twinning. The ground-mass consists largely of chlorite, epidote, zoisite, etc. Distinct traces of an ophitic texture can be seen where rods of plagioclase (now altered to saussurite) are embedded in the hornblende, which latter has in all probability resulted from augite.

The altered diabases here described are similar to certain pebbles, studied by Dr. Barlow, from the breccia-conglomerate of the Lower Huronian.[12]

(b) Area west of the Foster and University Mines

Two specimens from the Foster property were examined. One from the fifty foot level of the air-shaft consists of chlorite, biotite, feldspar and magnetite. Some of the feldspar not yet decomposed is in more or less distinct rods, but apart from this there is no trace of an igneous texture and no hint of what the rock was originally. One hundred and fifty feet southeast of the ore-house a thin section shows the rock to consist of a confused mass of chlorite, feldspar, biotite, hornblende, calcite (in small amount) and magnetite.

The small patch of Keewatin on the west part of Silver Bar is very fine grained; in places it is schistose in character. Under the microscope it is seen to consist largely of rods of feldspar usually twinned once, and badly decomposed. In the more decomposed areas chlorite, hornblende, biotite, magnetite and other secondary minerals displace the feldspar rods. Cutting irregularly through this ground-mass are stringers of chlorite, quartz, hornblende, etc. The unaltered areas, showing rods of feldspar, resemble the ground mass of andesite or basalt.

A silica determination of this rock by Mr. A. G. Burrows gave 53.24 per cent. This is about the silica content of the more acid basalts, though it is true that the basic andesites do in some cases fall this low in $Si\ O_2$.

A little south of Silver Bar, in the Provincial mines (Gillies limit), one thin section appears to be fragmental. Outlines of angular fragments can still be made out. These consist now of various secondary minerals, epidote, chlorite, etc., and are set in an exceedingly fine grained ground-mass, parts of which are nearly opaque with crossed nicols. As is so often the case in these Keewatin rocks, stringers of hornblende, chlorite, epidote, etc., ramify through the whole.

Farther south still (and a little west of Contact bay, Giroux lake) a section of the greenstone consists mostly of a very fine grained ground-mass consisting essentially of chlorite. In one or two areas very small rods of plagioclase, resembling the groundmass of andesite or basalt, can be made out. Epidote and zoisite, partly scattered through the ground-mass and partly in stringers, are exceedingly abundant.

(c) Area on east part of the Drummond mine and thence easterly to Cross Lake

The Keewatin as exposed on the surface in this area differs from that in any other part of the silver producing area of the township of Coleman. It weathers to a light grey color and has a chert-like appearance. Stringers of quartz a few inches in dia-

[12] Annual Report Can. Geo. Survey 1897, p. 98 and 99 I.

meter are found cutting it and are rather characteristic. At the southwest corner of the Silver Cross (adjacent to the Drummond mine) narrow belts of the iron formation are found. Dark red jaspilyte bands four and five inches in width are here seen to be highly contorted.

A thin section from the central part of the east boundary of the Drummond is made up of very small angular grains which have the appearance of being granulated Some fragments of plagioclase are present and show the albite twinning lamellæ. Judging from the chert-like appearance of the hand specimens and from the freshness of some of the individual fragments there is probably much quartz present, but the grains are too small to admit of their distinction by convergent light from orthoclase. There is some chlorite between the interstices of the grains and also cutting the material in the form of fine stringers. Microscopic veinlets of quartz or feldspar also cut through the rock. Northerly from here several hundred feet another thin section shows the material to be similar to the above. At Drummond's landing on Cross lake the rock is also similar under the microscope.

The Lower Huronian clastics at the east end of Kerr lake, 200 feet from the shore, contain large angular boulders, some of them five feet in diameter. These are similar to the Keewatin above described which is seen in place a few feet to the east and have apparently resulted from the breaking down of it. A thin section from the dump of the Drummond mine (main shaft) contains angular fragments identical with the large boulders just referred to.

(d) *Outliers east of Peterson lake and west of the north end of Cross lake*

A specimen from the lot east of the Nova Scotia property consists almost wholly of irregular rods and allotriomorphic grains of a very faintly pleochroic hornblende with extinction angles up to 20 degrees. Some of it occurs in long, slender, colorless rods, probably tremolite. Grains of strongly, doubly refracting, pleochroic epidote are irregularly distributed throughout this ground-mass together with some chlorite. Cutting across the slide are two veins of epidote about 1/16 inch wide. Some of this mineral contains a great number of long, needle-like inclusions (probably rutile). Another specimen from the same lot shows the rock to be quite similar to the one just described. The stringers of epidote, above mentioned, cutting the greenstones are characterstic of this series of rocks.

A thin section from the Keewatin on the Watt property, shows it to be made up essentially of a confused mass of feldspar rods, green allotriomorphic hornblende grains and chlorite. Calcite, quartz, pyrite and titanite are present in smaller amount. In certain areas, less decomposed than the general mass of the rock, plagioclase phenocrysts are set in a ground-mass of feldspar rods, resembling some andesites. The rock is, however, so badly altered that its original character is difficult to get at. Microscopic stringers of hornblende are found ramifying through the material.

(e) *The O'Brien Keewatin*

Several hundred feet east of the north end of Cobalt lake, a cobalt-silver vein crosses the township road. An open cut in the vein affords good samples of the Keewatin at this point. In hand specimens the rock appears to be porphyritic, the phenocrysts consisting of grayish green rods ¼ inch long. Under the microscope these phenocrysts are seen to have been entirely decomposed and to consist now almost wholly of chlorite together with smaller amounts of titanite, calcite and feldspar (sometimes twinned). The chlorite is the variety penninite, giving the deep indigo blue interference colors with crossed nicols. These phenocrysts are set in a ground-mass which is made up almost wholly of irregular plagioclase laths showing albite twinning lamellæ, giving a maximum extinction angle of 20 degrees in the zone normal to the twinning plane. Some calcite and titanite also occur in the ground-mass. A thin section one hundred and fifty feet south of the large bunk house on the O'Brien mine is somewhat similar to that just described. It is, however, much more decomposed and consists now essentially of a fine grained ground-mass of chlorite (variety penninite), biotite, titanite, quartz and magnetite. In less decomposed spots rods of plagioclase can be made out. Set in this are the phenocrysts just described on the Cobalt road. These also now consist mainly of chlorite.

A silica determination from these two places gave 51.04 and 53.8 per cent. respectively. These have about the same silica content as the Keewatin on Siver Bar and correspond with the more acid basalts.

(f) "Cobalt farm" between vein 49 and Cobalt lake on the Nipissing mine

A thin section from this part of the Keewatin reveals a confused mass of feldspar, chlorite, titanite, magnetite and much pyrite. The greenstone in this vicinity is stained with limonite due to the decomposition of the pyrite. Parts of the section show considerable numbers of rods of plagioclase similar to the ground-mass of some basic volcanic rocks.

(g) Keewatin from the Temiskaming Mine (south half of the northwest quarter of the north half lot one, con. III., township of Coleman).

In hand specimens the rock is very fine grained and of a dull greyish green color. Under the microscope it is seen to consist essentially of prisms and needles (some with terminal faces) of hornblende, showing slight pleochroism, light green to yellow. It is generally fresh but some is replaced by penninite. Lying in the interstices of the hornblende prisms are allotriomorphic grains of feldspar, sometimes showing albite twinning lamellæ. It has crystallized after the ferro-magnesian constituent and frequently contains needles of hornblende as inclusions. Small amounts of epidote, biotite and magnetite are present. The rock may be classed with the hornblende-lamprophyres.

Thin sections from the first and second levels of the Temiskaming mine show the rock to be made up of a felt work of plagioclase rods which are set in a ground-mass of epidote and other secondary material. This rock is similar to some of the Keewatin on the O'Brien and Silver Bar. These latter have the silica content of basalts or basic andesites.

(h) Keewatin at northwest corner of Kirk lake

Part of the greenstone here is fragmental, and angular pieces, sometimes four inches or more in length, are found. Some of these fragments are porphyritic types; phenocrysts of augite or hornblende ⅛ inch long are set in a fine, light green ground-mass. A thin section under the microscope brings out even more clearly its clastic origin. Angular fragments from a quarter of an inch down make up most of the slice. These fragments appear to have entirely lost their original composition, but in many the texture may still be seen. Long, narrow rods are embedded in a ground-mass. The latter now consists of chlorite and fibrous hornblende, while the rods are made up of a nearly colorless mineral, giving very low interference colors—possibly another variety of chlorite. The texture is like that seen in certain volcanic rocks, especially in the arrangement of the rods, which show "flow structures" in places, and resemble the ground-mass of trachytes in this respect. The ground-mass, in which are embedded these angular fragments, consists almost wholly of chlorite. In fact the section as a whole is made up mostly of this material. Magnetite grains are quite abundant. The rock may be classed as a volcanic-breccia. It appears to differ lithologically from the typical breccia-conglomerate of the Lower Huronian in two respects; (1) It lacks the numerous fragments of comparatively fresh orthoclase and plagioclase[13]

[13] Rep, Can. Geo. Sur., 1897. p. 96 I.

commonly found in the Lower Huronian clastics, of the same size of grain. (2) It is represented now, probably almost entirely, by secondary minerals. This fragmental material is cut, moreover, by the Lorrain granite, which is not the case with the Lower Huronian.

(i) *Keewatin on the Argentite property*

Some thin sections from a Keewatin rock on the Argentite property (the southeast corner of the northeast quarter of the south half, lot eight, concession five, Coleman township) were examined by Mr. M. B. Baker, in the laboratory of Prof. Rosenbusch, Heidelberg, Germany. Mr. Baker describes the rock as follows: "The dull green more or less schist-like rock shows many well formed crystals of a light green mineral, which in the hand specimen would readily be taken for olivene. Under the microscope the ground-mass is seen to be composed of chlorite for the most part, but with considerable talc, muscovite flakes and saussurite. This would represent a basic feldspathic ground-mass after severe metamorphism. In a few places even traces of the multiple twinning of the original plagioclase can be seen. Scattered through this very fibrous felt-like ground-mass are hypidiomorphic to idiomorphic crystals of monoclinic pyroxene, showing excellent cleavage parallel to the prism 110; but at the same time having the rare pinnacoidal cleavage 100 010 very well developed in two rectangular sets of cracks intersecting one another symmetrically, and to which the extinction is parallel. All three of these sets of cleavage appear, of course, as a set of parallel cracks in longitudinal sections, and here the extinction is inclined at angles as high as 39 degrees, showing clearly that the mineral is not olivene but a monoclinic pyroxene. The monoclinic pyroxene having the composition and other properties of augite or diopside, but having the pinnacoidal cleavage referred to above is called diallage. I should therefore say that this rock now represents a very highly altered or metamorphosed phase of dolerite or diabase."

Mr. N. L. Turner, provincial assay office, Belleville, analysed the pyroxene in this rock, with the following result:

SiO_2	48.92
Al_2O_3, Fe_2O_3	18.88
CaO	12.16
MgO	18.00
Combined water	2.56

Some Keewatin Dikes.

Mica—Hornblende Lamprophyre

On the west shore of Peterson Lake an hydraulic plant for prospecting was installed by the Nipissing Mining Company in 1906.. The soil on the hill facing the lake has thus been washed from the smooth glaciated rock surface, exposing the latter and revealing certain interesting dike rocks which are here described.

About 300 feet south of vein No. 12, a very narrow dike is seen in hand specimens to contain flakes of mica about 1-16 inch in diameter. Under the microscope the following minerals are recognized:—hornblende, biotite, feldspar, apatite, and magnetite. It consists essentially of the first two constituents. The hornblende occurs in rods, sometimes with terminal faces, showing light yellow to green pleochroism. The biotite is in plates, partly, sometimes wholly, weathered to chlorite (variety penninite); the decomposition begins from the outside and works its way towards the centre. Feldspar is not so abundant as the above two constitutents. It occurs in allotriomorphic grains, a few of which show albite twinning lamellae. Apatite and magnetite occur in small amounts; some at least of the latter is secondary after biotite and hornblende. The rock has a porphyritic texture, the hornblende and biotite occurring in two generations. The feldspar has crystallized after these two constituents and is found in the ground-mass. The rock is here classed as a mica-hornblende lamprophyre. The wavy extinction in many of the minerals shows it to have been subjected to considerable pressure.

Hornblende-Lamprophyre

Three hundred and fifty feet west of the hydraulic plant above mentioned another dike is found; it is two to three feet in width. Five thin sections were examined from this. The composition in all five is fairly uniform. Under the microscope hornblende is seen to be the most prominent constituent. It occurs in two generations both in rods and stouter prisms. Some of the phenocrysts have the deep, grass green color of the pyroxene, aegirite, but differ from the latter in having a higher extinction angle (up to 20 degrees) and also in having the least axis of elasticity nearest the vertical crystallographic axis. The hornblende in the ground-mass is, as a rule, not so pleochroic (light yellow to green) as the phenocrysts; the former occurs in irregular rods and needles. Biotite: in two of the five sections this constituent is absent; in two of them it is present in small amount, while in the fifth it is quite prominent but not so prominent as the hornblende. Feldspar is never an abundant constituent; it occurs mostly in the ground-mass in allotriomorphic grains. Generally no twinning lamallae are noted; a very few phenocrysts are present. Wavy extinction is always seen in the feldspar. Apatite, magnetite and pyrite are present as accessories.

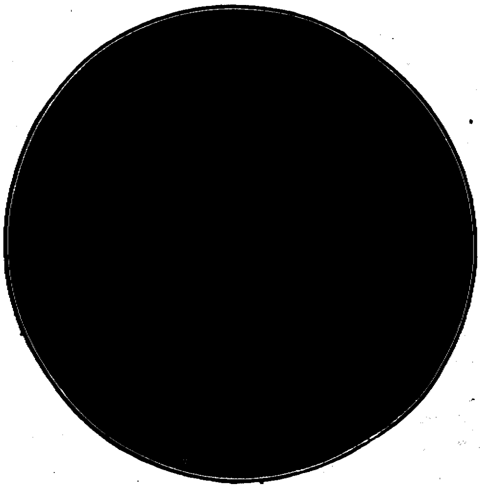


Fig. 21A. From photomicrograph of thin section of hornblende-lamprophyre dike cutting more ancient Keewatin on west shore of Peterson lake, Nipissing mines.

Texture. The texture is hollocrystalline-porphyritic, the phenocrysts being mainly hornblende, and sometimes biotite in addition. The rock is classed as a hornblende-lamprophyre. Often the lamprophyric rocks alter largely to calcite, but in this case very little is present.

Numerous inclusions are found in this dike. One of these under the microscope is seen to be fragmental in origin, consisting almost wholly of cleavage fragments and angular pieces of both twinned and untwinned feldspar. The ground-mass consists of the same material in finer grains.

Half way between the hydraulic plant and vein 49, is an irregular dike two to three feet in diameter. Two sections from this showed it to be similar to the last type described. Hornblende is the essential constituent. Biotite, feldspar, apatite, magnetite and pyrite are present in small quantities. This dike contains many inclusions. A thin section of one of these inclusions shows it also to be fragmental, and to be made up of angular pieces of twinned and untwinned feldspar and hornblende.

Huronian

The map, scale 1 mile to the inch, shows what we have called the Middle Huronian to be confined to the southeastern corner of that part of the area which belongs to Ontario. This series is here light in color, being composed essentially of granite debris. It is possible or even probable that there may be rocks of the same age on the western side of the area which differ in appearance from these Lorrain arkoses and other varieties. No outcrops of granite were seen in the western or northern part of the area; hence if rocks were being laid down in those parts of the field at the same time as they were being deposited in the southeast corner, the fragmental material, no granite being present, would be different in appearance from the Middle Huronian of Lorrain.

It may be seen from the map referred to that the writer has roughly subdivided what he has called the Lower Huronian, the coarser fragmental material or conglomerate being shown to be confined essentially east of a line which runs from the east side of Mud lake northeastward towards New Liskeard. Some outcrops of this conglomerate or breccia were, however, found in the township of Hudson.

Fig. 22. Breccia at the contact of the Lower Huronian with the Middle Huronian. Fragments of greywacké-slate are cemented together by the light colored Middle Huronian arkose. Lot 4 in the twelfth concession of Lorrain.

These rocks in the western part of the map resemble in a general way the greywacké slate which is associated with the conglomerate in the vicinity of Cobalt station and elsewhere, but the slates along the railroad, for instance near the town plot of Latchford, are usually reddish banded and present a somewhat different appearance from the typical slates of the Lower Huronian. Reddish banded slates are found along the shore of Temiskaming, on the Quebec side, to the east of the area we have mapped.

Contacts are very frequently difficult to find. The writer was fortunate in finding a striking one, a specimen from which is shown in figure 22, on lot 4 in the twelfth concession of Lorrain. This contact is shown on the map. A small knoll of slaty greywacké here has the arkose around its base, and fragments of the dark greywacké are cemented, as shown in the figure, with the light colored arkose. This is the only contact that the writer was able to find between the Lower and Middle Huronian.

There are some things that are rather difficult to understand in connection with the Huronian sediment. The cement material, for instance, and the angular character of the greywacké fragments at the contact just described do not indicate water erosion. The cement material is very fresh in appearance and only slightly decomposed, thus differing from material which has been produced in the presence of water. The greywacké fragments being angular also show no evidence of having been worked over by water. The writer is not able to offer a satisfactory explanation for the character of the sediment found in some of these strata. As previously stated, other writers in the district have claimed that this fragmental material was pyroclastic in origin. The present writer has disproved this, the fragmental material at some of the contacts being clearly derived from the older series close at hand. To account for the unde-

Fig. 23. Contact of Middle Huronian quartzite with Niagara limestone on the east shore of lake Temiskaming north of Pichè Point. The fragments of quartzite are cemented together by limestone.

composed and angular character of much of the fragmental material, the writer is inclined to the belief that desert conditions prevailed in this region at the time some of the Midle Huronian rocks, at least, were formed. Of course, much of the material in the Lower Huronian, after we get above its base, and much of that in the uppermost part of the Middle Huronian is well rounded and shows the effects of water action.

The writer does not pretend to say that there is no pyroclastic material intermixed with the fragmental material of the Huronian. The association of some of the strata is puzzling. It is difficult to understand, for example, how certain large boulders of granite in the conglomerate, which forms part of the highest outcrops of the Lower Huronian, have been carried so far from their parent masses. These large boulders are found over much of the district, and there are now no outcrops of granite in the neighborhood of many of them. Then some of the delicately banded greywacké slate may represent volcanic dust or fine grained pyroclastic material. In the present state of our knowledge we have little warrant for claiming that the granite boulders, often two or three feet or more in diameter and distant a couple of miles from exposures of the rock, indicate glacial conditions during Lower Huronian times, although we have no proof to the contrary.

The above statement concerning the possible glacial origin of some of the Lower Huronian conglomerate was published in the first edition of this report which was written at the end of 1904. It may be added that there are some points in connection with this conglomerate that are difficult to reconcile with a glacial origin of the material, viz.: (1) We know, as shown on preceding pages, that a good deal of the Huronian material has originated practically *in situ*. (2) The underlying surface of the rock does not show glacial striations. (3) There has been no boulder clay recognized. (4) Striations on boulders may be produced by faulting—there are numerous small faults in the Huronian rocks. (5) Boulders resembling those which are usually considered to be characteristic of glacial origin are said to be found in deposits of undoubted non-glacial origin. (6) No unconformity has been found between the underlying greywacké slate and feldspathic quartzite series with the overlying conglomerate. (7) During floods in semi-arid regions boulders of large size are frequently transported miles by rivers.

Analysis of Slate

The sample analyzed is from the well-banded, what I have called greywacké-slate, from the base of the cliff at the Little Silver mine in the southwest corner of location R L 404 (Fig. 1). It belongs to the Lower Huronian series. Mr. Burrows found it to have the following percentage composition:

	Per cent.
Silica	62.74
Alumina	16.94
Ferric oxide	5.07
Ferrous oxide	1.59
Lime	1.39
Magnesia	3.05
Soda and potash	6.07
Moisture	.36
Loss above 110 degrees	3.20
Total	100.41

Analysis of Breccia

A sample of the medium grained Lower Huronian breccia, in the wall of the La Rose vein, was submitted to analysis by Mr. Burrows, with the following result:

	Per cent.
Silica	43.12
Alumina	19.74
Ferric oxide	5.72
Lime	5.40
Magnesia	7.48
Soda	4.50
Potash	1.75
Cobalt and nickel	.55

Loss on ignition	10.94
Arsenic	1.18
Total	100.38

The sample showed in places the greenish arsenate of nickel and also bright specks of a white mineral, evidently smaltite or chloanthite.

Post-Middle Huronian Diabase

In the first and second editions of this report this diabase was spoken of as 'diabase and gabbro' owing to the fact that some varieties are coarse in grain and thus resemble gabbro. Mr. Knight has proved, however, that all varieties of the rock possess an ophitic structure and should be called diabase. Primary quartz is always present in this diabase.

This rock, as will be seen from the maps, occupies a considerable part of the area. Good contacts are found, especially between it and the Lower Huronian. A contact of diabase with the Middle Huronian can be seen along the shore of Temiskaming a short distance north of Martineau bay and elsewhere. One is struck by the fact

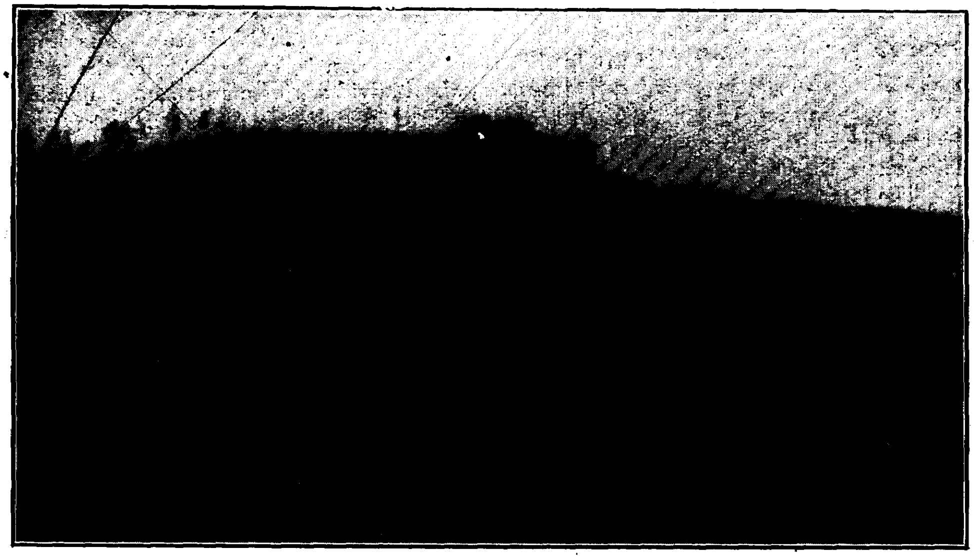


Fig. 23A. Post-Middle Huronian diabase, forming the "Devil's Rock," about 200 feet in height, on the west shore of lake Temiskaming, about two miles south of Haileybury.

that in many of these contacts the fragmental rocks, through which the diabase cuts, frequently dip towards the diabase. This is rather unusual. We generally find fragmental rocks dipping away from the intrusive varieties or forming anticlinal structures. The diabase here, as shown on preceding pages, formed, in many cases, laccolitic masses and sheets or sills at one time (Fig. 17). Hence it is probably to be expected that the slate and conglomerate series should dip towards outliers of the diabase which rests on them. A contact of the slate with diabase is seen across the railway from La Rose mine, and good contacts are also to be seen near the railway track a couple of miles south of Haileybury. The slate on lot 15 in the first concession of Bucke has been much disturbed by the intrusion of the diabase, and a peculiar columnar structure, perpendicular to the bedding, has been developed in it. This has already been described (Fig. 16).

It was thought that the metals in the cobalt-silver deposits might have been derived from the diabase. Samples from different outcrops were, however, tested by Mr. Burrows, who found no indication of the presence of any of these elements. Keewatin greenstone was examined with similar results. That the cobalt ores in all probability came from the same magma as the diabase is made evident, however, from the association of these ores with the rock over a large territory in the vicinity of Wendigo lake, in the township of James and elsewhere.

Elsewhere in this report it has been stated that this post-Huronian diabase is often much like some of the coarser varieties of basic rocks which are found in the Keewatin. Representatives of the latter, especially on freshly broken surfaces, have a more weathered and altered appearance than do post-Huronian representatives.

Further Notes on the Post-Middle Huronian Diabase

Mr. Cyril W. Knight has furnished me with the following detailed descriptions of types of the diabase from various parts of the Cobalt area.

The field relations, structural features, etc., of the diabase have already been described. These remarks will therefore be confined to the characters which are best studied in hand specimens and thin sections. For a microscopic description of the diabases outside of the immediate vicinity of Cobalt, Dr. Barlow's report on the Temiskaming map sheet may be consulted.[14]

In nearly all cases the ophitic texture of the diabases at Cobalt is of miscoscopic importance only, because it is rarely that this texture can be made out with the naked eye. The grain of the rock is very uniform, the individuals of augite and plagioclase probably averaging between 1-16 and ⅛ of an inch in diameter. There are, however, places where it is very much coarser than this, as for example near the shore of Peterson lake where the creek flows to the north.

The main point brought out in the following examination is the fact that two thirds of the thin sections examined contain primary quartz (though seldom in considerable amount). They are therefore quartz-diabases. The quartz is almost always associated with feldspar in what is known as micrographic intergrowth. Its primary nature may therefore be safely assumed.[15] This intergrowth is the last constituent to crystallize out and occurs between the interstices of the other minerals. In this connection it is interesting to note that some of the basic rocks (norite) at Sudbury also contain quartz. Both districts produce nickel and cobalt. The Cobalt quartz-diabases are evidently similar to those on the Blanche river, first rapids, described by Prof. Miller in the Bureau of Mines report for 1902, page 228.

(*a*) The diabase belt south of Kerr and Giroux lakes.

A thin section of the diabase near the southeast corner of the Jacob's mine on Kerr lake, shows the rock to be a normal diabase and to consist of the following constituents: plagioclase, augite, biotite, magnetite and an odd grain of quartz.

The plagioclase occurs in long, relatively narrow rods, nearly always showing albite twinning lamellæ. The maximum extinction in sections at right angles to these lamellæ is 43 degrees. The feldspar is therefore labradorite ($ab_3\ an_7$). Zonal banding is seen in a few cases with crossed nicols. The mineral is usually fresh but has in some cases altered to epidote, chlorite, etc. The augite occurs in very pale brownish, faintly pleochroic, allotriomorphic grains. In almost every case there is present a very fine lamination which is due to parting parallel to OP (001).[16] This parting is sometimes present to the exclusion of the ordinary prismatic cleavage of the pyroxenes. It is found in almost all the augite in the diabase at Cobalt and is a very characteristic point. A few irregular grains of biotite are present. This latter mineral is always a constant, though never

14 Annual Report Can. Geo. Sur., 1897.
15 Harker, page 132.
16 Rosenbusch—Iddings Pl. XIX., fig. 6.

prominent constituent of the rock. A very small amount of quartz (not in micrographic intergrowth with feldspar) is noted. Some magnetite is present.

The texture. The plagioclase has crystallized out before the augite so that rods of the former are found partly or wholly embedded in the augite. This is known as ophitic texture, and the rock is therefore classed as a diabase.

A specimen from the east end of Giroux lake (from the centre of what is known as the "Nugget" claim) contains the same constituents as the section just described. The quartz, however, is present in large enough quantities to class the rock with the quartz-diabases. It is not such a good example of that type of rock as others which will be described later. Decomposition has broken down much of the plagioclase to saussurite, and much of the augite to fibrous hornblende, chlorite, etc. The basal parting in the augite is very marked.

A specimen from Dynamite island in Giroux lake shows the rock to be a normal diabase without any quartz. It consists almost wholly of labradorite and augite with a very few grains of biotite and magnetite. An occasional rod of apatite is seen. The texture is ophitic, the labradorite occurring in rods partly or wholly embedded in the augite. This section (and that from the Jacob's mine) is fresher than most of the post-Huronian diabase at Cobalt.

Quartz-diabase, showing plagioclase (labradorite) P imbedded in a micrographic intergrowth of quartz and feldspar. From Diabase point, Giroux lake.

The rock from Diabase point, Giroux lake, is a good example of a quartz-diabase. The quartz is intergrown with feldspar, showing a micro-pegmatic texture; the feldspar in this intergrowth is usually too badly decomposed to determine its nature. The rock consists of labradorite, augite, quartz and small amounts of biotite and ilmenite (partly decomposed to leucoxene). The labradorite is not quite so basic as in other diabases which are free from residual quartz. The ophitic texture is marked.

As will be seen from the geological map of Cobalt, the diabase belt south of Kerr and Giroux lakes is about three quarters of a mile wide. A specimen from the south edge of it (S.E. corner of lot 2, con. IV) shows the rock to be badly decomposed. It consists of plagioclase, augite, quartz, ilmenite and biotite. The plagioclase is almost wholly gone to saussurite, the augite to green hornblende, chlorite, etc., ilmenite to leucoxene. The quartz is in graphic intergrowth with feldspar. It is therefore classed as a quartz-diabase, the plagioclase having crystallized out before the augite, giving the ophitic texture.

A thin section near the northwest corner of the University mine shows the rock to be a quartz-diabase. The quartz, however, is not such a prominent constituent as in sections from other parts of the area. The pagioclase occurs in the usual rods showing albite twinning lamellæ and giving extinction angles (in the zone normal to twinning) up to 36 degrees. The augite occurs in allotriomorphic grains showing twinning parallel to both 101 and 001, the latter repeated, resulting in the basal lamination already described in other augites. Biotite is present sparingly. A few grains of magnetite occur. The texture is ophitic.

(*b*) The diabase area between Kerr and Peterson lakes (on the south and north) and between Cross lake and the west face of Diabase mountain (on the east and west).

A specimen near the northeast corner of the "Silver Leaf" mine is a normal diabase similar to others already described. Northeasterly from this point about half a mile, a specimen was collected near lake Cyril. It consists of labradorite in the usual rods;

Quartz-diabase. P, plagioclase (labradorite) embedded in a micrographic intergrowth of quartz and feldspar, Q. From northeast corner of R L 403, O'Brien mine

augite, showing the basal lamination so commonly found; biotite in accessory amount; magnetite; and quartz in graphic intergrowth with feldspar. The labradorite is badly decomposed, while some of the augite has passed to uralite. There seems to be, however, some original hornblende present. The ophitic texture is well marked placing the rock with the quartz-diabases.

(*c*) The diabase north of Peterson lake.

Good specimens may be obtained from the creek, from the point at which it leaves Peterson lake; the lake has been partly drained here by a small canal cut in the rock. The texture of the rock is unusually coarse, the augite individuals being sometimes half an inch in length. The labradorite occurs in shorter rods than is the case with most diabases, but it has crystallized before the ferro-magnesian mineral. The maximum extinction angle in the zone normal to the twinning lamellæ is 34 degrees. Much of it is decomposed to saussurite. The augite shows the characteristic basal lamination; some of it has decomposed to green pleochroic hornblende. Biotite in accessory amount is present. Quartz is found partly in graphic intergrowth with feldspar and partly by itself. In the latter case its primary origin may sometimes be in doubt. Some magnetite grains are noted. The typical ophitic texture is not well developed, but the plagioclase has crystallized before the pyroxene, and in a few cases the usual rods of the former are wholly embedded in the augite.

Northeasterly from here half a mile on the Watts mine the thin section examined is less coarse in grain. The labradorite is in the usual rods, partly decomposed to saussurite. The augite occurs in allotriomorphic grains, showing the basal lamination; it has in part been altered to uralite. The micrographic intergrowths of quartz and feldspar are more abundant than in any so far described. Ilmenite, mostly weathered to leucoxene, is also unusually abundant. The rock is a fine example of quartz-diabase.

Northerly from this point two-thirds of a mile (the northeast corner of R L 403) a thin section shows the rock to be a quartz-diabase. It is similar to others already described, consisting of labradorite, augite (showing basal lamination), quartz and feldspar in micrographic intergrowth, and small amounts of biotite and ilmenite (weathered to leucoxene). The texture is ophitic.

Five hundred feet due east from the point where the last specimen was taken the type of rock is a little different from the general run of diabase at Cobalt. The plagioclase is an acidic labradorite (ab_1 an_1) partly in rods, partly in allotriomorphic grains. There is no augite present, its place being taken by a faintly pleochroic hornblende, occurring partly in rods but mostly in allotriomorphic grains. Some magnetite is present. Part of the plagioclase has crystallized before the ferro-magnesian constituent, while some has crystallized at the same time; hence the ophitic texture is not marked.

The diabase on the west part of the La Rose property appears to differ structurally from that in other parts. At the points where it is seen in contact with the Lower Huronian clastics the walls are vertical, so that it would seem to have the nature of a dike. It does not differ materially, however, in composition or texture from the typical outcrops in other parts of Cobalt, except that it is finer in grain. Rods of labradorite set in allotriomorphic grains of augite make up the rock essentially, and the usual decomposition products have resulted in places. Ilmenite and a small amount of quartz and feldspar in micrographic intergrowth are also present.

Three sections were examined which are a little outside the Cobalt silver area proper. They are all quartz-diabases. One of them, taken beside the Temiskaming and Northern Ontario Railway between Bass and Mud lakes, shows the rock to contain labradorite, hornblende, small amounts of augite, abundant quartz in micrographic intergrowth with feldspar, and ilmenite. The labradorite is nearly all decomposed to saussurite and the hornblende present appears to have resulted from the augite. The texture is ophitic. Another specimen (also beside the railway) was collected about half a mile farther west, between Mud lake and the Montreal river. It is about similar to the last specimen, with the exception that it contains accessory biotite.

A specimen from the Evans or Imperial mine, south half of lot 15 in the sixth concession of Coleman, was found to be very much decomposed and is represented now largely by green pleochroic hornblende. Rods of plagioclase, nearly always altered to secondary products (saussurite) can be seen embedded in hornblende giving the ophitic texture. The section contains considerable quartz in graphic intergrowth with feldspar, the latter is in some cases twinned. It is this feldspar which gives the rock, like most of the diabase in the Portage bay area, the appearances of containing pink or reddish grains. The rock may be called a quartz-diabase. It contains more quartz than any of the diabase in the immediate vicinity of Cobalt.

(*d*) Note on chemical composition.

Mr. A. G. Burrows of the Provincial Assay office, Belleville, Ont. has made silica determinations of two of the quartz-diabases. The SiO_2 content of the last thin section described above is 51.14 per cent. The other determination was made from the quartz-diabase from Diabase point, Giroux lake. It contained 49.44 per cent. $Si\ O_2$. Rosenbusch gives analyses of two quartz-diabases showing a $Si\ O_2$ content of 51.15 and 55.25 per cent.[17]

Later Basalt and Diabase

About the middle of the southwest shore of Cross lake a later diabase is seen to cut the diabase above described, and in which occur a little farther to the westward the Watts, Violet and other cobalt veins. At the immediate contact this later rock is very fine grained and is a basalt. Farther out, however, it passes into a diabase. The basaltic facies is made up of plagioclase, olivene, magnetite or ilmenite. The texture is porphyritic. The plagioclase phenocrysts occur in narrow rods showing carlsbad, albite and sometimes pericline twins. Zonal banding is seen. Few of the crystals happen to be cut exactly normal to the albite twinning lamellæ so that the composition cannot be arrived at exactly, but it is probably labradorite. The plagioclase in the ground-mass occurs in smaller rods of the same composition (labradorite). A tendency to fluxional structures is noted in these small rods. Olivene occurs both as phenocrysts and in the ground-mass. It is found in grains showing common crystal faces and also in rounded individuals. There is considerable opaque material lying in the interstices of the plagioclase rods. It is probably magnetite (or ilmenite); some of it shows dendrite forms.

Farther from the contact, the rock loses its basaltic texture and passes into a diabase . It is made up of labradorite, augite, biotite and magnetite (or ilmenite). The labradorite occurs in the usual rods embedded partly or wholly in augite. The latter is in allotriomorphic grains with a faint violet brown color indicating the presence of titanium. Some biotite is present and also much magnetite (or ilmenite).

This later diabase as exposed on Cross lake is much finer grained than the earlier quartz-diabase of the Cobalt area. Owing to drift its areal distribution has not been determined.

Analyses of Later Basalt and Diabase of Cross Lake

	No. 1.	No. 2.	No. 3.
Silica	45.20	49.84	48.06
Alumina	19.08	18.94	18.23
Ferrous oxide	14.64	6.40	9.57
Ferric oxide	3.64	1.51	
Lime	7.89	10.32	11.55
Magnesia	4.98	7.39	7.80
Soda	3.32	1.99	1.87
Potash	1.08	1.28	.27
Loss on ignition	......	2.57	3.54
Totals	99.83	100.24	100.89

No. 1 is the basalt described above. No. 2 is the diabase cut by the basalt. This diabase, near the piont mentioned on Cross lake, is seen to overlie a fine-grained representative of the fragmental series.

No. 3 is an analysis made in the Pittsburg Testing Laboratory of a specimen of diabase taken two feet away from the vein on the Violet claim and about six feet from the surface. The result of this analysis was given to the writer by Mr. J. O. Handy, who says that a thin section of the rock examined microscopically showed predominant hypersthene, much augite, plagioclase, magnetite and no quartz. This specimen is seen from the analysis to possess almost the same chemical composition as No. 2. The Violet claim lies a short distance west of the foot of Cross lake.

[17] Rosenbusch, Elmente der Gesteinslehre, page 336.

In the western part of the field the diabase frequently contains grains of reddish feldspar.

A Later Granite Dike

On the large contoured map of Cobalt a granite dike is shown cutting the diabase on the southwest corner of the University mine, Giroux lake. The dike is medium to fine in grain and has a pinkish flesh color. Two thin rock-sections examined show it to be made up of feldspar, quartz and a colored constituent. The feldspar predominates and consists of microcline, and an acid plagioclase showing fine albite twinning lamellæ, The quartz and feldspar occur in allotriomorphic grains, but in two instances show distinct micrographic intergrowths. The colored constituent is not abundant. It was apparently originally a mica, but is now represented by chloritic material.

This dike is not unlike certain small dikes in the Montreal river area (James township, etc.) known as aplites. The latter are, however, generally under eighteen inches in width, while that on the University property averages about fifty feet. All cut the diabase and are regarded as the end phase of the diabase eruption. The dikes of the Montreal river area are described on a following page.

Rocks of Cobalt and Sudbury compared

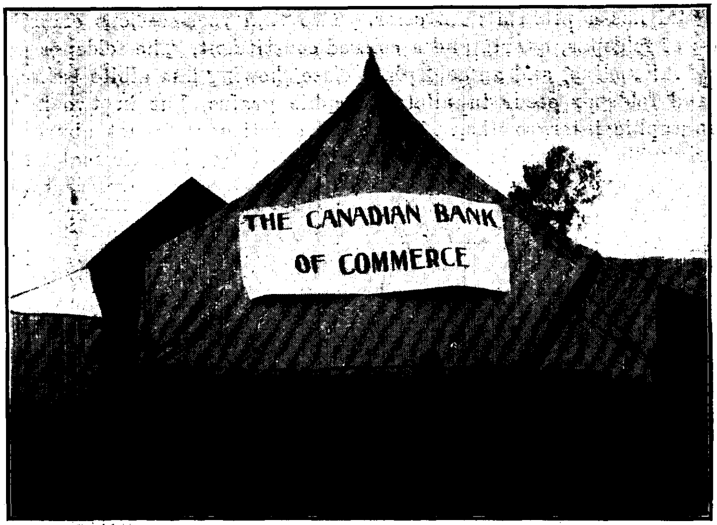
The diabase in which some of the veins of the Cobalt area are found appears to be of about the same age as the eruptives with which nickel-copper ores of Sudbury are associated. The eruptives of Sudbury are, however, coarser in grain and are classed as norites, thus differing materially in character from the Cobalt diabase. Both the Sudbury norite and the Cobalt diabase, however, have one somewhat unique characteristic, for such basic rocks, in common. Free silica or quartz is present as an important constituent in each. It would seem therefore, that these important ore-bearing rocks in the two areas have some genetic relation, the one to the other, and that the region in which Sudbury and Cobalt occur, distant 90 miles from each other, may be looked on as a single "petrographical province." Moreover, at Sudbury, the later basic eruptive is olivine diabase, and the later diabase-basalt of the Cobalt area, described above, is also olivine-bearing. It may also be added that nickel is a characteristic mineral at Cobalt as well as at Sudbury.

OTHER SILVER ORES OF THE REGION SURROUNDING COBALT

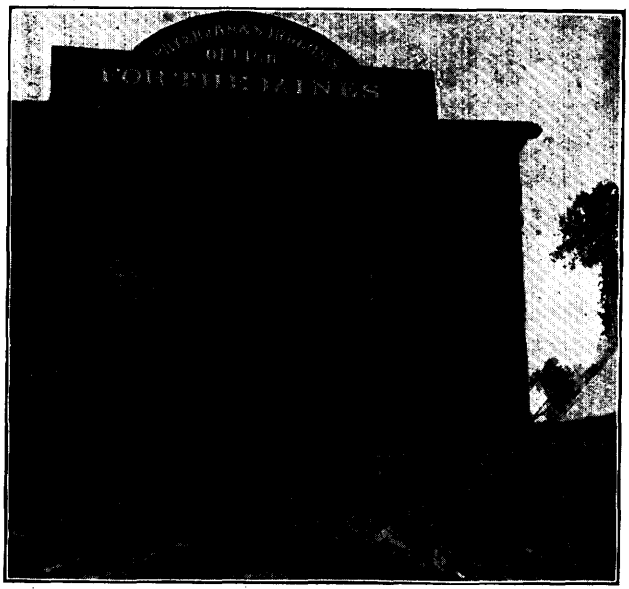
What has been known for years as the Wright silver mine is on the Quebec shore of lake Temiskaming. It is distant about nine miles northeastward of Cobalt station and lies about seven miles northward of the village of Ville Marie. Some of the rock here is conglomerate, associated with which is porphyry. The latter is similar to rock in Minnesota which has been considered to be of doubtful origin. The ore body lies in a zone of fracture which penetrates both of the rocks mentioned. Angular fragments of these rocks, sometimes a foot or more in diameter, are cemented together by calcite and galena. The pure galena has been found to contain from 18 to 24 oz. of silver to the ton of 2,000 lbs. Iron pyrites is found in small quantities associated with the galena, and is thought to be the source of the trace of gold usually present in the ore.

Seven years ago the writer visited this mine when it was in operation. The depth of the workings, which in the lower levels had the form of a circular chamber, was said to be about 200 feet. Work ceased shortly after this and has not been resumed. The equipment consists of a concentrating plant, including jigs, tables and other machinery. There is also a small smelter on the grounds. Considerable capital appears to have been expended in experimenting. Whether the deposit could be worked at a profit under proper management does not seem to have been proved. The concentrates were shipped to Europe.

The ore body is unique. An outcrop near the water's level together with the material on the dump afford an opportunity of learning its character. Two or three rather basic dikes are seen near the workings. These are probably of the same age as the fracture zone now occupied by the ore body. The location of this mineral deposit, one of the oldest known in North America, is shown in Fig. 2, Ance à la Mine.



Canadian Bank of Commerce, Cobalt, July, 1905.



Physician's office, Cobalt, July, 1905.

On Lady Evelyn and Cross Lakes

Silver-bearing galena is found at Cross lake, which lies southeast of lake Temagami, and at Lady Evelyn lake. According to Dr. Barlow there are quartz veins on the Matawapiki, as the last stretch of Lady Evelyn lake, before reaching the Montreal river, is called. These quartz veins are found here on both sides of the lake, and occur at the contact of the intrusive diabase and the banded slate, and in the latter. The minerals are galena, copper pyrites, iron pyrites, and zinc blende

W'th the excursion of the American Institute of Mining Engineers at Cobalt, July 1907.

There is a deposit on an island in Cross lake, which lies immediately east of the south arm of Temagami. The minerals are galena and copper pyrites in calcite. A sample showed the following values per ton; gold $2.00, silver $9.20, copper $4.20, lead $4.00, or a total of $19.40.

Galena and copper pyrites have also attracted attention in the vicinity of the Blanche river, especially along the upper part of the north branch.

Wide Distribution of Cobalt in the District

Prospecting during the last two years has shown the wide distribution of cobalt in the region, *e. g.*, to the north in the township of Casey, where the ore occurs in the Lower Huronian, and in the vicinity of Wendigo lake, 30 miles north of Cobalt, where cobalt bloom is found in numerous stringers in diabase. Much bloom has also been found in the vicinity of Animanipissing lake, southwest of Cobalt. Furthermore, ores similar to those of Cobalt occur in the Montreal river area in the vicinity of Anvil and Elk lakes. The most recent discoveries of cobalt-silver ores have been made in the area immediately south of the township of Lorrain. All of these occurrences are shown on the outline map, Fig. 15, page 37. Cobalt may be said to occur here and there over an area 2,500 to 3,000 square miles in extent, viz.: from Bloom lake on the west to township of Pense on the east, and from Rabbit lake on the south to the township of Pense on the north.

Some of the occurrences referred to are described on following pages.

CHAPTER II

THE WORKING MINES AT COBALT

By E. T. CORKILL

During the year 1907 the tonnage of ore shipped from the Cobalt camp was 50 per cent. more than that of 1906, while the amount of underground work done in 1907, in drifting, cross cutting, sinking and raising far exceeded that of the previous year.

In this report only the shipping mines and the prospects on which the most work has been done are mentioned. In addition to those properties described there are a great number of claims throughout the camp on which considerable work has been done both in trenching and sinking test pits. All the important shippers have installed compressor plants and erected substantial mine and camp buildings.

The number of accidents occurring in the camp in 1907 is to be regretted, and was unlooked for, considering the very few accidents that had occurred since the camp was discovered. The number of fatalities in the camp in 1907 was 14. Of this number 9 were killed either drilling into missed holes, picking into missed holes, or picking into the explosive in the muck; or in other words, 65 per cent. of the fatalities in the Cobalt camp in 1907 resulted from accidents due to explosives. The other fatalities were as follows:—Three men killed by falling out of bucket while riding to the surface. One man was killed by falling down shaft and one man killed by a falling rock. This large number of fatal accidents from explosives, following as it did a period of very few accidents, is due to a certain extent to the increased number of workmen employed, there being about 2,000 men employed at the shipping mines at Cobalt, in December, 1907. Also the accidents resulting from falling from buckets go to show the great danger of this practice of riding in buckets, and the necessity for strict rules by the management, that riding in the bucket is strictly prohibited and punishable by fine or dismissal. This practice is forbidden by the Mines Act, Part IX, section 164, 23, 1908.

The following is a description of the principal mines of cobalt-nickel-arsenic-silver ore of the Cobalt camp taken up alphabetically. The location of each mine can be seen by referring to the map of the Cobalt area, which accompanies this Report.

The amount of ore shipped from, and the dividends paid by, various mines is given on preceding pages.

Buffalo Mine

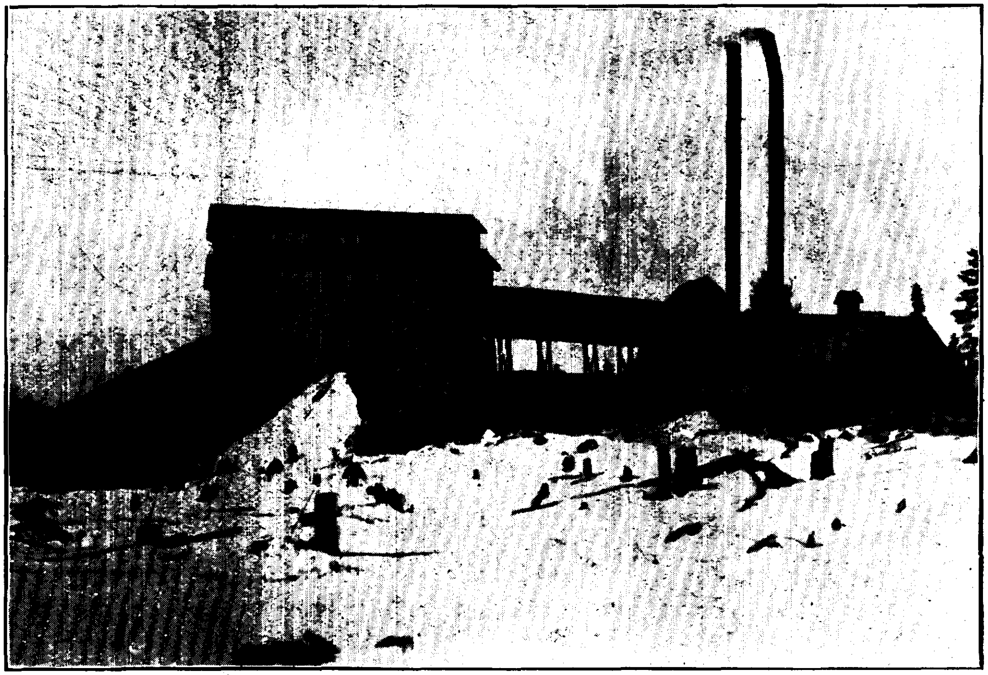
Mining work was first begun on this property in the spring of 1905. Since that time work has been carried on very extensively. The owners of the mine are The Buffalo Mines, Limited, with Chas. R. Denison, president and general manager, and Tom R. Jones, general superintendent. About 120 men are employed on the property.

Since the erection of the concentrator it has been the object of the management to connect all underground workings with No. 6 shaft, and make it a central working shaft, hoisting all the ore through this shaft to the mill.

From the first level of No. 6 shaft, drifts have been driven northwest 105 feet, east 120 feet and from this point a drift has been driven southeast 300 feet to connect with No. 5 shaft on the first level. Timbers have been put in for most of the distance along the drift in preparation for stoping. On the second level of No. 6 shaft, which is at a depth of 140 feet, a drift has been driven southeast 75 feet and some crosscutting done.

Buffalo mine.

From the first level of No. 5 shaft a drift has been driven northeast along the vein 120 feet. At this point the vein split, one branch going northeast and the other southeast. Drifts have been driven along each of these veins for 60 feet. Another vein has been followed from the shaft southeast for a distance of 130 feet. A drift has also been run southwest from No. 5 shaft a distance of 210 feet. On the second level of No. 5 shaft drifts have been run east 120 feet, west 65 feet and northwest 200 feet. The drift northwest on the second level of No. 5 is being continued to connect with No. 6 shaft. From 15 feet east of No. 6 shaft a crosscut has been driven south 425 feet to connect with veins No. 4 and No. 3. From No. 4 shaft first level, drifts have been driven northeast along the vein 100 feet and connect with crosscut to No. 6 shaft, also southwest 175 feet and connect with No. 3 vein. From this point drifts are run along the vein west 135 feet where a raise has ben put through to the surface, and east 45 feet to a point where the vein splits and runs parallel about 10 feet apart for a distance of 125 feet. At this point one of the veins turns northeast and a drift has been run 40 feet where a vein running east was encountered. A drift has been driven along this about 100 feet.



Buffalo mine concentrator.

No. 12 shaft, on the southeast corner of the property has been sunk 100 feet. A station has been cut on the 75-foot level, but no drifting done at present.

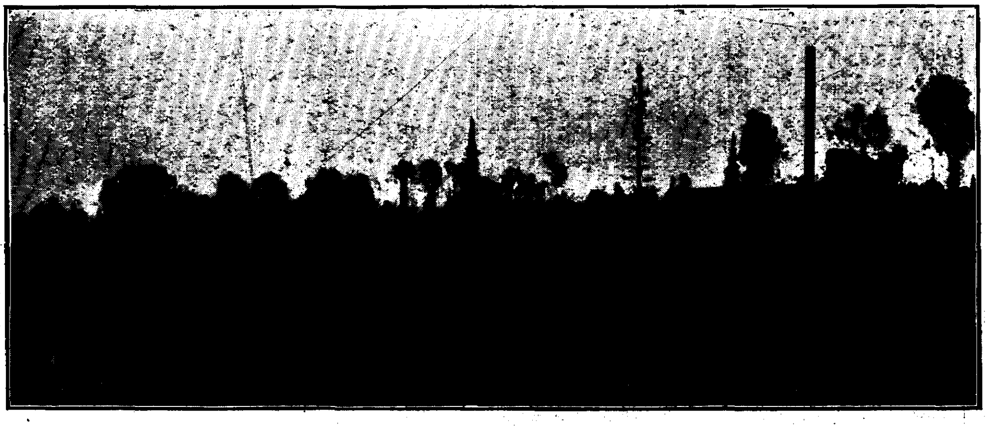
The concentrating plant is situated about 1,000 feet west of No. 6 shaft. The method of concentration is as follows:—The mill rock first passes over a picking table on to a coarse grizzly, the fines from the grizzly passing to the No. 1 rolls and the coarse material going to the jaw crusher. The product from the crusher is taken by elevator to an ore storage bin, from which it is fed to the No. 1 rolls. The recrushed product is elevated to a $\frac{1}{2}$-inch trommel. The oversize from this trommel passes to a $\frac{3}{4}$-inch trommel, and the undersize to a $\frac{1}{4}$-inch trommel. The oversize from the $\frac{3}{4}$-inch trommel passes back to the No. 1 roll, and the $\frac{3}{4}$-inch product to a $\frac{3}{4}$-inch jig. The tailings from the $\frac{3}{4}$-inch jig are taken to the No. 2 roll and then by elevator to the trommels. The oversize from the ¼-inch trommel passes to the ¼-inch jig, the undersize to a 20-inch impact screen, the undersize going to the Wilfley table and the oversize to the ½-inch jig. The tailings from the ½-inch jigs pass to a Chilian mill to be recrushed. The product from the Chilian mill passes over an 80-mesh impact screen, the oversize passing to four No. 3 Deister tables. The undersize from the 80-mesh screen passes to a Callow settler. The sands from the No. 1 Wilfley pass to the No. 3 Deisters, and the slimes from the Wilfley and the Callow settler to two No. 3 Deister slimers. All the tailings are caught in the storage sump and are from here fed to the cyanide tanks.

A 125-h.p. Corliss engine supplies the motive power for the mill. The power plant consists of two 100-h.p, boilers, a 12-drill air compressor, compound air and steam cylinder, and an electric light plant. Hoists are situated at each of the shafts, power being supplied to those at No. 5 and No. 4, by 15-h.p. upright boilers.

Beaver Consolidated

Discovery was made on this location, which is the north half of the northwest quarter of the north half of lot 1 in the third concession of Coleman, during the summer of 1906. Since that time work has been carried on steadily at the No. 1 shaft on the south part of the property, which has been sunk to a depth of 85 feet, and No. 2 shaft, some 150 feet east of No. 1, is 100 feet in depth. The first level, at a depth of 57 feet, has 35 feet of drifting. At the 100-foot level, 120 feet of crosscutting and drifting has been done.

An 80-h.p. boiler has been installed, also a 5-drill compressor and two small hoists. About 25 men are employed.



Beaver mine.

Bailey Mine

This property, situated on the southwest quarter of the north half of lot 4 in the fourth concession of Coleman, was not in operation at the time of my last inspection, but in a former inspection I found that an adit had been driven in on the vein 60 feet, and vein stoped out to the surface. A shaft has also been sunk to a depth of 60 feet, with a 20-foot crosscut to the east, and a drift driven 40 feet north on the vein.

Badger Mine

The Badger mine consists of the south half of the south half of lot 2 in the fourth concession of the township of Coleman. On these two lots considerable trenching has been done.

Shaft No. 1 has been sunk to a depth of 60 feet. At this level drifts have been driven north 30 feet, west 40 feet and southwest 54 feet. No. 4 shaft has been sunk to a depth of 70 feet at an angle of 79 degrees to the horizontal. No drifting has as yet been done. Shaft No. 5 has been sunk to a depth of 146 feet, with levels at 75 feet and 140 feet. At the 75-foot level a drift 33 feet in length has been run. On the 140 foot level drifts have been run north and south. Shaft No. 6 has been sunk to a depth of 103 feet, at an angle of 75 degrees to the horizontal. No drifting or cross-cutting has been done on this shaft.

Mr. A. A. Smith is manager of the Company, employing a force of 25 men.

Power for the drills is obtained from the Rochester Cobalt power plant.

Casey Cobalt Silver Mine

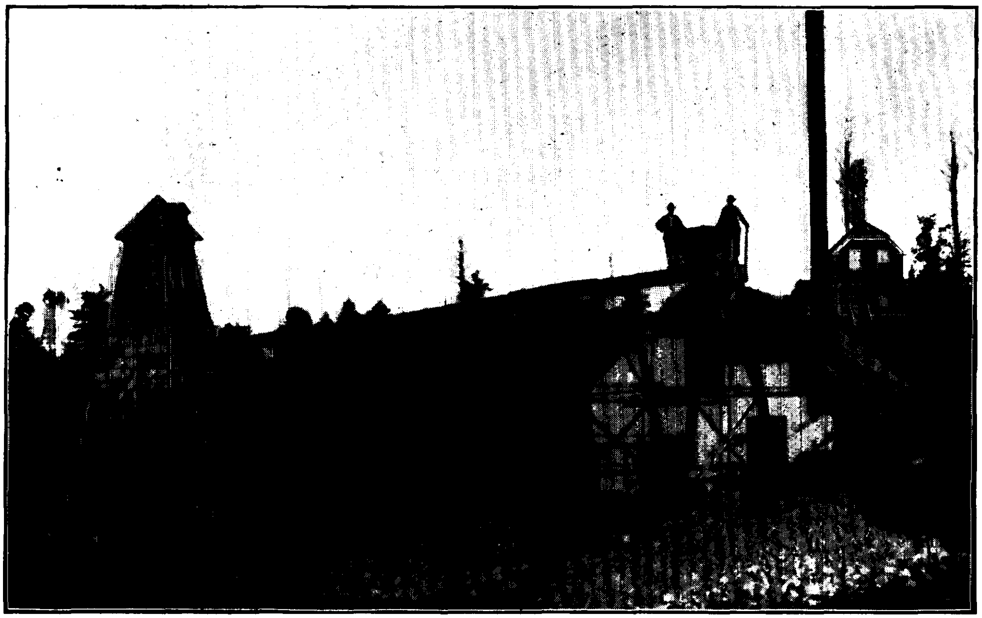
This property is situated on the southeast quarter of the south half of lot 5 in the first concession of the township of Casey, and was originally staked by David Bucknell, and since then transferred to the Casey Cobalt Silver Mining Company.

The shaft has been sunk on the incline of the vein to a depth of 125 feet, with levels at 33 feet and 100 feet. At the 33-foot level a drift has been driven southwest 110 feet. On the 100-foot level drifts have been driven northeast 85 feet and southwest 90 feet.

Mr. James Rennie is manager of the company.

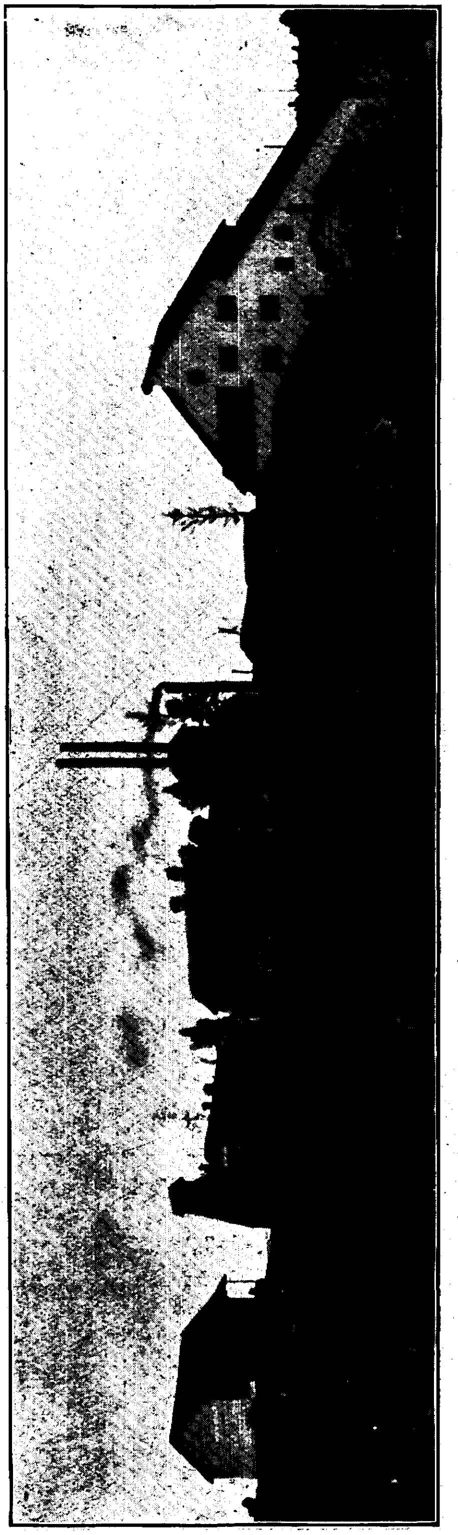
City of Cobalt Mine

This property is owned by the City of Cobalt Mining Company, and consists of that part of the town site of Cobalt lying east of the Buffalo and Nancy Helen mines and south of the Coniagas. At present work is confined to one vein near the southwest part of the location. A shaft has been sunk on the vein to a depth of 150 feet. The

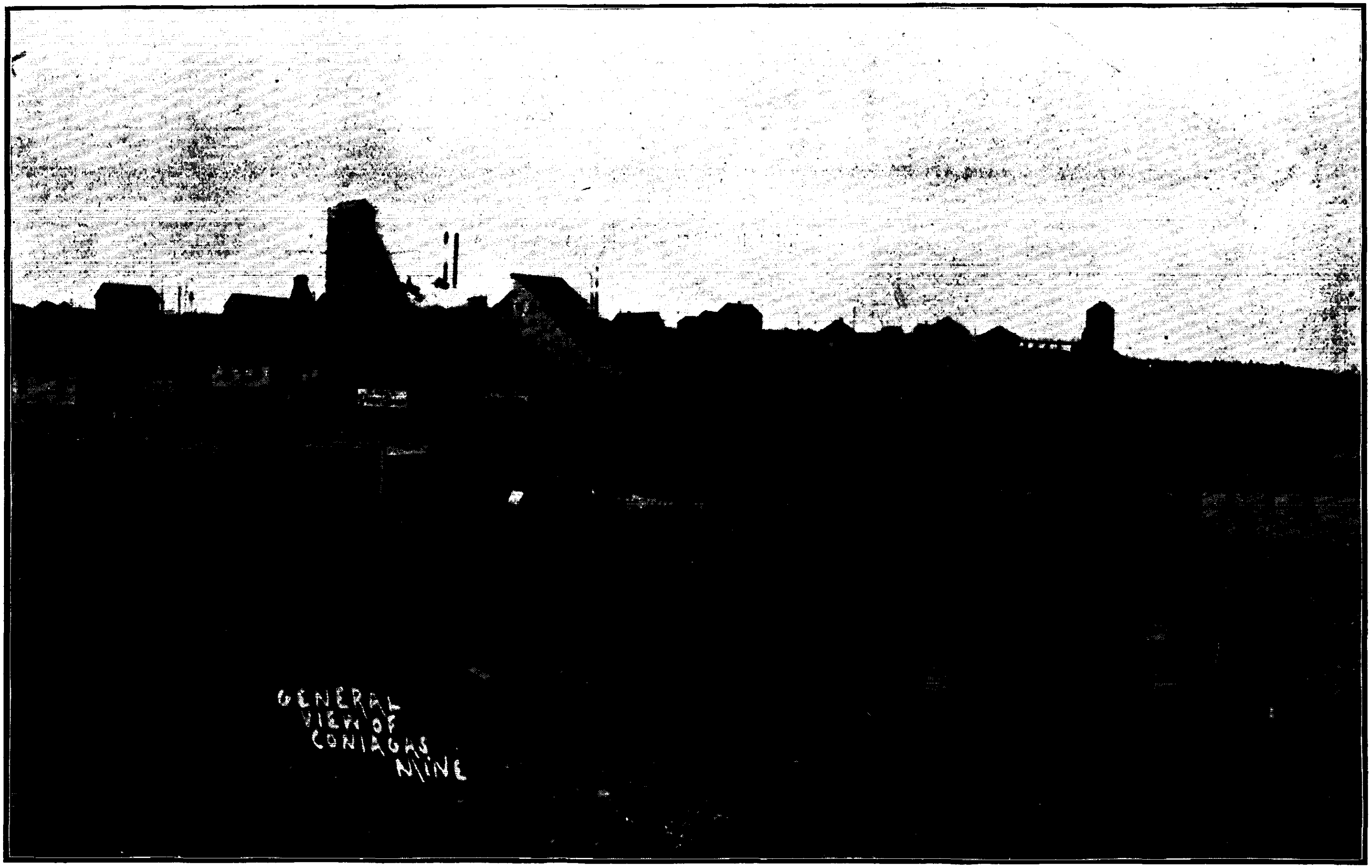


City of Cobalt mine.

first level, at a depth of 65 feet, has had drifts driven east and west on the vein for distances of 100 feet. A crosscut has also been driven north 100 feet. Some stoping has been done on the vein east and west of the shaft. A station has been cut at 140 feet and drifts started east and west on the vein. The shaft is timbered throughout with square sets.



Coniagas mine and mill.



General view of Coniagas, the high building being the new shaft house.

The machinery installed consists of a 60-h.p. return tubular boiler, a 3-drill straight line compressor and small hoist. The ore house has been built about 75 feet east of the shaft house.

Mr. H. H. Lang is managing director of the company, and Mr. J. Donaldson superintendent, employing a force of 25 men.

Coniagas Mine

The Coniagas mine, owned by the Coniagas Mines, Limited, is situated on the town site of Cobalt.

The president and general manager of the company is Mr. R. W. Leonard, with Mr. J. Reddington, superintendent.

The power plant consists of two 100-h.p. return tubular boilers, one 12-drill compressor, compound air and steam, one Fairbanks hoist and an electric light plant. The ore house, erected before the concentrating mill, has an engine, crusher and sorting table. The concentrating mill has a capacity of 50 tons per day. Water for concentration purposes at the mill is obtained from Sasaginaga lake, where an electric pump has been installed. A fully equipped blacksmith shop and machine shop have been built adjoining the shaft house.

Sleeping and dining camps for taking care of 120 men have been built.

The main working shaft of the mine has been, up to the time of my inspection, on the No. 2 vein. The shaft here has been sunk to a depth of 90 feet with the level at 75 feet. From this shaft drifts have been run east on the vein 35 feet and west 65 feet. Crosscuts have been driven north to No. 1 vein 50 feet and south to No. 3 vein 165 feet. A shaft was first sunk on No. 1 vein just north of the shaft on No. 2 vein. From the crosscut a drift has been driven west 115 feet and east 240 feet. At 175 feet east from the crosscut a vein was cut. On this vein drifts have been driven northwest 50 feet from No. 1 vein and southeast 240 feet. On No. 3 vein drifts have been driven west 110 feet and east 290 feet. At a point on this vein 250 feet from the crosscut some ore has been taken out by open cut works, and the new central working shaft is to be located at this point. The shaft has been sunk at this point to a depth of 150 feet, and the station cut at this level. From the shaft a drift has been driven southeast 180 feet. At a point 120 feet east of the crosscut from the old shaft the crosscut has been continued south a distance of 335 feet from the No. 3 vein. At 130 feet from the No. 3 vein, No. 4 vein was encountered, and a drift driven east on it 283 feet. Some stoping has been done on No. 1 vein and "A" vein. The new shaft house on No. 3 vein is 85 feet in height, and hoisting is done with skip, the skip dumping automatically into a shoot, which carries the ore to the storage bin at the mill.

Coniagas Concentrator

The ore from the mine is dumped direct from the car into a storage bin at the mill, from which it is fed into a 10×16-inch jaw crusher crushing to 2-inch. It is then elevated and passes over an inch grizzly, the undersize passing to a storage bin and the oversize to a 7 × 13-inch jaw crusher crushing to inch and a quarter. The product passes to a storage bin from which it is fed to No. 1 roll 10 × 30-inch, crushing to $\frac{3}{4}$-inch. The product is elevated to the No. 1 trommel, the $\frac{3}{4}$-inch product passing direct to three sets of jigs. The tailings from these jigs are recrushed by the No. 2 roll 10 × 30-inch, crushing to $\frac{3}{8}$-inch. The oversize from the No. 1 trommel passes back to the No. 1 rolls for recrushing, while the $^{5}/_{16}$-inch product from this trommel passes to the No. 3 trommel, is elevated to the No. 2 trommel, the oversize going back to the No. 2 rolls and the $\frac{1}{4}$-inch product from this trommel passing to the No. 3 trommel. The $\frac{1}{2}$-inch product from the No. 2 trommel passes direct to the ball mill, where it is crushed to 20-mesh or finer. The product from the No. 3 trommel over 3 m.m. in diameter passes to the fine jigs. The tailings from these jigs pass direct to the Huntingdon mill. The 3 m.m. product or finer from the No. 3 trommel passes to the classifier,

Coniagas concentrator.

The slimes from the classifier pass to the Frue vanner. The tails from the vanner are retreated. The sands from the classifier pass to a No. 1 Wilfley table. The tailings from the Wilfley pass direct to the Huntingdon mill, where it is crushed to 20-mesh or finer. The product from both the Huntingdon mill and the ball mill pass to a classifier. The overflow from the classifier is led to a Callow settler, and the overflow from this settler is lead to a settling tank. The sands from the Callow settler are treated on a Frue vanner, and the tails run to waste. The sands from the classifier are treated on four No. 2 Deister tables, the tailings from the Deisters going to waste, and the middlings retreated on the Wilfley table, the tailings from the Wilfley going to waste. The product from the settling tank from the overflow of the Callow settler are treated on a slimer, the tailings going to waste.

Crown Reserve Mining Company

The rights to the bottom of Kerr lake were acquired from the Ontario Government by the above company in December, 1906. This sale included all the lake, with the exception of the mining claims J B 9, J B 10 and J B 11, which had previously been granted to the Drummond and Kerr Lake mines.

The first work done was lowering the water of the lake about eight to nine feet, by putting a cut through the Silver Leaf property for a distance of some 500 feet. This lowering of the lake exposed three or four acres of land at the west end of the lake adjoining the Silver Leaf property. On this area so exposed, a good vein was discovered in the fall of 1907. An open cut was made along the vein for about 35 feet by 30 feet in depth, and several tons of high grade silver ore taken out.

It is the intention of the management to sink a shaft some little distance from the vein on higher ground and tap the vein from underground.

Mr. S. Cohen is consulting engineer, employing about 25 men.

Cobalt Central Mines

The company operating the Cobalt Central Mines Company's mines is known as The Standard Cobalt Mines, Limited.

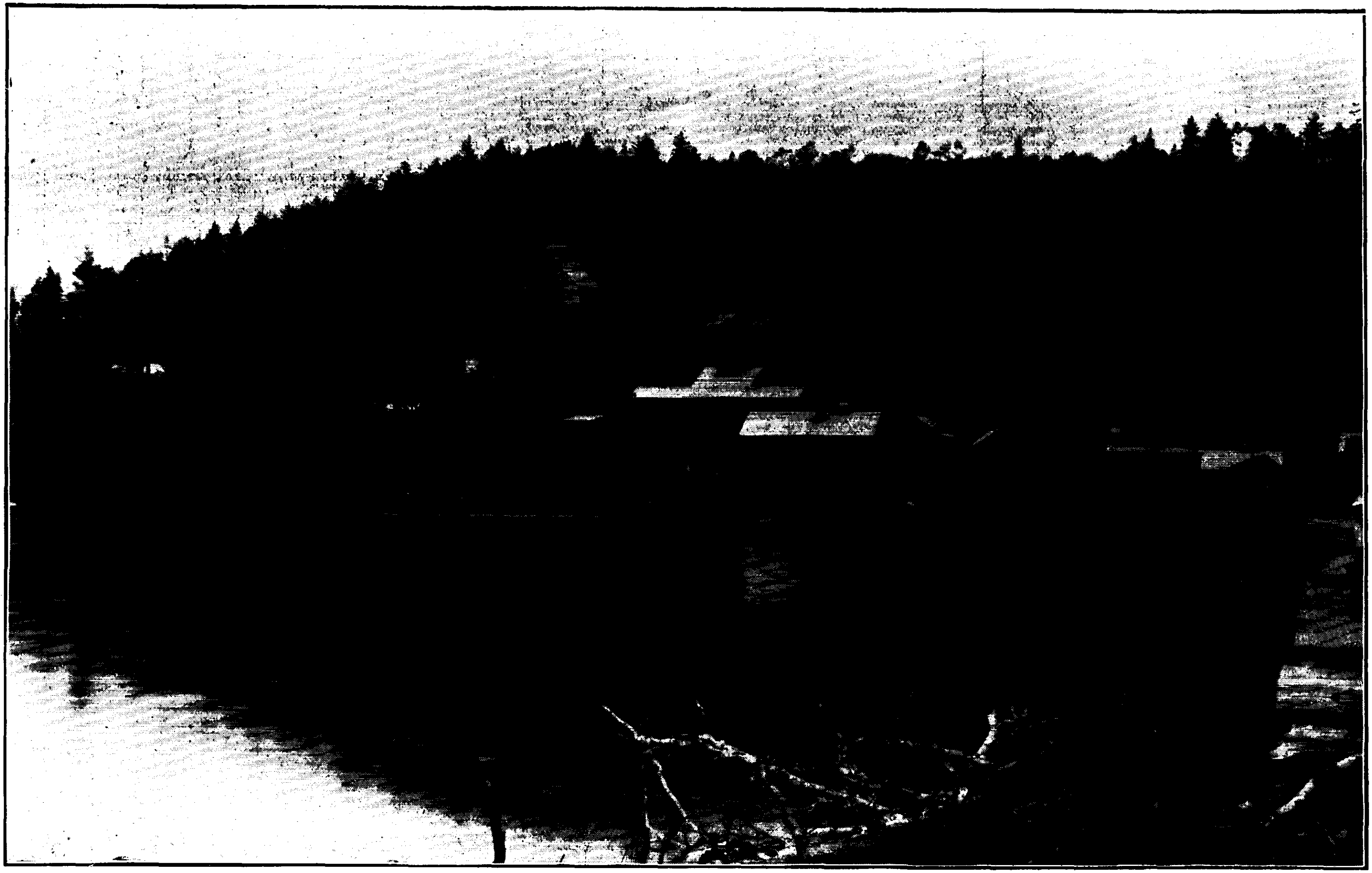
The company own a large acreage throughout the camp, but active developments at present are only being carried on at the Big Pete property, which is the northwest quarter of the north half of lot 4, in the fourth concession of Coleman.

Mr. Jacob M. Young is superintendent, employing a force of about 100 men.

The main shaft on the property has been sunk to a total depth of 150 feet, the first level being at 65 feet and the second level at 110 feet. On the first level drifts have been driven along the vein, which has a northwest direction, a distance of 308 feet. At this point a crosscut has been driven west 93 feet to connect with the Powell shaft on the adjoining lot. This shaft is 65 feet deep. At a distance of 167 feet from the shaft a cross vein was encountered, and a drift has been driven along it southwest 25 feet. On the second level the main drift along the vein is 170 feet in length, when the cross vein was again encountered. On this vein drifts have been driven northeast and southwest, 36 feet and 81 feet respectively. On the first level a raise has been started 80 feet from the shaft and timber and chutes put in along the vein for a distance of 100 feet, and stoping commenced. The ore is trammed from the shaft to ore bins which have a capacity of 1,000 tons. From the bins it is trammed by cars to the mill some 150 feet distant.

The power plant consists of one 125-h.p. water tube boiler, one 60-h.p. locomotive firing boiler, one 17-drill air compressor, duplex air and compound steam, and a small electric light plant. The power house is situated on the shore of Glen lake about 300 feet east of the mill.

The following is a short description of the Cobalt Central concentrator, the details of which have been kindly furnished by Mr. Young:



Cobalt Central, Big Pete mine.

The ore treated at the Cobalt Central mill consists principally of diabase, containing leaf silver and streaks of silver-bearing smaltite which are too small to be sorted and sacked in the mine, as is done with the larger veins. There is also a small amount of smaltite lost in sacking the high grade ore, which ultimately goes to the mill.

The concentrator was built by the Traylor Engineering Company of New York. This Company also manufactured the machinery installed, with the exception of the James tables and the Callow settlers. The process is entirely a wet one, and no attempt is made to carry it farther than concentration to a shipping product.

The machinery consists of a Blake crusher, three sets of rolls, three centripact screens, two hydraulic classifiers, four Callow settlers, eight James tables, two bucket elevators and two two-compartment jigs. All the machinery is driven by a 125-h.p. Corliss engine, supplied with steam from the boilers of the central power plant, some 300 feet distant.

A detailed flow sheet of the mill is as follows: The ore taken from the storage bins at the mine is trammed to a 10 × 20 Blake crusher, which reduces it to a size not exceeding 1½ inches in diameter. From the bin underneath the crusher it is drawn to a set of 14 × 42-inch heavy rolls the product of which is raised with a 7 × 12-inch elevator to the upper part of the mill. Here it passes over a two-mesh trommel screen, the undersize going to an eight-mesh centripact screen; the oversize by a belt conveyor to the storage bin for recrushing. From the eight-mesh centripact screen the oversize is sent directly to a pair of two-compartment jigs. The undersize product is sent to a fourteen-mesh centripact screen. The undersize of this centripact is sent to the hydraulic clasifier, while the oversize goes to a pair of 10 × 32-inch finishing rolls. The product of these rolls is again raised to an eight-mesh centripact screen to go through the process already described.

The oversize this time goes to a pair of 14 × 30-inch intermediate rolls, which also handle the tails from both two-compartment jigs. All undersize from the fourteen-mesh centripact screen ultimately finds its way to a pair of 20-inch hydraulic classifiers, each classifier having a pair of Callow settling tanks. The sands from the classifier and the thickened pulp from the settlers are treated on James tables. The overflow of the settlers goes to waste with the tailings of the tables.

The middlings resulting from the first table treatment are re-concentrated on another pair of James tables located on the lowest floor of the mill. The concentrates from all tables are dried by exhaust steam before sacking.

The entire mill is heated by exhaust steam, and no difficulty has been experienced from the freezing of water or from uncomfortably low temperatures inside the mill even in fifty degrees below zero weather.

A good deal of leaf silver is picked out from the feed trough of the rolls and melted directly into bullion on the property. This silver leaf seems to be quite pure, averaging 92 per cent. silver

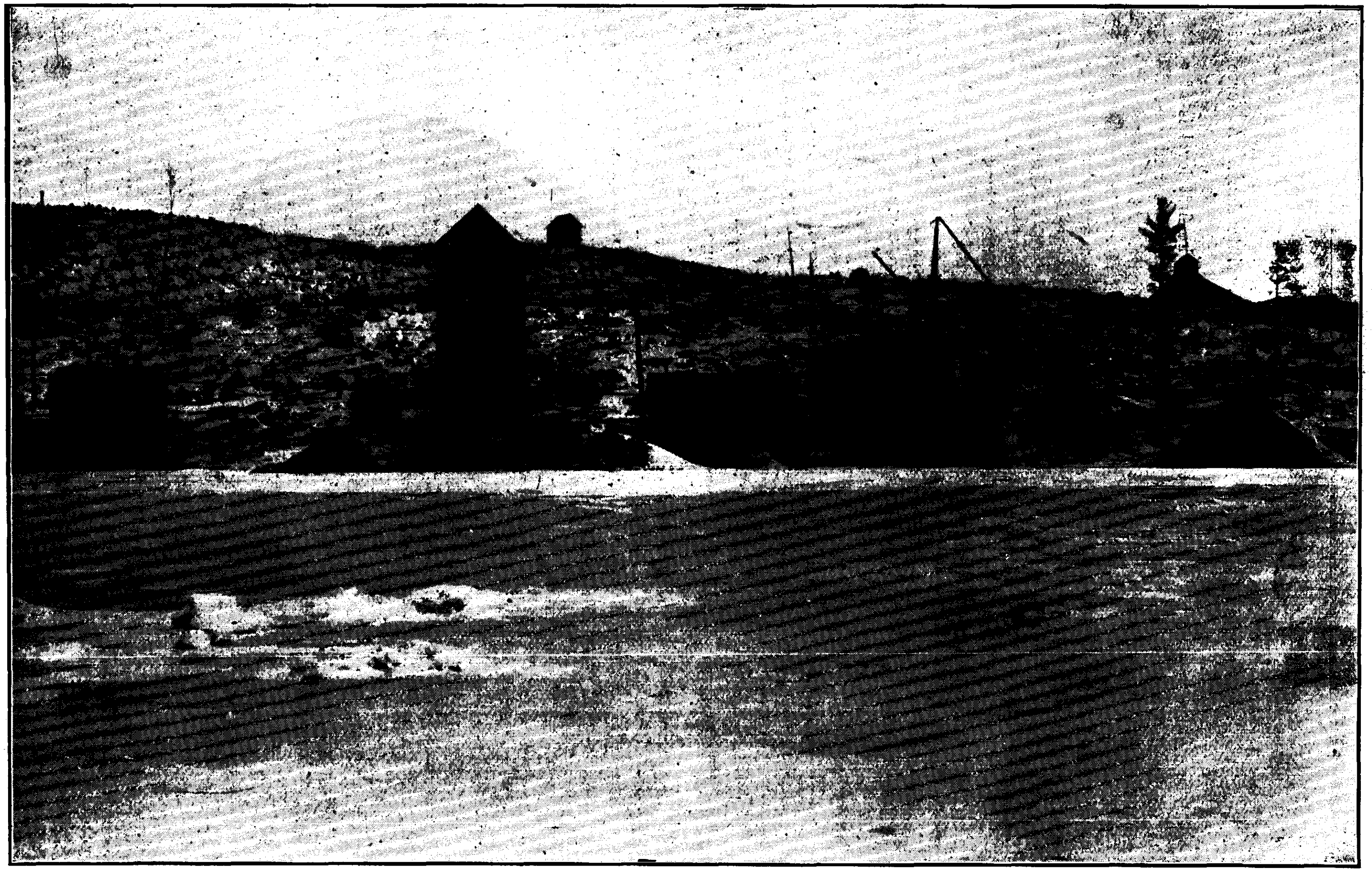
Columbus Mine

This mine is situated on the northwest quarter of the south half of lot 2 in the third concession of Coleman, and is owned and operated by the Columbus Cobalt Silver Company, Limited. Thos. Shovels is superintendent, employing a force of about 20 men.

A shaft has been sunk to the depth of 160 feet. On the first level at 64 feet there has been about 200 feet of drifting done along the vein. On the second level a crosscut has been driven 150 feet.

A small plant has been installed, consisting of a three-drill straight line air compressor and a 50-h.p. boiler.

Silver Queen mine.



Cobalt Lake mine, showing shaft house on No. 4 vein.

Cobalt Silver Queen Mine

This property is owned and operated by the Cobalt Silver Queen Mining Company, with F. Culver managing director and R. Bryce, superintendent. A force of 35 men are employed.

The main shaft has been sunk to a depth of 140 feet . The first level is at a depth of 65 feet. On this level drifts have been driven west 340 feet and east 250 feet. About 40 feet of crosscutting has been done off the west drift. At 150 feet east of the shaft a crosscut has been driven north 165 feet where a new vein was located. This vein is parallel to the main vein, and drifts have been driven east along it 60 feet and west 100 feet. On the second level drifts have been driven west 40 feet and east 200 feet. A winze has been sunk from the first to the second level and some stoping done between the levels. Some stoping has also been done on the first level.

A diamond drill has been at work on the property for some time.

The power plant consists of two 80-horse power return tubular boilers and a 5-drill straight line air compressor and an 8-inch × 12-inch Lidgerwood hoist.

An assay office has recently been built and a small furnace for melting down the rich silver ore.

Cobalt Contact Mine

This property is owned by the Cobalt Contact Mining Company, Limited, and is situated on the southeast quarter of the north half of lot 14 in the first concession of the Township of Bucke.

At the present time no work is being done on the property. During the last two years, however, considerable development work has been done. No. 1 shaft has been sunk to a depth of 120 feet with levels at 55 feet and 100 feet. On the first level drifts have been driven north and south on the vein, and also some crosscutting. About 150 feet of drifting and crosscutting has been done on this level. On the second level about 25 feet of drifting has been done. No. 2 shaft has been sunk to a depth of 65 feet, No. 3 shaft 40 feet and No. 4 shaft about 60 feet.

Cobalt Lake Mine

The bed of Cobalt lake and 33 feet of the road allowance on the east shore of the lake was purchased from the Ontario Government in December, 1906, and the Cobalt Lake Mining Company, Limited, was incorporated to operate the property. Mr. D. B. Rochester was appointed managing director, and Mr. E. L. Fraleck superintendent. An average of 75 men are employed on the property.

No. I shaft near the north end of the lake has been sunk to a depth of 75 feet, and a station cut at the 60-foot level. The shaft has been timbered to this level. Sinking will be continued to a depth of 120 feet, when it is intended to drift under the north end of the lake.

No. 4 shaft has been sunk to a depth of 160 feet with levels at 86 feet and 154 feet. On the 86-foot level a drift has been driven southwest on the vein 60 feet, and a crosscut driven north 96 feet to No. 3 vein. Along No. 3 vein 86 feet of drifting has been done and a raise started. The crosscut from No. 4 vein to No. 3 vein has been continued north a distance of 100 feet. On the 154 foot level a drift has been driven southwest for 50 feet, and a crosscut started north to cut No. 3 vein on this level. A shaft house has been erected here 52 feet in height.

No. 5 shaft is 100 feet in depth, with a station at the 93-foot level, and 42 feet of drifting has been done on the vein. A crosscut has been driven north 190 feet, connecting with No. 4 workings, thus making No. 4 a central working shaft. The crosscut to the south from No. 5 vein has been driven 120 feet.

No. 6 shaft at the south end of the lake adjoining the McKinley-Darragh mine has been sunk 110 feet and station cut at the 70-foot level, with a drift to the east on the vein 23 feet.

Cobalt Lake mine, showing camp buildings and power house.

A power plant has been installed consisting of two 100-horse power boilers, a 13-drill cross compound air compressor with jet condenser, electric light plant and a 4-inch pipe line extending from the power plant to all the workings. At all the shafts, hoists have been installed.

Boarding and sleeping camps for the accommodation of 75 men have been erected.

Cobalt Townsite Mine

The Cobalt Townsite Mining Company secured the mining right to the south part of the town site of Cobalt from the Temiskaming & Northern Ontario Railway Commission in 1905, and have since that time been actively engaged in mining operations.

Mr. B. W. Leyson is superintendent, employing a force of 25 men.

No. 1 shaft has been sunk to a depth of 140 feet, with the first level at 65 feet. The main drift west on the vein has been driven 340 feet, and a raise has been started here to connect with the surface. Some stoping has been done along the vein. At a point 140 feet west of the shaft on the main drift a crosscut has been driven north 90 feet. From the shaft a crosscut has been driven north 100 feet, and considerable drifting and crosscutting done on small veins encountered. A shaft has also been started on the north side of the property adjoining the Buffalo mine, and a depth of 40 feet has been reached.

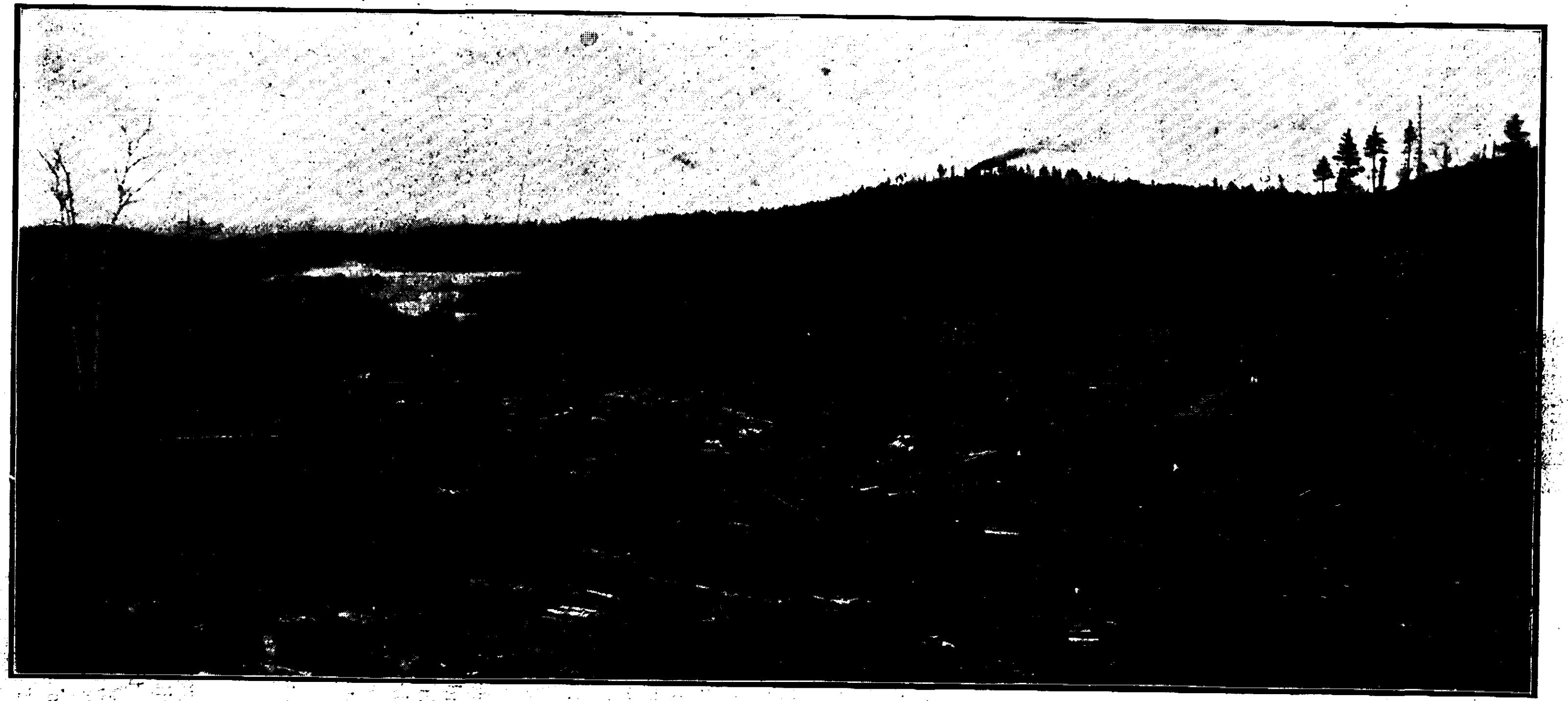
Cobalt Townsite mine.

The power plant consists of an 80-horse power return tubular boiler, a 5-drill straight line compressor and small hoist.

Boarding camps for the accommodation of the men have been built.

Colonial Mine

This property was not in operation at the time of my inspection, but during the last year considerable development has been carried on. The property, described in a former report of the Bureau of Mines as the Hanson mine, was purchased by the Colonial Mining Company in 1906.



Colonial mine, showing camp buildings and power house.

A power plant consisting of three 100-h.p. return tubular boilers, and a 12-drill air compressor was installed, and camp buildings for accommodating 100 men were erected.

The work done on the Colonial has been chiefly exploratory work, testing the veins which have outcropped on the surface by driving on them at lower levels. At No. 2 vein on the north side of the property a shaft has been sunk to a depth of 75 feet, and drifts driven east 90 feet and west 60 feet. A crosscut has been driven south from the shaft 30 feet. Near the northeast corner of the lot an adit has been driven south into the hill a distance of 165 feet, and from this point west 150 feet and southeast 220 feet. In the west adit a raise has been made to No. 1 vein. Some open cut work has been done on the vein near the north adit, but nearer the top of the hill, and an adit 80 feet in length driven. East of No. 1 shaft an adit has been driven southeast into the hill a distance of 225 feet. On the southern part of the lot an adit has been driven east into the hill, a distance of 170 feet. At 180 feet from the mouth of the adit a branch adit has been driven south 135 feet, and a cross adit from this driven 75 feet. A considerable amount of trenching and open cut work has been done on the property.

Drummond Mine

This mine is owned and operated by the Drummond Mines, Limited. Mr. R. W. Brigstocke is manager, employing a force of about 30 men.

The main shaft has been sunk to a depth of 135 feet with levels at 50 feet and 100 feet. On the first level drifts have been run north and south on the vein for a total distance of 400 feet. On the 100-foot level drifts have also been run north and south on the vein for a total distance of 525 feet. East and west from this vein 180 feet of crosscutting has been done.

The Wright shaft, to the east of the main shaft, has been sunk to a depth of 110 feet, with levels at 50 and 100 feet. On the first level 200 feet of drifting has been done north and south from the shaft on the vein. On the 100-foot level 70 feet of drifting has been done on the vein, and 30 feet of crosscutting. Three other shafts have been sunk to depths of 50 feet, 65 feet and 25 feet respectively.

The power plant consists of two 60-h.p. boilers and a 5-drill straight line compressor. Shaft houses have been erected at the main shaft, the Wright shaft and No. 3 shaft.

Erie Cobalt Mine

This property is situated on lot 1 in the tenth concession of the township of Lorrain, and is owned by the Erie Cobalt Silver Mining Company, of which Mr. N. McDonald is manager.

A number of test pits have been sunk at different places on the claim. No. 1 shaft has been sunk to a depth of 100 feet, with levels at 50 feet and 100 feet. At the 50-foot level about 35 feet of drifting has been done, and at the 100-foot level about 125 feet.

A 25-h.p. upright boiler has been installed, and a small hoist.

Foster Mine

This property is owned and operated by the Foster Cobalt Mining Company, Limited, with Mr. J. McDonald, superintendent, employing a force of 50 men.

At the time of my inspection the work on the property was largely confined to No. 5 shaft, which is a central working shaft for the property and is connected with No. 6 shaft underground.

No. 1 shaft is near the shore of Glen lake, and is where the original discovery on the property took place. The shaft has been sunk to a depth of 45 feet and the vein open

Drummond mine.

Foster mine.

cut for a length of 100 feet. No. 2 shaft, to the east of the boiler house, has been sunk to a depth of 80 feet. Drifts have been driven east from this shaft 50 feet and west 110 feet to an air shaft. The ore between No. 2 shaft and the air shaft has been mostly stoped out.

No. 5 shaft is the central working shaft about 100 feet due south of the power house. It is 165 feet deep with levels at 75 feet and 150 feet. On the first level a drift has been driven west by a few degrees north, a distance of 110 feet. East of the shaft a drift has been driven east a distance of 400 feet to connect with No. 6 shaft, which is near the southeast corner of the claim. In addition to this main drift a number of drifts have been driven on the veins encountered on the level. On the second level a station has been cut, and a drift driven east a distance of 50 feet. A shaft house has been erected and safety cage installed.

No. 6 shaft is 75 feet in depth. On the first level a drift has been driven east 85 feet. The west drift on this level forms part of the drift connecting No. 5 with No. 6 shaft.

A power plant has been installed, consisting of two 60-h.p. return tubular boilers, a straight line compressor capable of developing 807 cubic feet of free air per minute, a hoist and an electric light plant.

New office and camp buildings have been erected.

Green-Meehan Mine

The Green-Meehan Mining Company own the southwest quarter of the south half of lot 14 in the first concession of Bucke. At the time of my inspection there was no work being done on the property. Mr. Chas. O'Connell is manager.

The work on the property to date consists of sinking two shafts 110 feet and 85 feet deep respectively. The No. 1 shaft has been sunk on the main vein near the north end of the open cut. This open cut is about 250 feet in length, with an average depth of 25 feet. On the 100-foot level on the No. 1 shaft drifts have been driven north and south on the vein for total distances of 225 feet. Considerable surface prospecting has been done on the property.

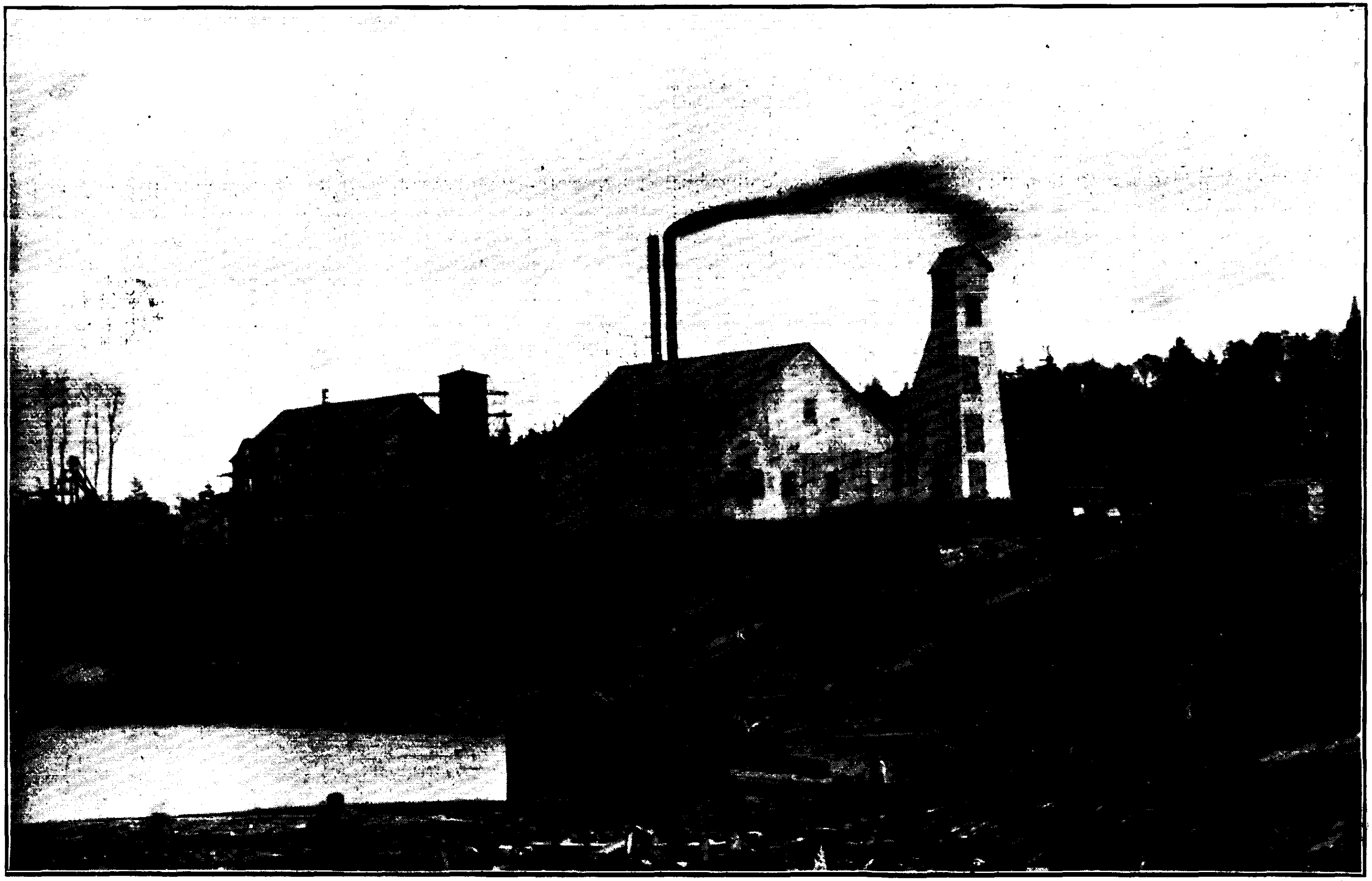
The power plant consists of two 100-h.p. boilers, a straight line compressor developing 410 cubic feet of air per minute, and a hoist. Camp buildings and office have been erected.

Kerr Lake Mine

This mine was described in the fifteenth Report of the Bureau of Mines as the Jacobs mine. It is operated by the Kerr Lake Mining Company, Limited, with Mr. S. R. Heakes, manager. A force of 100 men is employed.

During the last year a new power plant has been installed, consisting of two 100-h.p. boilers, a 13-drill cross compound air compressor, two hoists, duplex 10 × 12-inch cylinders, and 3-foot drum at No. 9 and No. 3 shafts and electric light plant. A new shaft and ore house has been erected at No. 9 shaft. In the ore house a No. 9 Austen gyratory crusher and picking tables have been installed.

On No. 3 vein, at the south end of the property, a shaft has been sunk to the depth of 200 feet with levels at 60 feet, 120 feet and 180 feet respectively. The shaft has been sunk at the mouth of the tunnel 220 feet from the south boundary of the property. This tunnel was described in a former report of the Bureau of Mines. The first level has drifts driven 220 feet to the south boundary of the property and 60 feet north. The south drift has been connected with the tunnel by a raise 140 feet from the shaft. A considerable amount of stoping has also been done on this level. The second level has drifts driven south 210 feet and north 90 feet. A raise has been put through to the first level 130 feet south of the shaft, and a winze sunk on the vein 20 feet south of the raise, a depth of 40 feet. At 80 feet south of the shaft crosscuts have been driven east and west 20 and 25 feet respectively. Some stoping has also been done on



Kerr Lake mine, showing camp buildings, power house and No. 7 Shaft house.

this level. On the third level drifts have been driven south 100 feet and north 60 feet. A raise is being put through from the third to the second level 25 feet north of the shaft. No stoping has been done on this level. The shaft is timbered by square sets throughout, and a safety cage is used.

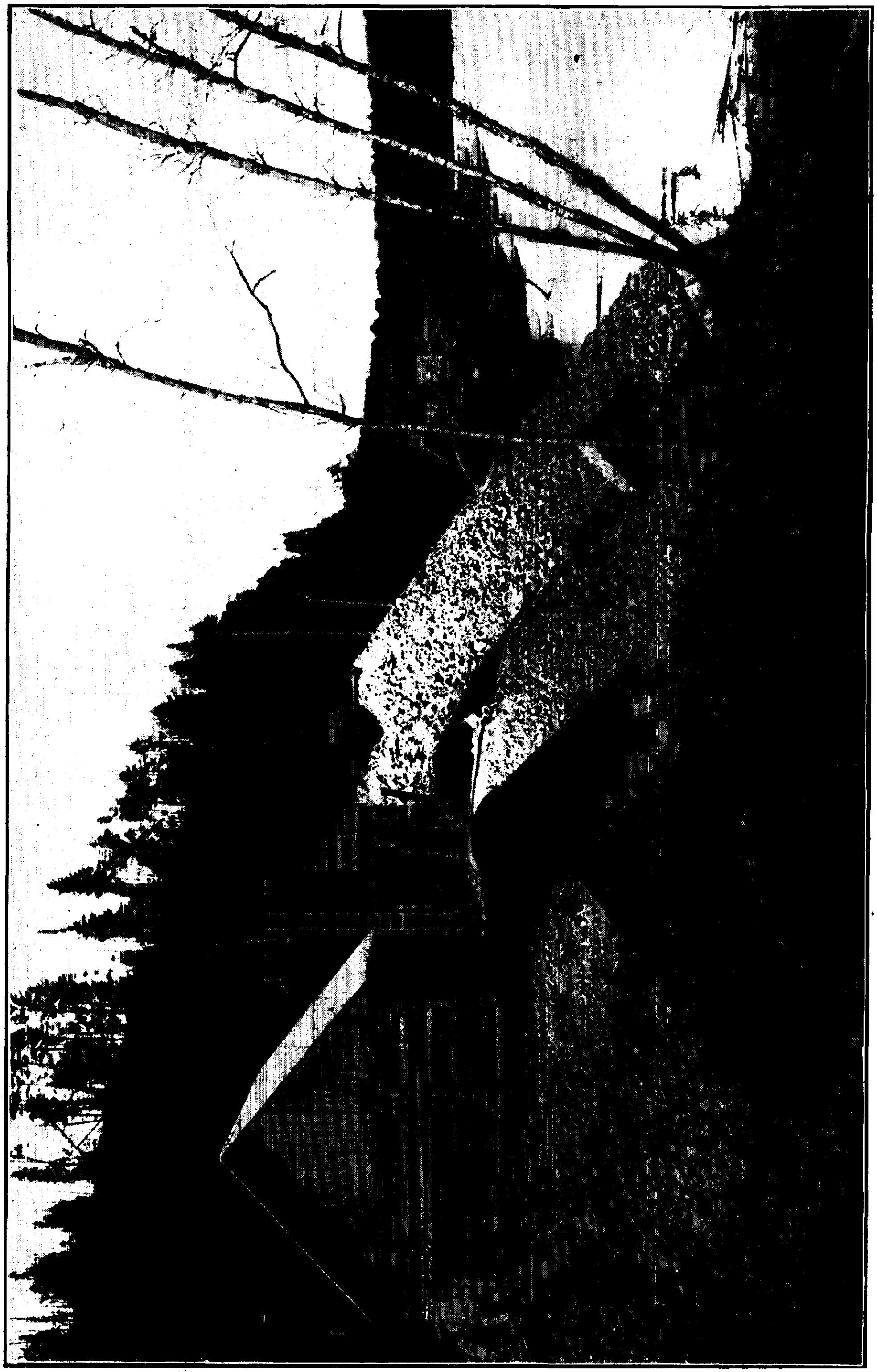
Kerr Lake, No. 3 shaft.

No. 7 shaft on the shore of Kerr lake has been sunk to a depth of 150 feet, the first level being at 85 feet and the second level at 140 feet. An adit level has been driven in on the vein from the shore of the lake a distance of 400 feet, where it connects with what is known as No. 12 shaft. Winzes have been sunk on the vein at distances of 170 and 230 feet south of the shaft. On the first level drifts have been run north and south of the shaft on the vein 200 feet and 40 feet respectively. On the second level drifts have been driven south 100 feet and north 80 feet.

At a distance of 40 feet west of No. 7 vein a parallel vein has been opened up by some open cut work, and an adit driven into the hill on the vein a distance of 160 feet. No. 9 vein east of No. 7, and having an east and west strike, has been open cut for a distance of 80 feet in length by 40 feet in depth. A shaft has been sunk on this vein to a depth of 110 feet, and drifts run west on this level 80 feet and east 40 feet.

King Edward (Watts) Mine

The King Edward Silver Mines, Limited, is a holding company which owns the entire capitalization of the Edward Cobalt Mines, Limited, formerly known as the King Cobalt, and the greater part of the stock of the Watts Mines, Limited. These two properties are adjoining, comprising the north part of the north half of lot 2 in the fifth concession and the northeast quarter of the north half of lot 3, in the fifth concession of Coleman. The greater part of the work of the company during the past year has been done on the latter location. This consisted of driving an adit on the east side of the hill, from near the northeast corner of the location southwest for a distance of 700 feet. The main vein, No. 4, was encountered 340 feet from the mouth of the adit. This vein runs northwest by southeast, and from the adit level drifts have been driven northwest 200 feet and southeast 350 feet. Small veins were



King Edward mine

encountered at 50 feet from the mouth of the adit on which drifts have been run northwest 100 feet and southeast 75 feet, at 100 feet from the adit mouth, on which 60 feet and 30 feet of drifting northwest and southeast have been done, also at 200 feet from the adit mouth on which there is 75 feet of drifting northwest, and 160 feet southwest. On the No. 4 vein two shafts have been sunk, No. 1 shaft being 300 feet southeast of the adit and No. 2 shaft 35 feet northwest of the adit. These shafts are 140 feet deep and connect with the drifts on the vein from the adit at this depth. A sublevel has been driven on the vein 70 feet from the surface, and is connected with the 140-foot level by raises every 100 feet. A drift has been driven to the vein between No. 1 and No. 2 shafts, and for 50 feet northwest of No. 2, and 125 feet southeast of No. 1 shaft. Stoping has commenced at different places on this vein. About 25 feet southeast of the main adit on the 140-foot level a winze has been sunk 40 feet on the vein.

A shaft house has been built at No. 1 shaft, and a hoist installed.

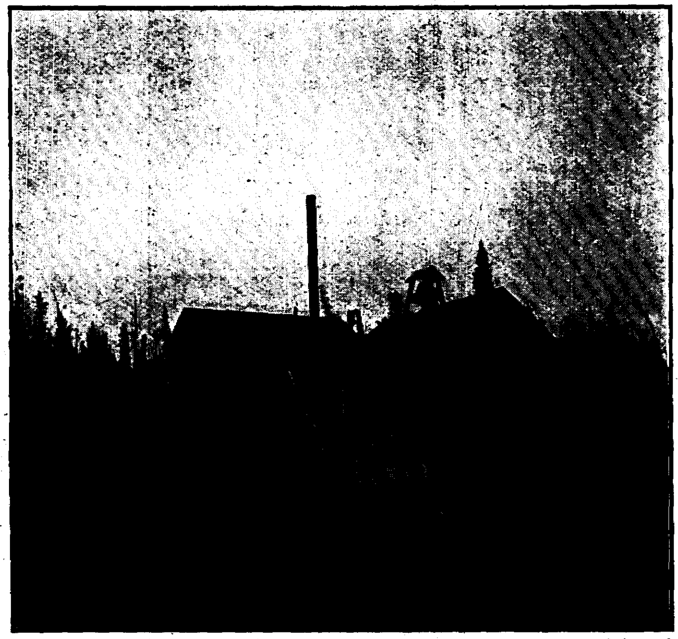
The power plant consists of two 100-h.p. boilers, a cross compound air compressor developing 1,015 cubic feet of free air per minute, a small electric light dynamo and engine.

Camp buildings and an assay office have been erected on the east side of the hill on the shore of Cross lake.

Mr. G. W. McCaskell is superintendent, employing a force of 60 men.

La Rose Mine

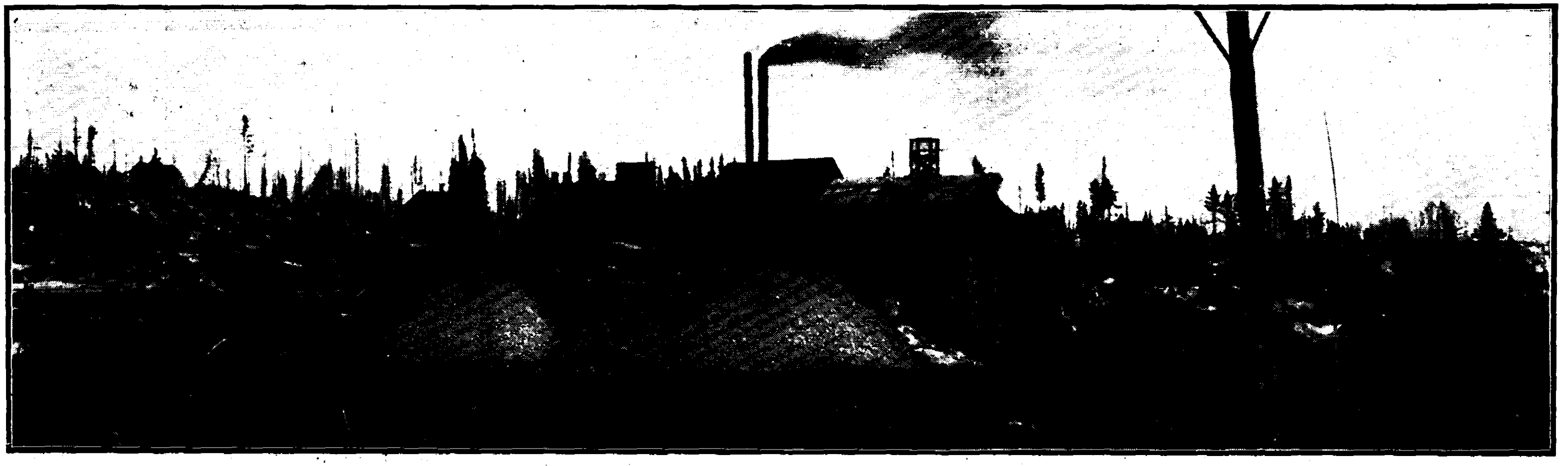
The La Rose mine is owned by the La Rose Mining Company, of which Mr. J. McMartin is president and Mr. F. N. Flynn, manager. This was one of the first



La Rose mine, June, 1905.

properties taken up in the camp in the fall of 1903. Since that time the property has been actively in operation.

The main shaft has levels at 62 feet, 157 feet and 240 feet.



La Rose mine, 1907.

On the first level a drift has been run south on the vein a distance of 280 feet. At 180 feet a drift has been run to the north on a cross vein a distance of 320 feet from the main veins. In this drift raises have been made at distances of 60 feet, 160 feet and 320 feet from the main vein. In the main vein at 170 feet from the shaft a winze has been sunk to the second level. In this winze at a depth of 30 feet from the level, drifts have been run north and south on the vein for a total distance of 75 feet. The discovery shaft is 100 feet south of the main shaft, and was the first shaft sunk on the property. In this shaft at a depth of 60 feet, or 25 feet above the first level, drifts have been run north and south from the shaft a total distance of 85 feet. North of the shaft a drift has been driven on the main vein a total distance of 520 feet. At a distance of 45 feet north of the shaft a raise has been made to a height of 25 feet above the level, and some drifting done. At 100 feet north of the shaft a winze has been sunk to the second level. At distances of 280 feet and 380 feet north of the shaft drifts have been driven southeast on stringers from the main vein for distances of 90 and 95 feet, respectively. At 400 feet north of the shaft a winze has been sunk to a depth of 25 feet.

On the second level a drift has been run south a distance of 280 feet and a crosscut driven west from the shaft 75 feet in length. North of the shaft a drift has been driven north 360 feet, with a number of drifts on stringers from the main vein. At a point 40 feet north of the shaft a winze has been sunk 30 feet.

On the third level a crosscut has been driven west from the shaft 50 feet, and a drift north 100 feet. It is interesting to note that this crosscut is in conglomerate, which shows that at the La Rose shaft the conglomerate has a thickness of at least 265 feet.

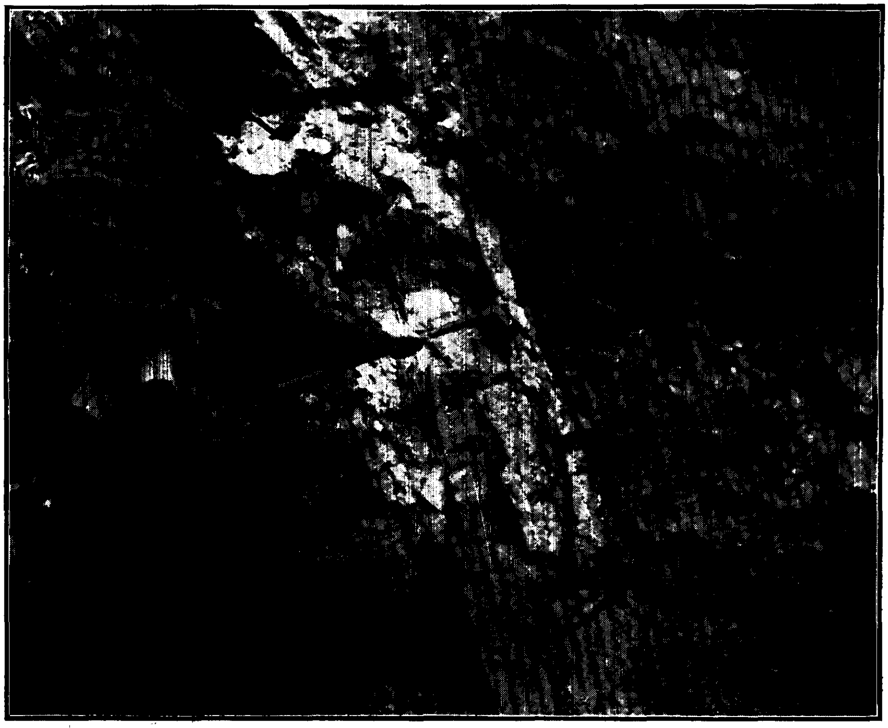
Underground view at La Rose mine, 1905. (From a photograph by Mr. A. de Romeu).

Two other veins on the property are also being worked at present. No. 3 vein described above as a cross vein from the main vein has an adit driven into the hill on the vein, beginning at a point about 400 feet east of the main vein, and ending at the south boundary line of the claim, 390 feet from the mouth of the adit and 790 feet from the main vein. A shaft has been sunk on the vein 210 feet from the mouth of the adit to a depth of 75 feet. Considerable stoping has been done on this part of the vein.

About 600 feet north of this vein an adit has been driven into the hill east on the vein a distance of 320 feet. At a point 135 feet from the mouth of the adit a winze has been sunk a depth of 40 feet, and a raise driven about 25 feet. Some stoping has been done on this vein.

On J B 4, known as La Rose extension, north of the La Rose and owned by the La Rose Company, a shaft has been sunk to a depth of about 50 feet.

A shaft house and ore sorting house have been erected at the main shaft. The power plant consists of one 150-h.p. boiler, one cross compound air compressor with feed water heater developing 1,700 cubic feet of free air per minute, and an electric lighting plant.



La Rose main vein, 1905.

The La Rose Company also own or control several other properties in the camp, namely: The Princess, Eplett, Fisher, Cochrane and University. On the first four of these considerable prospecting has been done. On the Eplett and Fisher a boiler and 4-drill compressor have been installed, and shaft sunk to a depth of 75 feet with some drifting. The University mine will be briefly described on another page of this Report. No work was being done at these properties at the time of my inspection.

McKinley-Darragh Mine

The McKinley-Darragh mine was one of the first mines to be developed in the Cobalt camp. It is at present owned by the McKinley-Darragh-Savage Mines, Limited, of which Mr. F. Robbins is manager.

The old No. 1 shaft was sunk quite near the lake, and the underground workings allowed the waters of the lake to break through. It was consequently abandoned, and the new No. 1 shaft was sunk 120 feet southwest on the same vein. This shaft has been sunk to a depth of 165 feet with levels at 75 feet and 150 feet. On the 75-foot level drifts have been driven northeast on the vein 50 feet and southwest 180 feet. From the end of this southwest drift a crosscut has been driven west 70 feet. On the 150-foot level a crosscut was driven west 40 feet to the vein, and a drift run 115 feet northeast. A crosscut has also been driven east a total distance of 400 feet to connect with No. 2 shaft at the 110-foot level. A vein was encountered in the cross cut 260 feet from the No. 1 shaft. On this vein drifts have been run north 70 feet and south 40 feet.

No. 2 shaft has been sunk to a depth of 125 feet, with levels at 60 feet and 110 feet. On the 60-foot level drifts have been run, east, a few degrees north, 120 feet, west, a few degrees south, 240 feet. At 80 feet west of the shaft on this vein a drift has been driven south on an offshoot of the vein 80 feet. A crosscut has also been driven northwest from the drift 50 feet. Considerable stoping has been done on this vein both east and west of the shaft. On the 110-foot level a crosscut has been driven 90 feet to the vein. From this point where the crosscut cuts the vein drifts have been driven east 65 feet and west 105 feet. A parallel vein to this has been cut 25 feet farther north, and drifts driven on it 35 feet east and 45 feet west.

No. 7 shaft which adjoins the Kendall vein of the Nipissing has been sunk to a depth of 60 feet. At this level a drift has been driven west 35 feet and a crosscut north 40 feet. A considerable tonnage of ore was taken out by open cutting the vein to a depth of 40 feet by 100 feet in length.

Shaft houses have been erected at each of the shafts.

The power plant consists of two 100-h.p. boilers, a 5-drill straight line compressor and a 10-drill duplex compressor and an electric light plant.

A concentrating mill was erected in 1907. It originally consisted of a battery of ten stamps, which crushed the ore to from 20 to 40-mesh. The product was then fed to two Frue vanners and the tailings led to waste.

During 1907 a coffer dam was built across the south end of the lake. This was done to enable the company to recover the free silver which was found in the sand and silt under the water at that end of the lake, which had been formed by the breaking down of the No. 1 vein.

Spacious camp buildings for the accommodation of about 100 men have been erected.

Muggley Concentrator

This concentrator is a custom mill, and is located on the town site of Cobalt just south of the town, and about 200 feet from the main line of the Temiskaming and Northern Ontario Railway.

The ore is hoisted by skip on an inclined tramway from the railway to the top of the mill, where it is fed to a jaw crusher and then to rolls, the product from the rolls is then fed to jigs. The tailings from the jigs are then led to four batteries of five stamps each, where it is crushed to about 40-mesh. From the stamps the crushed product passes to a Richards classifier. The spigot discharge from the classifier is treated on Wilfley tables and the overflow goes to a Callow settler to be treated on Frue vanners. The tailings from the vanners pass to a settler, and are then treated by pan amalgamation and cyanidation.

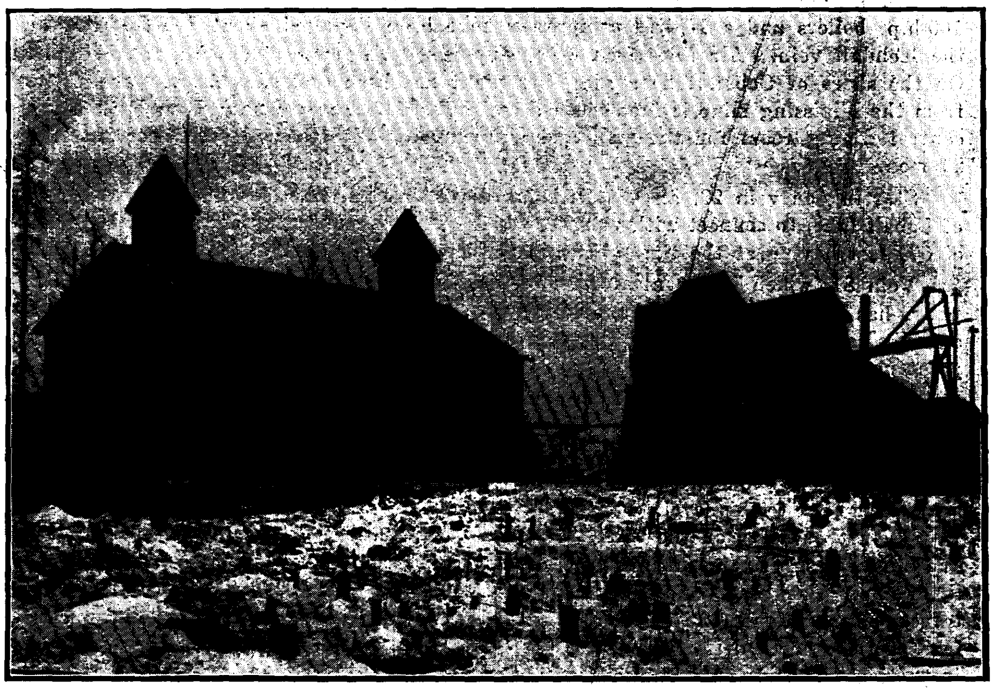
Nancy-Helen Mine

The Nancy Helen Mining Company have acquired from the Temiskaming and Northern Ontario Railway Commission the right to mine on a part of the town site of Cobalt, east of and adjoining the Buffalo mine. Mr. J. F. Black is manager, and Wm. Black, superintendent, employing a force of 30 men.

The shaft has been sunk to a depth of 120 feet, the first level being at 50 feet and the second level at 100 feet. On the 50-foot level drifts have been driven easterly and northeasterly along the veins for distances of 150 feet and 100 feet respectively. On

Muggley concentrator.

the 100-foot level drifts have been run east on the vein a distance of 44 feet and a crosscut driven north from the shaft a distance of 50 feet. No stoping has as yet been done.



Nancy Helen mine.

A gas producer plant has been installed, with belt driven air compressor capable of developing about 500 cubic feet of free air per minute. A small upright boiler supplies power for the hoisting. A shaft house, and ore house combined, has been erected. The power house is situated about 150 feet to the south of the shaft house.

Little Nipissing

On the 20 acre lease obtained from the Peterson Lake Mining Company prospecting work has been carried on this winter, and a shaft has been sunk to a depth of 35 feet on the vein discovered.

On J B 2, south of the Princess and Silver Queen, the company are driving an adit east into the hill from the level of Short lake. About 200 feet has already been driven.

Mr. S. Madden is looking after the work for the company.

Nipissing Mines

The Nipissing Mining Company, under the management of Mr. T. R. Drummond, and employing a force of about 200 men, was at the time of my inspection operating eight veins on its property. These veins were the Kendall, Nos. 28, 26, 49, 55, 25, 12 and 86. The location of these veins is shown on the contoured Cobalt map published with this Report.

During the summer of 1907, the Nipissing Company did considerable prospecting, particularly on that section of their property lying between Peterson and Cobalt lakes.

The Meyer vein east of the Trethewey property was discovered in 1907, and some work done on it. The management is making preparations to commence operations, at once on the part of their property north of the town of Cobalt.

The company in 1906 installed an 18-drill cross compound air compressor and two 100-h.p. boilers on the west shore of Peterson lake. During the winter of 1907, two 100-h.p. boilers and a 17-drill compressor have been installed about 300 feet south of the Kendall vein. Air lines from the compressors are connected with all the shafts. On the shore of Cobalt lake a sampling plant has been erected. All the ore shipped from the Nipissing mine is first crushed and sampled. The company have built a large central dining room for the men and a number of bunk houses each accommodating 25 men.

Starting on vein 28, an adit is being driven east from a few feet above the level of Cobalt lake, to connect with vein 49, which outcrops on the top of the hill, a distance of 600 feet having at the time of my inspection been attained.

Vein 81, which is a continuation of No. 3 vein of the Cobalt Lake Mining Company, has been open cut for a distance of 75 feet from the line, from which point an adit has been driven along the vein east for a distance of 100 feet, and from this point northeast 100 feet.

Vein No. 26 is now worked through the shaft on vein No. 10. The first level is at a depth of 50 feet. A crosscut has been driven west 75 feet to vein 26. From this point a drift has been driven north 20 feet to the open cut which was stoped out prior to the sinking of the shaft on No. 10 The open cut is about 120 feet in length, and has been stoped out to this level. From the north end of the open cut a drift has been driven 75 feet farther north on the vein. From the intersection of the crosscut with the vein, drifts have been driven southwest 180 feet and southeast 140 feet. In the southwest drift a little stoping has been done. The second level at a depth of 100 feet has a crosscut driven to vein 26, a distance of 75 feet, and drifts have been driven north 60 feet and south 55 feet. In the north drift, a raise has been put up 20 feet. The shaft at the time of my inspection was being sunk to the 200-foot level, a depth of 175 feet having been attained.

A shaft house has been erected at No. 10 shaft, and a 20-h.p. upright boiler, and a 10 × 12-inch double cylinder hoist installed.

Vein 25 was not being worked at the time of my inspection, but the work up to date shows the shaft to have been sunk to a depth of 50 feet. The vein has been open cut for a length of 80 feet to the 50-foot level, and a drift driven southwest 400 feet to connect with vein 49. A crosscut has been driven southeast 40 feet to cut vein 54, and a drift has been driven along this vein southwest a distance of 120 feet. A shaft house has been erected over vein 25, and hoist and small boiler installed 50 feet from the shaft.

Vein 55 has been open cut for a length of 90 feet and a depth of 35 feet. A shaft house has been erected at the vein.

Vein 49 has a strike east by west, and has been open cut for an average depth of about 25 feet along the vein for a distance of about 250 feet. The vein forks at a distance of 150 feet from the shaft, and the southeasterly branch has been worked for a distance of 80 feet from the main vein. No. 49 shaft has been sunk to a depth of 100 feet, and drifts have been driven east 250 feet and west 20 feet. The south crosscut from the west drift has been driven 70 feet. At 180 feet east of the shaft a raise has been put through to the open stope. A shaft house has been erected at No. 49 shaft, and hoist and boiler installed about 60 feet distant. Adjacent to the hoist house is the blacksmith shop and machine shop, where the steel is sharpened for all the workings, a mechanical sharpener being used, and all repair work is done.

Veins Nos. 6 and 19 were not being worked at the time of my inspection. Vein No. 6 has been open cut for a length of 60 feet by a depth of 50 feet. Vein No. 19 has been open cut for an average length of 125 feet by a depth of 50 feet. The shaft on vein No. 19 has been sunk to a depth of 112 feet and from the 50-foot level a drift has been

Nipissing mine, showing Ore Reduction Company's mill and Kendall shaft to the right.

driven north 190 feet from the shaft. At 175 feet north of the shaft on this drift crosscuts have been driven east and west 30 feet.

A shaft house has been erected and boiler and hoist installed 60 feet from the shaft house.

Shaft No. 12 has been sunk to a depth of 75 feet with the first level at 65 feet. From this level a crosscut has been driven southwest 140 feet. At 35 feet from the shaft, drifts have been driven east 50 feet and west 90 feet. A drift is being driven to intersect vein 15 about 150 feet west of No. 12. In the west drift a raise has been put through to the surface. Vein No. 12 has been open cut for 75 feet on the surface and to a depth of about 25 feet.

The Kendall shaft has been sunk to a depth of 125 feet, the first level being at 60 feet. On the surface immediately west of the shaft a shallow open cut 150 feet long was made in the summer of 1907. On the first level drifts have been driven east 100 feet and west 150 feet. On the east drift a raise has been put through to the surface. On the west drift timbers have been put in and stoping begun. A shaft and ore house has been erected.

The Little Silver vein has not been worked during 1907. The work that has been done consisted of open cutting the vein for a depth of 35 feet by a length of 150 feet. A drift has been run under the open cut at a depth of 50 feet from the surface. This drift is 100 feet in length. Immediately east of the open cut a parallel vein was encountered, and was open cut for a length of 120 feet, and for an average depth of 106 feet. At the 100-foot level drifts were run north 60 feet and south 60 feet. Drifts were also run east 25 feet and west 25 feet.

On the west shore of Cart lake about 500 feet north of the Provincial mine, vein 86, having a strike northeast by southwest, has been open cut for a length of 125 feet. A shaft has been sunk on the vein to a depth of 75 feet and drifting begun. An adit is being run into the hill to the northwest of the vein to cut veins 87, 88 and 89. The adit has now been driven a distance of 125 feet and a raise put through to the surface.

Nova Scotia Mine

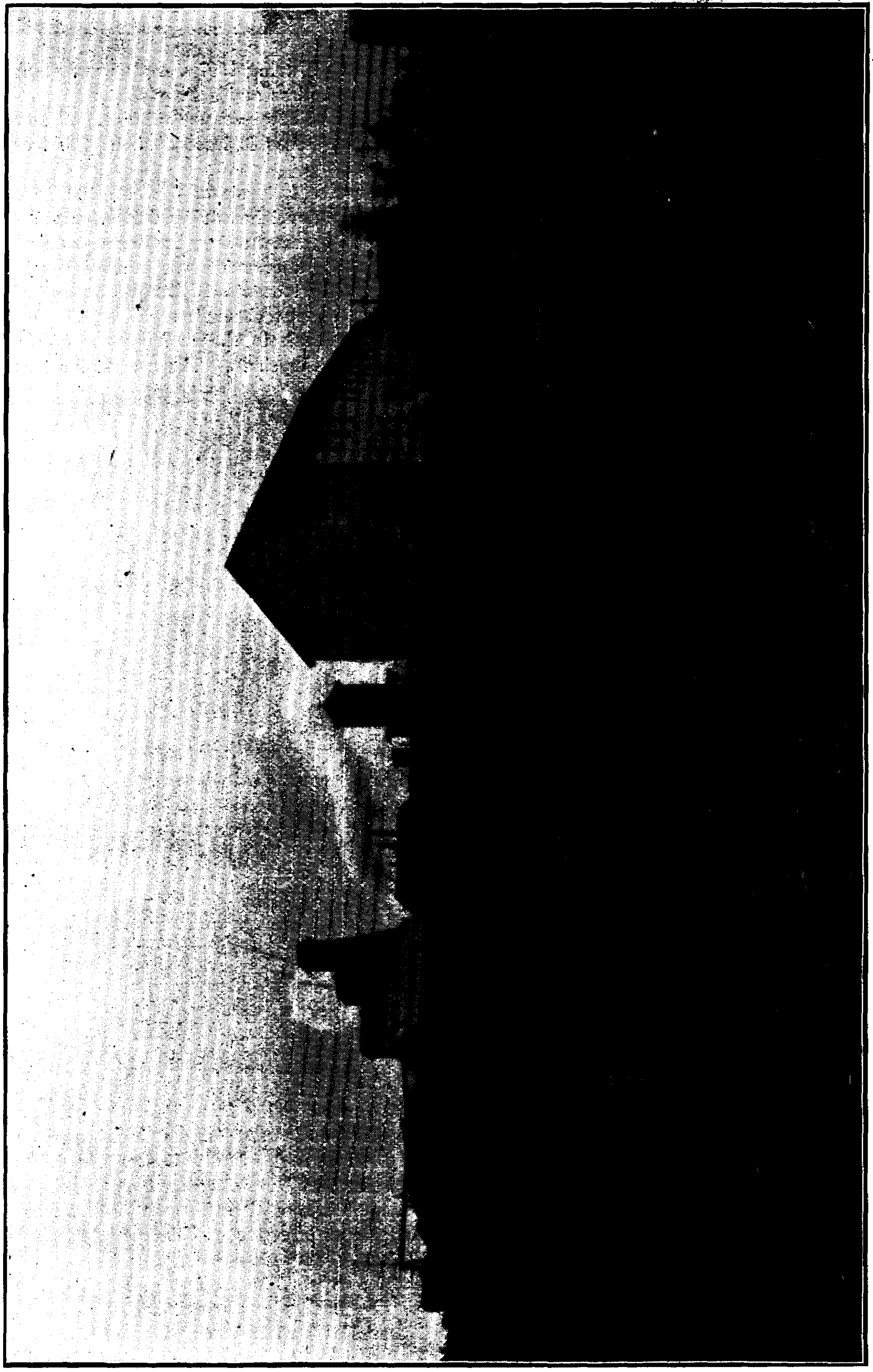
This property is owned by the Nova Scotia Mining Company with Mr. S. R. Heakes manager.

A new power plant was installed in 1907 consisting of two 125-h.p. return tubular boilers and a compressor, compound air and steam, developing 1,992 cubic feet of air per minute and an electric light plant.

No. 2 shaft has been sunk to a depth of 50 feet and connected with No. 1 shaft by a drift 75 feet to the east. East of No. 1 shaft a crosscut has been driven south 40 feet. No. 1 shaft has been sunk to a depth of 145 feet with levels at 50 feet and 125 feet. On the second level drifts have been driven east 50 feet and west 280 feet to connect with No. 3 shaft at the 75-foot level. Stoping has begun on the vein from No. 2 shaft, both on the first and second levels. No. 3 shaft on the shore of Peterson lake has been sunk to a depth of 150 feet. The first level of No. 3 shaft corresponds to the second level of No. 1 shaft. The main drift from No. 1 shaft is 40 feet north of the shaft and is connected with the shaft by crosscut. Drifts have been driven east from a point 10 feet south of the shaft, a distance of 60 feet and west 30 feet. At the 150-foot level of No. 3 shaft a crosscut has been driven north 100 feet and at a point 40 feet north of the shaft a drift has been driven east 50 feet. A crosscut has been driven 40 feet south of the shaft and drifts driven east 80 feet and west 20 feet. A central shaft house has been erected at No. 1 shaft.

O'Brien Mine

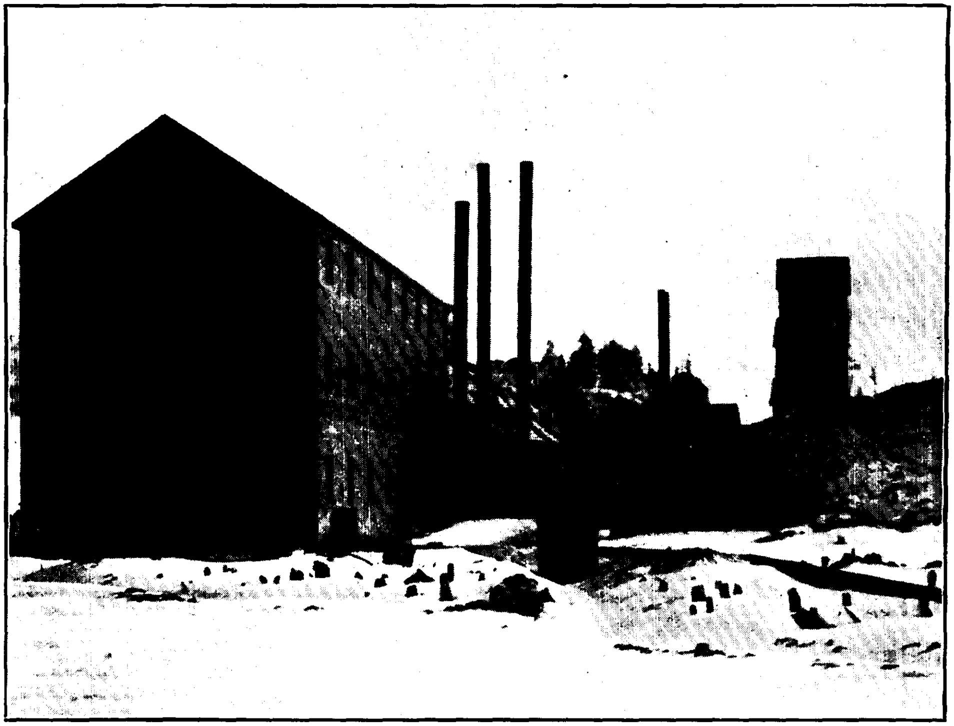
The O'Brien Mine is owned by Messrs. M. J. O'Brien and J. B. O'Brian, under the management of M. T. Culvert, and employs a force of 90 men.



O'Brien mine.

Work is being carried on at three shafts at present. During 1907 a new power plant was installed, consisting of two 100 h.p. return tubular boilers and a Franklin cross compound compressor, with a capacity of 2,000 cubic feet of free air per minute. A new electric light plant has also been installed. The power house is located about 700 feet east of No. 1 shaft.

No. 1 shaft has been sunk to a depth of 300 feet with levels at 50 feet, 100 feet, 150 feet, 200 feet and 300 feet respectively. The 50-foot level has drifts driven east 500 feet and west 200 feet. In the west drift considerable crosscutting has been done at 140 feet from the shaft. At 200 feet east of the shaft a crosscut was started south, but a cross vein was encountered, and the drift was then continued for a distance of 100 feet. At 190 feet east of the shaft a raise has been put through to the surface at an angle of 45 degrees. A raise has also been put through to the surface west of the shaft. Stoping has been begun both east and west of the shaft. The second level at



Ore Reduction Company's mill and Kendall shaft.

a depth of 100 feet has drifts driven east 425 feet and west 140 feet. At 100 feet west of the shaft a raise has been put through to the 50-foot level. Stoping has begun on the level east and west of the shaft. The third level at a depth of 150 feet has drifts driven east 130 feet and west 150 feet. Some stoping has been done west of the shaft. On the fourth level at a depth of 200 feet a crosscut has been driven south 30 feet from the shaft and then east 125 feet. On the fifth level at a depth of 300 feet a crosscut has been driven south 110 feet, and then a drift east 30 feet.

Hoisting from No. 1 shaft is done by means of a cage. The ore house, in which the ore is sorted, is connected with the shaft house. The small plant, consisting of a 60-h.p. boiler, 5-drill compressor and hoist, is situated near No. 1 shaft house.

No. 2 shaft has been sunk to a depth of 75 feet with level at 65 feet. At this level drifts have been run east for 40 feet and south 150 feet. Drifts have also been run west 140 feet and south 90 feet.

A shaft house has been erected at this shaft 65 feet in height, and a small boiler and hoist installed.

No. 6 shaft has been sunk to a depth of 125 feet with the first level at 75 feet. On this level a crosscut has been driven south 75 feet. At a distance of 40 feet from the shaft, drifts have been driven east 125 feet and from that point northwest 50 feet. The shaft is at present being sunk to the 150 foot level. A shaft house has been erected and a small boiler and hoist installed.

Ore Reduction Company

The plant has a capacity of 100 tons per day. The ore is first passed through a 6-inch × 20-inch Farrell rock crusher, and reduced to 1½ inch; it is then elevated to an ore bin and fed through a challenge ore feeder into the dryer. After drying, it is passed through another 6-inch × 20-inch crusher and reduced to ¼-inch. It is then gradually reduced through a series of rolls until all the ore will pass through a 16-mesh screen. It is now "sized" by passing through a series of four "plan-sifters" each of which takes out six sizes. (There are two sets of these machines). The ore goes direct from the plan-sifters to the concentrators. There are eight concentrators, or one for each plan-sifter.

Concentration is performed dry, air being used instead of water. Concentration is carried on in an inclined iron cylinder, through which a current of air is passed continuously, the ore being kept in motion by a set of brushes revolving inside the cylinder.

The crushers, rolls, etc., are driven by a ninety horse power slide valve engine. The plan-sifters, concentrators, etc., are driven by a similar engine of sixty horse power capacity, steam being furnished by two eighty horse power boilers.

Peterson Lake

No work has been done recently by the Peterson Lake Mining Company. The lake was lowered in 1906 about 15 feet by cutting a channel about 900 feet in length at the northeasterly end of the lake.

The Little Nipissing Company have secured a lease of 20 acres on the west side of the lake adjoining the Nipissing.

Provincial Mine

When work was commenced on the Gillies Limit in 1906 there were rumors of very rich silver finds having been made during the previous year by prospectors, who had gone on the limit without permit. All these finds where work had been done were examined, and trenching done in their vicinity, but no veins of value were uncovered. Several parties, who claimed to know of solid veins of silver on the limit, showed them on the understanding that they would receive $150 an inch in width for workable veins running over 500 oz. to the ton in silver. All these parties were unable to show veins of any value, in fact anything that was shown proved to be mere cracks in the rock. Several veins were found in trenching, but the most promising was discovered near the north boundary under 4 to 5 feet of earth on July 19th, 1906.

During the year 1906 but very little actual mining work was done. During the months from June to October, 1906, about twenty men were employed continuously, trenching about 18,000 feet. Several test pits were put down, and three small shafts were sunk 10, 30 and 55 feet respectively. In the 55-foot shaft to the west of the railway 45 feet of drifting and crosscutting was done on the 55-foot level.

In addition to the actual prospecting the surveying and mapping of part of the limit was done in 1906.

The main shaft, on the northern part of the limit adjoining the Nipissing Mine, was begun in October, 1906.

Owing, first, to the failure of the machinery companies delivering the machinery according to contract, secondily, to the labor difficulties in the Cobalt camp in 1907, and thirdly, to the construction of the Kerr Lake branch of the T. & N. O. railway, (as the camps were located about two hundred feet from two rock cuts, the danger from blasting retarded the work at the mine greatly, work only being carried on with jeopardy to the lives of the workmen), very little work was done at the mine between April and September, 1907.

The work at the mine shows the following development: The shaft has been sunk 140 feet with levels at 65 feet and 125 feet respectively. The shaft is timbered for its entire depth with square sets and the hoistway provided with guides for cage.

The Provincial mine on Gillies Limit.

On the first level 450 feet of drifting has been done and 70 feet of crosscutting. A raise has also been put through to the surface 50 feet east of the shaft on the vein, and timbers put in and stoping begun for 90 feet along the vein.

On the second level at 125 feet in depth 125 feet of drifting and crosscutting has been done and a raise to the first level begun.

Surface Plant

At the mine, buildings have been erected consisting of boiler house 32 x 50 feet; bunk house, two stories, 20 × 50 feet; dining room; office; ore house; blacksmith shop and shaft house.

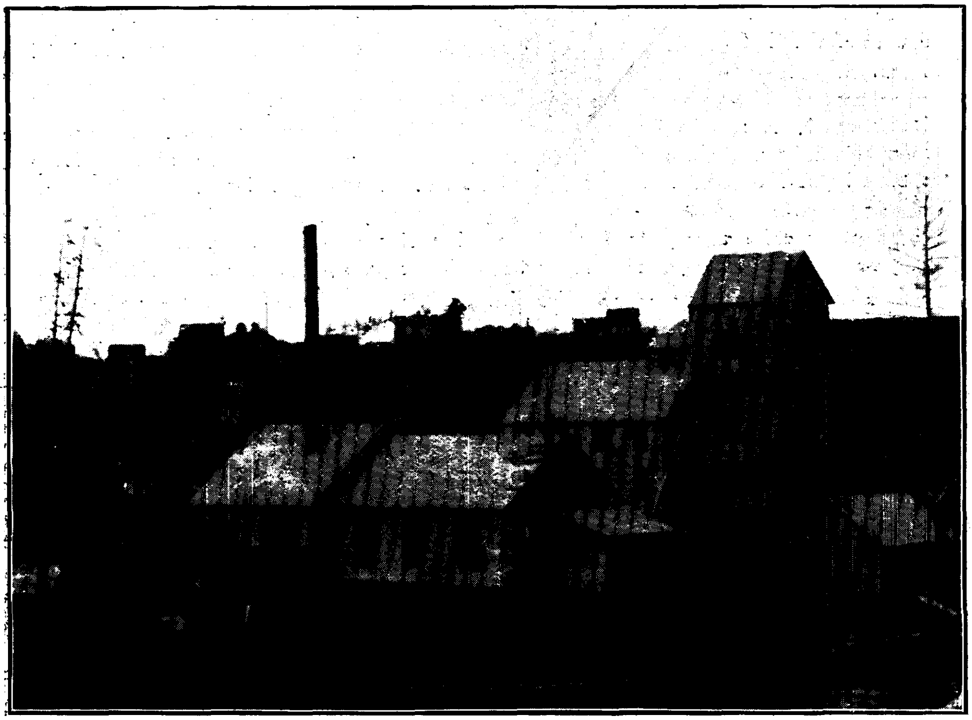
The machinery installed consists of a 100-h.p. return tubular Jenckes boiler, the high pressure half of a Rand air compressor developing 500 cubic feet of free air per minute, (the concrete foundation for the complete compressor has been put in), and a

7 × 10-inch Jenckes hoist. In the mine a Worthington pump has been placed on the first level, and a Cameron sinking pump on the second level. Five air drills have been purchased and three are kept continuously in operation.

About twenty-five men are at present employed at the mine under superintendent S Hunter.

Right of Way Mine

The Right of Way Mining Company in 1906 purchased the mining rights of the Temiskaming & Northern Ontario Railway from mileage 101 to 104 (excepting the west shore of Cobalt lake) from the Temiskaming & Northern Ontario Railway Commission. Mining operations have been carried on continuously since that time on that section of the Right of Way immediately north of Cobalt lake. Mr. T. A. Beament, of Ottawa, is president of the company, and Mr. Jos. Houston, manager.



Right of Way mine.

No. 1 shaft was sunk on the continuation of the La Rose vein about 50 feet from where the vein crosses the line. This shaft is 75 feet deep with level at 65 feet. The main drift has been run south for 240 feet from the shaft. On this vein just south of the shaft, timbers have been put in and some stoping done for about 75 feet along the vein. At 75 feet south of the shaft, a crosscut has been driven east 30 feet, and from this point a drift has been run south 90 feet. A crosscut has also been driven southwest 45 feet from a point in the main drift a little north of the shaft.

No. 2 shaft, about 600 feet south of No. 1 shaft, has been sunk to a depth of 140 feet with levels at 86 feet and 140 feet, At the 86-foot level a crosscut has been driven west 120 feet, and from a point 70 feet from the shaft a drift has been started north to connect with the main south drift from No. 1 shaft. This drift has been driven north

100 feet. No. 2 shaft is a three-compartment shaft, consisting of two hoisting compartments and ladder-way. The shaft house and ore sorting house are erected at this shaft.

The power plant consists of two 80-h.p. boilers, a cross compound-air compressor capable of developing 950 cubic feet of free air per minute, a double drum, 10 x 12 inch cylinder hoist and an electric light plant. The power house is located 50 feet east of the No. 2 shaft house.

A force of 50 men are employed under R. Sandoe, mine captain.

Rochester Cobalt Mine

This property is situated on the northwest quarter of the north half of lot 2, in the third concession of Coleman.

The mine was not in operation at the time of my inspection except its power plant, which was supplying air for the Badger mine. A shaft has been sunk on the property to a depth of 90 feet. At the 75-foot level about 95 feet of drifting has been done east and west of the shaft.

Silver Cliff mine.

The power plant consists of an 80-h.p. boiler and the high pressure half of a 12-drill compressor.

Camp buildings have been built for the accommodation of 40 men.

Red Rock Mine

This property consists of the north-west thirty acres of the south half of lot 14 in the first concession of the Township of Bucke. It is owned by the Red Rock Silver Mining Company.

Considerable surface work has been done on the claim, and three shafts sunk to depths of 35, 75 and 110 feet respectively. On the No. 3 shaft the greater part of the work has been done during the last year. At the 100-foot level a drift 75 feet in length has been driven

An 80-h.p. boiler and straight line compressor developing about 400 cubic feet of free air per minute have been installed.

Mr. R. W. Thompson is superintendent, employing a force of 25 men.

Rothschild Mine

The Rothschild Cobalt Mining Company has been doing no mining recently. During 1907 considerable diamond drilling was done on the property. Two shafts have been sunk to depths of 75 feet and 100 feet respectively, and some drifting and crosscutting done.

A 60-h.p. boiler and a 4-drill straight line compressor have been installed.

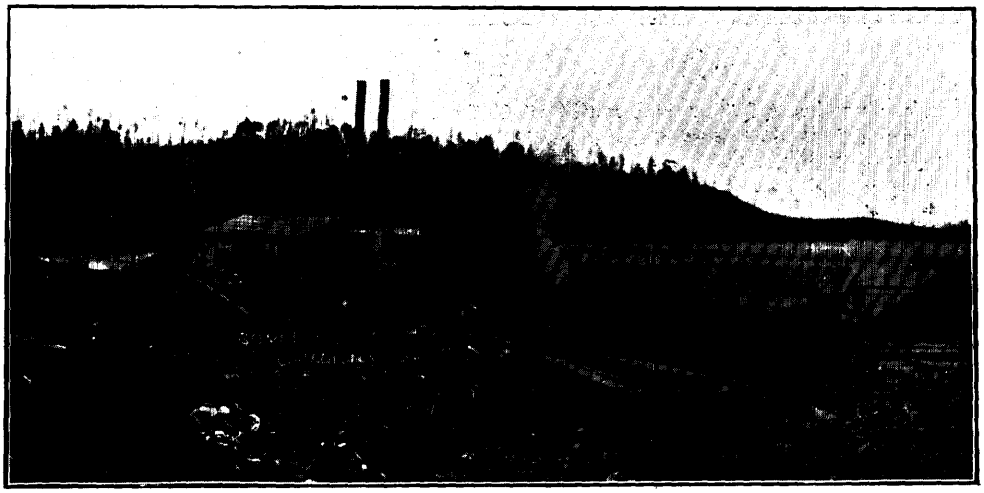
Silver Cliff Mine

This property is owned by the Silver Cliff Mining Company, and comprises the southeast quarter of the south half of lot 3, in the sixth concession of Coleman. It was not in operation at the time of my inspection.

Two adits have been driven west into the hill. No. 1 adit has been driven about 300 feet, and at 75 feet from the mouth drifts have been driven north 75 feet and south 100 feet. No. 2 adit is 400 feet north of No. 1, and has been driven in about 400 feet. Some drifting has also been done on the veins cut by the adit.

Silver Leaf Mine

At the time of my inspection of the property all work was confined to the new vein on the shore of Kerr lake. On this vein a shaft has been sunk to a depth of 110 feet with the first level at 85 feet, where a station was cut, and drifts east and west being driven.



Silver Leaf mine.

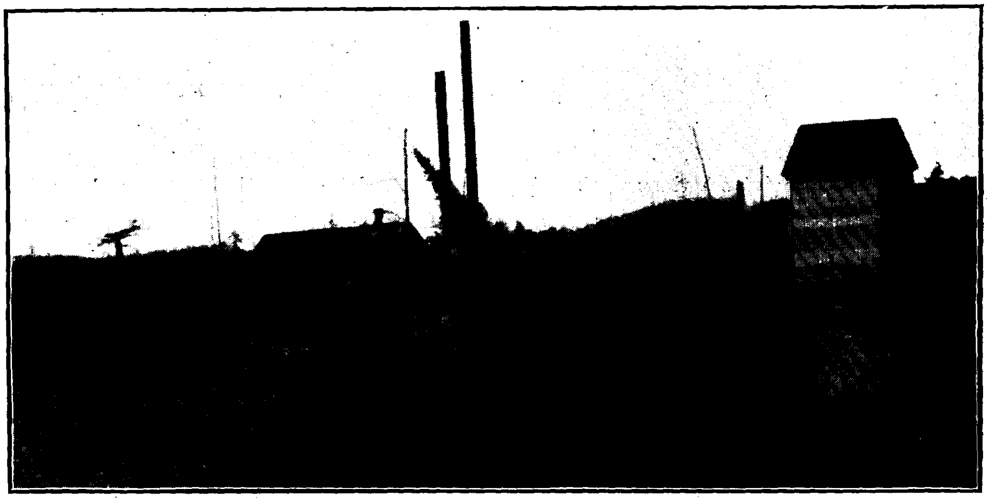
The work done formerly, before the new vein was found, consisted in sinking a shaft to a depth of 80 feet and drifts being driven east 130 feet and west 35 feet from which point a crosscut was driven north 260 feet. In the east drift, at a point 75 feet from the shaft, a crosscut was driven south 90 feet. In the crosscut to the north some 50 feet of drifting was done, and a vein cut by the crosscut. Another shaft was sunk to a depth of 50 feet on what was known as the original discovery.

The power plant consists of two 60-h.p. boilers and the high pressure half of a 10-drill compressor.

Mr. L. R. Symmes is at present manager of the company, and J. W. Merrill, superintendent, employing a force of 30 men.

Savage Mine

This property, owned by the McKinley-Darragh-Savage Mines, Limited, has been reopened after having been closed down for about a year. The chief difficulty in connection with the operation of the mine is the amount of water which it makes. The shaft has been sunk to a depth of 90 feet with the first level at 70 feet. Drifts have



Savage mine.

been run northeast 75 feet and southwest 60 feet. From the northeast drift a crosscut has been driven northwest a distance of 95 feet. Two No. 5 sinking pumps are used in keeping the mine free from water. An 80-h.p. boiler has been installed, and a 3-drill straight line compressor.

Mr. Howard Chapin is superintendent, employing a force of 20 men.

Silver Bar Mine

This property was not in operation at the time of my inspection. Some work was, however, done on it during 1907. The shaft has been sunk to a depth of 75 feet, and 150 feet of drifting done on this level. The vein was open cut at the surface for 30 feet by about 40 feet in length. The control of the company changed hands in the fall of 1907, and some extensions were made to the camp buildings. Work was resumed in the mine for a couple of months.

Temiscamingue Mine

The Temiscamingue mine is situated on the south half of the northwest quarter of the north half of lot I in the third concession of Coleman. This property lies the farthest south in Coleman of any of the shipping mines.

The No. 1 shaft has been sunk to a total depth of 240 feet with the first level at 80 feet and the second level at 183 feet. From the first level the drift has been run southwest to the south boundary of the claim, a distance of 40 feet, and northeasterly a distance of 150 feet. At 20 feet north of the shaft a crosscut has been driven west

35 feet. A sublevel has been driven north at a depth of 50 feet to connect with the ore body 100 feet to the north. At a point 100 feet north of the shaft a raise has been put through from the first level to the sublevel and some stoping done here.

On the second level a station crosscut was driven southeast, a distance of 50 feet, and from this point a drift was driven northeast 60 feet to a point where a crosscut, or more properly a drift on an offshoot of the vein has been driven northwest 70 feet. From the point 60 feet north of the shaft the main drift has been continued northeast a total distance from the shaft of 140 feet. From the north end of the main drift a crosscut has been driven west 30 feet. At a point about 85 feet north of the shaft on the main drift a raise has been put through to the first level and some stoping done.

Temiscamingue mine.

The mine is lighted underground by electric light. A shaft house and power house have been erected. The power plant consists of one 100-h.p. boiler, a straight line compressor developing 540 cubic feet of free air per minute, and a 10 × 12-inch double cylinder hoist with 36-inch drum. Camp buildings have also been erected.

Mr. N. Fisher is manager, employing a force of 40 men.

Temiskaming and Hudson Bay Mine

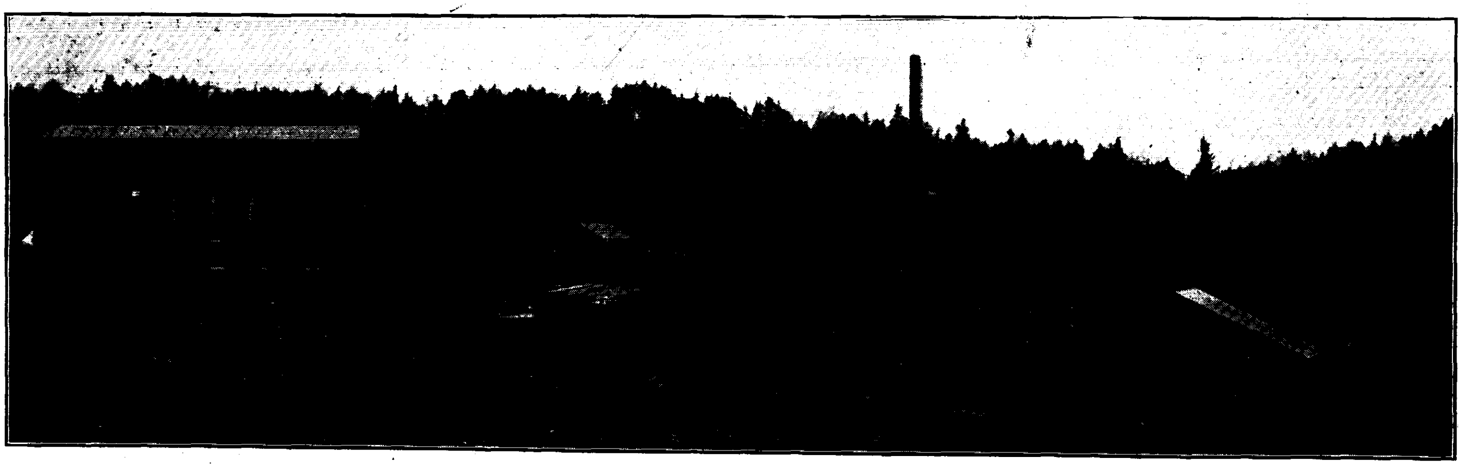
The Temiscaming and Hudson Bay Mining Company are operating on the northeast quarter of the north half of lot 6 in the sixth concession of Coleman. Mr. J. R. Kinler is manager of the company, employing about 45 men at the mine. Mining operations began on this property in 1906.

A shaft has been sunk on No. 1 vein to a depth of 125 feet, with first level at 60 feet and second level at 100 feet. On the first level a drift has been driven east on the vein 190 feet, and from this point northeast 90 feet to surface near the bottom of the hill. Drifts have also been driven west from the shaft 140 feet, and northwest 120 feet.

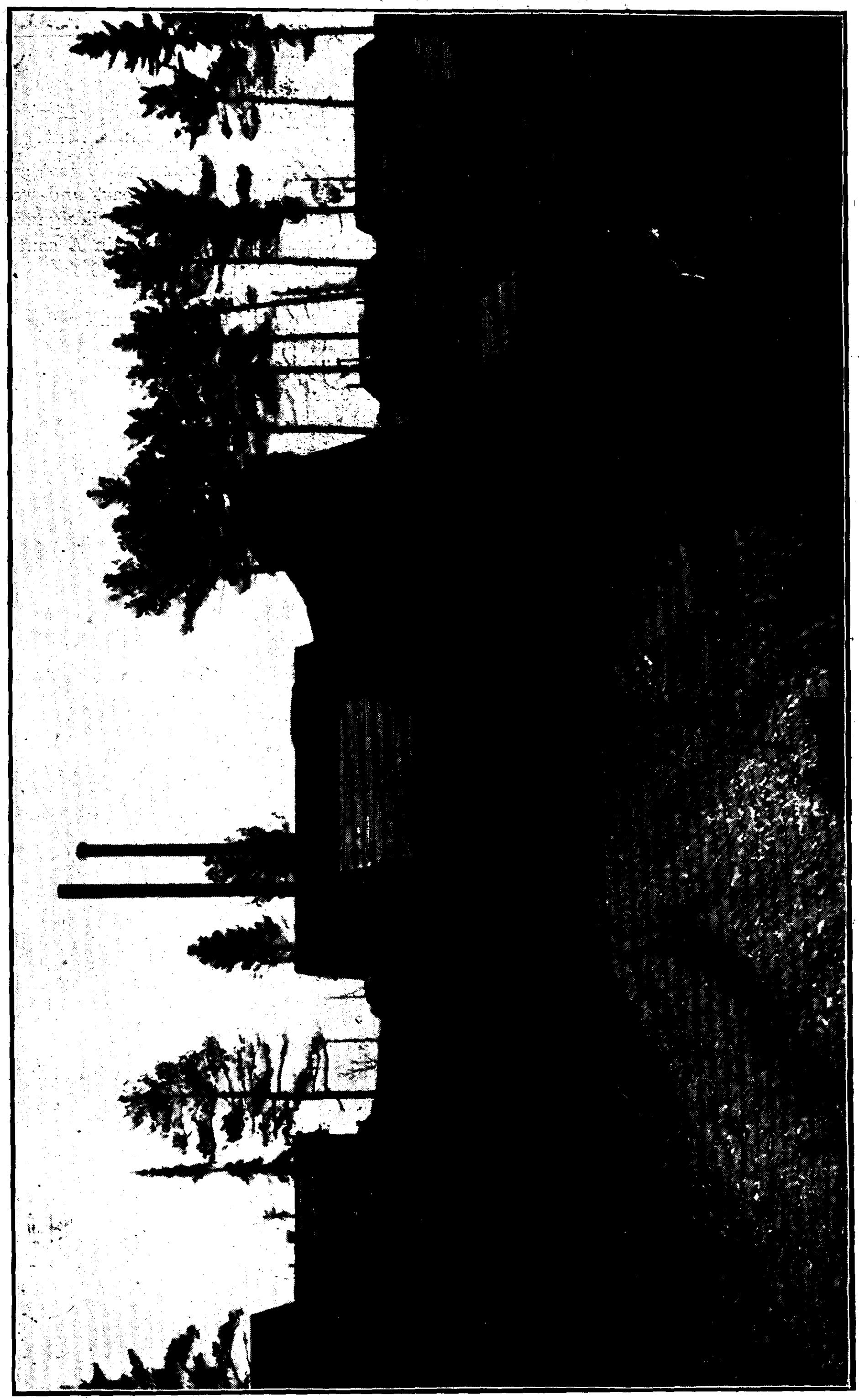
On the second level drifts have been driven east 180 feet and west 40 feet. From the shaft a crosscut is being driven north to the cobalt vein 450 feet north of No. 1 vein. A distance of 300 feet has already been driven. The shaft is timbered for the entire depth, and safety cage used for hoisting.

The power plant is situated to the north of the shaft, and consists of two 80-h.p. boilers, a cross compound air compressor developing 1,510 cubic feet of free air per minute, hoist and electric light plant. An ore house has been erected east of the shaft.

A large sleeping camp and dining room have also been erected.



Temiscaming and Hudson Bay mine.

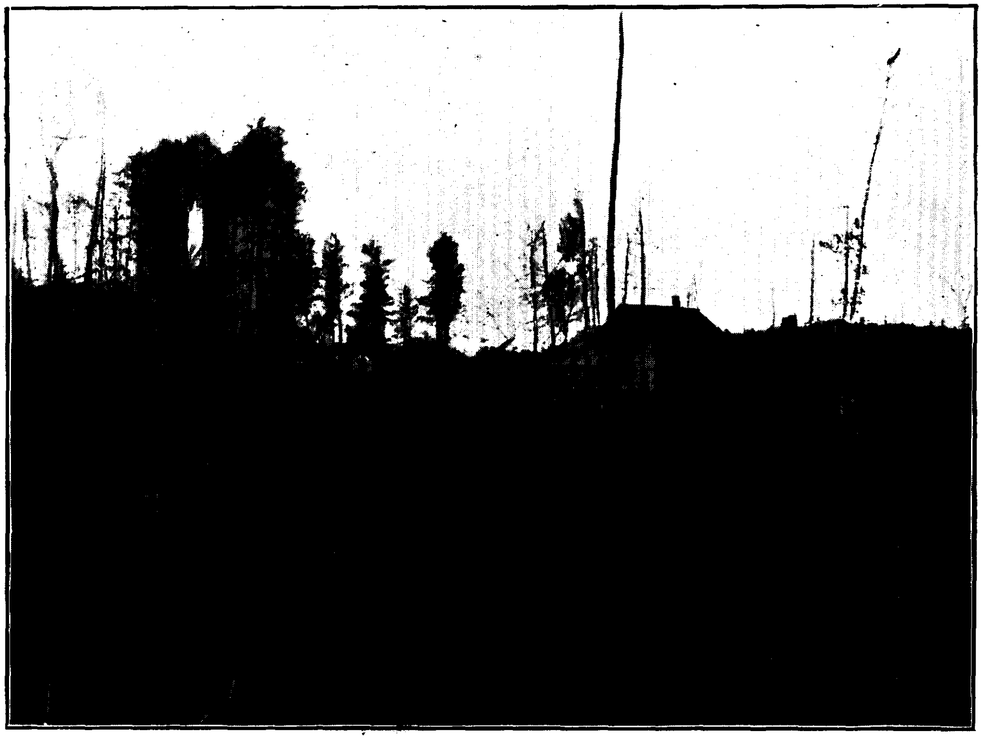


Trethewey mine.

Trethewey Mine

This property is owned and operated by the Trethewey Silver-Cobalt Mine, Limited, of which Mr. A. M. Hay is president and Mr. G. F. McNaughton, superintendent.

No. 1 shaft has been sunk a depth of 140 feet, the first level being at 60 feet and the second level at 125 feet. From the first level drifts have been run east and west on the main vein 225 feet and 175 feet respectively. This main vein is designated as vein A. At 65 feet east of the shaft, vein B has been followed from vein A southeast 125 feet. From vein B crosscuts have been run south and southwest 50 feet and 125 feet respectively. From the southwest crosscut a raise has been put through to the surface. At the easterly ends of vein B a winze has been sunk to the second level. At a point 150 feet east of the shaft on vein A a drift has been driven east on vein F a distance of 250 feet. From vein A near the intersection of vein B a crosscut has been driven north 275 feet. Vein D was encountered 150 feet north of vein A, and a drift 125 feet in length was driven on it.



Victoria mine.

On the second level a drift has been run east 175 feet. At this point a raise has been put through to the first level. A crosscut has also been driven south a distance of 100 feet to connect with the winze from vein B from the first level. Considerable stoping has been done on the veins above the first level. On the surface west of the shaft some open cut work was done on what was known as the cobalt vein.

No. 2 shaft about 600 feet east of No. 1 shaft and on the east side of the hill has been sunk to a depth of 100 feet. The first level is at a depth of 50 feet. On this level drifts have been driven east 100 feet and west 75 feet. Shaft houses have been erected at both No. 1 and No. 2 shafts, and at No. 1 shaft an ore sorting house has been built.

The power plant consists of two 80-h.p. return tubular boilers, a cross compound compressor developing 1,015 cubic feet of air per minute, two hoists and an electric light plant.

A force of 45 men is employed.

Temiskaming Cobalt Mine

This property formerly described as the Benn mine is situated on the north part of lot 15 in the first concession of Bucke.

A 15-h.p. upright boiler and hoist have been installed and a shaft 75 feet in depth has been sunk. The level is at a depth of 60 feet with drifts east and west 100 feet respectively. The property is owned by the Temiskaming Mining Company with Mr. F. J. Warner as manager.

Violet Mine

The Violet mine situated on the northwest quarter of the south half of lot 3, in the sixth concession of Coleman was not in operation at the time of my inspection.

The vein was open cut for a depth of about 40 feet by 65 feet in length. A shaft has been sunk to a depth of 120 feet with the first level at 85 feet. On this level drifts have been driven north 55 feet with some crosscutting west from this drift and south 35 feet.

University Mine

The University mine is controlled by the La Rose Mining Company, but has not been in operation since July, 1907.

No. 1 shaft is 160 feet in depth with levels at 50 feet and 100 feet. On the first level, drifts have been run east and west on the vein 110 feet and 100 feet respectively and some stoping done on the vein on each side of the shaft. From the same level a crosscut has been run north from the west drift about 90 feet. On the second level a drift has been driven west 125 feet, and some crosscutting done on this vein. The east drift has been driven 150 feet. Some stoping has been done west of the shaft.

No. 2 shaft near the boarding house has been sunk 50 feet with 60 feet of drifting to the east done.

The power plant consists of two 60-h.p. boilers, the high pressure half of a 10-drill compressor and electric light plant. A 50-foot shaft has been sunk on the hill near the power house, as a central working shaft, but this was discontinued by the new management.

Wright Mine

This property, situated immediately west of the Coniagas and north of the Buffalo on the town site of Cobalt, is being operated by the Cobalt Central Mining Company under the direction of Mr. J. M. Young.

A shaft 65 feet in depth has been sunk, and at this level drifts driven west 25 feet and south 25 feet.

Shipments

On page 20 a table is given showing the tons of ore shipped from the various mines in the vicinity of Cobalt to the end of 1907. The following shows the shipments since then:

SHIPMENTS FROM THE COBALT DISTRICT FOR THE FIRST FIVE MONTHS OF 1908.

Mine or Company.	1st 3 months.	April.	May.	Total.
Buffalo	206.38	51.94	46.65	304.97
Casey Mountain	20.00	....	....	20.00
City of Cobalt	110.97	55.26	....	166.23
Cobalt Central (Big Pete)	44.85	28.74	24.60	98.19
Cobalt Lake	88.65	1.96	32.92	123.53
Cobalt Townsite	41.36	....	....	41.36
Coniagas	193.61	....	62.34	255.95
Crown Reserve	6.84	20.00	....	26.84
Drummond	46.17	....	28.13	74.30
Foster	54.30	....	34.90	89.20
Kerr Lake	134.42	30.57	30.98	195.97
King Edward (Watts)	119.35	....	33.00	152.35
La Rose	929.40	431 90	160.00	1,521.30
McKinley-Darragh	379.55	182.51	124.83	686.89
Nancy Helen	69.52	....	....	69.52
Nipissing	442.22	112.35	251.75	806.32
Nova Scotia	40.39	20.00	53.38	113.77
O'Brien	725.94	126.00	360.78	1,212.72
Provincial	24.60	51.24	....	75.84
Right of Way	29.35	....	91.02	120.37
Silver Cliff	26.80	....	....	26.80
Silver Leaf	31.00	35.40	31.91	98.31
Silver Queen	244.99	21.95	55.16	322.10
Temiskaming (Temiscamingue)	112.72	....	44.07	156.79
Temiscaming and H. B	135.20	60.50	30.00	225.70
Trethewey	241.91	96.40	158.77	497.08
Totals	4,500.49	1,326.72	1,655.19	7,482.40

The output of silver from the camp during the first three months of 1908 amounted to 3,673,047 ounces, valued at $1,938,840. It is estimated that the ore shipped during this period contained 325 tons of cobalt, valued at $32,974. Nothing was received for the nickel in the ore and little for the arsenic.

CHAPTER III[18]

OTHER TEMISKAMING COBALT AREAS

Report on Part of Montreal River and Temagami Forest Reserve, District of Nipissing, including Townships of James, Tudhope, etc.

BY CYRIL W. KNIGHT.

The map, on a scale of one mile to the inch, accompanying this report takes in an area of one thousand and eighty square miles, and includes thirty townships, a few of whose boundaries were not surveyed in 1907. Less than one-third of this has been geologically colored. The southeast corner is three and a half miles west of the town of Latchford on the Temiskaming and Northern Ontario Railway. Bear Creek, in the township of James, now known as the town of Smyth, which was the centre of prospecting activity during the summer of 1907, is some thirty-seven miles northwest of the town of Cobalt. During the past summer (1907) a line of small steam and gasoline boats ran from Latchford up the Montreal river, to Bear creek, the trip taking from eight to ten hours depending on circumstances.

The methods and stratigraphical prinicples used by Willet G. Miller in mapping the Cobalt area were employed. Every square mile of the area geologically mapped was travelled, pacing being used to tie in contacts. Some of the townships have been divided into forty-acre lots (quarter of a mile square) by prospectors. Parts of the geology on these mining claims were taken from the notes of mining inspectors James Bartlett, A. G. Burrows, D. W. Houston, R. T. Irwin, G. C. MacKenzie, G. R. McLaren, C. W. Murray and E. Wade. The members of the geological party were: W. M. Goodwin, G. E. Kidd, W. R. Rogers and R. B. Stewart. The writer was not able to spend much time in the field, and most of the mapping was done by these gentlemen. The extreme western angle of the township of Coleman, together with a small part of the township of Kittson was geologically mapped by J. S. DeLury in the summer of 1906.

The Montreal river flows southeasterly (in this region) and divides the map roughly into two halves, the southwest half of which is part of the Temagami Forest Reserve. Much of the surface of the county is similar to that at Cobalt. In the southwest part of the area there is some very rough country. What is probably one of the highest hills on the peneplain of Northern Ontario is known as Maple Mountain, occupying parts of the townships of Banks, Whitson and Rorke. Its elevation has been given as 2,000 feet above sea level.[19] The mountain was named by Dr. Bell, of the Canadian Geological Survey in 1888. It rises between 950 and 1,000 (aneroid determination) above Anvil lake, which lies to the east about a mile. The ascent is easily made along the surveyed line of the south boundary of the township of Whitson. There are few places in Northern Ontario from which a better view may be obtained. One realizes what is meant by a peneplain when he notes the apparent, gently undulating, plane-like nature of the region to the east as seen from the mountain. The country to the west is much more rugged.

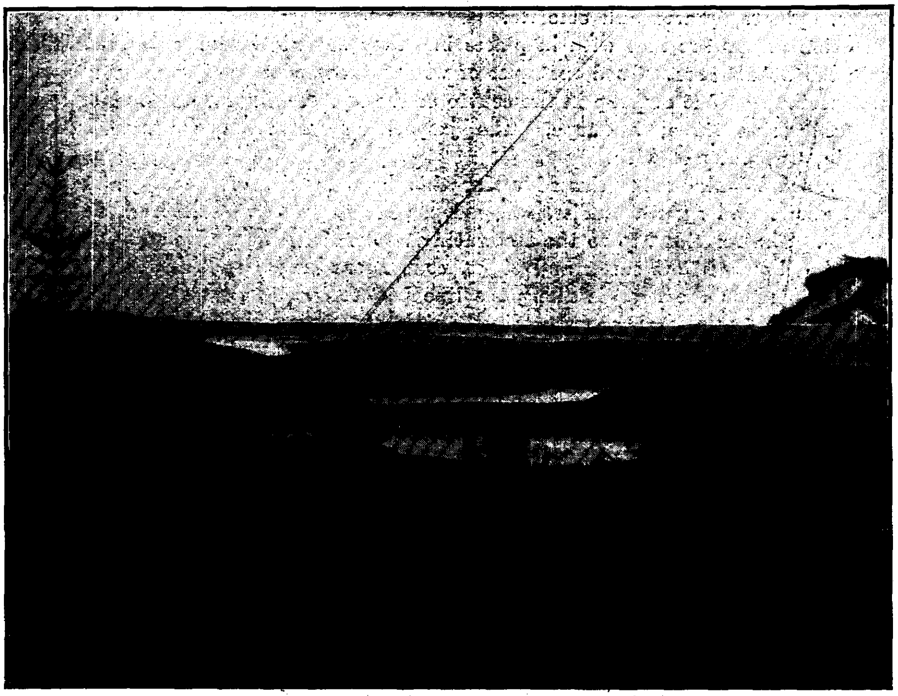
[18] In this chapter six cobalt-bearing areas, discovered since the Cobalt area proper, are described briefly. They are (1) part of Montreal River and Temagami Forest Reserve, (2) Bloom Lake, (3) Townships of Casey and Harris, (4) Wendigo Lake, (5) Bay Lake, (6) area south of township of Lorrain.

[19] Report of Canadian Geological Survey for 1897.


A stretch of Montreal river, Elk lake.

Rocks of the Area

Prospectors who are familiar with the geology of the Cobalt area will find the same kind and succession of rocks in the Montreal river area, where mapped by us. The rocks have been separated, therefore, into the same divisions as worked out by Willet G. Miller at Cobalt. We did not, however, find any contact between the quartzite-arkose series and the Lower Huronian conglomerate. At Cobalt the former is classed as Middle Huronian, and there is an unconformity between it and the underlying older



Looking southwest from the top of Maple mountain, Township of Rorke, district of Nipissing.

Lower Huronian. It is possible that the same relationship holds true in the Montreal river area, but on the geological map accompanying this Report the two series have simply been classed as Huronian. If the economic importance of the district warrants more detailed mapping this point will no doubt be cleared up.

Glacial and Post Glacial	Boulder clay, sands, gravels, clays.
	Great unconformity.
Huronian or Keweenawan (?)	Diabase.
	Igneous contact.
Huronian	Quartzite, arkose, conglomerate and slate.
	Great unconformity.
Laurentian	Granite, syenite and gneiss intrusive into Keewatin but not into Huronian.
	Igneous contact.
Keewatin	The series is an igneous complex, consisting generally of highly metamorphosed basic igneous rocks.

Beginning with the oldest series the divisions are as follows:

Keewatin. In the field a convenient term is "greenstone." It is both massive and schistose. The only areas met with were in the township of Tudhope. On lot seven, concession three, it is in places a rather coarse amphibolite, consisting almost wholly of green hornblende occurring for the most part in grains about one-eighth of an inch in diameter, and also in fibrous masses. Small amounts of epidote and quartz are also present. In other places it is a dark, grayish green, fine grained variety, which under the microscope is seen to consist mainly of small rods and irregular grains of green hornblende, together with allotriomorphic grains of twinned (and untwinned) feldspar, epidote, quartz and chlorite.

Torsion cracks are met with in places but they are not as large as those generally seen in the Cobalt area. Good examples of what is known as "ellipsoidal structure" are seen, especially on one outcrop in the centre of the square mile formed by lots seven and eight, concession three, Tudhope. The jasper-iron formation, characteristic of the Keewatin, was not met with.

Laurentian.—The rocks classed under this head consist of coarse-grained granite, granite gneiss and syenite gneiss, many exposures of which are seen in the township of Smyth. The relationship to the Keewatin is splendidly exposed on the north half of the lot line between lots seven and eight, concessions three, township of Tudhope. A good way to reach the area is along the line between concession two and three. The granite here is a uniform, coarse-grained, pink variety similar to that exposed about four miles to the west on lots four and five, concessions two and three, James township. The granite clearly invades the greenstone, and is therefore younger in age.

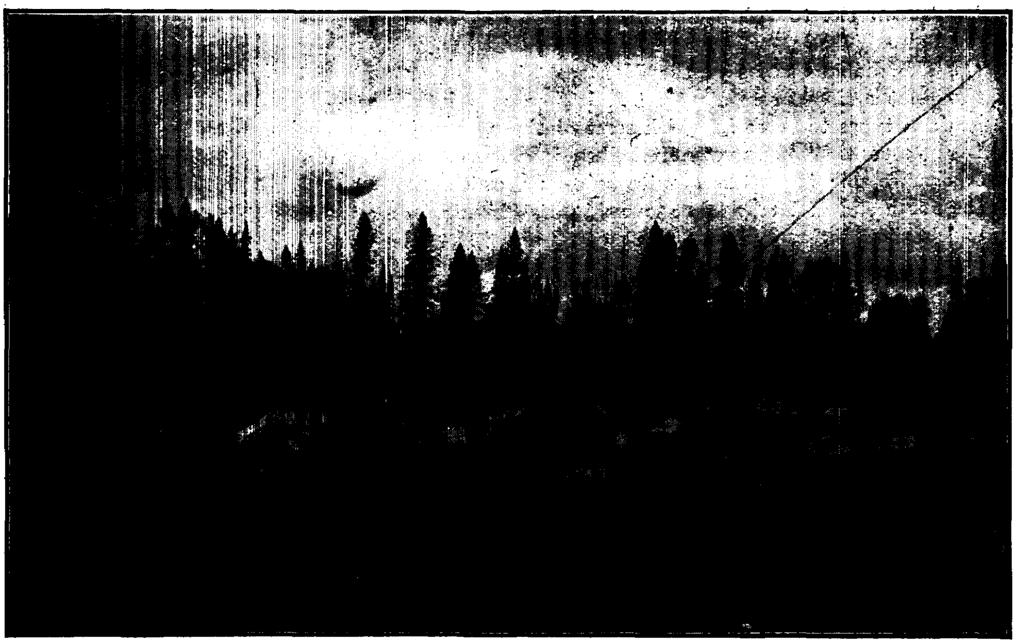
The contact is irregular and sriking in appearance. Thousands of dikes from a foot or more down to a fraction of an inch are found ramifying in all directions through the greenstone. The light color of these dikes contrasts strongly with the dark green Keewatin. Angular fragments of greenstone have been caught up and included in the Laurentian. The mineral epidote, with its peculiar yellowish-green (sometimes called pistachio-green) color has been abundantly developed in the greenstone at its contact with the granite.

The prospector who desires to understand the relationship of the granites and gneisses of the Laurentian to the Keewatin greenstones should visit this contact.

Huronian.—(1) *Conglomerate Series.*—These rocks do not differ essentially from the Lower Huronian series at Cobalt, but we did not find any fragments of the Keewatin iron formation in them. On the north part of lot ten, concession five, James township, there is an area of conglomerate which contains a considerable number of granite boulders with typical gneissoid structure. The Laurentian which is in place immediately to the west is similar to some of these gneissoid boulders. The unconformity between the Laurentian granite and the overlying conglomerate is well exposed on lots four and five, concessions two and three, James township. Here there is an irregular belt of granite generally less than half a mile in width. It is easily reached from the Montreal river by going west along the line between concessions two and three. The fragmental series is well exposed on the east shore of a small lake known as "Deserted." A few hundred feet from the shore and thence southerly along the contact with the granite will be found good exposures for study. The granite is a uniform, coarse-grained, pink variety similar to that in the eastern part of Tudhope township, a few miles to the east. A gneissoid structure was not seen in the vicinity of Deserted lake. Under the microscope the granite is seen to be made up of quartz, feldspar and a colored mineral. The latter is now decomposed to a dark green, strongly pleochroic chlorite; some of this has a hexagonal outline suggesting that the original mineral was a mica, probably biotite. The quartz occurs in allotriomorphic (having no regular crystal outline) grains, and is the last mineral to crystallize out. The feldspar is a pink orthoclase, together with an acid plagioclase, the latter showing albite twinning lamellæ. Some of the feldspar is idiomorphic. As is usual, both the feldspars are slightly decomposed. At the contact of the granite with the overlying fragmental series, the former is seen to have broken down in places *in situ*. The granite pebbles and boulders in the conglomerate are similar to the granite of the underlying floor. There is no evidence of an igneous contact.

In the Cobalt area (township of Coleman) there is no known contact showing the relationship of these two great series of rocks. The prospector therefore will do well to visit the place and see the relationship for himself.

(2) *The Quartzite-Arkose Series.*—There are considerable areas of this series. We found good exposures in the southwest part of James township, in Barber, in Speight, Whitson, Van Nostrand, Rorke, and in the vicinity of Lady Evelyn lake. The rocks do not differ materially from the Lorrain arkose and quartzites on the shores of the north part of lake Temiskaming. There are, however, more of the quartzites than the arkose in the Montreal river area. One of the most prominent hills in northern Ontario, known as Maple mountain, is composed, so far as our explorations showed, of cream-colored, yellowish, to flesh-colored quartzites. In rare cases the series becomes conglomeratic by the appearance of rounded white quartz pebbles. The mountain is in



Elk City, James township, summer of 1907.

the eastern parts of the townships of Banks, Whitson and Rorke. Its outline is indicated on the map accompanying this Report. The series consists essentially of fragments of quartz together with some feldspar. In some areas the prospector may have difficulty in distinguishing certain phases from granite, because the arkose is merely a broken down and partly decomposed granite.

As already stated we did not find a contact between these quartzites and the Lower Huronian conglomerates, so that the relation to the latter is not yet clear. It may be conformable and younger, or there may be an unconformity as was found by Willet G. Miller on the west shore of lake Temiskaming.

Diabase and Gabbro.—These rocks are economically the most important in the area under review, because the cobalt-silver veins occur in them. Their exact age is not known, but where their contacts with the other rocks have been met with they are seen to penetrate them, and are therefore the youngest series in the field. Like similar

10 M

rocks at Cobalt they appear to be in the form of sheets or sills, and we saw no evidence of surface flows. At the southwest corner of lot ten, concession five, James township, there is a small area of quartzite or arkose. It lies at the foot of a diabase hill which showed a height of 120 feet by aneroid barometer. The diabase overlies this fragmental material. The actual contact is 450 feet east of the northwest corner of the northwest quarter of the north half of lot ten, concession four. The arkose floor upon which the diabase rests, dips gently to the southeast. It may be traced south of the concession line for about a hundred feet. At the immediate contact the two series have been fused together but otherwise the arkose does not appear to have been altered. The structural relationships here appear to show that the diabase is in the form of a sheet.

Other contacts with the diabase are as follows: On the southwest quarter of the north half of lot ten concession five, James Township, it is seen to invade the Laurentian gneiss. At the southeast corner of the northeast quarter of the north half lot five, concession three, James township, it also invades the granite. On the northwest quarter, north half, lot four, concession five, James township, it is seen to be younger than the Huronian conglomerate. On the west shore of a small lake known as Beaver, in the township of VanNostrand, the diabase is seen to be younger than the quartzite. The latter, however, in this case overlies it.

The diabase series of the Montreal river presents somewhat greater variety than that of the silver area at Cobalt. It is usually medium in grain, but varies from fine grained types to those in which some of the pyroxene individuals are an inch in length. In some cases it shows very marked magmatic differentiation, that is to say it may pass into more acid types like syenite or even granite. An example of the latter is seen on the north end of Darby lake, township of Whitson. Frequently a pink feldspar develops which gives the rock a reddish appearance. Sometimes this feldspar is present in large amount, resulting in a syenite. Such a facies occurs on White Bros.' mining claim (T R 207), township of Whitson. A thin section of this showed the rock to consist of an acid plagioclase and hornblende, together with a little augite, quartz, titanite and ilmenite. The feldspar is nearly all striated, and shows extinction angles under 15 degrees. Mr. A. G. Burrows separated this pink plagioclase from the rock and analyzed it with the following result:

SiO_2	67.76
Al_2O_3	17.86
CaO	2.37
MgO	.27
K_2O	2.48
Na_2O	6.87
FeO	1.6
	99.21

Regarding the variety of this feldspar Mr. Burrows says: "The high per cent. of silica would indicate albite, and there is also very likely a little orthoclase, as I noticed there seemed to be a very slight difference in the reddish portion of the sample, some parts being pinker than others. The alumina seems low for an albite and quite low for an oligoclase-albite, but it may be partially replaced by iron oxide. I simply calculated all the iron to ferrous oxide."

In other instances the diabase series carries quartz in micrographic intergrowth with feldspar, resulting in a quartz-diabase. Such an example is found at the southwest corner of lot four, concession six, James township. It consists essentially of plagioclase, augite and micrographic intergrowths of quartz and feldspar. The plagioclase occurs in rods and stout prisms, and the ophitic texture is marked. The augite is pale brown and non-pleochroic, and has partly altered to green fibrous hornblende and chlorite. The micrographic intergrowths of quartz and feldspar together crystallized out last.

On the lot immediately to the south the rock is also a quartz-diabase.

A group at Elk lake, October, 1907.

On the west shore of Bergeron lake, township of VanNostrand, there is an interesting dike cutting the quartzite series. Its position is indicated on the map. It begins at the northeast corner of J S 163, and can be traced northwest a quarter of a mile, showing a width of 75 feet. It is coarsely porphyritic, the phenocrysts of plagioclase sometimes having a length of two inches. Under the microscope the ground mass is seen to be made up of rods of plagioclase, pale brown augite, olivene and magnetite (or ilmenite). The texture of this ground mass is distinctly ophitic. The dike is a porphyritic-olivene-diabase.

We found a similar rock on the southeast end of Kerry lake, township of Van Nostrand.

In the field the prospector may sometimes find it difficult to distinguish between a diabase and gabbro. They both have the same composition, consisting essentially of pyroxene and a basic plagioclase feldspar. The difference in the two rocks is one of crystallization. In a gabbro the two main constituents have crystallized out practically at the same time, so that there was not room to allow crystal faces to form. In a diabase, however, the plagioclase has crystallized out first, generally in rods. Then followed the pyroxene, so that we find rods of plagioclase embedded in the pyroxene, giving what is known as an "ophitic" texture. The ophitic texture is, according to Prof. Kemp, a matter for the microscope. Diabase is characteristically finer in grain than gabbro and is commonly called "trap."

Glacial and Post-Glacial.—Boulder clay, sands, gravels and clays cover much of the area. The glacial striæ on top of Maple mountain are from 1 to 15 degrees west of north, whereas on lower altitudes they are usually some degrees east of north.

Notes on Veins

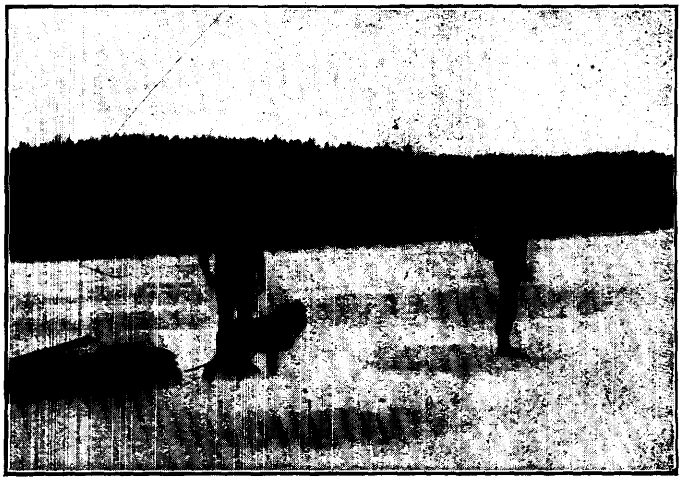
The development work done during the summer and fall of 1907 throughout the Montreal river area is too meager to base any guesses as to the future of the district. What is very striking, however, is the wide area over which the mineral cobalt bloom in small quantities has been found—in the majority of cases occurring in small cracks in the diabase series. The centre of James township is about 37 miles northwest of the town of Cobalt. At many places between these two points "bloom" has been found. It was not found practicable to attempt to show these innumerable small cracks on the map accompanying this Report. Some of them contain native silver. They have been found in the townships of VanNostrand, Whitson, Banks, Speight, Barber, Tudhope, James, Mickle, Farr, Smyth and in other townships; also some miles farther north at Bloom lake, which is in unsurveyed territory.

Many of these small veins differ in character from the Cobalt type. They are aplite dikes—sometimes, in this region, spoken of as diabase pegmatites. They have the composition of a granite, but are finer in grain and contain few colored constituents, like mica or hornblende, etc. A thin section from a dike in Smyth township (southwest quarter, south half, lot eight, concession two) was studied under the microscope. It is seen to consist of irregular grains of quartz and feldspar. A few grains of epidote occur. A small amount of calcite is present; this is seen to be younger than the other parts of the dike, because it occurs in cracks and ramifies between the grains of the quartz and feldspar. A vein on the Currie claim, on Hubert lake, township of Farr, also shows that the calcite is later than the quartz or feldspar. It is possible that this relationship does not always hold. On the shores of Silver lake, township of Mickle, the calcite in some of the veins there was deposited later than the quartz. The latter has crystallized in prisms more or less at right angles to the walls of the crack. Calcite has later on come in, together with certain copper sulphides (bornite and chalcopyrite). Native silver when present was probably deposited with the calcite. Thin sections from other aplites in Tudhope and Farr sometimes show quartz and feldspar in micrographic intergrowth. Chlorite is also sometimes present, apparently secondary after some ferromagnesian constituent.

These aplite dikes are supposed to have been formed by cracks appearing in the diabase as it cooled and contracted; they were subsequently filled with vein or dike material, which probably came from hot solutions (aqueo-igneous) given off by parts of the diabase still molten. Small scales of native silver occur frequently in the aplites.

(It is interesting to know that veins or dikes carrying cobalt, somewhat similar to those of the aplite of the Montreal river area, are found in South Africa. The geologists who have studied these veins or dikes in both Ontario and South Africa have come independently to the conclusion that they are probably of igneous origin. A brief description of the South African veins is given on a following page. W. G. M.)

Some of the veins have the same general character as those at Cobalt. The former sometimes, however, contain barite, which was not known at Cobalt. A few only of the numerous mining claims are here mentioned by way of illustration. (1) White Bros.' and Darby claims at Darby and Morin lakes, east part of Whitson township. White Bros. own three claims, known as T R 173, 207 and 210. The Darby claims lie adjacent to the north and are known as H F 23, 24, 25. They occur in a belt of diabase which lies at the foot of and is roughly parallel with Maple mountain. This diabase ridge rises in places about 300 feet (aneroid measurement) above Anvil lake. Its relation to the quartzite of Maple mountain was not worked out on account of the covering of drift. The base, however, was seen to be resting more or less horizontally on the underlying fragmental series. It is possible that the sheet simply thins or



Prospectors, with outfit, travelling up Montreal river, March, 1907.

pinches out when it reaches the foot of the mountain, or it may have continued as a sheet under the mountain. The veins here have all a general northwest and southeast trend and are more or less vertical. There are several of these on the White Bros., two of which are mentioned: (*a*) On T R 173, immediately south of Morin lake, there is a small pond at the southeast end of which is found what is probably the most promising vein in the Anvil lake country. It strikes E. 20 degrees S. (magnetic). At the bottom of the hill there is an open cut ten or twelve feet long and a few feet deep. The vein here shows an inch and a half of calcite carrying some smaltite. It has been stripped up the hill for one hundred feet, in which distance it appears to be represented largely by a crack. For an inch or so on each side and at several points along it native silver is found in leaves in the wall rock. Small quantities of smaltite are also present. The vein was visited by Willet G. Miller in March, 1907, when the snow was still on the ground. (*b*) On the lot adjacent to the south (T R 207) vein No. 1 strikes N. 45 degrees W.

(magnetic). It is at the northwest part and 100 feet south of the lot line. In October, 1907, there was a shaft down 6 feet deep exposing a vein of smaltite an inch and a quarter in places. Some native silver was seen at one point.

On the three Darby claims there are six small veins from an inch and a quarter in width, down. Five of these are on the shore of Darby lake, the edges of which are very steep. Most work has been done on the vein 250 feet south of the northeast corner of H F 23. The vein strikes W. 6 degrees S. (magnetic). Along the north face of this a tunnel has been driven 50 feet. Considerable cobalt bloom occurs along this main crack which is about an inch wide, and in other smaller parallel fissures and cracks.

Tobogganing ore on the ice of Montreal river, March, 1907.

(2) Bergeron's claim at south end of Bergeron lake, township of Van Nostrand. About 250 feet southeast of the portage a shaft has been sunk 25 feet. There is a vein here which shows about an inch of smaltite. Between here and the end of the portage mentioned another shaft has been sunk at the junction of two cracks. Cobalt bloom was noted on the surface at some points. The veins are in diabase.

(3) Moose Horn Mines, Limited, (Gifford), the northwest and northeast quarters, north half lot four, concession five, James township. There are about half a dozen veins on these two lots all occurring in a rather fine-grained diabase. They carry smaltite and some native silver. One of these in September, 1907, showed an inch of smaltite carrying native silver in quantities usual in the rich ores at Cobalt.

(4) Shane-Darragh claim, southeast of Silver lake, township of Mickle. In September this lot had not been surveyed by an O.L.S.; it is therefore shown by dotted lines on the map. The vein is near the southwest corner and strikes N. 70 degrees E. At

the time of my visit about six feet had been stripped. In this distance it had a width of from two and a half to seven inches. The gangue is calcite, quartz and feldspar. The place at which the vein measured seven inches in width contained native silver, mixed with the gangue, from wall to wall. The ore here would be considered rich in the Cobalt camp. No work was being done on account of a dispute. This was the most promising vein seen by the writer in the Montreal river area.

(5) On the east shore of Skull lake, township of Speight, there are several veins averaging about an inch in width, containing smaltite, and in some cases a little native silver.

(6) The Munroe group of claims is in the northeast part of James township, and about the centre of the diabase area shown on the map. According to Mr. C. W. Murray (mining inspector during the summer of 1907) there are several veins carrying native silver on this group of claims.

(7) The Downey group. These claims are in the south part of lot ten, concession five, James township, and at Silver lake, township of Mickle. On the southwest quarter, south half lot ten, concession five, James, there is a three-inch vein of calcite showing some native silver. A shaft was sunk here fifty feet, according to Mr. Murray. Mr. Downey's claim on Silver lake also has veins carrying some native silver.

There are other claims in the vicinity of Silver lake carrying native silver.

(8) The Harbeck claim (southeast quarter, north half lot one, concession five), also carries native silver.

(9) The Fenwick-Ellis claim (northwest quarter north half lot one, concession five, James township), has a four-inch vein carrying native silver.

Canoe Route from Spring Creek (N. E corner Township of Speight) on Montreal River, southerly to Lady Evelyn Lake

On account of the cobalt and silver mining claims near Anvil and Bergeron lakes, the following description of the canoe route is given. It was used considerably in the summer of 1907.

With a loaded canoe it takes about two and a half hours' paddle from the mouth of Spring creek to Mendelssohn lake (Trout lake). The distance in a straight line is only about 2¼ miles, but the creek is extremely sinuous. There is a portage of eight chains near the lake. At low water, however, it is necessary to get out at several points. Mendelssohn lake is three and three-quarter miles long. The portage at the south end is a mile and an eighth to a shallow pond; a small creek from Greenwater lake flows into it. At the south end of the creek there is a short portage of 12 chains.

Greenwater lake is about three-quarters of a mile long; the portage into Holden lake is only a few chains. From the latter into Beaver there is a lift of 17 chains. This is a shallow muddy pond. The last mentioned portage is the height of land between the Montreal river to the north and Lady Evelyn lake to the south.

From Beaver to Niccolite lake the portage is ten chains. A very shallow creek from a bay on the west side of the lake flows south into a small pond, sometimes referred to as Little Niccolite lake. There is a short portage between the two which is used in low water. From the pond to Bergeron lake the portage is 4 chains.

From Bergeron lake there is a portage of 35 chains to a stream which flows into Anvil lake. The stream is navigable with canoes for about three-quarters of a mile, after which a portage of 15 chains leads to a bay in Anvil lake known as Hammer lake. The trail to White Bros.' claims at Darby lake runs westerly from here about a mile.

Anvil lake is a little over two miles long. A 5-chain portage at the south end leads to a small lake known as Inez. From here to Bessie the portage is 15 chains. From Bessie to the creek flowing into Old Bill lake the portage is 17 chains. The south part of this creek is navigable. The creek from Old Bill to Emily lake is also navigable with canoe.

The portage from the southeast shore of Emily lake to Lady Evelyn lake is three-quarters of a mile over a rough hill. It may be avoided by taking the creek (which is navigable with the exception of three short rapids) from the south end of Emily lake to Willow Island lake. We made this latter trip on October 16, 1907, in an hour, the water being high for that time of year. From the mouth of the creek there is a paddle northeasterly of about a mile to what is known as Willow Island falls (a drop of about six feet) the portage being only a few chains over a polished and very slippery quartzite. From the foot of the falls the northwest branch of Lady Evelyn lake begins.

To sum up, the total length of portages from the northwest arm of Lady Evelyn lake to the mouth of Spring creek on the Montreal river is three and three-quarter miles.

Forest fire on the east side of Cobalt lake, opposite the railway station, June, 1905.

Notes on the Bloom Lake Area

By W. R. Rogers

Winter Road.—During the latter part of January, 1908, parties interested in the district got together and cut out a road starting from Cahill & Jodouin's tie camp on the Montreal river. The tie camp is located on the south half of lot 14, concession IV, township of Smyth, its position being indicated on accompanying plan of the Bloom lake area. From the town plot of Smyth at the mouth of Bear river the road follows the west shore of Elk lake to its head, cutting off several points en route. The course followed from here to the tie camp is along the west bank of the river. From the tie camp the road follows a southwesterly course, and crosses the west boundary of Farr one and a half miles from the southwest corner of the township.

The north end of Bloom lake lies about 6½ miles due west from the point where the road intersects the township boundary. Several lakes are crossed, the chief of these being Hubert, Grassy, High Bluff and Pike lakes. The full distance by the new road from the tie camp to Bloom lake is 13¾ miles, of which 8¾ miles are cutting; the remainder crossing marsh land and lakes. In addition to this the portages between Bloom and Lost lakes, ¾ of a mile in all, have been cut out sufficiently to accommodate a team and sleigh. For the most part the winter road keeps to low land, crossing lakes and swamps, or following ravines and creek beds. Only two bad hills are encountered, and these occur on the eastward trip, rising from Pike and Green lakes respectively.

Summer Routes.—The route most travelled by prospectors during the past summer branches off from the Montreal river a short distance below Indian Chute. It starts off with a portage 1½ miles long which leads to Stony Creek. This creek with its numerous expansions is followed to Portage lake. In all there are nine portages from the Montreal river to Portage lake, and four additional between Portage and Bloom lakes. A portage of 50 chains in a westerly direction from the north end of Portage lake leads to the east branch of the Montreal river.

There is also another route by way of Bear river, following up its north branch to Twin lake, crossing over to Long Point lake, and proceeding north to Eagle and Pike lakes. The portages, however, are poorly cut out, and during low water the Bear river affords poor canoeing.

From the East Branch, Bloom lake is easily reached by way of Sanderson, Hunt, Birch and Pike lakes. The portages are short, well cut out and fairly level.

Drainage and Topography.—In general the surface of the district is broken, rough and rocky, the trend of the hills and ridges being in a northerly and southerly direction. A glance at the map will show that the lakes are chiefly long and narrow, wedged in between high ridges. The chain of lakes extending from Calcite to Portage drains into Stony creek. This area presents higher and more extensive ridges than are met with farther east. This is particularly noted in Bloom, Lost and Calcite lakes. The last is a very narrow lake, its southern end lying between precipitous walls of considerable height. High Bluff lake, and another lake of nearly similar size lying out half a mile east and a little south, find their outlet in Dead Moose creek. Otter lake, Ross lake and Grassy lake drain into the north branch of Bear river. Long Point lake drains northward into Pike lake and thence into Stony creek by way of Birch and Portage lakes. Prospectors report a chain of lakes ten or twelve miles in length extending south from Calcite lake. They have been little travelled as yet, and portages are poorly cut out.

Geology.—Very little information regarding the district in this particular could be gathered, due to the depth of snow and lack of time. Slate, with patches of coarse conglomerate and occasional small outcroppings of diabase occur between Grassy and High Bluff lakes.

According to prospectors' reports the formation is similar for two or three miles on either side of the winter road.

High Bluff lake was so named because of the high cliff on the east shore. This cliff, estimated to be 200 feet high, has a base of reddish banded slate, horizontally bedded. The lake east of High Bluff is said to have a rocky broken shore line on its east side, and the formation is reported as conglomerate. Slate is exposed on both sides of Long Point lake; the east side being especially rocky for nearly its whole length. This ridge is probably a continuation of the cliff on the east shore of High Bluff lake. On Bloom lake the diabase seems to be confined pretty much to the western shore. Towards the south end of Calcite lake there is a gulch on the east shore, marking the contact between diabase on the north and quartzite on the south. Just opposite this gulch is a high hill of diabase, much disturbed.

Work and Showings.—During our stay in the district the following were at work on their claims: Messrs. Shields and McKinnon; Sanderson, Hunt & Duncan; Cahill and Jodouin; Leroy; Grant and Scott; Burns and Son. The first named parties have a promising discovery on the shore of Bloom lake just south of Shields' island. The calcite vein, 6 inches to 8 inches in width, showing a good deal of bloom and considerable smaltite, has been stripped for over 100 feet along the shore. This claim has pasesd inspection. Several other promising leads have been uncovered, and some work has been done in opening them up. Small quantities of native silver are said to have been found on these claims, also on the Sanderson and Leroy claims.

West of Birch lake, on one of the Sanderson claims, there is a showing of galena imbedded in chloritic material. On another of the Sanderson claims, on the east shore of Portage lake between the two narrows, a calcite vein has been opened up, and shows bloom, copper pyrites and a little smaltite.

Map of the District.—The plan which accompanies this Report shows the main topographic features, including lakes in the district, the new winter road, sketch of summer route from Montreal river to Portage lake and of additional lakes to the east of Bloom lake. These latter were sketched from the only information available; and the size, shape and position of lakes and streams indicated only approximately by the dotted outlines.

A Mineralized Area in the Townships of Casey and Harris.[20]

By R. E. Hore.

On August 14, 1906, with Mr. Gerald Galt, I went west from the Blanche river along the Casey-Harris township boundary to lot 5, Casey township. From our camp at this point we examined the country for about three miles around. The map, which accompanies this Report, shows the distribution of the rocks in the parts of Casey and Harris examined by us.

Bucknell Property

About one hundred yards west of the southeast corner of lot 5, concession 1, Casey township, which is part of a farm owned by Jas. Snider, cobalt bloom was discovered by David Bucknell. Mr. Bucknell, who is the son of a farmer residing on the Blanche river, having seen the silver veins in conglomerate rock at Cobalt, recalled an outcrop of similar rock on a neighbor's farm, returned home, and found a vein the same afternoon.

A shaft sunk on the vein disclosed an ore body which is in some parts five inches in width. The chief values are in cobalt, nickel and arsenic, which are present in the minerals smaltite, chloanthite and niccolite, in calcite gangue. No silver was seen in the ore. Partings in the slaty wall rock are frequently filled with sheets of native bismuth for a few inches from the vein.

The vein, where it outcrops at the foot of a conglomerate ridge strikes about 25 degrees north of east. A few feet east of the shaft it disappears under the drift. In the opposite direction it is not well defined, there being only a narrow crevice to indicate its extension up the hill to the west.

A similar, but smaller, vein was discovered during the summer, and it is said to contain some native silver. This vein is about fifty yards west of the first one, which strikes N 70 degrees W.

Other Claims

Most of the surrounding country is heavily drift covered. Northwards the next outcrop of any extent is in the second concession. About one-half mile to the east a diabase ridge runs northwards. To the west is a low, flat, clay-covered area which extends southwards to Sutton bay. To the south, however, a ridge of conglomerate, locally called Casey mountain, extends to Sutton creek, and thence eastward along the bay shore.

On the Murray claim, which adjoins the Bucknell, there is a good showing of cobalt bloom. Elsewhere along the outcrop we did not see any important discoveries.

Development Work

At the time of our visit no work was being done on the Bucknell and Murray properties, as negotiations for sale were under way. We could not make a closer examination of the Bucknell vein as the shaft was nearly filled with water. This shaft was said to be only thirty-five feet deep, and consequently little is yet known of the extent of the ore body.

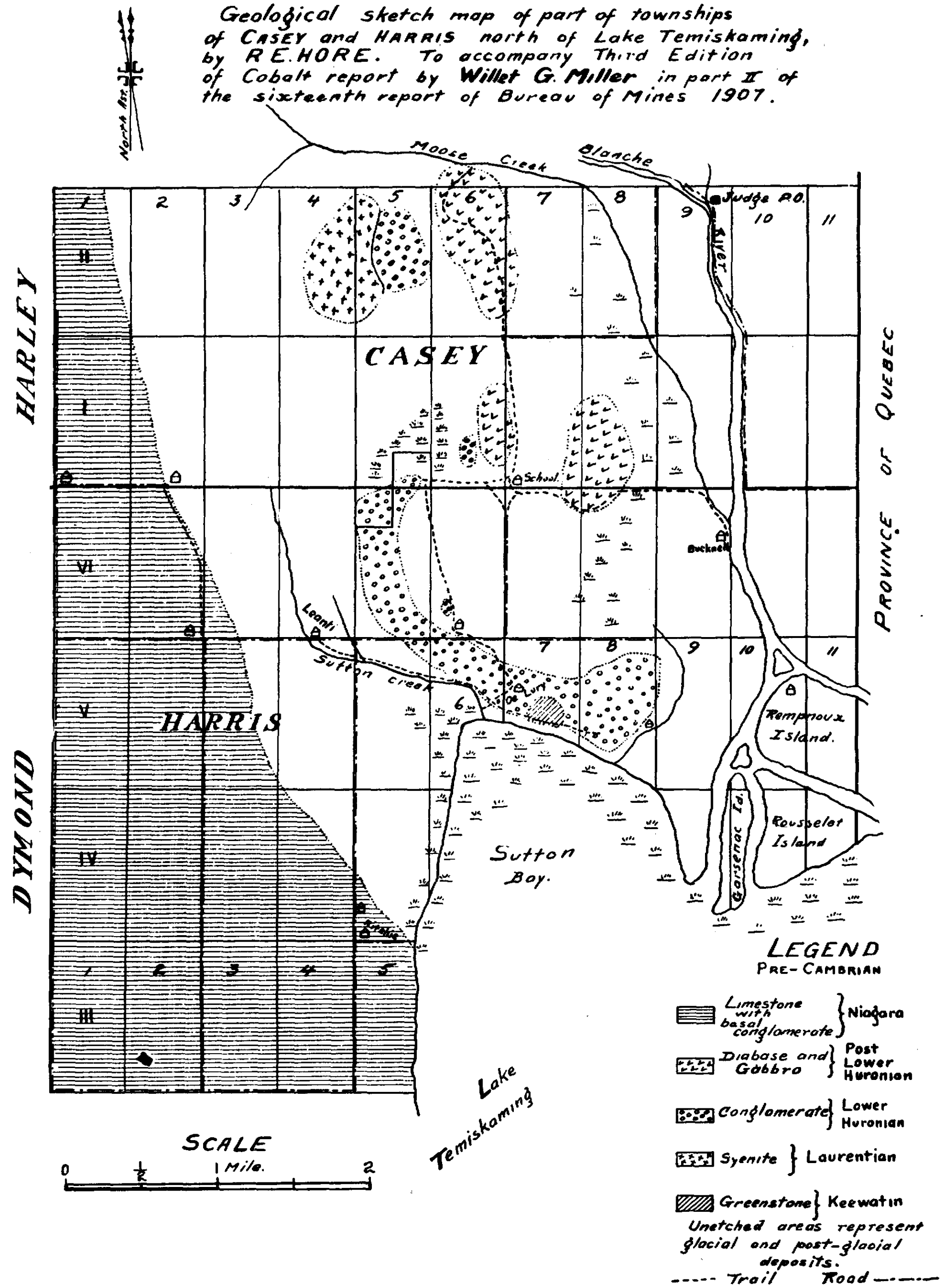
On several of the other properties pits have been sunk on small veins, without remarkable success. The rock has been well exposed in many places by forest fires, thus giving an opportunity for the prospector to work over the district rapidly. Most of the district is, however, heavily covered, and prospecting in the future must be slow and expensive.

Geology

There is a considerable variety in the rocks exposed in this small area. Greenstone, conglomerate and slate, basic and acid igneous intrusions, limestone and clay deposits are all found here.

[20] Since this report was written considerable development work has been done in the townships. W. G. M.

The greenstone is much metamorphosed and is probably the oldest rock in the district and of Keewatin age. A hornblende syenite of reddish color, intruding Keewatin, represents the Laurentian series, on which were deposited the Lower Huronian clastics. Diabase intrudes the Lower Huronian. The limestone must have been deposited after a great lapse of time, as it has been determined to be of Niagara age.



Classification According to Age

	7. Post-Glacial	Clay.
	6. Glacial	Drift.
	5. Niagara	Limestone.
	Unconformity.	
Pre-Cambrian	4. Post Middle Huronian	Diabase.
Pre-Cambrian	Igneous contact.	
Pre-Cambrian	3. Lower Huronian	Conglomerate, Arkose, Greywacké.
Pre-Cambrian	Unconformity.	
Pre-Cambrian	2. Laurentian	Syenite.
Pre-Cambrian	Igneous contact.	
Pre-Cambrian	1. Keewatin	Greenstone.

Post-Glacial

A high percentage of this area, and of the district to the north and northwest, is overlain by a deposit of clay and clayey marl. An extensive belt of clay is found on either side of the Blanche river for several miles from its mouth. The river brings down annually a large quantity of similar material, which is deposited in the shallow waters at the head of lake Temiskaming.

Settlers are gradually getting these lands cleared, and find the soil is fairly well adapted for farm purposes.

Glacial

There is very little glacial drift in the area. The only occurrenece of any extent is a moraine on the east of, and running parallel to, the Blanche river near Judge P.O

Niagara

The Niagara limestone of Wabi point covers the western part of the townships of Casey and Harris. The rock outcrops here and there along a cliff, the level of the limestone being over fifty feet above that of the clay flats. Grey colored limestone, interbedded with shales is the chief constituent of these sediments, which were years ago correlated with the Niagara of southern Ontario.[21]

Diabase

This rock outcrops about one-half mile east of the Bucknell discovery. The immediate contact with the sedimentary rocks is everywhere covered, and the delimitation of rock areas as shown on the map is therefore only approximate. In field appearance and in mineralogical composition, the several outcrops are quite similar to the diabase in localities to the north and south, where the field relations can be studied. It is therefore considered as part of the same magma as the sills of Cobalt and Wendigo districts.

A typical specimen is a dark gray, medium grained, crystalline rock, composed of bronze colored augite and light colored feldspars. Nearly all the minerals are colorless in thin section. Under the microscope the large augite individuals are seen to enclose the lath-shaped crystals of feldspar. In subordinate amount are brown pleochroic biotite, green chlorite, and opaque iron ore,—ilmenite or magnetite. The typical diabasic structure is not generally detected by the naked eye but, except in the coarser parts, is generally seen under the microscope.

The most extensive outcrops are in the southern parts of lots 7 and 8, concession 1, Casey, and in lot 6, concession II, of Casey.

Lower Huronian

The Lower Huronian is made up of greywacké slate, arkose and conglomerate.

Under the microscope the fine grained rock is seen to be composed largely of minute grains of quartz and feldspar, with here and there groups of larger particles

[21] G. S. C. 1863.

of these minerals (körnige grauwacké). Chlorite is a common constituent of the rock, giving it a dark color.

Similar material to this, enclosing pebbles of syenite, granite, diorite, etc., makes up the greywacké conglomerate.

Underlying the conglomerate north of Sutton bay is a rather poorly defined layer of arkose. This consists of medium sized grains of quartz and feldspar and some chlorite.

This series of rocks is remarkably free from any evidence of great disturbance after deposition, and in general character is quite similar to the clastic rocks at Cobalt.

Besides the well exposed ridge, already mentioned and known as Casey mountain, there is an outcrop of considerable extent on lot 5, concession II, Casey township. Small outcrops were found in lot 6, in concession VI, Harris, and concession 1, Casey.

Laurentian Syenite

Reddish colored syenite outcrops on lots 4 and 5, concession II, Casey township. A somewhat conglomeratic appearance is given to the rock by the inclusion of fragments of greenstone, which it has picked up in forcing its way through the Keewatin series.

The most abundant mineral in the rock is orthoclase, which is quite reddish in color. Long slender crystals of dark green color, resembling actinolite, is the other chief constituent. Under the microscope these green crystals are found to be quite pleochroic, and many cross sections show the typical cleavage and crystal habit of hornblende. Small particles of quartz are found in nearly all specimens, but, as the quantity is quite subordinate to that of feldspar, the rock is nearer the syenite than the granite type. Other minerals are sphene, iron ores and some secondary chlorite. The petrographical character, and the lack of evidence of metamorphism and chemical alteration, shows that the syenite is later in age than the Keewatin. The field relations show that it is older than the Huronian conglomerate. It is, therefore, probably of Laurentian age.

Contact of Laurentian and Lower Huronian

The contact of syenite and conglomerate is very well exposed for several yards. The conglomerate has evidently been formed by sedimentary deposits derived from the syenite and older rocks. At the immediate contact large angular blocks of syenite are cemented together by fine, gray material, forming a breccia conglomerate. A few feet from the syenite the fragments are well rounded, and farther on pebbles of other composition form a greater and greater percentage of the conglomerate, which then appears quite similar to the Lower Huronian at Cobalt. Detailed examination may show that the former conglomerate is of later age than the latter; but from our rather hurried survey it seems that they are of the same character and probably deposited at the same time. The conclusion which we come to is, therefore, that the conglomerate is younger than the syenite.

Keewatin

A chloritic igneous rock of basic composition, containing irregular stringers of quartz, is exposed on lot 7, concession V, Harris township. In the field its green appearance distinguishes it from the later diabase.

A typical specimen is a dark colored fine grained crystalline rock, showing small crystals of light colored feldspar. Under the microscope it is seen to consist largely of grains of augite and small feldspar laths. That there has been considerable chemical alteration is shown by the abundance of chlorite, which results from the decomposition of the augite. That the rock has suffered severe metamorphism is shown by the granulation of the augite individuals, and by wavy extinction in the feldspar crystals.

This outcrop is, therefore, probably an old hill top of Keewatin age, none of the later rocks in the vicinity being much metamorphosed.

A Part of the Area South of Lake Wendigo

By R. E. Hore

On September 3, 1906, with Mr. Gerald Galt, I went to Tomstown to examine an area including parts of the townships of Ingram and Pense and unsurveyed territory northwards to Wendigo lake. In this area there have been several discoveries of small veins which show cobalt bloom in a quartz gangue. A few of them show massive smaltite. No native silver or argentite has yet been discovered. Small quantities of sphalerite and galena have been found in some of the veins.

The discoveries of bloom, which are widespread over this area, are in diabase and gabbro. None were seen in the clastic rocks in the area mapped.

The map which accompanies this Report shows the distribution of the rocks in the area examined by us.

Character of the Country

The southern part of the area mapped is heavily covered and includes many acres of swamp and muskeg. In the northern part of the surveyed townships, and in the unsurveyed territory, the country is more rugged. The rock is well exposed in numerous ridges, and around the shores of Wendigo lake.

Geology

The lower levels, at the lake shores and south of lake Wendigo, represent a horizon of greywacké slate. Hills of fragmental rock in this area, rising one hundred to two hundred feet above lake Wendigo, show slate, arkose and coarse conglomerate in ascending order. From the south a great sill of diabase and gabbro, rising very slowly, overlying the greywacké slate, extends northwards touching lake Wendigo at Wilson's bay.

Classification

Post-Middle Huronian	Diabase and gabbro.
Lower Huronian	Conglomerate, arkose, slate
Keewatin	Greenstones.

Diabase and Gabbro

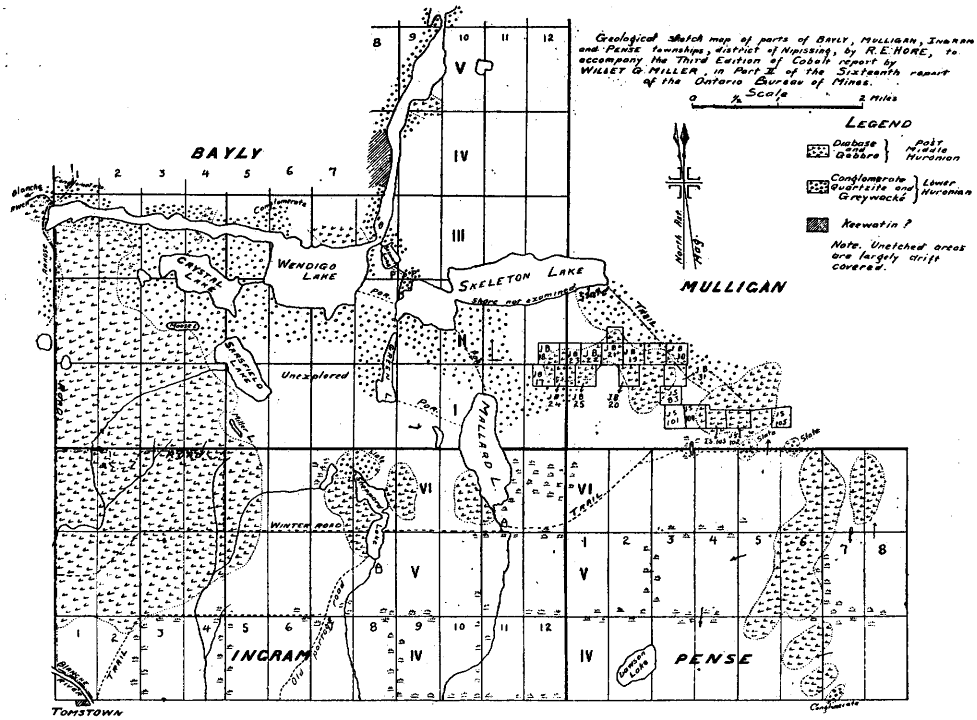
The nature of the diabase sill is well shown in a number of places. At the foot of cliffs of diabase, the igneous rock is seen to overlie horizontally bedded, slaty greywacké. At the west end of lake Wendigo the slate dips slightly to the south under diabase. This sill structure is seen wherever the contact is exposed. The cooling of the igneous sheet has produced vertical cylindrical columns. These are often well defined in the ridges north of Ingram township, where columns twenty to thirty feet in diameter form the vertical cliffs, while wide cracks mark out the continuation of the column boundary.

To the naked eye the ophitic structure is not often apparent; but under the microscope most of the finer grained specimens were found to have typical diabasic structure. The coarser parts, as in and north of Pense township, do not show this structure. The fine grained rock on the west shore of Mallard lake is also gabbro.

A typical diabase is that at the outlet of Wendigo lake. This is a dark grey rock showing light colored feldspar and brown augite. Under the microscope the large individuals of augite are seen to enclose lath-shaped feldspar crystals. There are present a few crystals of magnetite and ilmenite and some brown biotite.

A specimen taken from the east shore near the head of lake Wendigo, is coarser in texture. The augite is partially altered to chlorite. There is more ilmenite and also some quartz and pyrite.

At the narrows about two miles from the foot of lake Wendigo there is a pink colored phase of the diabase. This color is due to an abundance of pink feldspar. The feldspar and augite are both much decomposed, and chlorite and calcite are prominent secondary minerals. Ilmenite, accompanied by the alteration product, leucoxene, is common. A more acid phase of this rock is composed chiefly of orthoclase, with a few crystals of plagioclase and quartz. The pyroxene has a faint violet color and is probably titaniferous. It decomposes to calcite and chlorite.



The coarser parts of the igneous rock, such as occur on lot 6, in the sixth concession of Pense township, and north of Pense, contain considerable quartz. The quartz is often in graphic intergrowth with pink colored feldspar.

A fine grained type, on the Le Roy claim, Mallard lake, is composed largely of yellowish-brown pyroxene along with a small proportion of plagioclase feldspar. Chlorite has resulted from alteration of the pyroxene. Magnetite and ilmenite are also present.

Isolated outcrops on the Blanche river, in the neighboring townships of Marter and Evanturel, have been described by W. G. Miller[22] and W. A. Parks.[23]

Lower Huronian

The clastic series may be conveniently divided into three parts: graywacké, arkose and coarse conglomerate. The change from one to another of these is generally by insensible gradations; but in good exposures in cliffs it is possible to define the layers

[22] L. Temiskaming to the Height of Land.
Annual Report Bureau of Mines, 1902. Pg. 228.

[23] From L. Temiskaming Northwards.
Summary Report, G. S. C., 1904, Pg. 214.

approximately. The order is the same as at the Little Silver Cliff at Cobalt, greywacké slate being the lowest member and conglomerate capping the ridges.

Under the microscope these rocks are found to be quite similar to those of Casey township described in this Report.

A good exposure showing these rocks is in the cliff at the north of Green lake. The arkose layer, here as elsewhere is only a few feet in thickness. Below the arkose, greywacké is exposed for fifty feet. Above, is a somewhat thicker bed of coarse conglomerate.

There is a rather large area of arkose south of the foot of lake Wendigo. It is a light colored rock composed of quartz and feldspar cut by numerous small stringers of quartz. Some darker phases of the arkose receive their color from chlorite. Similar rock outcrops southeast of Beaver lake.

Underlying the gabbro in the southeast corner of lot 6 in the fifth concession of Pense there are several alternate layers of greywacké and arkose varying in thickness from four inches to three feet. The greywacké is composed of very small particles which are scarcely distinguishable. The arkose contains a high percentage of chlorite, and is consequently quite dark in color.

Keewatin

On the west shore of the north arm of lake Wendigo there is a series of greenstones which are probably of Keewatin age. These consist largely of pyroxene rocks which have suffered considerable granulation and chemical alteration. A porphyritic phase contains crystals of orthoclase, augite and hornblende in a fine grained ground mass of the same materials.

As we did not examine the territory north of lake Wendigo, the field relationships of these rocks are not known. From the petrographic characters alone, it seems most likely that they belong to the Keewatin series.

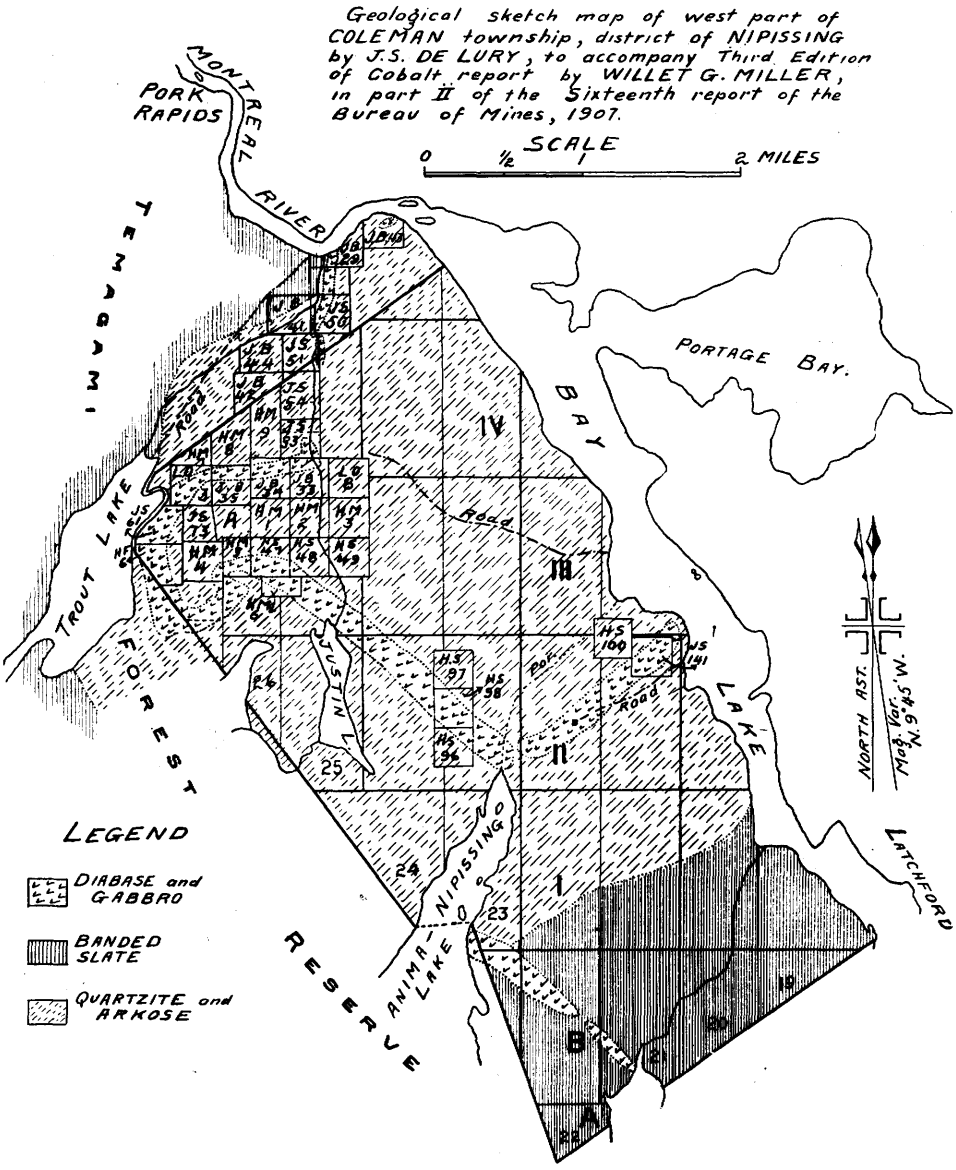
It is noteworthy that in the area mapped south of lake Wendigo, the diabase sheet does not come in contact with rocks of Keewatin age, and in this respect the geology differs from that around Cobalt lake.

The Area West of Bay Lake on the Montreal River

By J. S. DeLury.

Introduction

On July 16th, 1906, acting on instructions from Professor Miller, the Provincial Geologist, the writer proceeded from the Government camp, on Giroux lake near Cobalt, to the west side of Bay lake to map out the geological features, and to examine the mineral claims which are staked out there. The area was mapped by Dr. Barlow,



of the Dominion Geological Survey, and was included in his Temiscaming and Nipissing map sheets issued in 1899. This map and a blue print made by the Ontario Crown Lands Department from timber and mineral lands surveys, were used as a basis for the topography. In mapping in the geological features, owing to the very limited time in the field at the disposal of the writer (namely from July 17th to July 31st) distances were paced from exactly surveyed lines such as timber and mineral claim lines; angles were measured with a prismatic compass.

The geological map of the Montreal river and vicinity, which accompanies this Report shows the area mapped by us.

The area mapped embraces the country bounded on the north and east by Bay lake and the Montreal river, and on the south and west by the Gillies and Booth timber lines. The country covered by the writer is fairly well wooded, though the best timber has been removed by the lumberman. A good wagon-road runs from the mouth of Trout creek to an old lumber camp on the east end of Trout lake; there are also roads cut out from Trout creek, near its mouth, to several of the mining claims to the south. A portage trail runs westward from about the middle of Bay lake to the extreme eastern end of Anima-Nipissing lake; this according to Dr. Barlow was cut out under the directions of Father Paradis in 1891, to form a winter road from Bay lake to Temagami. Trout creek is the only navigable stream in the area mapped, and only small boats can go up this for a short distance from its mouth.

Glaciation has left its characteristic topography, the country consisting of small valleys and hills which show glacial striations.

Rocks of the Area

The only sediments occurring here are banded slates and quartzites together with some intermediate rocks. These seem to be typical Lower Huronian rocks and are a continuation westward of the same rocks mapped by Professor Miller for the Cobalt area, east of Bay lake. In every place where both types of rock could be seen together, they were quite conformable, there being a regular transition from banded slates below to typical white quartzite above; this transition zone usually of considerable thickness, and made up of rocks intermediate between the slates and quartzites, shows that the banding of the slates is parallel to the bedding of the lower quartzites; these lower bedded quartzites which are quite impure, pass into white quartzites, and these, on account of their lack of impurities and constant composition show no bedding planes. These rocks were doubtless deposited as a result of water action over wide areas. None of the old Keewatin formation was positively identified in this section of the country, though on the north-west side of Trout lake, outside of the area mapped, was an exposure of what seemed to be an old Keewatin greenstone.

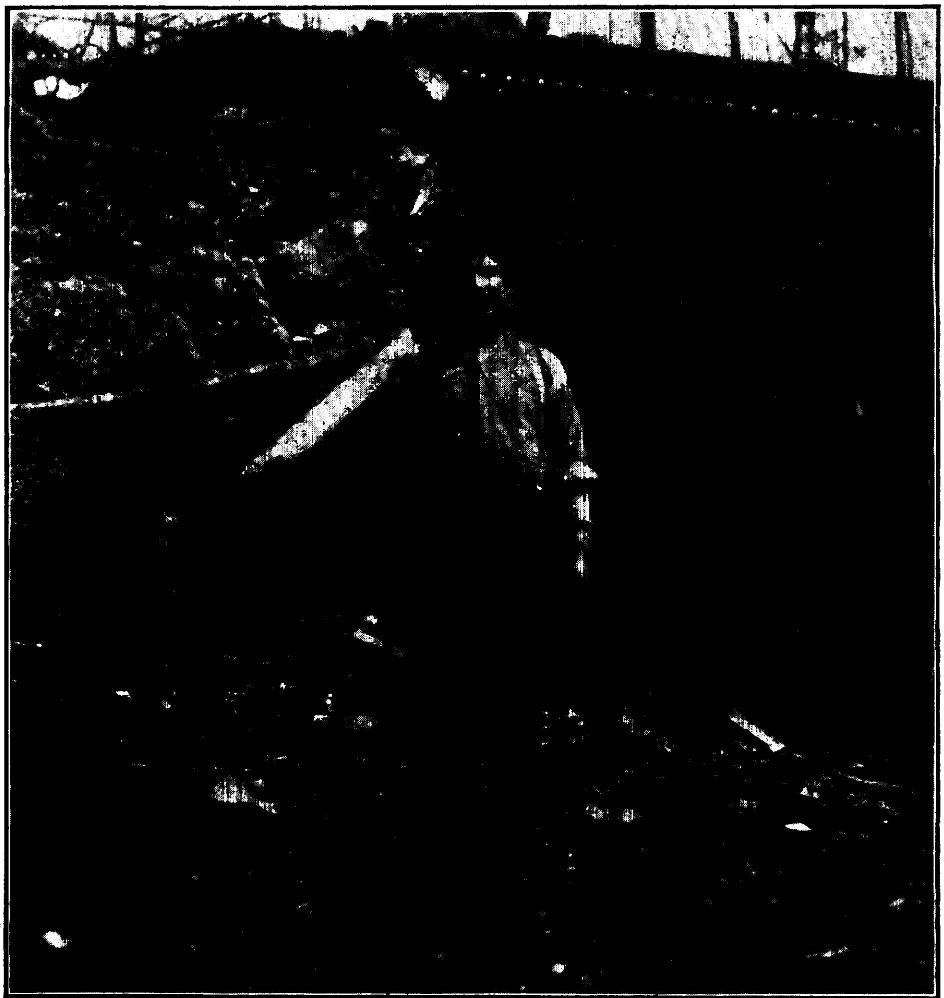
The only igneous rocks of the area are diabase and gabbro intrusives, which cut the slates and quartzites above mentioned. These rocks come up in the form of narrow dikes which seem to be near the vertical in position, and in no case has an extensive metamorphism of the sedimentaries resulted from their intrusion. The larger diabase and gabbro dikes have altered a narrow zone of quartzite along the contact; and in many cases small zones (usually less than two yards in width) of autoclastic rocks or friction breccia were formed. In one place in particular (on J S 54) a zone, from two to three yards in width, consisting of compressed fragments of diabase and quartzite, lies between the unaltered intrusive and the typical unaltered quartzite. Along most of the contacts however the quartzite has been crumbled for a short distance from the contact, and these fragments having been compressed and cemented together form a coarser looking quartzite which in some cases looks like an igneous rock. This is particularly the case when the quartzite is rather impure. In no place was a contact observed between the slate and the intrusive, so that the metamorphic effects on that rock could not be observed. This is probably owing to the fact that the slate, having been more readily glaciated than the diabase and quartzite, is generally flat and drift covered.

The diabase and gabbro resisted glaciation more than the sedimentaries and throughout the area, stand out in relief from the quartzite as well as from the slates.

The individual rocks will now be briefly described:

Banded Slate

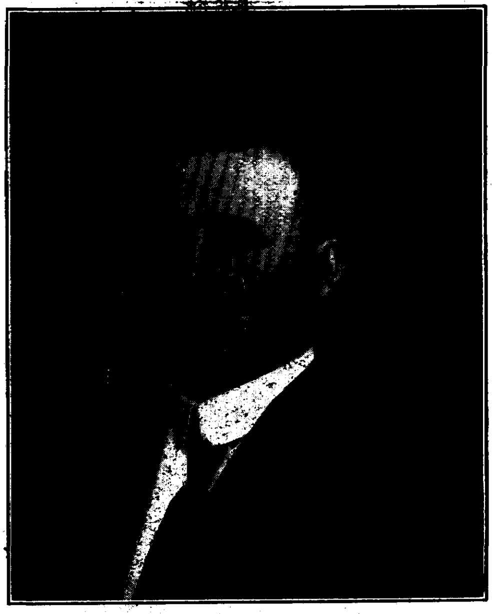
The slates are of the type described by Dr. Barlow and Professor Miller for similar areas in Temiscaming district; they are of the so-called banded type, showing



Fred. La Rose, discoverer of La Rose Mine.

fine banding of alternating greenish, reddish and dark bands. This pronounced banding indicating the bedding, and higher up the general conformable transition into slaty-bedded quartzites leave no doubt as to the true sedimentary nature of the slate, and indicate that the slates have been deposited as a result of water erosion and deposition over wide areas. Except where they approach the quartzites, they are very fine and even grained, and in no case noticed did they contain any larger fragments of clastic material. The darker and greenish colors are probably due to secondary silicates such as chlorite and the reddish stain of some of the bands is likely caused by the

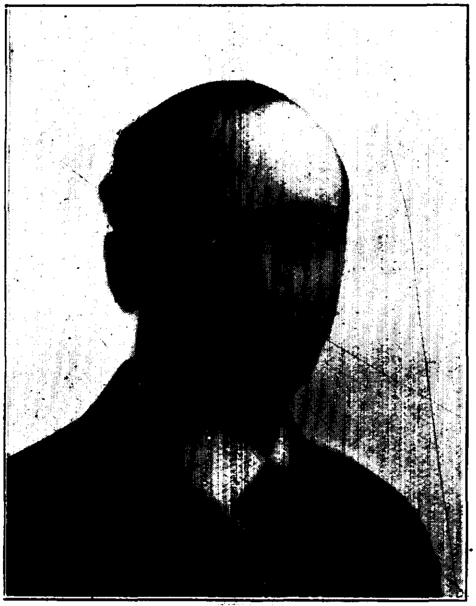
J. H. McKinley, who with his partner, Ernest Darragh, was the first to discover mineral in the Cobalt area.



W. G. Trethewey, discoverer of the Trethewey and Coniagas Mines.

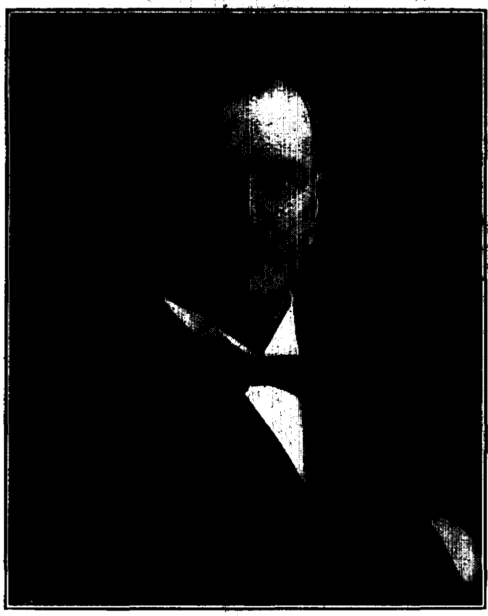
Alex. Longwell, discoverer of the Buffalo Mine.

R. W. Leonard, President Coniagas Mine.

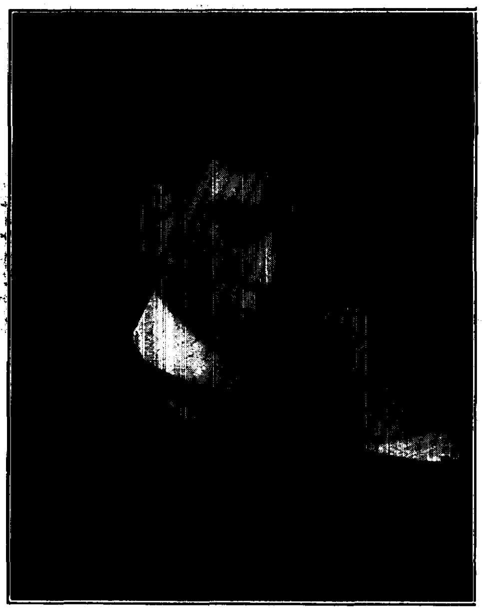


M. Wright, the discoverer of the Drummond Mine.

N. C. Wright, the discoverer of the Jacobs Mine.



Albert Foster (father)



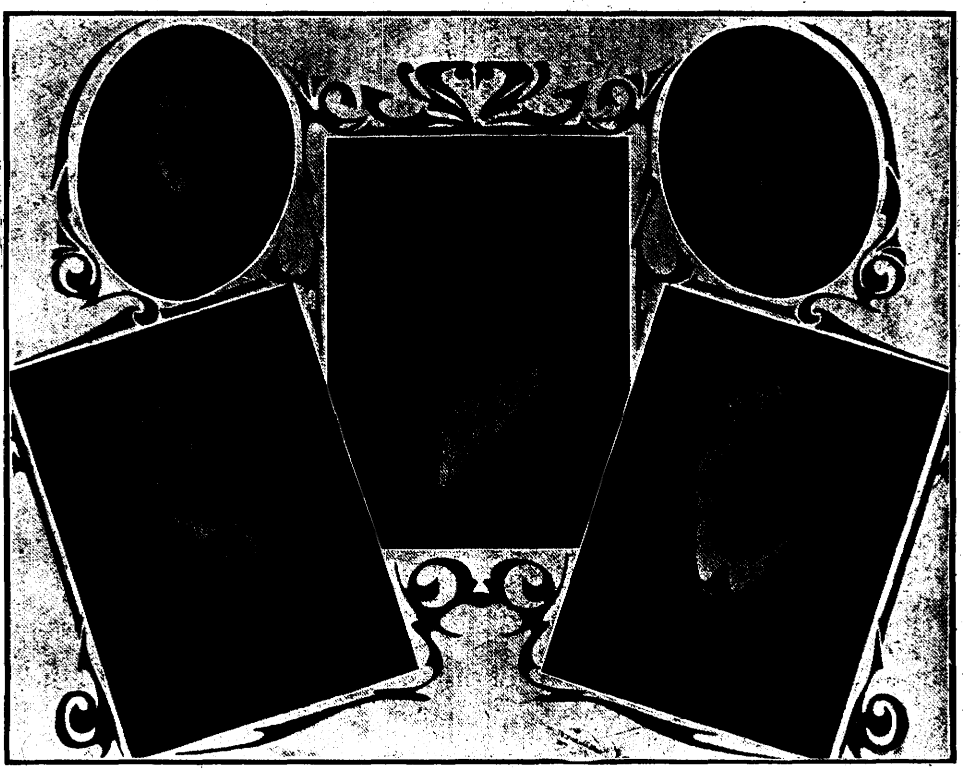
C. A. Foster (son)

Discoverers of Foster Mine.

presence of hydrated iron oxide. As the quartzite is approached above, the slate changes into chocolate-colored, fine to medium grained, intermediate rock, which is in most places of considerable thickness.

Quartzite

With the gradual transition from the banded slates below through an intermediate zone of quartzitic slates and slaty-quartzites, the impure quartzite comes in above and higher up the typical white quartzite. As there is no superior formation the thickness of this quartzite bed could not be ascertained. No quartzite was found consisting of pure quartz though the higher quartzite has a greater percentage of



The Owners and Developers of La Rose Mine.

D. McMartin John McMartin N. A. Timmins
L. H. Timmins D. A. Dunlap

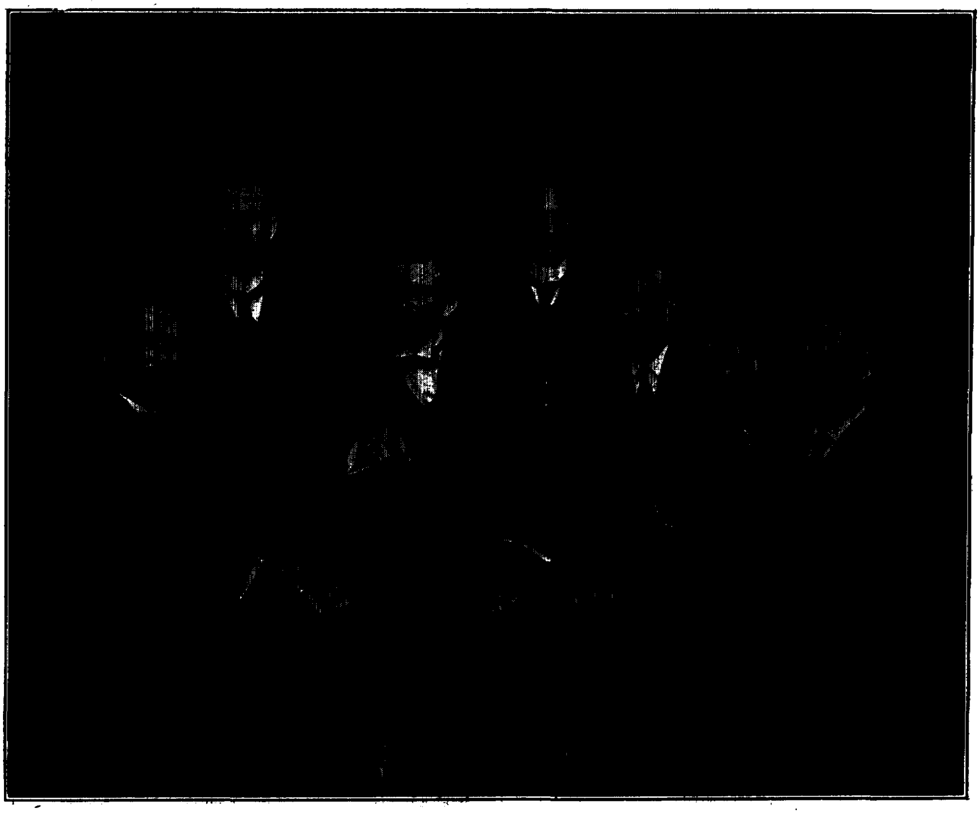
free silica. In all the quartzite is a considerable amount of feldspar and most of it shows small amounts of white mica. As the slate is approached below, the impurities increase, the coloring matter, such as iron oxide and secondary silicates become more prominent and the quartzite becomes gradually darker in color.

A thin section of the whitest quartzite examined under the microscope shows the following: The rock is made up of even rounded grains, the major part being quartz; orthoclase and microcline are in a considerable amount and a little plagioclase can also be seen. This section shows no mica though in many fragments it may be seen without the assistance of a microscope. The quartzite is evidently formed from sandstone by great pressure and some cementation, as some of the quartz fragments show additional secondary silica.

Diabase and Gabbro

The exact age of the intrusives could not be ascertained, though from their general appearance and degree of alteration, it is probable that they are the result of the same active period that caused the similar intrusions in the Cobalt area.

The smaller dikes of intrusive rocks are typical diabases, very fine-grained near the contact, and becoming more coarsely grained and more acid as the centre is approached. In the centre of the larger intrusives the rock is more of the gabbro type, being coarser grained and more granitoid in structure than are the edges of the same intrusive and the smaller dike rocks. The diabase and gabbro have undergone some alteration,



The Founders of the Nipissing.

W. B. Russell — R. K. Russell

W. C. Chambers — E. P. Earle — Arthur Ferland — R. Galbraith

particularly near the surface; diabase from some of the shafts was quite fresh looking and resembled very closely the diabase of the Cobalt area.

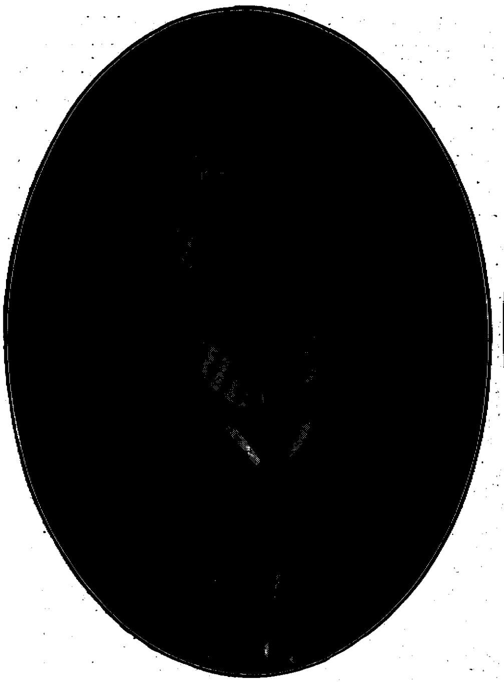
Several thin sections, prepared from fragments taken from the dikes at different distances from the contact, were examined under a microscope. Near the contact the diabase is fine grained and considerably altered; the plagioclase is much kaolinized and the ferro-magnesian minerals are almost entirely changed to secondary chlorite and serpentine. Ilmenite changing into secondary leucoxene is quite a prominent constituent. As the contact is left, free quartz is noticeable in the section, and at the centre of the larger intrusives a micrographic intergrowth of quartz and orthoclase is quite pronounced. This last probably represents the part of the original magma which was last to cool.

An interesting exposure of porphyritic diabase can be seen on the timber line between V lake and Trout lake. This consists of a typical diabase in which are embedded large phenocrysts of plagioclase some of which are about three inches in length. The exposure is so small that it is mapped as part of the ordinary diabase-gabbro intrusion.

Veins and Mineral Indications

At the time the claims were visited, no great depth had been attained in prospecting; the shafts were sunk on only about five claims, namely J S 53, J B 33, J B 29, J B 32, and J S 50.

The veins of the area are made up principally of calcite gangue, and near the surface there is cobalt bloom, pyrite, and chalcopyrite. Deeper down in the veins, where



Geo. Glendenning W. J. Blair

Messrs. Glendenning and Blair with H. L. Kerr were the founders of the University mine. The survey of Coleman township was made under Mr. Blair's direction.

shafts have been sunk, occur small quantities of smaltite, and sometimes niccolite. The veins are very irregular and are either altogether in diabase or are on the diabase contacts. Some of the veins, particularly those associated with the smaller dikes, follow through the diabase within a few feet of the contact. In the larger intrusives the veins are most irregular, and run through the diabase with no definite strike or dip. The veins along the small diabase dike near the mouth of Trout Creek, are examples of the former type; in fact, there seems to be a fractured zone following the whole length of the west contact of this dike. The small area of diabase near where the Montreal river widens into Bay lake contains a small stringer of calcite showing chalcopyrite. Of the deposits in the larger bodies of diabase-gabbro, the most important are in J B 33 and J S 53. On J B 53 (the Edison claim) is a network of calcite stringers, some of which approach a foot in width in the larger parts. Cobalt bloom is found at the surface and, deeper down, smaltite is found, though not in paying quantities at the time the property was visited.

In the cases where shafts have been sunk the mineralization seems to increase with depth. In no cases were silver minerals noticed, though low silver assays were claimed on two of the properties. Most of the claims, particularly those not in the diabase, had no lines to their discoveries. As many of these are located on quartzite and as no good indications were observed at any place in that rock it is probable that nothing of importance will develop on these properties.

Unlike the slate-conglomerate near Cobalt, the quartzite does not seem to be fissured. A small fissure in diabase about one mile due north of the extreme east end of Anima-Nipissing lake contains small quantities of stibnite.

The Claims on Whitewater Lake

Three days were spent on a trip through Anima-Nipissing lake to Whitewater lake in the Temagami Forest Reserve to examine certain mineral claims which were staked out there. On the eastern side of the middle enlargement of Anima-Nipissing is a pyrrhotite deposit associated with what seems to be granite rock. It was claimed by the owners that it contained a small percentage of nickel. An exact idea of the importance of the deposit could not be obtained at the time of this examination.

On the claims near Whitewater lake, nothing very valuable was seen, though none of the veins had been developed. T R 2 claim showed a quartz stringer in diabase holding some chalcopyrite and showing secondary copper stains. T R 6 was the only claim bearing indications of cobalt. There was a little bloom associated with calcite in a small crack in diabase. The other claims examined showed nothing of importance and few of them had lines to their discoveries.

La Rose mine, May, 1904.

Cobalt-Silver Veins, South of the Township of Lorrain

By CYRIL W. KNIGHT

The new camp is distant about sixteen miles southeast of the town of Cobalt, and about two or three miles west of lake Temiskaming. A plan of the area accompanies this Report.

The area was visited the latter part of March, 1908. At that time several veins containing smaltite had been discovered. One of these (the Keeley) carried good values in wire silver.

The two properties on which most work had been done were: The Keeley (H R 19), and The Haileybury Silver Mining Company (H R 16).

The Keeley

The vein on which work was being done lies about nine chains from the northeast corner of the forty-acre lot. It was discovered, according to Mr. Keeley, December 5th, 1907. There was an open cut some forty feet long and fourteen feet deep in places. Here the vein showed two to six inches in width, striking S. 62 degrees E. Massive smaltite appears to be present in quantity. Cobaltite, the sulpharsenide of cobalt (Co As S), was suspected to be present. A sulphur determination, however, by Mr. A. G. Burrows showed only 1.7 per cent. Wire silver occurs in what appears to be considerable amount. Its occurrence in this form differs from that at Cobalt, in which place it is found essentially in leaf-like forms. Quartz occurs as gangue, Two hundred and twenty-six bags of ore were ready for shipment.

The Haileybury Silver Mining Company

The vein which was being worked is about one hundred yards from the northeast corner of the forty-acre lot, and strikes S. 20 degrees E. with dip 70 degrees to the east. The shaft was down forty feet. At the bottom massive smaltite, together with some niccolite and a little native bismuth was seen, having a width at one point of five or six inches. The gangue is calcite and a chloritic material, together with a fine grained pink mineral, which under the microscope is seen to be made up of acid plagioclase feldspar.

Mr. A. G. Burrows made an analysis of the massive ore from The Haileybury Silver Mining Company's vein, with the following results:

	Per cent.
Cobalt	15.92
Nickel	11.18
Arsenic	60.38
Silver	Trace.

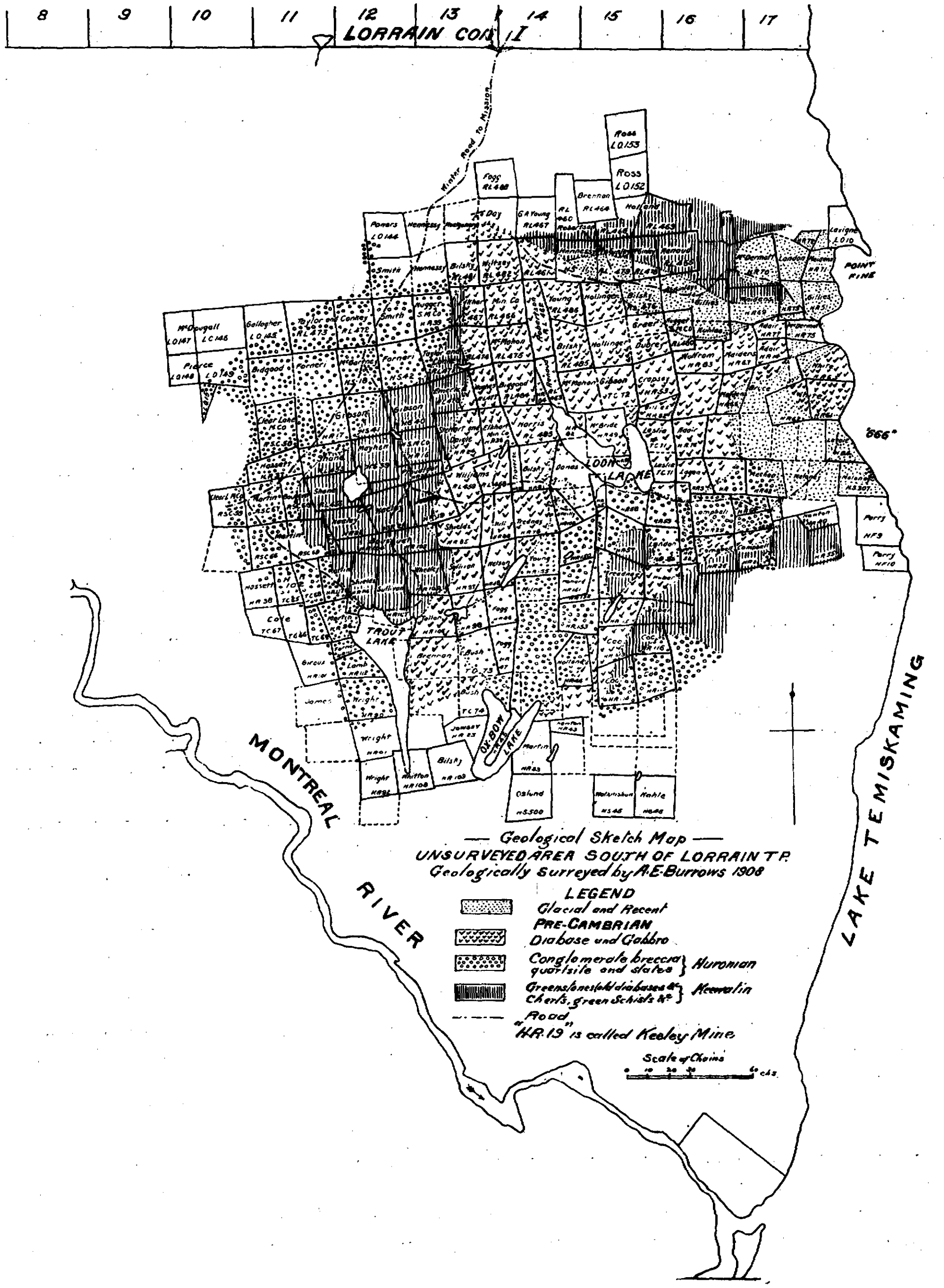
There was considerable snow on the ground at the time of our visit (March, 1908), but judging from the few exposures we saw, the rock appears to belong to the Keewatin series in the vicinity of both veins.

Further Notes on the Area South of Lorrain.

While this report was going through the press further notes on the rocks together with the accompanying geological plan were received from Mr. A. G. Burrows, who was sent into the field by the Bureau of Mines to undertake the mapping of the area. The notes are taken from a letter written by Mr. Burrows to the Provincial Geologist.

LOON LAKE, south of Lorrain township, June 17th, 1908.

"B. came down last evening with your message about the sketch map, so I put what I had up to date on it. It is rather unfinished on the edges, but it will give a fair idea of the area as far as mapped. We hurriedly put on some of the roads also, which are as nearly correct as I could get them, and which will be convenient for anyone travelling in.



"I have seen several diabases which are included in the Keewatin area and which I considered to be the old (Keewatin) diabase, from the altered appearance, veins, etc. In a few cases I was not altogether sure, but from the occurrence judged it better to call them old diabases, as they were so much different from the ordinary variety of diabase and gabbro met with.

"The formations seen here are similar to those in the vicinity of Cobalt. The Keewatin rocks vary considerably in appearance in the different areas mapped. In the area about a mile southeast of Loon lake, the Keewatin is seen in well-defined bands with a schistose structure in part, and almost vertical dip. Some of the rock has a cherty appearance, and some resembles ordinary green schist, in which the characteristic torsion cracks, filled with calcite or quartz, are developed. Several acid porphyry dikes with phenocrysts of red feldspar are seen, folded in the bands, showing that they are of Keewatin age. Several later granite dikes of a reddish fine-grained appearance, are also noted.

"The Keewatin belt, in the vicinity of Keeley's has a harder, more compact appearance, and breaks with a rounded fracture, and to the eye has a slate-like structure. In the western portion of this area there is much old diabase, some of which retains the diabase structure and much of which is apparently altered to amphibolite. This area contains most of the promising veins along the eastern border and near the contact with the post-Middle Huronian diabase.

"The Keewatin area, just west of Point Fine, has a very dark rusty appearance, and is marked with a network of lighter colored veinlets of a hard material which stands out from the surrounding rock, and forms a striking appearance. Just south of this rock is a belt of apparently old diabases.

"The Huronian rocks consist of breccia, conglomerate, slate and quartzite. A beautiful effect is shown in a breccia formed in place from angular Keewatin, in the southwest corner of R L 455. The slates are in some localities fine grained, but are usually not finely laminated. Towards the upper portion of the series they are more quartzitic in character and pass into true quartzites.

"The western portion of the area mapped is chiefly a reddish quartzite; some banded reddish slates are seen in this section also, underlying the quartzite mentioned above. The Huronian formations are comparatively flat and show little evidence of disturbance. The diabase and gabbro rocks may be seen in contact both with the Keewatin and Huronian, and cutting the latter at an inclined angle and overlying it.

"Most of the promising veins have been found in the Keewatin, but good silver values have been obtained in veins in the diabase on several claims.

"A well-constructed wagon road has been built from "66" to the Keeley property via Loon lake, while the northern portion of the district is served by a road from Point Fine. Old lumber roads furnish easy access to most of the district."

Some small outcrops of Keewatin, conglomerate and diabase along the shore are not shown on Mr. Burrows' plan.

CHAPTER IV.

LAKE SUPERIOR SILVER DEPOSITS

The Silver Islet mine and the silver mines on the main shore to the southwestward of Port Arthur are well known to students of ore deposits. In richness of silver they resemble those of Cobalt station. but they contained a much lower percentage of cobalt, nickel and arsenic. Cobalt bloom and nickel bloom, together with arsenides and other compounds, were, however, found in these lake Superior deposits with the silver. A similar assemblage of minerals, but in a much smaller quantity, was briefly described years ago as occurring on Michipicoten island. It is well known that native silver occurs in association with native copper in the great copper mines of Michigan on the south shore of Superior. It would seem then that native silver is not a very rare mineral in the region between the Quebec boundary and the north and south shores of lake Superior. Port Arthur, however, lies about 500 miles west of Cobalt station, and in the intervening area no deposits of the metal have been found. There is ground for hope that deposits will be discovered when this area is explored. Little is known about much of it at the present time

The Port Arthur Mines

Much has been written on the silver mines in the area adjacent to Port Arthur. This literature has been summarized and many additional details diven in an important report written by Mr. E. D. Ingall of the Canadian Geolgical Survey.[25] None of these mines are now working.

It will be seen from the following notes, condensed from Mr. Ingall's report, that these Port Arthur deposits in many respects, especially in the facts that they occupy for the most part vertical fissures which cut slightly inclined pre-Cambrian beds, and in their mineral contents, resemble the silver-cobalt deposits in the vicinity of lake Temiskaming. The chief difference between the two as regards their mineral contents is that the Port Arthur deposits contain a higher percentage of gangue material, the ore usually occurring in bunches or pockets, and the percentage of silver is always much higher than that of the associated nickel and cobalt which generally occur in small quantities or are entirely absent in some of the deposits. Some of the veins in the vicinity of lake Temiskaming on the other hand contain a much smaller amount of gangue, and the percentage of cobalt, nickel and arsenic is often higher than that of silver. One of these veins, that in the northwest corner of R L 404, as shown above, consisted as exposed at the surface of about 14 inches of solid smaltite together with niccolite. There was little gangue in this ore. The Cobalt station deposits, as previously stated, resemble, among veins which have been worked in the world, more closely those of Joachimsthal in Austria and Annaberg in Saxony than any others.

It is interesting to know, however, that nickel did occur in the Silver Islet mine, at least in economic quantities. The first ores of this metal of this Province, which is now such an important producer of the metal, were those of the Silver Islet mine. Mr. W. M. Courtis, in a paper read before the American Institute of Mining Engineers, October, 1873, in speaking of the smelting works at Wyandotte, says that the matte was treated to save the nickel and that the silver was extracted from the marketable nickel speiss.

Ingall says the vein-filling minerals consist of quartz, barite, calcite and fluorite. In these occur different metallic minerals, viz.: blende, galena, pyrites of various

[25] "Report on Mines and Mining on Lake Superior," by E. D. Ingall, Part H Annual Report of the Geological Survey of Canada, 1887, 124 pages.

species and occasionally some sulphurets of copper, whilst the silver occurs as argentite and in the native state, the former being the more common. At places the veins carry a dark green, probably chloritic, material, which on some surfaces has a bright waxy lustre, whilst occasionally a soft, greasy, talcose material, probably saponite, accompanies the ore, notably at the Beaver mine, and to a lesser extent at one or two other places. Carbon in various forms has also been found here and there, whilst in some of the vugs in the veins which have been found near the surface stiff clay and ochreous material have sometimes been obtained along with nuggets of argentite, the former however, having evidently been washed in from the surface and thus imbedded the silver minerals already existing in the vugs.

The same writer further states: "These then are the mineral constituents of these veins, but the Silver Islet vein forms somewhat of an exception in that it carried, besides these, various arsenical and antimonial ores of silver with compounds of nickel and cobalt and other metallic minerals which have so far not been found in the rest of the veins (?). Other salient features were the pink and cream-colored dolomitic spar which so frequently formed a characteristic and prominent constituent of the gangue of the rich ore, and the predominance of native silver in the rich parts, whereas in the rest of the veins, though this form of silver occurs in considerable quantity in places, yet argentite seems to be the form in which it is generally found."

"Again, it is interesting to know that both the mineral waters and the inflammable gas that were met with in opening up the Silver Islet mine have also been encountered at other points in the district. At the Rabbit Mountain mine in one of the lower levels I saw water running over the breast of the drift which gave off a faint odor of sulphuretted hydrogen and was depositing a white flocculent material, whilst both at this place and at the Beaver mine I was informed that small quantities of inflammable gas had been met with."

These veins, like those of Temiskaming, frequently present a brecciated appearance, angular fragments of rock being enclosed in the vein material.

Ingall found the distribution of the silver minerals in the veins very irregular, the rich ore generally occurring in detached bodies of varying dimensions surrounding very poor or quite barren areas of the vein.

As regards the metallic minerals, it was observed by Ingall that the blende comes first in importance, being the most plentiful. This mineral is practically absent in the Temiskaming deposits. The galena does not play such an important part, Ingall says, as the blende. Pyrite is found to a lesser extent than the two last mentioned minerals. Both pyrite and galena are likewise rarely met with in the Temiskaming veins. Marcasite and pyrrhotite are found in the Port Arthur veins, but copper compounds represented by chalcopyrite and copper-glance are rare. Through these minerals, or through the gangue minerals, are distributed the argentite and native silver. It is said that, with the exception of Silver Islet, the native silver is more characteristic of the ore bodies near the surface and is replaced by argentite in depth. The likelihood of blende, galena and pyrite carrying silver is asserted to be in the order in which they are here named. Silver was found in but few specimens. Some traces of gold were obtained in these minerals, in a few instances.

The calcite is said to be apparently older than the quartz, and there is also some secondary calcite. The silver minerals seem to be due to a later infiltration of silver-bearing waters subsequent to the deposition of the gangue minerals.

Regarding the source of the silver minerals Ingall does not offer any definite theory. He says some writers have thought them to be connected with the trap eruption, the silver being brought up by thermal waters accompanying these intrusions. He points out, however, that these fissures intersect and dislocate the trap sheets and dikes. He adds that the fact remains that all the ore bodies occur near or within a reasonable distance of trap in some form, either in dikes or in sheets. This suggested the idea to him that the silver may be derived by decomposition of some of the mineral constituents of the trap carrying minute quantities of silver. On decomposition, waters infiltrating downwards through the fisures might have deposited their silver contents in them. He thinks that the various forms of carbon present in the sedimentary rocks may have had some influence in effecting this precipitation.

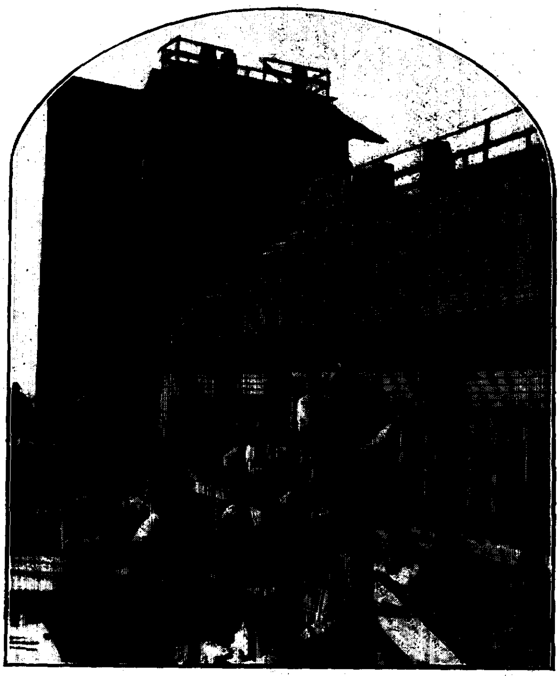
Silver Islet Mine

This deposit, which occurs on an islet, less than 80 feet in diameter, about a mile out in the lake off Thunder Cape, was discovered in the summer of 1868. It is the most famous silver mine worked in Canada, till the discovery of the Cobalt camp, the silver produced from it amounting in value to $3,250,000. The vein on this islet intersects what is called a chloritic diorite dike in its course through the sedimentary beds of the Animikie. The producing part of the vein was practically confined to that portion between the walls formed of the dike material.

Silver Islet, Main Shaft and Office.

We shall not attempt to give a fuller account of this vein here, but shall refer the reader who wishes more details to Mr. Ingall's interesting report. It will be well, however, for the purpose of comparison to give a list of the minerals found in this vein. Among these are the gangue minerals calcite, quartz and dolomite, the latter varying in color from cream to pink according to the amount of manganese contained. A variety known as rhodochrosite is said to have been found. The metallic minerals are native silver, argentite, galena, blende, copper and iron pyrites with marcasite, tetrahedrite, domeykite, niccolite and cobalt bloom, together with a mineral known as macfarlanite containing arsenic, cobalt, nickel and silver. Two new minerals are said to have been found in the ore; these were called huntilite and animikite, those with macfarlanite, according to one writer, being the principal producing silver ores of the mine. There were also found, annabergite, antimonial silver and cerargyrite, the latter "where the rock has been decomposed." Graphite is said to occur in quantity. A curious feature of the vein was the combustible gas met with in large quantities in the workings and the mineral water which carried considerable amounts of chloride of sodium and other metals. Two very rich bunches or bonanzas of ore were found in the vein. One of these was completely worked out by 1874, yielding over $2,000,000. The shape of this bonanza was that of an irregular pear, and throughout its extent in both veins, that is the main and branch vein, it was occompanied by a strong impregnation of graphite. The bulk of this bonanza was arborescent silver more or less mixed with macfarlanite, a rich ore of silver carrying 78 per cent. of that metal along with arsenic, cobalt and nickel. Its physical structure resembles niccolite.

In drifting south on the third level in 1878, strong impregnations of graphite were met on the hanging wall which were soon followed by the second bonanza. This deposit of silver was remarkable for its great width, five feet solid across the breast, and the occurrence in great quantity of the two previously unknown compounds of silver, animikite and huntilite. The shape of this bonanza was that of an inverted



Silver Islet, Main Shaft of Mine.

cone with a base of about 50 feet in the third level, with the apex down as far as the fifth level. This deposit was phenomenal in its structure, and a winze in the middle of the deposit to the fourth level, 60 feet, was sunk literally through native silver, the metal standing out boldly from the four walls of the winze. In the breast of the drift it stood out in great arborescent masses in the shape of hooks and spikes, in gnarled, drawn out and twisted bunches, followed by arborescent silver with intercalated bands of animikite and huntilite. The width of the vein was over 10 feet, and the entire deposit, including the stamp rock, yielded about 800,000 oz. of silver.

While the vein continued to the greatest depth reached in the shaft, over 1,200 feet, little ore was met with in the lower workings, no silver being obtained from great stretches of vein material.

To give an idea of the richness of the ore produced from this vein in the earlier part of its history, it may be said that the 1,154,537 lbs. of ore produced up to the season of 1872 averaged $1,322.44 per ton. Silver then sold, however, at more than twice its present price.

Ores of other Lake Superior Mines

In order to show the character of the minerals found in other deposits of the Port Arthur area we may cite the following examples given in Ingall's report. Argentiferous blende was the chief silver-bearing ore of the vein on McKellar's island. On Spar island the metallic minerals were copperglance, copper pyrites, zinc blende and a little argentite. Prince's mine, the oldest mine on the Canadian shore of the lake, having been worked in 1846 or 1847, appears to have been regarded more in the light of a copper than of a silver-bearing vein. It contained native silver disseminated in thin laminæ through the calcareous spar and blende. Argentite was also found in this vein, and the calcareous spar was stained with blue and green carbonates of copper and with arseniate of cobalt. The vein on Pie island contained blende, galena and iron pyrites.

A Miner of Silver Islet.

The veins so far mentioned belong to what Ingall calls the Coast group. In the second or Port Arthur group he says the silver veins may be considered in two divisions: (1) Those which occur in the Animikie rocks; (2) Those occurring in the Archean area to the north of the former. Most of the veins are contained in the first division. A number of veins are described by Mr. Ingall under this heading. The Shuniah or Duncan mine is interesting owing to the fact that the vein here passes downward from the Animikie rocks into the underlying Archean, which consists of what are called diorite, syenite, felsite, etc. It is said that no silver was found in that part of the vein contained within Archean walls. At the 3A mine the gangue was mostly quartz with a little calcite through which were distributed ores of iron, copper, lead, zinc, nickel and silver, with some cobalt and gold as shown by the assays. The silver was found native and combined with sulphur and nickel. One sample of the ore is said to have assayed 1.4 per cent. of cobalt and 25 per cent. of nickel. This vein was in what Ingall called the Archean or Huronian, the rocks being gray dolomitic schists associated with dark-green compact diorite, whilst dark grayish red, felsitic syenite occurs a short distance to the south. Near the 3A mine was a vein containing 2 feet of milky quartz, which is interesting on account of the fact that it was said to carry native bismuth, the only mention made of this mineral, which occurs in most of the Temiskaming deposits. The Emmons' mine, on lot A in the township of McIntyre, is said to have contained mispickel, another mineral which seems to be rare in the vicinity of Port Arthur.

Rabbit Mountain Group

This group of mines, which was discovered a number of years after the Silver Islet and other veins of the Coast group, is said to present somewhat different conditions of occurrence from those just mentioned. The veins are all in the Upper argillaceous division of the Animikie with its associated trap sheets. The ore of the Rabbit Mountain mine consists of native silver and argentite with other minerals. A special feature of the Porcupine mine, one of this group, is that it carries witherite, the carbonate of barium. In the Beaver mine there is the occurrence of saponite already mentioned.

The Silver Mountain group presents features similar to those of the group just referred to. The veinstones are calcite, barite and quartz with fluorite. The enclosing rock is argillite. The metallic minerals are represented by blende, both light and dark-colored, galena and iron pyrites, with occasionally a little copper pyrites, the silver occurring both native and as argentite.

Woodside's vein differs from the others in the area in that it occurs in the Archean granitic and gneissic rocks underlying the Animikie. The vein in its nature and contents is very similar to the rest, and carries blende, galena and pyrites distributed through the usual gangue in moderate profusion.

There is also what is called the Whitefish Lake group. The veins here mostly occur in the lower silicious rocks of the Animikie. They have much the same contents as the preceding ones.

Minerals of Port Arthur Veins

With the object of comparing the minerals of the Port Arthur silver mines with those of the Temiskaming veins, the following table has been prepared from the minerals mentioned by Ingall as occurring in the former:

I. Native elements:
    Native silver, native bismuth, graphite.
II. Arsenides:
    Niccolite, domeykite, macfarlanite (?), huntilite (?).
III. Arsenates:
    Cobalt bloom, annabergite.
IV. Sulphides:
    Argentite, zinc blende, galena, pyrite, marcasite, pyrrhotite, chalcopyrite, copper glance.
V. Sulph-arsenide:
    Mispickel.
VI. Antimonide:
    Animikite.
VII. Sulph-antimonide:
    Tetrahedrite.
VIII. Chloride:
    Cerargyrite.
IX. Carbonates:
    Malachite, azurite, witherite.

The vein filling materials are quartz, barite, calcite, dolomite, rhodochrosite and fluorite. Chlorite, saponite, inflammable gas and mineral water were also found.

Many writers appear to have held that the trap or diabase and gabbro which overlies the Animikie rocks in this region represented a vast surface flow. In a paper published some years ago Dr. A. C. Lawson showed, however, that this trap, together with the layers of the same material which lie at a greater depth in the Animikie, is intrusive in character (Fig. 17). His work proved that these traps are of the nature of intrusive sheets or sills and that they are not only younger in age than the Animikie but that they belong to post-Keweenawan times.[26]

OTHER CANADIAN NICKEL-COBALT ORES

The following extract from the Report of the Geological Survey of Canada for 1890-91 summarizes a number of the known occurrences of nickel and cobalt in Canada at that time.

"It may not be amiss to draw attention here to certain other nickel and cobalt ores, or minerals containing a noteworthy amount of one or the other of these metals, which have from time to time been met with in Canada in the course of this Survey's work.[27].

"One of these, described as a steel-gray pyritous ore, from the Wallace mine on lake Huron, was found by Dr. T. S. Hunt to contain 13.93 per cent. of nickel. Of two others found on Michipicoten island, lake Superior, the one was shown by Dr. Hunt to be an intimate mixture of the arseniurets of copper and nickel; different portions of the same mass affording him from 17.03 to 36.39 per cent. of nickel, whilst the other, also examined by Dr. Hunt, proved to be a hydrated silicate of nickel which, after drying at 100°C., was found by him to contain 30.40 per cent. oxide of nickel, (equivalent to 23.91 per cent. nickel). The arsenide of nickel, which for present purposes may be regarded as consisting of 44.1 of nickel and 55.9 of arsenic, has also been found at the 3A mine, on lot 3A of the township of McGregor, district of Thunder Bay, where it occurs in somewhat large nodular grains and nuggety bunches, together with native silver, of a similar form, freely disseminated through a gangue of calcspar with some quartz. The foregoing are all rich ores of nickel, and should the deposits on further exploration be found to yield a sufficiency of the material these would, as available sources of this metal, prove of economic importance.

"Less important, by reason of their occurring only in limited quantity or as containing but a relatively small amount of nickel or cobalt, are the following:—Millerite or nickel sulphide, a rich and valuable ore of nickel, occurs in small grains and prismatic crystals disseminated through a mixture of chrome-garnet and calcspar in a vein on the east side of Brompton lake, in the township of Orford, Province of Quebec. It is also reported to have been observed, in the form of prismatic crystals, disseminated through certain portions of the nickeliferous ore of the Copper Cliff mine, in the township of McKim, district of Nipissing, Ontario. Erythrite or hydrous cobalt arsenate, a valuable ore of cobalt when met with in quantity, is mentioned by Dr. Hunt as occurring in rose-red incrustations on calcareous spar at Prince's mine on lake Superior. Smaltite, a cobalt arsenide, was observed by Mr. E. B. Kenrick in the form of minute crystals in a sample of copper pyrites (brought to the Survey for examination) from the township of McKim, district of Nipissing, Ontario. A sample of iron-pyrites from the seigniory of Daillebout, Joliette county, Province of Quebec, was found by Dr. Hunt to contain 0.55 per cent. of oxide of nickel (equivalent to 0.43 nickel) mixed with cobalt, and a brilliant compact variety of iron-pyrites from Elizabethtown, Leeds county, Ontario, yielded him from 0.5 to 0.6 per cent. oxide of cobalt (equivalent to 0.39 to 0.47 cobalt), whilst a sample of iron pyrites from Londonderry, Nova Scotia, was found by me (Rep. Geol. Surv. Can., 1874-75, p. 316) to contain 0.81 per cent. of cobalt and 0.14 per cent. of nickel."

[26] Bulletin No. 8, Geological Survey of Minnesota. 1893.
[27] P. 47 R.

The mineral danaite was found some years ago in developing nickeliferous pyrrhotite on the north half of lot 6, concession 3, of the township of Graham. Specimens of the mineral were found to carry about 4 per cent. of cobalt.

Cobalt bloom has also been found on magnetite at the Dominion mine and at the Cross mine, lot 2, in the second concession, in the township of Madoc, Hastings county.

In the western part of the Province the mineral occurs in small quantity at the southeast corner of the Bay of Islands, Bad Vermilion lake.

In the Report of the Geological survey for 1848-9, page 61, T. Sterry Hunt has this to say concerning the ore of the Wallace mine at the mouth of the White Fish river, a partial examination only having been made of it:

"The specimen was a mixture of a steel gray arseniuret, the species of which I have not yet determined, with white iron pyrites and probably some arsenical sulphuret of iron."

The percentage of cobalt in this ore was slight, only a fraction of one per cent., while the nickel ran about eight per cent. He further says:

"The Wallace mine is the second place in which cobalt has been detected in Canada. I have already noticed it in the form of an arseniate of cobalt, forming reddish crusts upon calcareous spar, at Prince's location on lake Superior. In this locality it is associated with vitreous copper, green and blue malachite and native silver, while other parts of the same vein yield native silver, vitreous silver, blende and copper pyrites; in this connection it may be mentioned that a mass of silver ore selected by myself from some hundreds of pounds, as an average sample, gave on assay 3.6014 per cent. of silver, equal to 72 lbs. to the ton of ore. A portion of the silver extracted by a furnace assay from this ore was found on examination to contain a small portion of gold amounting to about one part in 7,000 of silver."

Speaking at this early date Hunt made the remark which after a lapse of a lifetime reads like a prophecy: "The detection of a small portion of cobalt in association with these metals upon the shore of lake Huron should lead us to look for deposits of this rare and valuable material."

FOREIGN COBALT DEPOSITS

Germany and Austria

Known deposits of cobalt-silver ore in other countries which resemble, most closely, those in the vicinity of Cobalt station, are found in Germany and Austria. The two principal areas in these countries are those at Joachimsthal and Annaberg. Mining was begun in the former at the end of the fifteenth or in the early part of the sixteenth century. The deposits of the latter, it is said, were discovered in 1492, a year which possesses special interest for inhabitants of this continent, for then Christopher Columbus first sighted its shores.

The ores of these two regions are similar to those of Ontario, and include compounds of cobalt, nickel, bismuth and silver, with the ore of uranium, which has not been found in the Ontario deposits. With these are silver ores of various kinds. The rocks belong to the older systems, but are different in composition from those of Cobalt.

An outline of the history of the cobalt industry at Schneeberg, another German area which contains ores similar to those of Cobalt, Ontario, is given in an appendix to this Report.

At Joachimsthal, in Bohemia, there is a series of mica schist, calc schist and limestone which is cut through by dikes of basalt. The veins are said to be older in age than the diabase and cut all of the other rocks mentioned. The veins are narrow and contain quartz, hornstone, calcite and dolomite as gangue material, and they often show a brecciated structure.[28] The minerals in these ores are embraced in the following list:

[28] Beck; "The Nature of Ore Deposits.

(1) Silver ores (native silver, argentite, polybasite, stephanite, tetrahedrite, proustite, pyrargyrite, sternbergite, argentopyrite, besides rittingerite, acanthite and cerargyrite).
(2) Nickel ores (niccolite, chloanthite, millerite).
(3) Cobalt ores (smaltite as well as bismuth-bearing linnæite and asbolite).
(4) Bismuth ores (native bismuth together with bismuthinite and bismuth ochre).
(5) Arsenic ores (native arsenic, arsenical pyrites).
(6) Uranium ore (uraninite or pitchblende).

With these are galena, zincblende, pyrite, marcasite, copper pyrites and others.

Among these ores those of cobalt and nickel are generally the older; those of silver the younger. The veins cut through dikes of quartz-porphyry, and are in turn cut across by basalt and later dikes.

Of similar composition to those of Joachimsthal are the veins of Annaberg in Saxony. In this neighborhood the rock is gray gneiss. There are two groups of veins in the district, the younger carrying the silver-cobalt ores. These are the most important of the ore bodies. The gangue material is chiefly heavy-spar, fluor-spar, quartz and brown-spar with various cobalt, nickel and bismuth ores, namely: chloanthite, smaltite, red and white nickel pyrites, annabergite, native bismuth, rarely bismuthinite. Of the silver ores there are pyrargyrite, proustite, argentite, native silver, silver chloride, and finally iron pyrites. The subordinate minerals are the gangue materials, hornstone, chalcedony, amethyst, calcite, aragonite, kaolin, gypsum; among ores are copper pyrites, galena, zincblende, marcasite, tetrahedrite, siderite, uraninite, uranochalcite, uranochre, gummite, native arsenic.

The great amount of chloride of silver, which was mined on a large scale at one time, is interesting. The structure of the veins is irregular.

From more than 200 observations which have been made the following is given as the relative ages of the various minerals of the Annaberg veins:

V. Decomposition products, for example, annabergite and cobalt bloom.
IV. Silver ores and native arsenic.
III. Calcite and uraninite.
II. Brown-spar and cobalt-nickel-bismuth ores.
I. Heavy-spar, fluor-spar and quartz.

The silver-cobalt veins cut across the older tin and lead veins of the district as well as the dikes of microgranite and lamprophyre. The latter, especially, is often cut by the silver-cobalt veins. These are cut by basalt, which occurs not only in true dikes, but also in boss-like forms.

Somewhat similar silver-cobalt ores are found in certain veins at Schneeberg, but they are not so strikingly like those of Temiskaming, in mineral composition, as are those of Joachimsthal and Annaberg.

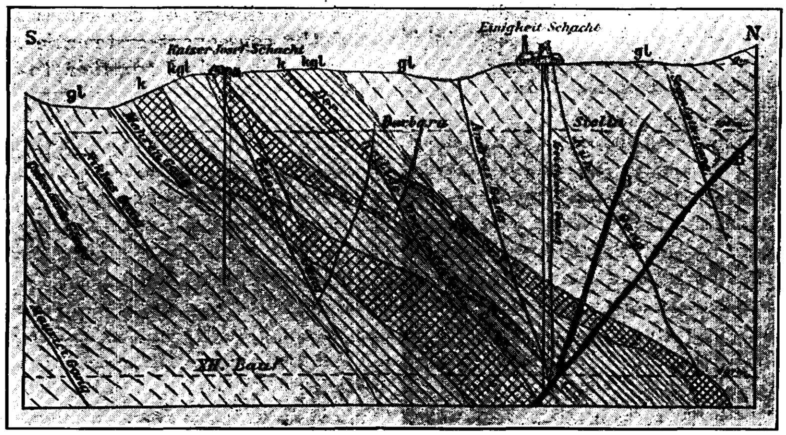
A like association of ores is found at Wittichen, where the veins occur in granite.

In 1904 only one cobalt-silver mine in Germany had a production worth consideration. This is in the Schneeberg field. Its output was valued at about $132,147. The values were in silver, cobalt, nickel, bismuth, arsenic, uranium, samples, etc. The works in which these ores are treated in Germany are at Schneeberg and are known as the "blue color works." Both the government and private companies are interested in tho industry (See appendix).

According to Von Cotta, the Joachimsthal district consists of mica schist, together with more or less hornblende schist and crystalline limestone, the whole being cut by numerous dikes of quartz-porphyry and basalt. There are also two large granite masses which rise out of the mica schist. There are lodes of tin, silver and iron. Tin lodes are found only in the granite region. Silver lodes are divided into four groups tolerably distinct from one another. One set, which has a strike in a certain direction, contains about 17; another set has 21 lodes. There are also lodes which do not come to the surface. Both classes of lodes are said by Von Cotta to intersect the mica schist, with all its subordinate strata, quartz-porphyry and often even the dikes of basalt and wacké. This author also says that there seem to be cases where dikes of the last have intersected lodes or have penetrated into their fissures, from which it may be deduced that the silver lodes were almost contemporaneous with the formation of the basalt in that their fissures in part follow the basalt dikes, in part are intersected by the basalt. At all events they stand in a certain genetic connection to the porphyry, which here is evidently of much greater age than the basalt. The subject is still somewhat obscure. The silver lodes have not yet been found in the granite. Other writers do not agree with Von Cotta, as they appear to claim that the basalt is younger than the veins.

The following notes are taken from Phillips' "Ore Deposits," p. 436. The mountains known as Erzgebirge lie on the boundary between Saxony and Bohemia. Joachimsthal lies on the Bohemian side, and is therefore an Austrian town, while Annaberg is in Saxony.

The country rock in the neighbourhood of Joachimsthal is for the most part mica schist enclosed between masses of granite. In the eastern portions of the mine where there are some masses of included limestone, the lodes usually carry calcite as the predominating veinstone, but in the western part where the veins are not infrequently associated with dikes of porphyry, the gangue is almost entirely quartzose. There are seventeen veins striking north and south and seventeen others of which the direction is east and west. It has been constantly observed that the former exhibit a tendency to become enriched where they pass through the porphyry or included limestone, while the latter set of veins are not similarly affected when they come in contact with these rocks. The ores raised contained values in silver, cobalt, nickel, bismuth and uranium. In the eastern division of the mine there are two shafts situated about 260 fathoms apart, the Einigkeit's shaft and the Kaiser Joseph shaft (Fig. 32).



Vertical section through the Kaiser Josef and Einigkeit shafts at Joachimsthal showing several narrow veins (gang), and dikes of diabase (B). The veins in mineral contents, size and distribution resemble those of Cobalt, Ont. (After Babanek-Beck).

In 1864 when the former shaft had reached a depth of 280 fathoms, a heavy outburst of water, at a temperature of 25 C. and evolving sulphuretted hydrogen, took place and greatly interfered with underground operations. It took two years before this water could be successfully tubbed off and mining proceeded with.

It is interesting to know that the uranium ores of Joachimsthal took an an additional value two or three years ago, when it was found that uraninite was the chief commercial source of radium.

The character of the ore produced will be seen from the following statement made by Phillips:

During the period from 1877 to 1880 there were obtained 29⅓ tons of ore, containing 4,497 oz. of silver, 198 lbs. bismuth, 878 lbs. uranic oxide, 1½ tons arsenic and 314 lbs. of cobalt-nickel with a little lead, representing a total value of £1,687.

"About this time it became evident that the uranic oxide was the most valuable product of these mines, and workings were especially directed to develop the minerals yielding it. From 1881 to 1886 the average annual production was 38 tons of silver and uranium ores, worth about £6,520."

It is thus seen that these Joachimsthal veins, during late years at least, cannot be compared in richness with those of the Temiskaming district.

Chalanches, France

Somewhat similar silver, cobalt, and nickel ores occur in a network of narrow veins in crystalline schist at the Chalanches, in the Dauphiné, France. These deposits were discovered in 1767 and have had an interesting history. They were described some years ago by Mr. T. A. Rickard (Trans. Am. Inst. M. E. Vol. XXIV).

The following extracts are from Mr. Rickard's interesting paper:

"In southeastern France, among the magnificent Alpine masses of the Dauphiné, there is a group of celebrated mines of silver, nickel and cobalt ores, the deposits of which present many features of interest. . . . .

"The discovery of these, as of many other notable mines, was accidental. In 1767, Marie Payen, a shepherdess (bergère) of Allemont, found an outcrop of silver ore, and brought away, in ignorant curiosity, a lump of heavy stone, which she handed to the village smith. When tested on his forge, the molten silver trickled from it. The shepherdess received 600 francs upon her wedding day as a reward for the discovery.

"The record of the Chalanches presents a story similar to that which is told of mines in more modern mining districts. The inaccessibility of the mines in winter, the richness of the ore, its great fusibility, and the consequent systematic robbery of the silver are local commonplaces. Circumstances all worked together to make the Chalanches mines the prey of the most barefaced plunder. With the aid of a common forge-fire, even without the intervention of a crucible, and with little knowledge or skill, lumps of silver could be produced from the very rich chlorides, ruby silver and black sulphides which constituted in the main the soft earthy ores or *terres* found in the crevices of the outcrop. Aged inhabitants still talk sportively of the theft like old smugglers and point out nooks in the woods, which the remaining ruins of the little furnaces dug out by the miners show to have been the scenes of former illicit silver-ore smelting. In these furnaces, no larger than an ordinary fire-place, dug in the earth and smeared with clay, with charcoal, or, failing that, clods of dung for fuel, and two or three little urchins to blow, like cherubs on the old maps, out trickled the white metal. Clergy and people joined cheerfully in these moonlighting operations without in any degree shocking local ethics. The priest at Allemont, who lately restored the parish church, says that the old church had a room adjoining the sacristry in which a former reverend father used to melt down silver-ore brought to him by the faithful. The slags were concealed in an excavation under the floor, where a large accumulation of them was found when the church was restored. . . . .

"During the earliest period of mining at the Chalanches, some bodies of extremely rich ore were found near the surface. It is said that two shots produced sufficient silver to pay for the two buildings known as the pavilions of Allemont, with their various ornamentations, including the *fleurs-de-lis* which still adorn the roof. As 200 to 300 kilos. of silver would at that time be worth from $10,000 to $15,000, this statement does not seem incredible. . . . . . .

"It is not a little remarkable that although the silver is always associated in the lodes with rich nickel and cobalt ores, often with bunches of stibnite, and more rarely and erratically with gold, the government engineers took no notice of any metal other than silver. None of the valuable metals mentioned figure in the old accounts. The speiss containing nickel and cobalt was rejected with the slags, and went to fill the swamps and to form the road-beds, which, in later times were furrowed and turned over to recover their valuale contents. . . . . .

"The possibility of utilizing three metals instead of one seems to have dawned upon the engineers quite as a discovery; and this fact stimulated the repeated spasmodic attempts to rehabilitate the old mine. The arsenides of nickel and cobalt were sold in England and Germany. More recently, a German chemist was employed at Allemont in an experiment to manufacture cobalt pigments for the arts. He was not successful, and the attempt was abandoned.

"In 1891 the gold value was first recognized. Its importance proved greater from a scientific than from a commercial point of view. The old mine-workings, aggregating 20 kilometers in length, showed that a great deal of unsuccessful exploration had been carried out. Search among the galleries, particularly near the surface, resulted in the finding of certain rich bunches of ore, which were soon exhausted. An attempt to introduce the tribute or lease system was made, with partial success. . . . . .

The Ore Deposits

"The geological formation is simple. A net work of veins traverses crystalline schists of very variable character. The country forms a part of the great crystalline formation usually referred to as the Archaic schists of the Alps, though in point of fact they probably include rocks from the granite up to the Carboniferous. Lithologically, certain sections suggest the Huronian and Laurentian. These schists lie immediately upon the granite; they are extremely variable in character, so that at different places they can be described as gneissoid, granitoid, talcose, micaceous, graphitic, or amphibolic. At the base of the slope leading to the mines there are superb blocks of rock containing crystalline epidote. . . . . .

"The maps of the mine exhibit a wonderful network of galleries, spreading like a cobweb over an area of about 600 by 300 meters.

"It is computed that the workings aggregate in length not less than twelve miles, an extent in remarkable contrast to the relatively small quantity of ore produced. . .

"It has been thought by several observers that the lodes were more numerous near the surface than in the interior of the mine. This is due to the fact that any single fissure, in approaching the surface, spreads itself out into a number of subordinate fractures. It has also appeared that the lodes gained in regularity as they penetrated the mountain. Caillaux, therefore, adds that this fact seems to indicate the probable occurrence in depth of only a small number of lodes but that those surviving will have a regularity greater than those which have been hitherto exploited. Regularity of structure would be a poor compensation to the miner for the fact that the enclosing rock is much harder, and the thickness of ore smaller, than in the ground nearer the daylight.

"The veins vary in width from a knife-blade to 80 centimetres (31.5 inches); their usual thickness lies between 3 and 30 centimeters (0.1 to 1 foot). . . . . .

"Examination of the old workings proves clearly that with increasing distance from the surface the country gets harder, the veinstuff loses its soft character, the veins become fewer in number, more regular, less wide and less ore-bearing. Approaching the surface, on the contrary, the schists are fractured in a multiplicity of directions, the veins become larger, their filling is generally earthy and they throw off branches, at the intersections of which ore bodies are found. In general, mineralization becomes more pronounced with approach to daylight; this being due, not merely to the oxidation of the sulphides but to an actual relative increase of 'orey' matter. . . . . . .

"The observations made from day to day led me to conclude that the richest part of the mine was that which was within the influence of oxidation, and that both chemical agencies and structural conditions favored an enrichment of ore near the surface. This statement is particularly applicable to the silver contents. It also holds true of the gold, but it is less accurate with respect to the nickel and cobalt. The richness in silver of the oxidized ores suggests secondary precipitation. This is confirmed by the fact that the silver appears to be thrown down upon the nickel and cobalt arsenides, and often envelops them in such a way as to impart to them the rudiments of a nodular structure. The hard, undecomposed arsenides contain only small amounts of silver. The gold, only occasionally present, is associated invariably with soft, maroon-colored, earthy, iron-bearing vein stuff. The nickel and cobalt minerals appear to be primary ones, and are more persistent than those of silver and gold. . . . . .

"If we accept the current theory that the nickel and cobalt came from the leaching of magnesian silicates, (and facts are numerous pointing that way), then, we must conclude that the origin of the nickel and cobalt of the Chalanches was not the immediately enclosing country, but rocks similar to it, which underlie it at a greater depth. The silver and gold, it may be suggested, were precipitated from other solutions, and at a period other than that which saw the deposition of the nickel and cobalt. The precious metals were probably derived from a deeper-seated source; and may have been leached from the granite which underlies the schists and is penetrated by the basic eruptives. In both cases the various metals must have come from a depth where leaching action was powerful, and from which ascending currents brought the metallic constituents, the subsequent precipitation of which produced valuable ore-deposits."

Norway

"The cobaltiferous fahlbands of the districts lying around Skutterud and Snarum occur in crystalline rocks varying in character between gneiss and mica schist, but from the presence of hornblende they sometimes pass into hornblende schists. These schists of which the strike is north and south and which have an almost perpendicular dip, contain fahlbands very similar in character to those of Kongsberg. They differ from those of that locality, however, in as much as while here the fahlbands are often sufficiently impregnated with ore to pay for working, those of Kongsberg, although to some extent containing disseminated sulphides, are only of importance as zones of enrichment for ores occurring in veins. The ore zones usually follow the strike and dip of the surrounding rocks and vary in breadth from 2½ to 6 fathoms. The distribution of the ores is by no means equal, since richer and poorer layers have received special names and are easily recognized. The predominant rock of the fahlbands is a quartzose granular mica-schist or gneiss. The ores worked are cobalt-glance, arsenical and ordinary pyrites containing cobalt, skutterudite, magnetic iron pyrites, copper pyrites. molybdenite and galena. It is remarkable that in these mines nickel ores do not accompany the ores of cobalt in any appreciable quantity. The principal fahlband is known to extend for a distance of about six miles, and is bounded on the east by a mass of diorite which protrudes into the fahlband, while extending from the diorite are small dikes or branches traversing it in a zig-zag course. It is also intersected by dikes of coarse-grained granite which contain no ore, but which penetrate the diorite."[29]

These deposits, which at one time were among the world's chief producers of cobalt, are too low grade to be now worked at a profit.

New Caledonia

As the table given below shows, there have been during late years about half a dozen countries supplying the world with cobalt. The output of New Caledonia, at the time Cobalt was discovered was much larger than that of any other country. It produced probably 85 or 90 per cent. of the world's supply.

Since the ore from Ontario has been put on the market the prices seem to have fallen materially in New Caledonia. It seems strange that Ontario should be practically the only competitor which this French penal colony, in the southern Pacific, has in

[29] Phillips, Ore Deposits.

both nickel and cobalt. The rivalry between the two countries in the production of the former metal has attracted attention for a number of years. It is now the more surprisinig that this Province becomes a competitor with the island in another way.

The cobalt depostis of New Caledonia occur under similar conditions to those of nickel and the two metals are frequently associated in eoconomic quantities. The depostis of the two metals in Ontario, on the other hand, occur under conditions different from those of New Caledonia, and little connection has been proved between the cobalt deposits of Temiskaming and the Sudbury nickel ores ninety miles to the southwest. The Sudbury ore consists of pyrrhotite and copper pyrites. It is associated with basic igneous rocks, the deposits being supposed to be of igneous origin. The cobalt silver deposits, on the other hand, occur in distinct veins and are of aqueous origin.

It may be added, however, that the Cobalt and Sudbury areas appear to belong to the same "petrographical province," the diabase and the cobalt of the former area seem to have been derived from the same magma. This diabase is characterized by the presence of free silica, quartz, as is also the coarser grained igneous rock, norite, associated with the Sudbury nickel deposits.

New Caledonia is a non-glaciated country. Over a considerable part of its surface the immediately underlying solid rock belongs to the basic igneous group known as peridotite. This rock, like other basic varieties, weathers readily, and over a large part of the surface of New Caledonia it is represented by its alteration product, serpentine. The surface of this serpentine is more or less broken down, forming comparatively loose or slightly coherent deposits. It is in association with these that the cobalt is found, its ore being what is known as asbolite, earthy cobalt or cobaltiferous wad. Asbolite is a mixture of oxides of cobalt, manganese and other metals. It can hardly be called a distinct mineral. It has been proved that the cobalt, nickel and other metals found in this decomposed rock were originally constituents of the peridotite.

The peridotites are believed by some writers to be post-Cretaceous in age, and are said to be in the form of a surface flow covering the uneven or eroded surface of the underlying Cretaceous strata.

They constitute the great serpentine formation of New Caledonia, and are high in magnesia and low in iron. They are more or less charged when fresh with crystals of pyroxene, uniquely ferro-magnesian, which lies between enstatite and bronzite. The unaltered rock belongs, therefore, in Rosenbusch's classification, to harzburgite. Dunite, which is composed of olivene with chrome iron ore and without pyroxene, is met with at times. These peridotites usually show traces of advanced alteration which results in the more or less complete transformation of olivene to serpentine, and in the development of talc from pyroxene. At times the alteration is complete enough to produce perfect serpentines, uniquely constituted of an aggregate of crystals of antigorite with some films of talc.

Since these rocks always contain a little manganese, nickel and cobalt, it would appear that these metals are integral of the olivene as well as of the enstatite. Grains of chrome ore are abundant in all samples.

The rocks are often traversed by dikes, less basic, of the character of gabbro, that is to say, rocks which contain feldspar and pyroxene Diorites fine in grain or at times holding large crystals of hornblende sometimes outcrop in the middle of serpentine exposures.

Much of the mineral mined appears to contain only two or three per cent. of oxide of cobalt. After washing, it averages probably 4½ per cent. In one deposit described by Glasser, it is said that the decomposed material occupies a profound depression in the serpentine. This basin is filled by a red, clay-like deposit which has a depth of about 52 metres in the centre and 10 or 12 metres around the border. The richest ores appear to occur near the centre of the basin and near the contact of the serpentine.

It will be seen that all the cobalt deposits are irregular in form, and hence it is difficult to estimate their value.

The cobalt ore is all exported in the unrefined state.

The metal comes on the market in the form of oxide, CoO, which finds use in small quantities in several industries, the principal being that of pottery, where the blue coloration which it tends to give to the ware is employed to counteract the reddish tinge that traces of iron so often produce. It is also used to color porcelain, enamels and glass. The properties of metallic cobalt are remarkable. It would be used in alloys and for purposes to which nickel is put if it were as low in price as the latter metal. The different uses of cobalt, which absorb annually about 200 to 250 tons of oxide, guarantee a regular demand for the ore.[30]

Mr. A. Glasser, from whose "Report in 1904 to the Minister of the Colonies on the Mineral Wealth of New Caledonia" the foregoing is taken, states that New Caledonia has practically a monopoly of the production of cobalt in the whole world. He further says that while the deposits of the mineral are capricious they are at the same time numerous and extended.

This monopoly has now been broken by the discovery of the Ontario deposits.

At the time of Mr. Glasser's visit to the colony, the prices paid for cobalt ore were about as follows:—

Mineral with 4 per cent. CoO .... 330 Fr. a ton ($66)
Mineral with 3 to 3½ per cent. was paid on the same basis, 145 fr. and with an increase of .60 fr. for each 1-10 of 1 per cent., above .... 195 Fr. a ton
From 4 to 5 per cent., for each 1-10 of 1 per cent. above 4 per cent., there was paid .... .80 Fr.
From 5 to 6 per cent., for each 1-10 of 1 per cent. in excess of 5, was paid .... .90 Fr
From 6 to 7 per cent., for each 1-10 of 1 per cent. above 6, was paid .... 1. Fr
Above 7 per cent., for each 1-10 of 1 per cent., was paid ... 1.50 Fr
On this basis mineral carrying 8 per cent. brings 750 Fr. ($150) a ton.

Production of Cobalt 1896 to 1900

Country.	1896.		1897.		1898.		1899.		1900.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		francs		francs		francs		francs		francs
New Caledonia	4,823	482,300	4,757	475,700	2.373	237,300	3,294	336,000	2,438	275,500
New South Wales	....	....	....	....	119	14,000	193	22,975	145	39,750
Chili	....	....	6	780	18	4,540	55	20,450	27	10,060
Spain	18	9,000	13	17,000	....	....	....	....	....	....
Norway	19	13,500	24	13,500	21	10,800	....	....	....	....
Prussia	181	49,340	121	31,280	34	8.500	17	4,250	4	800
Total	5,051	554,140	4,921	538.266	2,565	275,140	3,559	383.675	2,614	326,110

1 franc=20 cents.

This total was augmented by some tons of complex mineral mined in different parts of Germany and Austria, from which a little cobalt was produced.

Taking the world's consumption of cobalt oxide, CoO, at 200 to 250 tons a year, as given above, the 2,614 tons of ore produced in 1900 would need to contain on the average over 8 per cent. of the oxide. The price of the ore averaged, as shown by the table, approximately 125 Fr. or $25 a ton. It may be added that cobalt oxide, CoO, contains 78.66 per cent. of cobalt and 21.34 per cent. of oxygen by weight. The Temiskaming ore is sold on the basis of metallic cobalt, not on that of the oxide as in New Caledonia.

[30] It may be added that the method of manufacturing blue Cobalt glass has been known almost from prehistoric times, as the glass has been found in the graves of the ancient Egyptians and in the ruins of Troy.

On a following page, under the heading "The Cobalt Industry," the prices recently paid for New Caledonia cobalt ores and statistics of shipments are given.

New South Wales

The second largest producer of cobalt in the world has been New South Wales. The deposits in this country are situated near Port Macquarie and are similar in character to those of New Caledonia.

In 1903 the quantity of cobalt ore exported from the deposits near Port Macquarie amounted to 153 tons valued at £1,570.

South Australia

Cobalt ore, containing smaltite and other minerals, is found at Bimbowrie, near Olary, on the Broken Hill line, but little work has been done on the deposit.

South Africa

While silver has, as we have seen, been worked in association with cobalt, the latter metal has been very seldom found in association with gold in important quantities. Reference to only one such occurrence has been seen by the writer. This is in the Middleburg district in the northern Transvaal. Here in this non-glaciated district the gangue material, in the vein to which reference has been made, is kaolin, with which is mixed gold-bearing quartz. In the latter mineral are small nest-like aggregations of smaltite and copper ores, and at times molybdenite and the secondary minerals cobalt bloom, limonite and skoradite.

In a recent publication ("Geology of the Neighborhood of Middleburg," Transvaal Mines Dept., Pretoria, 1907), a brief account of one of the cobalt deposits is given in the following words: "Cobalt, in the form of smaltite and erythrite, is found at Balmoral, and also just beyond the northern boundary of the map in the valley of the Kruis river. At Balmoral the cobalt is associated with felspar and actinolite, together with secondary quartz and calcite, in veins most probably of igneous origin, which traverse a series of highly altered sedimentary rocks of shaly character in the neighborhood of the junction of the Waterberg and Transvaal systems."

It will be seen that these South African cobalt veins resemble those of the Montreal river area, Ontario, described on a preceding page, in that they contain felspar and appear to be of igneous origin.

United States

Up to the present time there has been more or less production of cobalt oxide in the United States. Some of this came from the cobalt associated with the nickel ores at Sudbury, Ontario. In the process of smelting, which is now used at Sudbury, the cobalt is slagged out of the matte. Hence none of this metal will be produced in the future from Sudbury matte in the United States. According to the "Mineral Industry," in 1902 there was no production of cobalt oxide from domestic ores in the United States. In 1901, 13,360 lbs. of cobalt were derived from slag produced in the smelting of the lead ores at Mine La Motte, Missouri. In 1903 cobalt and nickel are said to have been discovered near Marion, Kentucky, in association with the fluorspar in that region. In the same year the Mine La Motte Company undertook the construction of a smelter and refinery for treating the nickel and cobalt ores obtained in connection with lead mining. A refinery is now operated at Fredericktown, Mo.

It is said that a few years ago one or two small trial shipments of cobalt ore from deposits in Grant county, Oregon, were made to France. The deposits in this county are described as occupying fissures in a dark greenish, more or less altered diabase-porphyry. They have a general northeasterly and southwesterly strike, and dip southeast. The ore bodies appear to be more or less lenticular in shape and vary from a few inches to several feet in width. The principal minerals are chalcopyrite, smaltite, arsenopyrite, pyrite, pyrrhotite, malachite and bornite with a quartz and calcite gangue. The values are chiefly in gold, cobalt and copper. Smaltite from a sample of the ore carrying this mineral and chalcopyrite was found by Mr. Burrows to have the following composition (No. 1). This smaltite had a rather unusual appearance, resembling somewhat acicular or fine columnar stibnite. In composition it is close to that from Gunnison county, Colorado, an analysis of which is given by Dana (No. 2).

	No. 1.	No. 2.
Cobalt	14.88	11.59
Nickel	1.12	trace
Arsenic	64.06	63.82
Sulphur	.57	1.55
Iron	11.14	15.99
Insoluble	2.22	etc.
Calcium carbonate	6.34	
Total	100.33	

Mexico

Cobalt-holding minerals have been found at several localities in Mexico. Little has, however, been published concerning these occurrences. Near the village of Pihuamo, state of Jalisco, cobalt minerals are found in veinlets cutting a large vein of magnetite associated with pyrite and pyrrhotite. The chief rock in the vicinity is described as andesite. It is said that some tons of ore have been mined which contained 8 or 9 per cent. of cobalt. The minerals are cobaltite together with small quantities of smaltite and cobalt bloom. The veinstones are calcite, slightly greenish, and a little barite. A little niccolite appears to be present.

The following Mexican localities are also said to contain cobalt minerals: Iturbide, in Chihuahua, Guanacevi in Duranago, Cosala in Linaloa, at the mine "Mirador" in Jalisco. It is said that the zinc in smithsonite is partly replaced by cobalt in Baleo, Lower California.

Chili

From the table on a preceding page it will be seen that Chili has been a producer of cobalt. References to the occurrence of the metal in that country are few, and the writer is not able to say what the ores are. According to Dana smaltite occurs, but in small quantities, at the silver mines of Tres Puntas and elsewhere in Chili.

THE COBALT INDUSTRY

In the issue of July 1st, 1905, "Le Bulletin du Commerce," of New Caledonia, which during late years has been the country producing the greater part of the cobalt consumed, gives some interesting notes concerning the industry under the heading "Cobalt Canadien et Cobalt Calédonian."

Attention is drawn to the fact that Ontario is now a serious competitor in the cobalt market with New Caledonia and a synopsis is given of the paper, in the last Report of the Bureau of Mines, on the Temiskaming cobalt-silver deposits.

The following is a rather free translation of a part of the article:

The governing powers of the colony (New Caledonia) have shown themselves in the last April session strongly opposed to the reduction of the export duty on minerals inaugurated in 1903. Since that time the condition of the cobalt market has been profoundly changed by the discovery of deposits in Ontario. New Caledonia cobalt no longer controls the market; as in the case of nickel, a strong competitor has arisen.

The Canadian, or rather American, oxide of cobalt is about to be placed on the European market. In March last, a meeting of those interested in the manufacture of cobalt oxide was held in Paris, and the Americans there proposed to furnish three-quarters of the world's consumption. The stocks of mineral or oxide to be delivered or in storage were then large. The manufacturers of oxide in France, England and Germany have restricted their purchases. It is this state of things which has resulted in the prolonged lowering of the market since the complete stoppage of the buying.

Another meeting of European and American manufacturers was announced for June. It will be interesting to know whether it was decided at this meeting that the manufacturers of the two continents should work together or that they should enter into competition. In either case it means a reduction of our export if the Canadian cobalt is put to the same uses as our own.

It is then evident that the cobalt situation has radically changed and that it would be folly to willingly persist in the continuation of a tax, which while reasonable in 1903, will be disastrous in 1905, and will prevent all exploitation of deposits, especially those carrying low grade ore.

It may be added to this that it is difficult to see how any of the deposits of New Caledonia can be worked in competition with those of Ontario. The ores of this Province carry such high values in silver that they will be worked primarily for this metal, although they contain on the average much higher values in cobalt than do those of New Caledonia. Then there are the other by-products, nickel and arsenic, in the Ontario ores. The ores of this Province should control absolutely the cobalt market.

In 1905, New Caledonia shipped the following number of tons of cobalt ore to the countries named, viz.: England 3,852, France 2,238, Austraila 1,792, Germany 537, or a total of 7,919 tons, which is over 1,000 tons less than the shipments of 1904.

The following are the shipments of cobalt and nickel ores for the last three years:

	1905.	1906.	1907.
Cobalt	7,919	2,487	3,942
Nickel	125,289	130,688	101,707

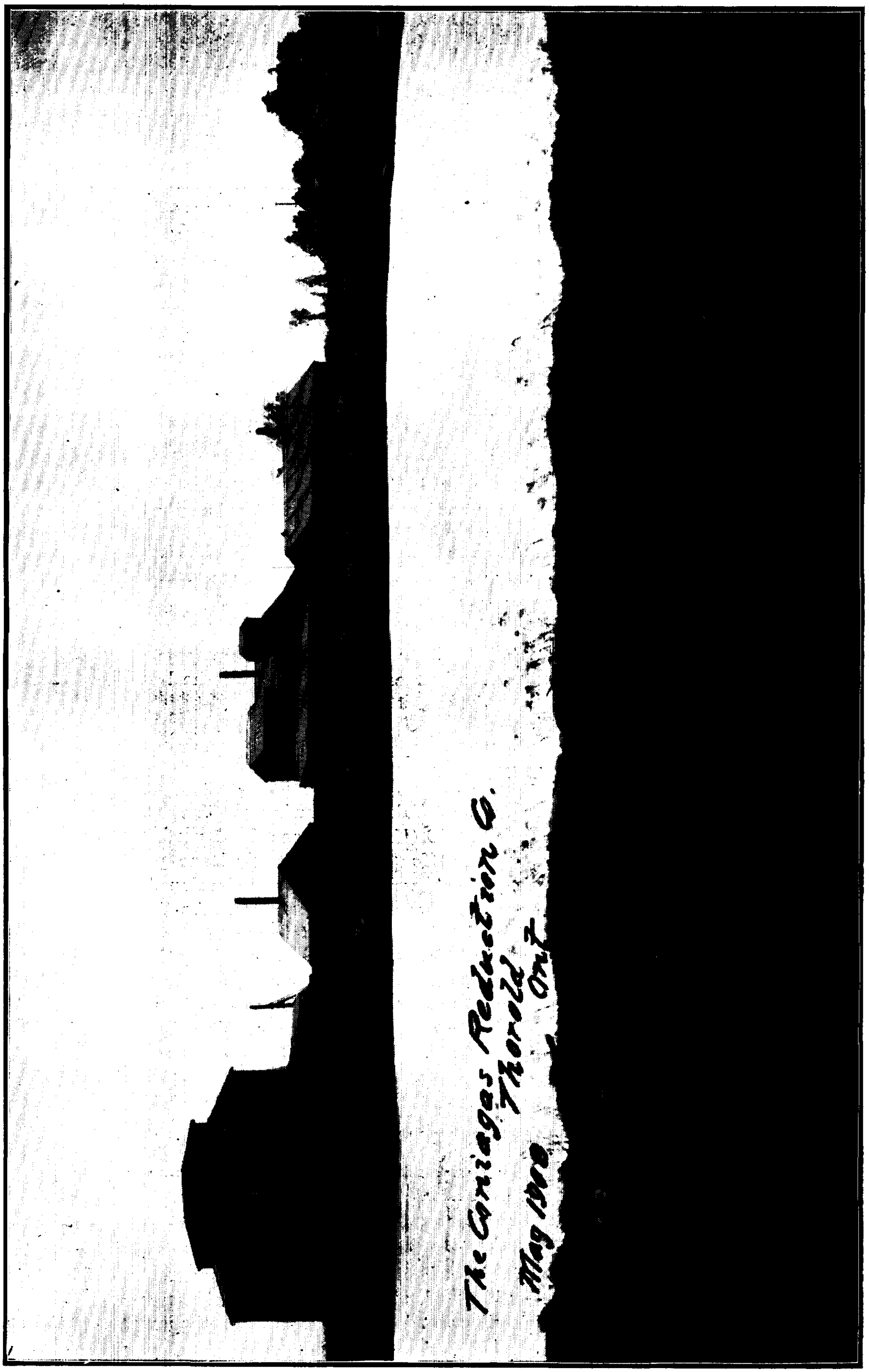
The prices paid for cobalt ore in New Caledonia during the first quarter of 1908 were about as follows: For 4½ per cent. $23 (115 fr.) a ton; for 5 per cent. ore $27 to $28 (135 to 140 fr.), and 90 cts. (4.50 fr.) for each one-tenth of one per cent. above. At these prices, it is said, only the richest, well situated and developed mines can be worked. Many of the smaller mines have been obliged to close. An 8 per cent. New Caledonia ore at the price quoted would bring $36 a metric ton.

The Anglo-French Nickel Company of Swansea, Wales, who have been buying ore at Cobalt for the cobalt contents alone, pay 30 cents a pound for the metallic cobalt in an 8 per cent. ore. This is about $53 per ton for such ore. It is to be concluded, therefore, that the Canadian ores are preferred to those of New Caledonia by the refiners.

METALLURGY

The characteristics of the metal cobalt and its compounds are much like those of nickel and its compounds. The methods used for extracting one metal from its ores are similar to those used in the case of the other. Since these methods are complicated, an attempt will not be made to describe them. The reader, desirous of a knowledge of the methods, is referred to some standard work on metallurgy, such as that of Schnabel.

In former times cobalt glass, "blue color," was made directly from some of the purer ores carrying cobalt, nickel, silver and arsenic. Most of the arsenic was first



Coniagas Reduction Company's Plant, erected for the refining of ores from Cobalt.

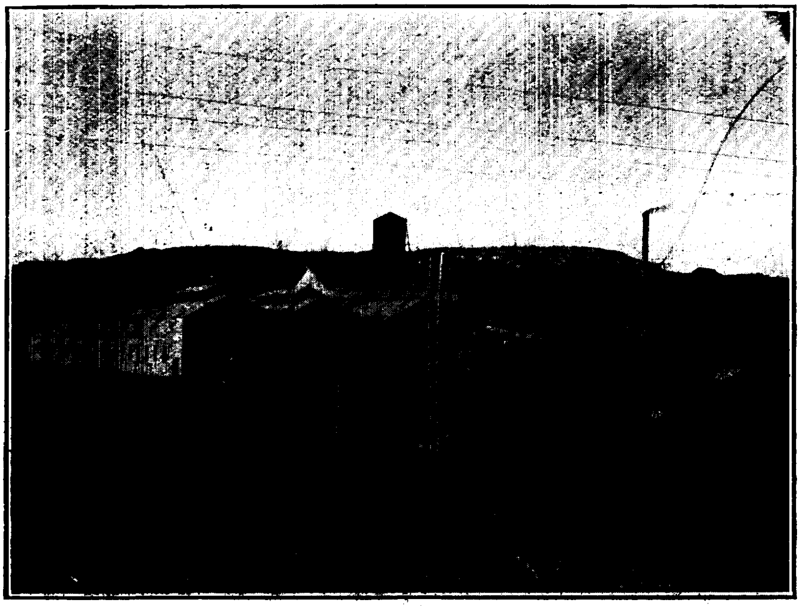
roasted off, and to the residue were added the constituents of potash glass—powdered quartz and carbonate or other compound of potash. The roasted ore, with these constituents added, was then melted down, the cobalt uniting with the glass to form smalt and the nickel and silver settling to the bottom of the furnace. If a little arsenic was not left in the ore some of the nickel would also combine with the glass, thus injuring its color.

Plant at Deloro, Hastings County, for refining ores from Cobalt.

The blue glass, or smalt as it is called, was powdered and sieved, and was then ready for the market. An interesting account of this method of manufacturing smalt is given in Knapp's "Chemical Technology," first American edition, Vol. II, 1848.

Cobalt now comes on the market in the oxide form, the latest quotation being \$1.60 per lb. for the pure oxide, CoO. There are seven or eight manufacturers of this oxide in Europe—three in England and two or three each in France and Germany. Little cobalt is used in the metallic form, owing to the fact that nickel serves practically the same purposes as metallic cobalt and is much lower in price. It is said that a little cobalt added to nickel in plating tends to produce a more silvery and less steel-like lustre. By far the largest consumers of cobalt are the potteries.

This Province has three plants working on the Temiskaming silver-cobalt ores, and two other plants have been erected but are not yet in operation. The International Nickel Company has plant at Copper Cliff, Ont. The works at Deloro in Hastings county, which formerly treated auriferous mispickel, have been rebuilt and are now refining ore from Cobalt. The third operating plant in Ontario is at Thorold, and was completed in the spring of 1908.



Plant at Copper Cliff, Ont., for refining ores from Cobalt.

At Copper Cliff the only material in the ores which is turned out in the refined state is arsenic. After the arsenic is roasted off, the residue containing silver, cobalt and nickel is melted down. The product is shipped to the United States to be refined. At Deloro both silver and arsenic are refined, the cobalt and nickel residue being stored with the intention of selling them to refiners of these metals. At Thorold all four products of the ore, viz., silver, cobalt, nickel and arsenic, are to be refined.

The methods of refining the cobalt-silver ores at the various works referred to are kept more or less secret. A brief description of the plant at Copper Cliff will be found on pages 64-65 of the 15th Report of the Bureau of Mines. An outline account of the Deloro Mining and Reduction Company's plant is given on pages 517-522 of the Canadian Mining Journal, Nov. 15th, 1907.

APPENDIX I

LIST OF MINING COMPANIES INCORPORATED IN CONNECTION WITH COBALT.

The following list of companies incorporated in Ontario during the years 1904 to 1907, in connection with mining enterprises, gives an idea of the effect which Cobalt had on the organization of companies.

Mining Companies Incorporated in 1904

The number of companies organized under the laws of the Province in 1904 was 54, with an aggregate nominal capital of $28,355,000, as against 43 companies in 1903 having a total share issue of $35,534,000. In addition 12 companies of extra-provincial origin took out licenses enabling them to do business here, their joint combined capital amounting to $21,155,000, as against 12 such companies in 1903, having an aggregate capital of $12,000,000.

The only company incorporated in 1904 which has become prominent in the Cobalt field was The Nipissing Mining Company, Limited, which was incorporated on December 16th, with a nominal Ontario capitalization of $250,000.

The Temiscaming and Hudson Bay Mining Company, Limited, was incorporated on the 29th of July, 1903, with an authorized capital of $25,000. Its incorporation precedes the discovery of Cobalt but the company has since become prominent in this field.

Mining Companies Incorporated in 1905

The following list, so far as is known, includes the joint stock companies incorporated for mining purposes in connection with the cobalt-silver deposits in 1905.

The total number of mining and allied companies incorporated in the Province in that year was 89, with an aggregate authorized capital of $27,509,000. There were also 17 companies of foreign incorporation licensed in that year to do business in Ontario. They had a united capital of $6,190,000.

It will be seen from the lists of companies incorporated in 1906 and 1907, what effect the Cobalt boom had on the organization of companies.

Name of Company.	Head Office.	Date.	Capital $
Coleman Cobalt Mining Co., Limited	Toronto	August 25	250,000
Cobalt Development Co., Limited	Toronto	October 6	1,000,000
Cobalt Merchants' Mining Co	Toronto	October 31	200,000
New Ontario Cobalt & Silver Mining Co., Limited	Ottawa	August 15	1,000,000
Ontario Smelters, Limited	Toronto	August 25	500,000
Sovereign Cobalt Mining Co., Limited	Toronto	November 29	200,000
Temiscamingue Reduction Works, Limited	Cobalt	November 15	166,000
The Blanche River Mining Co., Limited	New Liskeard	September 22	40,000
The Chester Silver Mining Co., Limited	New Liskeard	September 30	25,000
The Cobalt Canadian Mining & Milling Co., Limited	Kingsville	October 13	500,000
The Coleman & Bucke Consolidated Cobalt Silver Mining Co., Limited	Ottawa	July 28	1,000,000
The Dymond and Abitibi Mining & Development Co., Ltd.	New Liskeard	August 16	25,000
The Gordon Cobalt Silver Mining Co., Limited	Toronto	October 31	200,000
The Imperial Silver Mining Co. of New Liskeard, Limited.	New Liskeard	October 6	50,000
The McCormick Cobalt Silver Mining Co. of Toronto, Ltd.	Toronto	December 13	500,000
The New Liskeard and Northern Ontario Mining & Development Co., Limited	New Liskeard	May 5	25,000
The New Ontario Ore Refining Co., Limited	Toronto	August 9	500,000
The Northern Exploration Co., Limited	Toronto	September 22	10,000
The Ontario Cobalt Development Co. Limited	Toronto	December 20	350,000
The Pittsburg Cobalt Co., Limited	Toronto	December 27	75,000

Mining Companies Incorporaled in 1905—Continued

Name of Company.	Head Office.	Date.	Capital $
The Rothschild Cobalt Co., Limited	Haileybury	September 22	500,000
The Savage Cobalt Silver Mining Co., Limited	Toronto	August 25	250,000
The Silver Bar Mining Co., Limited	Ottawa	December 13	500,000
The Silver Five Mining Co., Limited	New Liskeard	October 25	40,000
The Silver Gulch Mining & Prospecting Co., Limited	Cobalt	October 31	75,000
The Silver Hill Mining Co., Limited	Mattawa	October 4	50,000
The Standard Silver and Cobalt Mining Co., Limited	New Liskeard	September 22	40,000
The Temiskamingue Mining Co, Limited	Haileybury	August 16	100,000
The White Silver Co., Limited	Toronto	October 13	100,000
The Windsor & Cobalt Mining Co., Limited	Windsor	July 22	150,000
Toronto Cobalt Mining Co., Limited	Toronto	December 1	300,000

Mining Companies

The schedule given below shows the mining companies incorporated under the laws of Ontario and also companies of foreign incorporation licensed to do business in this Province, during 1906. Of the former, 263 concerns were organized with a nominal capital aggregating $184,677,000, and of the latter, 18 received licenses having a united capital of $12,536,000. The increase of companies as compared with 1905 was very marked, the numbers being 263 and 99, and aggregate capital $184,677,000 and $27,509,000 respectively. The larger part of the increase, as will be seen by looking over the list, was due to the great activity in exploiting the silver-cobalt field.

Mining Companies Incorporated, 1906

Name of Company.	Head Office.	Date of Incorporation.	Capital. $
Abitibi and Cobalt Mining Company, Limited	Sault Ste. Marie	March 10, 1906	2,500,000
Algoma Custom Smelting and Refining Company, Limited	Sault Ste. Marie	November 28, 1906	250,000
Amalgamated Cobalt Mines, Limited	Toronto	June 23, 1906	1,000,000
Anima-Nipissing Silver Mines, Limited	Cobalt	November 22, 1906	300,000
Anthony Blum Gold Mines, Limited	Toronto	November 28, 1906	100,000
Argentite Mining and Smelting Company, Limited	Toronto	April 24, 1906	2,000,000
Atlantic Oil Company, Limited	Toronto	June 30, 1906	2,000,000
Banner Cobalt Mining Company, Limited	Windsor	December 19, 1906	
Barnard-Argue-Roth-Stearns Oil and Gas Company, Limited	Chatham	October 3, 1906	400,000
Baxter Oil Company, Limited	Thamesville	October 26, 1906	50,000
Beaver Silver Cobalt Mining Company, Limited	New Liskeard	April 24, 1906	500,000
Becktels, Limited	Waterloo	November 30, 1906	75,000
Ben Allen Portland Cement Company, Limited	Owen Sound	February 14, 1906	500,000
Bonanza Reef Extension, Limited	Toronto	December 14, 1906	100,000
Boston Mines, Limited	Toronto	July 26, 1906	50,000
Burrough Larder Lake Gold Mining Company, Limited	New Liskeard	December 5, 1906	500,000
Calumet Cobalt Mining Company, Limited	Haileybury	November 24, 1906	500,000
Campbell-Crawford Cobalt Silver Mining Company, Limited	Cobalt	December 12, 1906	1,000,000
Canada Minerals, Limited	Toronto	September 26, 1906	100,000
Canada and United States Oil and Gas Company, Limited	Chatham	October 12, 1906	30,000
Casey Cobalt Silver Mining Company, Limited	Haileybury	December 19, 1906	100,000
Cobalt-American Development Company, Limited	Toronto	March 16, 1906	600,000
Cobalt Annex Silver Mines, Limited	Haileybury	November 16, 1906	500,000
Cobalt Bullion Mines, Limited	Haileybury	December 7, 1906	1,000,000
Cobalt Chief Silver Mining Company, Limited	Toronto	November 28, 1906	3,000,000
Cobalt Consolidated Mines, Limited	Cobalt	March 16, 1906	2,500,000
Cobalt Diamond Drilling and Development Company, Limited	Toronto	September 26, 1906	100,000
Cobalt and Hudson Bay Development Company, Limited	Haileybury	April 6, 1906	100,000
Cobalt Lake Mining Company, Limited	Toronto	December 22, 1906	5,000,000
Cobalt Merger, Limited	Toronto	November 28, 1906	3,000,000
Cobalt Mines Syndicate, Limited	Toronto	December 28, 1906	100,000
Cobalt Monarch Mining Company, Limited	Toronto	November 24, 1906	500,000
Cobalt Native Silver Mining Company, Limited	Haileybury	November 7, 1906	500,000
Cobalt and New Ontario Prospectors, Developers and Investors, Limited	Toronto	November 16, 1906	500,000
Cobalt North-Ontario Mining Company, Limited	Haileybury	January 31, 1906	40,000
Cobalt Nugget Silver, Limited	Haileybury	April 28, 1906	40,000
Cobalt Silver Queen, Limited	Cobalt	April 6, 1906	1,500,000
Cobalt Silver Ores, Limited	Toronto	November 16, 1906	1,000,000
Cobalt Silver Prince, Limited	Cobalt	November 16, 1906	1,000,000
Cobalt Smiley Mining Company, Limited	Toronto	November 16, 1906	40,000

Mining Companies Incorporated, 1906.—Continued

Name of Company.	Head Office.	Date of Incorporation.	Capital. $
Cobalt Townsite Mining Compan,y Limited	North Bay	April 9, 1906	100,000
Cobalt Union Mines, Limited	Toronto	November 16, 1906	1,000,000
Coin Silver Mining Company, Limited	Windsor	November 21, 1906	300,000
Coleman and Quebec Mining Company Limited	Ottawa	November 28, 1906	1,000,000
Dardanelles (Larder Lake) Gold Mines, Limited	Toronto	December 19, 1906	250,000
Davis Silver Cobalt Mines, Limited	Toronto	December 5, 1906	2,000,000
Deep Rock Cobalt Silver Mines, Limited	Toronto	December 21, 1905	1,000,000
Detroit and Algoma Silver Mining Company, Limited	Windsor	August 15, 1906	100,000
Duluth Cobalt Mining Company, Limited	Haileybury	December 28, 1906	500,000
Edward Cobalt Mines, Limited	Toronto	November 16, 1906	100,000
Empress Cobalt Silver Mining Company, Limited	Toronto	November 9, 1906	500,000
Erie Cobalt Silver Mining Company, Limited	Toronto	May 28, 1906	1,000,000
Floyd Silver Mines, Limited	Toronto	March 13, 1906	2,000,000
Foster Cobalt Mining Company, Limited	Toronto	February 14, 1906	1,000,000
Forest Reserve Mining Company, Limited	Toronto	November 16, 1906	100,000
Freeda Larder Lake Gold Mining Company, Limited	Toronto	December 21, 1906	500,000
Gallagher Iron Mining Company, Limited	Sault Ste. Marie	June 13, 1906	500,000
Giant Silver Nugget Mines, Limited	Haileybury	June 13, 1906	500,000
Glen Lake Mining Company, Limited	Toronto	April 24, 1906	500,000
Golden Park Mining Company, Limited	Windsor	October 12, 1906	100,000
Gordon Benson Cobalt Mining Company, Limited	Toronto	October 3, 1906	300,000
Great Lakes Portland Cement Company, Limited	Toronto	June 13, 1906	1,000,000
Green-Meehan Mining Company, Limited	Toronto	October 24, 1906	2,500,000
Hanson Consolidated Mining and Milling Company, Limited	Toronto	April 11, 1906	1,500,000
Harris-Maxwell Gold Mining Company, Limited	Toronto	November 30, 1906	50,000
Hudson Bay Extended, Limited	Toronto	April 17, 1906	100,000
Huron Oil Producers, Limited	Petrolea	March 10, 1906	60,000
Imperial Cobalt Silver Mines Company, Limited	Toronto	November 16, 1906	1,000,000
Independence Cobalt Silver Mines Company, Limited	Toronto	December 28, 1906	1,000,000
Iroquois Cobalt Silver Mining Company, Limited	Haileybury	May 3, 1906	100,000
Keewatin Silver Cobalt Mining Company, Limited	Toronto	December 5, 1906	1,000,000
Kennedy Cobalt, Limited	Toronto	December 21, 1906	1,000,000
King Cobalt Mining Company, Limited	Toronto	January 24, 1906	300,000
Latchford Silver Mining Company, Limited	Toronto	November 21, 1906	100,000
Larder Lake Gold Mining Company, Limited	Haileybury	October 17, 1906	500,000
Lehigh Portland Cement Company, Limited	Township of Thurlow	September 19, 1906	1,000,000
Little Nipissing Silver Cobalt Mining Company, Limited	Toronto	November 2, 1906	650,000
Maple City Oil and Gas Company, Limited	Chatham	July 26, 1906	40,000
Mining Development and Securities Company, Limited	Toronto	April 20, 1906	150,000
Montreal Cobalt Mining Company, Limited	Toronto	March 14, 1906	500,000
New York and Canadian Mining Company, Limited	Toronto	January 5, 1906	40,000
New York and Ontario Oil and Gas Company, Limited	Chatham	October 12, 1906	30,000
Nipissing Copper and Silver Company, Limited	Toronto	December 14, 1906	3,500,000
North Bay Brick and Tile Company, Limited	North Bay	July 16, 1906	50,000
North Cobalt Mining Company, Limited	Cobalt	November 7, 1906	50,000
Northland Mining Company, Limited	London	December 5, 1906	250,000
North Ontario Reduction and Refining Company, Limited	Toronto	June 13, 1906	500,000
North Range Nickel and Iron Mining Company, Limited	Sudbury	May 12, 1906	1,000,000
Nova Scotia Silver Cobalt Mining Company, Limited	Toronto	November 9, 1906	2,000,000
Ontario Quebec Cobalt Mining Company, Limited	Toronto	December 28, 1906	1,000,000
Ore Contracting Company, Limited	Bessemer	November 7, 1906	40,000
Peerless Larder Lake Mines, Limited	Toronto	December 5, 1906	1,000,000
Penn Cobalt Mining Company, Limited	Toronto	December 19, 1906	500,000
Pennsylvania Cobalt Silver Mines, Limited	Toronto	December 21, 1906	1,000,000
Peterson Lake Silver Cobalt Mining Company, Limited	Toronto	April 11, 1906	3,000,000
Rochester Mining Company, Limited	Toronto	August 21, 1906	40,000
St. Anthony Cobalt Mining Company, Limited	Haileybury	December 5, 1906	100,000
Sasagenaga Mining Company, Limited	Cobalt	June 8, 1906	250,000
Silverhorn Mining Company, Limited	Toronto	April 6, 1906	50,000
Silver Horse Shoe Cobalt Mining Company, Limited	Toronto	December 28, 1906	40,000
Silver Ledge, Limited	Toronto	April 24, 1906	20,000
Silver Wonder Mining Company, Limited	Toronto	April 24, 1906	300,000
Sombra Oil and Gas Company, Limited	Chatham	November 7, 1906	40,000
Standard Cobalt Mines, Limited	Toronto	December 19, 1905	2,000,000
Star Silver Cobalt Mining Company, Limited	Toronto	April 11, 1906	2,000,000
Stellar Silver Cobalt Corporation, Limited	Sudbury	November 28, 1906	1,000,000
The Abitibi Mining and Development Company, Limited	Finch	January 12, 1906	100,000
The Albert Mining Company, Limited	Toronto	May 12, 1906	375,000
The Alder Street Natural Gas Company, of Dunnville, Limited	Dunnville	December 12, 1906	20,000
The Amalgamated Oil Company of Canada, Limited	London	June 4, 1906	1,000,000
The Amalgamated Petroleum Producers, Limited	Belleville	April 20, 1906	40,000
The American Cobalt Mines, Limited	Toronto	February 15, 1906	1,000,000
The American Silver King Mining Company, Limited	Haileybury	May 30, 1906	1,000,000
The Bailey Mining Company, Limited	Windsor	August 15, 1906	5,000,000
The Barron Brick Company, Limited	Toronto	September 19, 1906	500,000
The Big Six Silver Cobalt Mines, Limited	Cobalt	December 12, 1906	1,750,000
The British American Oil Company, Limited	Toronto	October 17, 1906	200,000
The British American Silver Company, Limited	Toronto	August 24, 1906	50,000
The Brooks Hudson Silver Mining Company, Limited	New Liskeard	November 30, 1906	500,000
The Brussels Oil Company, Limited	Brussels	April 4, 1906	100,000
The Bucke Silver and Cobalt Mining Company, Limited	Ottawa	December 19, 1906	300,000
The Buffalo Mines, Limited	Toronto	April 27, 1906	1,000,000

Mining Companies Incorporated, 1906.—Continued

Name of Company.	Head Office.	Date of Incorporation.	Capital. $
The Canadian Cobalt and Silver Mining Company, Limited	Ottawa	January 19, 1906	250,000
The Canadian Cobalt Corporation, Limited	Toronto	November 28, 1906	1,000,000
The Canadian General Industrial and Development Company, Limited	Chatham	November 30, 1906	150,000
The Capital Cobalt Mining Company, Limited	Ottawa	December 5, 1906.	250,000
The Central Oil and Gas Company, Limited	Toronto	March 6, 1906	40,000
The Century Silver Mining Company, Limited	Toronto	December 14, 1906.	1,000,000
The Cheapside Natural Gas and Oil Company, Limited	Cheapside	January 19, 1906	10,000
The City of Cobalt Mining Company, Limited	Cobalt	October 5, 1906	500,000
The Clarks Standard Developing Company, Limited	New Liskeard	January 19, 1906	40,000
The Clear Lake Mining Company, Limited	Toronto	May 16, 1906	650,000
The Cleveland Cobalt Silver Mines, Limited	Toronto	October 12, 1906	1,000,000
The Cobalt and Larder Lake Gold Mining Company, Limited	New Liskeard	December 19, 1906.	300,000
The Cobalt Central Silver Mining Company, Limited	New Liskeard	April 24, 1906	500,000
The Cobalt Chartered Company, Limited	Haileybury	April 27, 1906	350,000
The Cobalt Contract Silver Mines Company, Limited	Toronto	May 16, 1906	300,000
The Cobalt Ore Sampling Company, Limited	Cobalt	December 28, 1906.	100,000
The Cobalt Portage Mines, Limited	Toronto	October 26, 1906	1,000,000
The Cobalt, Silver and Copper Mining Company, Limited.	Sault Ste. Marie	February 23, 1906.	500,000
The Cobalt Smelting and Refining Company, Limited	Toronto	May 18, 1906	250,000
The Colonial Mining Company, Limited	Cobalt	October 19, 1906	100,000
The Columbus Cobalt Silver Company, Limited	Toronto	April 24, 1906	450,000
The Commercial Brick Company, Limited	Toronto	July 18, 1906	50,000
The Coniagas Mines, Limited	St. Catharines	November 24, 1906	4,000,000
The Croesus Mining Company, Limited	Ottawa	January 19, 1906	500,000
The Crown Mining Company, Limited	Leamington	January 26, 1906	1,000,000
The Cuyahoga Silver Cobalt Mines, Limited	Toronto	November 24, 1906	1,000,000
The Detroit and Cobalt Development Company, Limited.	Windsor	April 17, 1906	25,000
The Dominion Cobalt Mining and Development Company Limited	Cobalt	May 3, 1906	450,000
The Douglas Mining Co., Limited	Toronto	November 16, 1906	500,000
The Dufferin Cobalt Silver Mining Company, Limited	Ottawa	November 30, 1906	1,000,000
The Dunnville Gas Development Company, Limited	Dunnville	May 12, 1906	40,000
The Dwyer Mining Company, Limited	Toronto	January 5, 1906	100,000
The Erie Natural Gas Company, Limited	Dunnville	October 17, 1906	40,000
The Esperanza-Cobalt Mines Company, Limited	Windsor	November 21, 1906	1,000,000
The Eureka Silver Mining Company, Limited	New Liskeard	April 24, 1906	100,000
The Exploration Company of Canada, Limited	Toronto.	November 7, 1906	100,000
The Findlay Mining Company, Limited	Windsor	April 24, 1906	20,000
The Florence Mining Company, Limited	Toronto	March 21, 1906	100,000
The German Canadian Smelting and Refining Company, Limited	Toronto.	July 6, 1906	1,000,000
The Gillies Silver Mining Company, Limited	Haileybury.	April 9, 1906	500,000
The Gilpin Cobalt Silver Mining Company, Limited	Toronto	April 24, 1906	500,000
The Gold and Silver Mountain Mining Company, Limited.	Cobalt	December 5, 1906	1,000,000
The Golden Reed Mining Company, Limited.	Sault Ste. Marie	August 31, 1906	1,200,000
The Green Rock Mining Company, Limited	Sault Ste. Marie	April 24, 1906	600,000
The Heathcock Mining Company, Limited	Dresden	October 12, 1906	100,000
The Hudson Cobalt Mining Company, Limited	Barrie	June 27, 1906	300,000
The Hunter Cobalt Silver Mining Company, Limited	Ottawa	November 21, 1906	1,000,000
The Huronian Cobalt Silver Mining Company, Limited	Cobalt	August 21, 1906	500,000
The International Cobalt and Silver Mining Company, Limited	Sault Ste. Marie	September 19, 1906	500,000
The Interprovincial Mining Company, Limited	Haileybury	August 31, 1906	1,500,000
The Jessie Fraser Copper Mining Company, Limited	Niagara Falls	January 26, 1906	250,000
The Jury Copper Mines, Limited	Sault Ste. Marie	December 5, 1906.	1,000,000
The Kerr Lake Lawson Mining Company, Limited	Cobalt.	November 16, 1906	1,500,000
The Lake Abitibi Gold Mining Company, Limited	Toronto	December 19, 1906.	200,000
The Lawson Cobalt Silver Mining Company, Limited	Eganville	May 12, 1906	500,000
The Lorrain Mining Company, Limited	Toronto	November 7, 1906.	400,000
The Lumsden Mining Company, Limited	Toronto	December 14, 1906.	1,000,000
The McKinley-Darragh-Savage Mines of Cobalt, Limited	Toronto	April 17, 1906	2,500,000
The Manhattan Cobalt Mining Company, Limited	Toronto	November 2, 1906.	100,000
The Manufacturers Natural Gas Company, Limited	Hamilton	June 13, 1906	200,000
The Mining and Lands Development Company Limited	Toronto	April 17, 1906	40,000
The Montreal River Silver Syndicate, Limited	Toronto	April 24, 1906	200,000
The Nancy Helen Mines, Limited	Cobalt.	October 3, 1906	500,000
The National Cobalt Silver Mining Company, Limited	Ottawa	December 21, 1906.	1,000,000
The National Mining and Development Company, Limited.	New Liskeard	August 24, 1906	40,000
The Nepigon Mines Company, Limited	Toronto	December 5, 1906	5,000,000
The New System Brick Company, Limited	Brantford	January 17, 1906	50,000
The New York Cobalt Silver Mines, Limited	Toronto	October 26, 1906	1,000,000
The North American Cobalt Refining Company, Limited.	Hamilton	February 28, 1906.	1,000,000
The Northern Ontario Consolidated Copper Company, Limited	Sault Ste. Marie	October 17, 1906	1,500,000
The Northern Ontario Copper Mining Company, Limited	Sault Ste. Marie	January 17, 1906	500,000
The Norwalk Mining Company, Limited	Sault Ste. Marie	March 2, 1906	300,000
The Ohio Cobalt Mining Company, Limited	Haileybury	May 3, 1906	60,000
The Old Chap Mining Company, Limited	Cobalt.	November 16, 1906.	1,000,000
The Ontario Nickel Company, Limited	Worthington	October 5, 1906	1,000,000
The Ontario Oil and Refining Company, Limited	Chatham	August 31, 1906	100,000
The Ontario Sewer Pipe Company, Limited	Toronto	January 12, 1906	300,000
The Ottawa Cobalt Silver Mining Company, Limited	Ottawa	September 19, 1906	250,000
The Owen Sound Brick Company, Limited	Owen Sound	March 30, 1906	40,000

Mining Companies Incorporated, 1906.—Continued

Name of Company,	Head Office.	Date of Incorporation.	Capital. $
The Pontiac and Nipissing Exploration Company, Limited	New Liskeard	December 19, 1906.	1,000,000
The Port Arthur Sand Lime Brick Company, Limited	Port Arthur	March 28, 1906	60,000
The Progress Cobalt Silver Mining Company, Limited	Cobalt	September 19, 1906	500,000
The Queen City Mining and Development Company, Limited	Toronto	February 28, 1906.	150,000
The Red Rock Silver Mining Company, Limited	Haileybury	March 2, 1906	1,000,000
The Renfrew Brick and Tile Manufacturing Company, Limited	Renfrew	June 22, 1906	20,000
The Right of Way Mining Company, Limited	Ottawa	July 13, 1906	500,000
The Rochester-Cobalt Mines, Limited	Cobalt	October 26, 1906	1,000,000
The Ross Cobalt Silver Mines Company, Limited	Cobalt	November 21, 1906	1,500,000
The Ruby Silver Mining and Development, Company, Limited	Hamilton	November 9, 1906.	500,000
The Russell Brick and Tile Company, Limited	Russell	December 19, 1906	100,000
The St. Paul Cobalt Mining Company Limited,	Cobalt	November 28, 1906	600,000
The Savage Mine of Cobalt, Limited	Toronto	February 14, 1906	500,000
The Shakespeare Development Company, Limited	Sault Ste. Marie	March 14, 1906	300,000
The Sharpe Lake Cobalt Silver Mining Company, Limited	Ottawa	December 28, 1906	1,000,000
The Silverado Cobalt Mines, Limited	Cobalt	December 7, 1906	1,500,000
The Silver Bell Mining Company, Limited	North Bay	April 6, 1906	250,000
The Silver City Mining Company, Limited	Toronto	March 21, 1906	350,000
The Silver Cliff Mining Company, Limited	Ottawa	April 17, 1906	2,000,000
The Silver Crown Mining Company, Limited	North Bay	May 3, 1906	500,000
The Silverland Development Company, Limited	Toronto	March 26, 1906	1,000,000
The Silver Leaf Mining Company, Limited	Toronto	February 14, 1906.	5,000,000
The Silver Lion Mining and Development Company, Limited	Cobalt	October 5, 1906	500,000
The Silver Star Mining Company, Limited	New Liskeard	February 19, 1906	40,000
The Soo Cobalt Mining Company, Limited	Cobalt	May 18, 1906	50.000
The South American Petroleum Company, Limited.	Toronto	January 10, 1906	1,000,000
The Southern Belle Cobalt Silver Mining Company, Limited	Cobalt	November 24, 1906	1,000,000
The Steep Rock Development Company, Limited	Fort Frances	April 6, 1906	150,000
The Sudbury Cobalt Mining Company, Limited	Sudbury	April 27, 1906	300,000
Tarentorus Mining Company, Limited	Sault Ste. Marie	March 2, 1906	700,000
Temagami Iron Mining Company, Limited	Toronto	February 28, 1906.	40.000
Temiskaming Hematite Iron Company, Limited	Toronto	January 17, 1906	150,000
Temiskaming Sterling Mining Company, Limited	Milberta	September 14, 1906	42,000
The Temagami Silver Mining Company, Limited	Sturgeon Falls	November 16, 1906	2,500,000
The Temiskaming Mining Company, Limited	Toronto	April 6, 1906	40,000
The Terra Cotta Pressed Brick Company, Limited	Toronto	February 21, 1906.	60,000
The Terrill Cobalt Mining Company, Limited	Sault Ste. Marie	December 27, 1905	100.000
The Thorold Natural Gas Company, Limited	Toronto	December 22, 1905	40,000
The Trout Lake Cobalt Mining Company of Montreal Limited	Ottawa	December 10, 1906	3,000,000
The Twin Lake Mining Company, Limited	New Liskeard	August 24, 1906	500,000
The Two Lakes Copper Mining Company, Limited	Sowerby	October 12, 1906	500,000
The University Mines, Limited	Toronto	May 3, 1906	1 000.000
The Violet Mining Company, Limited	Toronto	August 3, 1906	250.000
The Wabi Cobalt Silver Mining Company, Limited	Cobalt	June 27, 1906	500,000
The Waterloo Mining Company, Limited	Berlin	October 12, 1906	200,000
The Wendigo Progressive Mining and Development Company, Limited	New Liskeard	December 27, 1905	40,000
The Wet Process Reduction Company, Limited	Toronto	October 12, 1906	1,000,000
The White Lily Mining and Milling Company, Limited	Fort William	December 21, 1906	1,000,000
The Williams Copper Mining Company, Limited	Toronto	September 7, 1906	100.000
The Williamson-Marks Mines, Limited	Toronto	February 21, 1906.	300,000
The Youngstown-Cobalt Silver Mining Company, Limited.	Cobalt	December 28, 1906	1.000,000
Trethewey Silver Cobalt Mine, Limited	Toronto	May 30, 1906	1,000,000
United Mines of Cobalt, Limited	Toronto	September 5, 1906	1.000,000
United Silver Company, Limited	Cobalt	October 26, 1906	1,000,000
United States Cobalt Company, Limited	Toronto	December 7, 1906	3,000.000
Vermilion River Ore Company, Limited	Toronto	December 20, 1905	80,000
Victoria Silver Cobalt Mines, Limited	Toronto	November 2, 1906	1,000,000
Wainfleet Natural Gas Company, Limited	Port Colborne	January 17, 1906	100,000
Watts Mines, Limited	Toronto	October 12, 1906	1,000,000
Wendigon Silver and Copper Mining Company, Limited	Windsor	May 16, 1906	400,000
Wolst-Rees Cobalt Silver Mining Company, Limited	Windsor	May 7, 1906	250,000
Wonderland Silver Mining Company, Limited	Windsor	March 21 1906	250,000
Wright Silver Mining Company, Limited	Toronto	August 15, 1906	200,000
Zone Consolidated Oil Company, Limited	Thamesville	December 28, 1906	40,000

Mining Companies Licensed, 1906

Name of Company.	Head Office.	Date of Incorporation.	Capital. $
Acme Oil Company	Leamington	February 2, 1906	1,000,000
Amalgamated Silver Mines Company	Port Arthur	October 12, 1906	1,000,000
Arbor Oil Company	Chatham	December 28, 1906	50,000
Arizona Cobalt Silver Company	Toronto	May 28, 1906	1,000,000
Chicago Cobalt-Silver Mining Company, Limited	Toronto	December 10, 1906	500,000
Commonwealth Jewel Oil Company	East Tilbury	September 7, 1906	40,000
Kerry Mining Company	Woodstock	September 26, 1906	5,000
Lake Huron Company	Ottawa	August 15, 1906	100,000
Manitou Mines Company, Limited	Wabigoon	June 6, 1906	40,000
Northern Pyrites Company	Toronto	August 21, 1906	100,000
Olympia Gold Mining Company, Limited	Toronto	October 26, 1906	40,000
Stanley Smelting Works	Bannockburn	December 5, 1906	40,000
The Braddock Development Company, Limited	Michipicoten River	August 24, 1906	5,000
The Can-Amer Mining and Developing Company	Niagara Falls	October 12, 1906	500,000
The Consolidated Mining and Smelting Company of Canada, Limited	Toronto	April 17, 1906	5,500,000
The Ontario Oil and Gas Company	Chatham	December 12, 1906	15,000
Verona Mining Company	Kingston	July 18, 1906	1,000
Western Oil and Coal Consolidated	Toronto	November 16, 1906	100,000

Mining Companies Incorporated in 1907

The following list gives the names of all mining companies incorporated for mining and allied industries in Ontario in 1907. It will be seen that many of them are Cobalt companies. Larder Lake was also responsible for a number of flotations.

Name of Company.	Head Office.	Date of Incorporation.	Capital. $
Adelaide Mining Company, Limited	Napanee	October 21	1,000,000
Aggani Cobalt Mines Limited	London	August 29	600,000
Airgiod Cobalt Mining Company, Limited	Ottawa	January 18	2,000,000
Algoma Lead Limited	Port Arthur	July 31	1,500,000
Algonquin Larder Lake Mining Company, Limited	Toronto	May 15	2,500,000
American Consolidated Mining Company, Limited	Toronto	March 15	500,000
Anglo-Canadian Cobalt Mining Company, Limited	Toronto	March 28	1,100,000
Argyle Silver Mining Company, Limited	Toronto	February 8	500 000
A. W. Jacobs Cobalt Mines Limited	Ottawa	May 24	1,500,000
Barnard's Point Gold Mining Company of Larder Lake	Hamilton	February 8	1,000,000
Beamsville Larder Lake Prospecting Company, Limited	Beamsville	April 8	100,000
Beaver Consolidated Mines, Limited	Toronto	February 25	1,500,000
Beaver Superior Silver Mines, Limited	Toronto	May 31	3,000,000
Bedford Mica, Limited	Toronto	December 11	100,000
Big 4 Larder Lake Mining Company, Limited	Toronto	February 25	1,000,000
Big Pete Canadian Mines, Limited	New Liskeard	November 1	2,000,000
Bonanza Consolidated Mines, Limited	Toronto	July 10	1,000,000
Bonanza Larder Lake Mining Company, Limited	Haileybury	February 22	1,000,000
Blue Bell Gold Mines, Limited	Toronto	April 8	5,000,000
British-Canadian Smelters', Limited	Toronto	June 12	400,000
Buffalo Larder Gold Mines, Limited	Toronto	May 31	2,000,000
Canada Brick Fields, Limited	London	October 11	100,000
Canada Consolidated Cobalt Syndicate, Limited	Toronto	February 21	1,000,000
Canada International Gas Company, Limited	Toronto	September 7	5,000,000
Canada Mexico Development Company, Limited	Toronto	December 4	200,000
Canada Southern Gas & Oil Company, Limited	Tilbury	December 27	100,000
Canadian Bessemer Ores, Limited	Toronto	May 22	100,000
Canadian Central Mines, Limited	Toronto	January 23	1,000,000
Canadian Mines Syndicate, Limited	Ottawa	January 16	100,000
Canadian Pacific Cobalt Development Company, Limited	Ottawa	April 8	3,500,000
Canuck Silver Mines, Cobalt, Limited	Toronto	April 17	1,000,000
Carleton Cobalt Silver Mining Company, Limited	Ottawa	January 23	1,000,000
Clark Cobalt Mining Company, Limited	Toronto	August 29	3,000,000
Cobalt Blue Silver Mining Company, Limited	Toronto	March 1	1,000,000
Cobalt Combine Silver Mines	Toronto	May 15	1,000,000
Cobalt Concentrators, Limited	Toronto	February 25	500,000
Cobalt Confederated Mines, Limited	Cobalt	May 31	3,000,000
Cobalt Crystal Silver Mines, Limited	Toronto	February 28	50,000
Cobalt Eagle Silver Mines, Limited	Ottawa	January 26	1,000,000
Cobalt Eldorado Mines Company, Limited	Toronto	May 1	2,000,000
Cobalt Gem Mining Company, Limited	Toronto	January 1	1,000,000
Cobalt and James Mines, Limited	Toronto	May 24	1,000,000
Cobalt Lorrain Mining & Development Company	Cobalt	April 10	1,500,000
Cobalt Magnet Mines, Limited	Toronto	March 22	600,000
Cobalt North Star Silver Mining Company, Limited	Bridgeburg	February 8	10,000

Mining Companies Incorporated, 1907.—Continued

Name of Company.	Head Office.	Date of Incorporation,	Capital. $
Cobalt Silver Bell Mines, Limited	Cobalt	May 8	800,000
Cobalt Silver Fountain Mines, Limited	Toronto	July 12	500,000
Cobalt Superior Mining Company, Limited	Toronto	October 17	1,000,000
Cobalt Syndicate of Montreal, Limited	Toronto	March 25	600,000
Cochrane Cobalt Mining Company, Limited	Toronto	March 22	1,000,000
Coleman-Bucke Silver Mining Company, Limited	Ottawa	May 22	1,000,000
Columbia Cobalt Development Company, Limited	Cobalt	July 8	500,000
Combined Goldfields, Limited	Toronto	May 10	3,000,000
Commercial Travellers Larder Lake Gold Mining Company, Limited	New Liskeard	March 6	500,000
Commonwealth Mines of Cobalt, Limited	Toronto	January 28	5,000,000
Confederation Mines, Limited	Hamilton	March 8	250,000
Conference Exploration Company, Limited	Cobalt	June 19	500,000
Crawford Mining Company, Limited	Toronto	October 11	600,000
Credit Valley Brick Company, Limited	Toronto	November 20	50,000
Cross Lake Silver Mining Company, Limited	Cobalt	June 28	1,000,000
Crown Oil Refining Company, Limited	Hamilton	June 26	40,000
Cullen Cobalt Mines, Limited	Toronto	February 28	1,000,000
Culver Silver Cobalt Mines, Limited	Toronto	February 18	1,000,000
Deloro Mining & Reduction Company, Limited	Toronto	February 13	100,000
Dominion Bessemer Ore Company, Limited	Port Arthur	July 19	7,000,000
Dominion Exploration & Development Company, Limited	Toronto	May 10	1,000,000
Dominion Oil Company, Limited	Hamilton	August 5	100,000
Dominion Smelters, Limited	Sault Ste. Marie	January 23	1,000,000
Dr. Reddick Larder Lake Mines, Limited	Ottawa	February 6	2,000,000
Dr. Orok Larder Mines, Limited	Haileybury	May 3	750,000
Duchess Silver Mining Company, Limited	Toronto	January 16	75,000
East Bay Larder Lake Gold Mines, Limited	Toronto	May 10	1,000,000
Eastern & Cobalt Mining Company, Limited	Cobalt	May 8	1,000,000
Elk Lake Prospecting & Development Company, Limited	Toronto	March 20	250,000
Elk Lake Silver Mines, Limited	Haileybury	April 8	100,000
Emerald Development Company, Limited	Sudbury	February 18	150,000
Empire Cobalt Mines, Limited	Cobalt	March 27	3,000,000
England's Premier Cobalt Mining Company, Limited	Toronto	March 8	1,100,000
Erie Portland Cement Company, Limited	Toronto	March 6	1,000,000
Floyd Silver Mines, Limited	Toronto	March 13	2,000,000
Forest City Mining Company, Limited	Toronto	May 15	1,000,000
Georgian Bay Oil Company, Limited	Fort Erie	January 25	1,000,000
Glengarry Cobalt Mines Company, Limited	Haileybury	September 13	600,000
Gold Consols, Limited	Toronto	October 25	1,500,000
Gold Mint Mining Company of Larder Lake, Limited	Toronto	June 12	1,000,000
Golden Empire Mines Company of Larder Lake, Limited	Powassan	June 6	1,000,000
Golden Horn (Larder Lake) Mines, Limited	Toronto	February 13	500,000
Good Hope Mines, Limited	Toronto	April 26	3,000,000
Gould Consolidated Mines, Limited	Ottawa	November 27	2,000,000
Grand Manitoulin Oil Company, Limited	Toronto	August 23	500,000
Greater Canada Mining Company, Limited	Toronto	April 23	2,500,000
Green Robin Gold Mines, Limited	Toronto	June 26	1,500,000
Haileybury Brick & Tile Company, Limited	Haileybury	September 3	50,000
Haileybury Bucke Cobalt Company, Limited	Toronto	April 17	40,000
Hall Mark Silver Mines, Cobalt, Limited	Toronto	June 26	300,000
Hanson Consolidated Silver Mines, Limited	Toronto	May 24	1,500,000
Hardwood Glen Mining Company, Limited	Toronto	February 6	60,000
Harris Maxwell Larder Lake Gold Mining Company, Limited	Toronto	January 26	500,000
Hiawatha Cobalt Silver Mining Company, Limited	Ottawa	February 28	1,000,000
Higbee Mines, Limited	Toronto	April 17	40,000
Holden Silver Mining Company, Limited	Cobalt	November 6	650,000
Imperial Consolidated Mining Company, Limited	Toronto	April 23	1,500,000
Indiana Cobalt Silver Mining Company, Limited	Toronto	November 13	250,000
Industrial Natural Gas Company, Limited	Welland	November 27	40,000
Island Oil and Gas Company, Limited	Manitowaning	January 18	100,000
James Bay Gold Mining and Development Company, Limited	Toronto	July 19	2,000,000
James Mines, Limited	Toronto	February 28	25,000
James Proprietary Mines Company, Limited	Toronto	June 26	250,000
Johnson Mines, Limited	Toronto	August 14	1,000,000
Jumbo Cobalt Silver Mines, Limited	Toronto	February 15	1,000,000
Kerr Lake Crown Reserve, Limited	Toronto	January 16	2,000,000
Keystone Cobalt Mining Company, Limited	Toronto	January 4	500,000
Keystone Lorrain Mining Company, Limited	Haileybury	July 31	1,000,000
King Solomon Larder Lake Gold Mining Company, Limited	New Liskeard	April 23	1,000,000
Kismet Mines, Limited	Pittsburg, Pa	January 23	500,000
Knickerbocker Cobalt Mines, Limited	Toronto	February 22	550,000
Lake George Cobalt Silver Mining Company, Limited	Toronto	February 6	600,000
Laplata Cobalt Mines Company, Limited	Toronto	April 3	1,000,000
Larder Central Gold Fields, Limited	Toronto	April 12	1,500,000
Larder Gold Reefs Company, Limited	Ottawa	October 2	40,000
Larder Lake Consolidated Gold Mines, Limited	Toronto	January 23	1,000,000
Larder Lake Exploration and Development Company, Limited	Haileybury	January 16	500,000
La Rose Mines, Limited	Toronto	February 21	6,000,000
Lehigh Cobalt Silver Mines, Limited	Toronto	April 17	1,000,000
Le Roi Larder Lake Mines, Limited	Haileybury	March 15	1,000,000

Mining Companies Incorporated, 1907—Continued

Name of Company.	Head Office.	Date of incorporation.	Capital. $
Lincoln-Nipissing Development Company Limited	St. Catharines	February 6	160,000
Little Larder Lake Gold Mining Company, Limited	Haileybury	February 15	100,000
London Cobalt Mining Corporation, Limited	Toronto	January 4	2,000,000
Long Lake Gold Mining Company, Limited	Welland	October 25	1,000,000
Lucky Boys Gold Mines, Limited	Toronto	April 16	3,000,000
Manchester Cobalt Mines, Limited	Toronto	February 28	450,000
Martin Larder Gold Mines, Limited	Toronto	May 10	1,000,000
Midas Mines, Limited	Toronto	August 2	1,000,000
Milburn Cobalt Silver Mines, Limited	Peterborough	March 8	200,000
Mines, Limited	Toronto	January 4	40,000
Mississippi Cobalt Silver Mining Company, Limited	Carleton Place	April 23	1,000,000
Mohawk Cobalt Silver Mines, Limited	Toronto	April 16	1,500,000
Monessen Cobalt Mining Company, Limited	Cobalt	August 29	200,000
Monitor Cobalt Prospecting and Development Company, Limited	Toronto	April 23	500,000
Montreal Gold and Silver Mining Company, Limited	Cobalt	May 31	10,000
Montreal River Mines, Limited	Toronto	June 28	30,000
Montreal River International Silver Mines, Limited	Toronto	May 17	1,000,000
Moose Horn Mines, Limited	Toronto	August 21	2,000,000
Munroe Prospecting and Developing Company, Limited	Cobalt	May 17	200,000
Murphy Mines, Limited	Haileybury	May 22	1,000,000
New Ontario Exploration Company, Limited	Sault Ste. Marie	January 16	100,000
New York Ontario Exploration Company, Limited	Bracebridge	May 15	1,000,000
North Bay Cobalt Silver Mining Company, Limited	North Bay	February 25	300,000
Northern Consolidated Cobalt Mines, Limited	Toronto	April 23	1,500,000
Northern Gold and Silver Mining Company, Limited	Ottawa	April 3	1,000,000
Northern Larder Lake Mining Company, Limited	Haileybury	February 13	1,000,000
North Star Larder Lake Mining Company, Limited	Toronto	April 17	1,000,000
North West Bay (Larder Lake) Mining Company, Limited	Toronto	February 15	500,000
Onaping Iron Ore Company, Limited	Toronto	June 26	200,000
Ontario Boston Cobalt Mining Company, Limited	Toronto	January 11	2,000,000
Ontario Copper Company, Limited	Toronto	May 15	3,000,000
Ore Reduction Company, Limited	Toronto	March 8	250,000
Power City Cobalt Mines Company, Limited	Toronto	September 7	1,000,000
Pride of Cobalt Silver Mines, Limited	Toronto	August 2	5,000,000
Prince Rupert Cobalt Silver Mines, Limited	Cobalt	January 18	1,000,000
Prospect Developing and Mining Company, Limited	Cobalt	May 22	1,000 900
Provincial Mines, Limited	Toronto	April 8	50,000
Queen Alexandra Mining Company, Limited	Toronto	March 22	40,000
Queen of Sheba Gold Mines Limited	Sudbury	February 18	1,000,000
Rabbit Mountain Mines, Limited	Toronto	March 6	3,000,000
Ragged Falls Mining Company, Limited	Toronto	July 19	1,000,000
Railway Reserves Mines, Limited	Ottawa	January 4	1,000,000
Red Rose Mining Company, Limited	Toronto	March 6	600,000
Searchlight Larder Lake Mines, Limited	New Liskeard	May 31	3,000,000
Shamrock Silver Company, Limited	Toronto	March 1	1,000,000
Silver Belt Cobalt Mining Company, Limited	Toronto	April 10	1,500,000
Silver Circle Mining Company, Limited	Toronto	May 24	500,000
Silver Cross Cobalt Mining Company, Limited	Ottawa	March 27	500,000
Silver Pick Cobalt Mining Company, Limited	Ottawa	February 13	1,000,000
Silver Spade Mining Company, Limited	Toronto	December 2	500,000
Silver Square Mining Company, Limited	Cobalt	February 8	50,000
Silver 9 Cobalt Mines, Limited	Ottawa	March 1	1,000,000
Smaltite Silver Mining Company, Limited	Toronto	April 12	1,000,000
Societe Electrometallurgique Canadien, Limited	Toronto	February 1	40,000
Spears Mining Corporation, Limited	Toronto	September 17	50,000
St. Lawrence Cobalt Mining Company, Limited	Bridgeburg	February 13	40,000
Sterling Gas Company, Limited	Port Colborne	May 8	40,000
Sutton Bay Cobalt Silver Mining Company, Limited	Haileybury	January 23	50,000
Tecumseh and Walkerville Oil and Gas Company, Limited	Walkerville	July 8	40,000
Tighe-Larder Lake Gold Mines, Limited	Toronto	November 8	4,000,000
Tilbury Romney Gas and Oil Fields, Limited	Toronto	May 24	300,000
The American Cobalt Mines, Limited	Toronto	February 15	1,000,000
The Arsenic Lake Silver Mining Company, Limited	North Bay	July 8	300,000
The Ash Grove Mining Company, Limited	Englehart	October 4	500,000
The Auld Silver Mines, Limited	North Bay	May 8	500,000
The Bay Lake Mining Company	Ottawa	June 21	1,000,000
The Big Hundred Larder Gold Company, Limited	New Liskeard	April 3	2,500,000
The Big 3 Silver Mining Company, Limited	Toronto	March 6	2,000,000
The Bloom Lake Mines Company, Limited	Sandwich	November 6	100,000
The British Dominion Mines, Limited	Toronto	May 10	1,000,000
The Canadian Smelting and Refining Company, Limited	Toronto	April 12	1,000,000
The Canadian Smelting and Refining Company, Limited	Toronto	September 13	2,500,000
The Carleton Gold and Silver Mining Company, Limited	New Liskeard	May 10	1,000,000
The Casey Mountain Cobalt Mining and Developing Company, Limited	Haileybury	January 4	250,000
The Champion Mines Company, Limited	New Liskeard	April 19	1,000,000
The Chaudiere Mines, Limited	Ottawa	March 27	1,500,000
The Chesterville Larder Lake Gold Mining Company, Limited	Chesterville	March 20	1,000,000
The Cleopatra Mining Company, Limited	Ottawa	February 28	2,000,000
The Cobalt and Blanche River Silver Mining Company, Limited	Ottawa	February 1	500,000
The Cobalt Certainty Silver Mines, Limited	Toronto	March 13	2,000,000
The Cobalt Mutual Mines Company, Limited	Haileybury	January 4	100,000
The Cobalt Raven Mining Company, Limited	Ottawa	April 16	600,000

Mining Companies Incorporated, 1907—Continued

Name of Company.	Head Office.	Date of Incorporation.	Capital $
The Cobalt Shippers, Limited	Cobalt	October 21	40,000
The Cobalt Silver-Gold Pool Mining Company, Limited	Cobalt	March 20	100,000
The Cobalt Silver and Gold Claims Company, Limited	Cobalt	May 22	40,000
The Cobalt Silver Mountain Mining Company, Limited	Ottawa	January 26	1,000,000
The Cobalt Silver Stone Mining Company, Limited	Ottawa	February 20	500,000
The Cobalt Silver Wedge Mines, Limited	Cobalt	June 12	1,000,000
The Cobden Copper Company, Limited	Sault Ste. Marie	February 15	500,000
The Coleman and Larder Lake Gold and Silver Mining Company, Limited	Toronto	January 26	1,000,000
The Cooper Tilbury Oil and Gas Company, Limited	London	July 10	100,000
The Crown Gas and Oil Company, Limited	Ottawa	July 8	250,000
The Crown Gypsum Company, Limited	Cayuga	November 22	100,000
The Dominion Larder Gold Mines, Limited	Cobalt	April 3	3,000,000
The Dominion Mining Company, Limited	Ottawa	September 3	150,000
The Dowker Brick Company, Limited	Fort Frances	March 6	40,000
The Electrical Ore Finding Company, Limited	Toronto	October 21	1,000,000
The Elgin Cobalt Mining Development Company, Limited	St. Thomas	June 6	200,000
The Elk Lake Mining and Prospecting Company, Limited	Ottawa	July 8	1,500,000
The Elk Lake Cobalt Silver Mining Company, Limited	North Bay	March 6	1,000,000
The Empire Larder Lake Gold Mines, Limited	Toronto	May 3	1,000,000
The Empress Tilbury Oil and Gas Company, Limited	Chatham	April 4	150,000
The Enterprise Corporation Limited	Hamilton	January 4	500,000
The Federal Oil Company, Limited	Toronto	March 13	200,000
The Gilmour Mining Company, Limited	Belleville	September 7	300,000
The Gold Belt Mining and Development Company, Limited	Ottawa	March 25	1,250,000
The Gold Horse Shoe and Larder Lakes Mining Company, Limited	Ottawa	August 14	1,500,000
The Golden Peak Larder Lake Exploration and Mining Company, Limited	Toronto	March 22	250,000
The Gray Hadley Spelter Company, Limited	Kingston	June 14	500,000
The Great Northern Oil Company, Limited	Sault Ste. Marie	January 31	500,000
The Haileybury Silver Mining Company, Limited	Haileybury	February 20	50,000
The Haileybury Townsite Mining Company, Limited	Sudbury	March 15	750 000
The Harwick Oil and Gas Company, Limited	Chatham	November 8	100,000
The Hazel Jule Cobalt Silver Mining Company, Limited	Toronto	February 20	500,000
The Highland Mary Gold Mines, Limited	Toronto	September 16	3,000,000
The Hillman Copper Company, Limited	Sault Ste. Marie	March 6	60,000
The Independence Larder Lake Gold Mines, Limited	Toronto	October 4	4,000,000
The Ivanhoe Cobalt Silver Mining Company, Limited	Ottawa	December 27	1,000,000
The Jack Pot Cobalt Silver Mining Company, Limited	Toronto	January 16	750,000
The James Township Silver Mines, Limited	Toronto	May 10	1,500,030
The Jessop Prospecting and Mining Company, Limited	Toronto	February 20	1,000,000
The Kelly Island Lime Company, Limited	Windsor	January 16	40,000
The Lake Temiskaming Silver Mining Company, Limited	Ottawa	January 16	850,000
The Lansing Cobalt Mining Company, Limited	Windsor	May 31	400,000
The Larder Gold Queen, Limited	New Liskeard	April 12	1,500,000
The Larder Lake Gold Hill Mines, Limited	Toronto	April 23	1,000,000
The Larder Lake International Mines, Limited	Ottawa	July 19	5,000,000
The Larder Lake Proprietory Gold Fields, Limited	Toronto	January 16	3,000,000
The Lasalle Development Company, Limited	Toronto	March 18	1,000,000
The Lawson Mine, Limited	Toronto	April 23	5,000,000
The Lincoln Silver Mining Company, Limited	Cobalt	December 23	300,000
The Load Star Mining Company, Limited	Toronto	June 28	3,000,000
The Lombard Cobalt Silver Mines, Limited	Toronto	March 27	1,000,000
The Lucky Strike Cobalt Silver Mining Company, Limited	Cobalt	March 13	3,000,000
The MacRae Mining Company, Limited	Ottawa	January 30	1,000,000
The Massive Corumdum Company of Ontario, Limited	Niagara Falls	February 13	2,000,000
The Master-Stein Cobalt Mining Company, Limited	Winnipeg	May 22	1,000,000
The McConnell Silver Mining Company of Cobalt, Limited	Ottawa	February 6	200,000
The McGill Cobalt Mining Company, Limited	Cornwall	May 31	1,000,000
The McKinnon Mines, Limited	Haileybury	May 17	1,000,000
The Meridian Bay Mining Company, Limited	Berlin	January 16	1,000,000
The Nanton Coal Fields, Limited	Ottawa	August 21	100,000
The Niagara Cobalt Silver Mining Company, Limited	Niagara Falls	January 16	750,000
The Niagara Falls Mining and Drilling Company, Limited	Niagara Falls	April 3	40,000
The Night Hawk Lake Mining Company, Limited	Toronto	October 17	70,000
The Nipissing Gold Estates, Limited	Cobalt	May 31	4,000,000
The Nonsuch Cobalt Silver Company, Limited	Toronto	May 1	50,000
The North American Oil and Gas Company, Limited	Niagara Falls	October 11	1,000,000
The North Canadian Gold Mines, Limited	Toronto	June 28	1,000,000
The North Star Oil and Gas Company, Limited	Chatham	November 4	36,000
The North Cobalt Mines, Limited	Cobalt	November 4	1,000,000
The Ottawa Mica Mining Company, Limited	Ottawa	April 23	350,000
The Ottawa Prospecting & Development Company Limited	Haileybury	June 12	200,000
The Oxford Prospecting and Mining Company, Limited	Cobalt	August 29	20,000
The Peel Oil and Gas Company, Limited	Toronto	August 29	100,000
The Pense Cobalt Mining Company, Limited	Toronto	February 18	1,000,000
The Perfect Brick and Tile Company, Limited	Ottawa	March 6	100,000
The Producers' Natural Gas Company, Limited	Hamilton	September 12	100,000
The Red Jack Mining Company, Limited	Midland	June 6	500,000
The Rex Argent Mines Company, Limited	Latchford	October 17	100,000
The Ridgeway Mining Company, Limited	Toronto	October 25	500,000
The Robinet Brick Company, Limited	Sandwich	February 6	40,000
The Rush Larder Lake Mining Company, Limited	Toronto	April 3	1,000,000
The Safe Oil and Gas Company, Limited	Chatham	February 28	150,000
The Silbert Consolidated Mining Company, Limited	Toronto	March 1	2,000,000

Mining Companies Incorporated, 1907—Continued

Name of Company.	Head Office.	Date of Incorporation.	Capital. $
The Silver Bird Cobalt Mines, Limited	Toronto	January 31	1,500,000
The Silver Field Mining Company, Limited	Toronto	January 4	200,000
The Silver Heels Mining Company, Limited	Toronto	January 16	500,000
The Silver Ridge Mining Company, Limited	Toronto	January 23	1,000,000
The Silver Rock Mining Company, Limited	Cobalt	January 23	1,000,000
The Stadacona Cobalt Silver Mining Company, Limited	Cobalt	February 18	1,000,000
The St. Lawrence Lumbering & Mining Company, Limited	Cornwall	December 18	50,000
The Strathcona Silver Mining Company of Cobalt Limited	Toronto	March 1	800,000
The Soo Larder Lake Exploration Company, Limited	Sault Ste. Marie	April 17	150,000
The South-Western Oil and Gas Lands, Limited	Petrolea	February 20	60,000
The Temagami Copper Company, Limited	Toronto	April 19	2,000,000
The Tiffany Cobalt Mines, Limited	Cobalt	January 23	600,000
The Tilbury Town Gas Company, Limited	Chatham	May 31	40,000
The Toronto Tilbury Oil and Gas Company, Limited	Toronto	July 10	750,000
The Tournenie Old Indian Mining Company, Limited	Toronto	July 10	2,500,000
The Treasure Island Gold Mining Compony, Limited	Toronto	October 4	1,000,000
The Veterans Prospecting and Mining Company, Limited	Toronto	January 31	1,000,000
The Viceroy Cobalt Mining Company, Limited	Toronto	February 6	300,000
The Victoria Creek Mining & Development Company, Ltd	Ottawa	June 6	40,000
The Webbwood Copper Mines, Limited	Toronto	June 26	1,000,000
The Welland Copper Company, Limited	Toronto	April 28	1,000,000
The Wendigo Crater Mines, Limited	Cobalt	January 31	40,000
The Wentworth Quarry Company, Limited	Hamilton	December 28, 1906	60,000
The Westmont Silver Mining Company, Limited	Toronto	November 22	60,000
The Wettlaufer Cobalt Mining Company, Limited	Toronto	August 14	1,000,000
The Winnipeg Cobalt Prospecting & Development Co., Ltd.	Kenora	March 15	500,000
Wayne Cobalt Silver Mining Company, Limited	Windsor	February 1	50,000
Wee-Tu Mining Company, Limited	Latchford	July 8	300,000
Wilbur Iron Ore Company, Limited	Toronto	September 3	500,000
W. J. Trethewey Company, Limited	Toronto	March 15	1,000,000
Wilgar Lake Cobalt Mining Company, Limited	Toronto	January 25	100,000
Zone Consolidated Oil Company, Limited	Thamesville	December 28	40,000

Licenses.

Name of Company.	Head Office.	Date of Incorporation.	Capital. $
Arbor Oil Company	Chatham	December 28, 1906	50,000
Bonanza Cobalt Mines Company, Limited	Toronto	March 22	1,000,000
Bully Boy Mining Company, Limited	Kenora	October 11	250,000
Cobalt Wonder Mining Company	Toronto	March 22	1,000,000
Continental Cobalt Mines, Limited	Haileybury	June 12	1,000,000
Kerry Mining Company	....	January 26	2,500,000
Net Lake Mines, Limited	Toronto	June 12	....
Octo Oil Company	Sarnia	May 10	40,000
Pequot Smelting Company, Limited	Cobalt	January 11	10,000
The Abitibi Mining Company, Limited	Toronto	February 8	....
The Anglo Canadian Petroleum Company, Limited	Petrolea	May 3	250,000
The Canadian-Ohio Oil Company, Limited	Chatham	June 14	24,000
The Michipicoten River Mining Company	Sault Ste. Marie	July 23	250,000
The Philadelphia Cobalt Mining Company	Toronto	April 19	2,000,000
Yukon District Gold Mining Company, Limited	Toronto	November 7	....

Mining Companies Incorporated Jan. 1st to May 31st, 1908.

Name of Company.	Head Office.	Date of Incorporation.	Capital $
Aaba Cobalt Mines, Limited	Haileybury	April 16, 1908	1,000,000
American Drummer Cobalt Silver Mining Company, Limited	Toronto	February 3, 1908	500,000
Aureole Mining Company, Limited	Ottawa	February 29, 1908	40,000
Black Donald Graphite Company, Limited	Calabogie	March 20, 1908	40,000
Cobalt Silver Hills Mines, Limited	Cobalt	February 3, 1908	1,000,000
Du Nord Gold Mines Company, Limited	Dunnville	February 14, 1908	500,000
Gold Leases, Limited	Toronto	April 27, 1908	500,000
Granite Crushed and Dimensions, Limited	Toronto	April 8, 1908	40,000
Imperial Gold Mines, Limited	Toronto	January 6, 1908	4,000,000
Larder Lake Incline Mines, Limited	Toronto	May 11, 1908	50,000
Magnet Mines Company, Limited	Pembroke	April 16, 1908	1,500,000
Maiden's Silver Mining Company, Limited	Haileybury	April 16, 1908	400,000
Nipissing Reduction Company, Limited	Toronto	April 1, 1908	250,000
Northern Discovery Company, Limited	Bracebridge	April 10, 1907	40,000
Northern Star Mining and Development Company, Limited	Ottawa	May 15, 1908	100,000
Ontario Development Company, Limited	Toronto	June 6, 1907	25,000
Ontario Limestone & Clay Company, Limited	Belleville	February 17, 1908	50,000
Otto Lake Mining Company, Limited	London	March 20, 1908	500,000
Peerless Brick & Tile Company, Limited	Ottawa	April 10, 1908	150,000
Pennsylvania Lumber & Mineral Company, Limited	Toronto	March [illegible], 1908	100,000
Roswell Silver Mining Company, Limited	Toronto	May 1, 1908	1,000,000
Sharpe Lake Mines, Limited	Haileybury	March 2, 1908	120,000
Strathcona Nickel Mines, Limited	Sault Ste. Marie	March 16, 1908	250,000
Temagami Gold Reefs Company, Limited	Toronto	May 8, 1908	500,000
The Acidus Mineral Company, Limited	Ottawa	January 17, 1908	60,000
The Alpine Mining Company, Limited	Ardoch	April 13, 1908	300,000
The Bay Lake and Montreal River Mining & Development Company, Limited	Sault Ste Marie	January 6, 1908	300,000
The Big Fissure Mining Company, Limited	Toronto	March 30, 1908	2,000,000
The Big Moose Silver Cobalt Mining Company, Limited	Toronto	April 1, 1908	750,000
The Brant Portland Cement Company, Limited	Brantford	March 20, 1908	500,000
The Breeches Lake Mining Company, Limited	Ottawa	March 23, 1908	500,000
The Consolidated Gold & Silver Mines of Elk and Larder Lake, Limited	Toronto	May 8, 1907	3,000,000
The Elkhart Proprietary Silver Mines, Limited	Haileybury	March 2, 1908	40,000
The Excelsior Cobalt Larder Lake Mining Company, Limited	Niagara Falls	February 3, 1908	1,000,000
The Great West Coal Company, Limited	Port Arthur	January 21, 1908	250,000
The Holmes Cobalt Silver Mining Company, Limited	Windsor	April 16, 1908	500,000
The Keeley Jowsey Wood Mine, Limited	Toronto	May 28, 1908	1,000,000
The King George Mining Company, Limited	Ottawa	March 11, 1908	750,000
The Loughboro Mica Company, Limited	Toronto	February 7, 1908	40,000
The Mother Lode Mining Company, Limited	Windsor	April 13, 1908	1,000,000
The Nickel Copper Assets Conversion Company, Limited	Hamilton	March 2, 1908	40,000
The Norfolk Gas Company, Limited	Port Dover	February 28, 1908	60,000
The Oneida Lime Company, Limited	Hamilton	February 7, 1908	20,000
The Ontario Gas & Oil Fields, Limited	Ottawa	January 25, 1908	1,000,000
The St. Catharines Brick & Tile Company, Limited	St. Catharines	March 11, 1908	60,000
The Soo Copper Company, Limited	Windsor	February 7, 1908	1,000,000
The Swastika Mining Company, Limited	Toronto	January 6, 1908	750,000
The Toronto and Niagara Carbide Company, Limited	Toronto	May 18, 1908	100,000
The Vipond Mining Company, Limited	Haileybury	March 25, 1908	1,000,000
Ulrica Mining Company, Limited	Toronto	March 18, 1908	1,000,000
West Coleman Silver Mines, Limited	Haileybury	March 2, 1908	750,000

Mining Companies Licensed to do Business in Ontario, Jan. 1st to May 31st, 1908.

Name of Company.	Provincial Head Office.	Date of License.	Capital authorized $
Adrian-Wolverine Oil Company	Leamington	April 23, 1908	15,000
Boston International Oil & Mining Company	Chatham	January 17, 1908	40,000
Canadian Gypsum Company, Limited	Toronto	April 23, 1908	Dom. Charter
Mineral Development Company, Limited	Toronto	April 29, 1908	Dom Charter
Nova Scotia Cement & Plaster Company, Limited	Toronto	March 30, 1908	Dom. Charter
Ontario Copper & Smelting Company, Limited	Toronto	October 28, 1907	250,000
St. John's Temagami Gold & Silver Mining Company, Limited	Toronto	March 11, 1908	Dom. Charter
The Dominion Nickel Copper Company, Limited	Ottawa	January 17, 1908	Dom. Charter

Appendix II

THE EARLY HISTORY OF THE COBALT INDUSTRY IN SAXONY

Translated by G. R. MICKLE

"Is there anything whereof it may be said, See, this is new? it hath been already of old time which was before us."—Ecclesiastes.

Introduction

The following translation of portions of W. Bruchmuller's work (now unfortunately out of print) on the early history of cobalt mining and the manufacture of blue color in Saxony will perhaps interest those engaged in the colbalt industry to-day.[1] In the main the problems ahead of the miners of that metal at the present time are the same as they were over three hundred years ago.

The cobalt production marked a second period of mining activity in the district in question. The first was characterized by a feverish excitement and activity and a comparatively short life. Silver was the only metal sought at first and the veins were sometimes fabulously rich.[2] Two systems of veins were known—the silver with barite as gangue mineral and the cobalt veins with quartz.

The exact time when mining started in the cobalt region is not known, but the first important discovery of silver ore was made at Schneeberg in 1470, and the growth of the industry was phenomenal; by 1474 there were 176 producing mines. The most famous was the St. George at Schneeberg where veins of different formations joined and where one enormous block weighing 20 tons, described as 6 feet wide and 12 feet high, consisting of native silver, argentite, ruby silver and the chloride of silver was found. Records mention a banquet given underground by the Duke of Saxony using this block or nugget as a table.

Silver mining flourished for 25 years or more and then began to die down. Some of the veins had a length of about 2,500 feet and were followed in depth about 1,000 feet. These were, however, extreme limits.

In the case of the essentially cobalt veins (which carried some silver) there was an extraordinary massing or crowding together. In an area of less than four square miles 150 productive veins were found. After the invention of cobalt blue, mining flourished again.[3] It is with this second period of activity that Bruchmueller's work is concerned.

It is evident from the translation given below that an immense amount of searching into old archives was involved in the preparation of this work.

FORMER PRODUCTION OF COBALT GREATER THAN AT PRESENT

One thing that is striking in reading the accounts of the cobalt industry of one or two hundred years ago is that at that time the amount of cobalt produced was probably greater than it is now. A work by Friedrich Kapff, published in 1792, gives details of the state of the industry at that time. Kapff was employed by the Finance Minister of Prussia to make a report on the works in Querbach in Silesia particularly,

[1] Der Kobaltbergbau und die Blaufarbenwerke in Sachsen bis Zum Jahre 1653 von W. Bruchmueller, 1897.
[2] Stelzner-Bergeat. Erzlagerstaetten.
[3] This was really a re invention, as cobalt is said to have been used for staining glass in pre-historic times.

and he included also a description of all the other works existing at that time, which he had visited. These amounted in number to twenty-three, not including the works of Holland. One French works is included and also one in Norway. Unfortunately the amount of cobalt oxide is not given, but the amount of smalt or blue color, the manufacture of which is described below, is mentioned. In sixteen out of twenty-three cases such information is given that the amount can be fairly closely estimated, and it comes to about 2,500 tons, so that if the other seven works were included it would probably amount to over 3,000 tons. Of this amount about one-half was produced in the Saxon works which were much the most important. The works were of course small when compared with smelting works as they exist now. For instance, in the description of one of the best of the smelting works the external dimensions were 48 feet × 34 feet and 44 feet high, and this building included a room for the foreman. The mechanical building, where the stamp batteries were for pulverizing, was 114 feet, 30 feet wide, and contained eight stamps, a grinding mill, storeroom and drying rooms for drying the quartz. The works were built always on some stream which furnished the water power and were worked by over-shot wheels.

With regard to the smelters in Holland no details are given of amounts. It is known, however, that the Dutch refineries supplied the Irish trade almost entirely, and also consumed a large amount themselves in the linen industry and in the manufacture of litmus.

In all the trade, including the amount made in Holland, the total manufacture of color would probably be from four to five thousand tons, and this color might contain anything from three to say fifteen per cent. of cobalt, therefore probably three to four hundred tons of cobalt were actually manufactured in Europe over one hundred years ago, so that in spite of the enormous increase in the consumption of all the other metals, owing to the expansion of industries, the consumption of cobalt has probably actually decreased. This is due no doubt to the fact that it has been replaced in the linen trade by vegetable coloring matter.

BEGINNING OF COBALT INDUSTRY

The beginning of cobalt mining and the knowledge of the use of cobalt in Saxony are wrapped in obscurity. The discoveries of the blue color is said to have been a Frenchman, Peter Weidenhammer, who settled in Schneeberg in 1520 and made a blue color which he sold in Venice for 25 thalers[4] a hundredweight (112 lbs). Christian Schuerer is said to have improved the invention of blue color. He had a glass works at Neudeck, and it is believed that there for the first time a blue color was made out of the cobalt from Schneeberg by fusing and the addition of pearl ash or potassium carbonate. It is said that this color was sent to Nueremberg and was there seen by the Dutch, who then went themselves to Neudeck and persuaded Schuerer to go with them to Madgeburg to make cobalt blue for them. Afterwards, when they had learnt Schuerer's secret, they sent him home again, where he started a small color mill. A hundredweight of this color at that time cost 7½ thalers. It sold in Holland for 50 or 60 gulden.[5] The Dutch are said to have immediately built eight color works and to have imported the necessary cobalt from Schneeberg. This blue color was made by taking the cobalt ore, in this case, smaltite, which contained some bismuth, and melting the bismuth out by gentle heating; then it was stamped and roasted in reverberatory furnaces. It was important that the roasting or oxidation should be as complete as possible. The result of this process was the cobalt oxide, known in the trade as safflor, a grayish brown powder. In order to make cobalt blue out of the oxide it is mixed with potassium carbonate (pearl ash) and white quartz and fused, then dipped out with iron spoons into a large vat, in which cold water runs continuously. By this means the blue colored glass attained its deep blue tint and became so brittle that it could be crushed and

[4] Thaler = about 75 cents.
[5] Gulden = about 45 cts.

ground.[6] This crushed and ground material is then sifted, washed and finally graded through very fine sieves. By means of the washing the soluble constituents are removed, and the different colors known to the trade are produced, according to the fineness of the material.

We see, therefore, that in the beginning the production of the cobalt oxide in Schneeberg was not in the hands of large operators, but the small works treated their own cobalt and sold it to dealers who came to Schneeberg. The oxide was then sent to foreign countries

Cobalt Works in 1568

In the knowledge of the art of color-making they seem to have made rather rapid progress, for about the end of the sixteenth century they had begun to make the blue color themselves. The first one to make this was Christopher Stahl, who put up a small smelting works at Schneeberg in 1568, also some mills, melting furnaces and color works, in which he made a blue color for artists. Nothing is known about the extent of his works, but it could not have been great, as Stahl's undertaking is only mentioned incidentally, and the production of colors for artists could naturally not be carried out on a large scale. These works did not last long. They were swept away by flood in 1573. After Stahl's death an attempt was made to carry on the color trade on a larger scale, and according to the spirit of the times, this undertaking must first be protected against competition by a decree on the part of the State, but in spite of the energy and business ability and large capital of the two engaged in the undertaking, it failed The two in question were Hans Harrer and Hans Jenitz. They went to the Prince in 1575 requesting a concession to erect a color works and to allow them the exclusive right for ten years to purchase cobalt ore in Schneeberg. They stated that they had noticed for fourteen years how the oxide which was prepared in Schneeberg and the vicinity was bought up by agents of foreign merchants and sent out of the country to Nuremberg and from there to Italy and Venice and other places. Out of this oxide blue color was made and sold at a high price. By means of laborious experiments and at a large expense they had arrived at the secret of the preparation of the blue color and they were now wiling to put up a works, but they were afraid that very soon others would be engaged in the preparation of colors and therefore they requested the concession mentioned above. Stahl's works were not mentioned by them at all, and from this we see that his plant cannot have been large.

First Monoply Granted in 1575

This concession was granted them by Prince August in 1575. According to it Harrer and Jenitz could erect the color works and they alone had the privilege for the next ten years to buy cobalt oxide in Schneeberg, and they could work it up and deal with it as they wished. They had to pay, however, the cobalt mines the same price which they had got for the ores from the foreign dealers. No one during these ten years could engage in the preparation of color without their consent, neither could he buy the ore or the oxide and ship it out of the country.

This undertaking, however, did not fulfil the expectations placed upon it. Schneeberg was, of course, the principal place of production for the oxide, which, as before, was chiefly prepared by the works themselves, and then sold to Harrer and Jenitz. The color exchange was in Dresden, but in spite of numerous efforts, the disposal of the colors presented great difficulties. Moreover, contrary to the royal concession many engaged in the preparation of color in Schneeberg, and bought up the oxide and sold to competitors in Nuremberg, who probably also worked up Bohemian cobalt and brought it on the market. A letter of this period, namely, 1579, from Hans Harrer to foreign merchants shows us the state of affairs and how Harrer exerted himself to find a market

[6] The blue color or smalt usually contains about 6% cobalt.

for his product. Harrer complains that he had spent a great deal of money for the purchase of the oxide and the preparation of the color, but in spite of all that he could not find a market for it. He could only deal in the matter at a loss. Not long before, he stated, he had sent some of his color to Lisbon, but the merchants there had done very little with it and finally it was left unsold. He (Harrer) had quite a stock on hand which he wanted to get rid of, and he therefore asks for the addresses of those to whom he might send it.

Troubles of the Cobalt Buyers

In 1579 Harrer & Jenitz complained to the Prince. They stated that in spite of the concession which had been granted them there were about twenty others in Schneeberg who were engaged in buying up cobalt and making it into color, and that these others were putting everything into barrels, whether it was good or bad, and trying to sell it for good color, and therefore it had come to this that during the four years of their monopoly they had put several thousand gulden into the undertaking, and had not been able to sell most of the color or oxide which they had prepared. Moreover, several of the inhabitants of Schneeberg, contrary to their concession, had demanded a higher price for their oxide, and when this was not granted they had taken the color out secretly at night and even sometimes had packed it out openly on their backs. Harrer and Jenitz therefore begged for a renewal of their monopoly and an extension for four years more, and a sharper decree against the smuggling of cobalt and cobalt oxide.

The Prince granted this request and renewed the concession till 1589, according to it the contractors alone had the right to buy bismuth and cobalt and the oxide. The works might, it is true, work up their cobalt ore themselves to oxide, but then they must sell it to Harrer & Jenitz for 10 groschen[7] a hundredweight. Selling to others would be punished with a fine of 200 thalers and confiscation of the goods, which would belong to Harrer & Jenitz. In spite of this decree the undertaking was not a success, and after the death of Jenitz in 1589 (Harrer had died in 1580) and the expiry of the concession in the same year, it was not renewed, so that the first attempt to organize the Schneeberg cobalt and color trade and to make the blue color in Saxony themselves, was a failure.

Change in Industrial Conditions

About this time there was a change in the political organization of the country. Every undertaking of any size required a concession from the Prince, just as we saw in the case of mining, and the ideas of the rights of the Princes gradually changed. These conditions made their influence felt on the cobalt mining of Schneeberg, and rendered it possible to bring in considerable amounts of foreign capital, because the Princes, who were at this time almost always in need of money, gave concessions for the exploiting of their mining privileges in consideration of certain loans from foreign traders. This was acceptable to the foreign traders, as they had thereby the only security for their money.

Stealing of Ore in 1603

In the year 1603 we hear for the first time of a more strict supervision on the part of the Prince over the production of oxide. In this year the mining office complained to the Prince that there were people in Schneeberg who were engaged in making the oxide, but did not have any cobalt or bismuth mines. The Prince decreed, therefore, that for the future no one should be allowed to buy cobalt or bismuth or sell it before it had been accepted by the mining office and determined whether it came fresh from the mine or had been taken from some dump.

[7] Groschen = about 2½c.

Export Tax

Shortly after this also the Prince put a tax on the Dutch merchants for the cobalt that was bought in Schneeberg, and ordered a strict supervision of the export. In the decree in question it was stated that merchants from Holland in the last quarter of the year had bought over four thousand hundredweight of oxide in order to take it to Holland, England and Spain—from this the Prince did not receive any taxes. Out of the tax of one-twentieth very little came in, and from this the Prince had always to keep the principal adits in order and therefore for every cask of oxide that was sold a gulden must be paid as tax. This tax would fall on the foreigner, and they would not evade it because they had a good market for their wares; all colors, for the purpose of collecting this tax, must be weighed by an official in Schneeberg, and recorded. Any evasion of the tax would be punished with a fine of 500 florins, and confiscation of the goods. Every cask must be printed with a certain mark, and all casks without this mark were to be expropriated. In the same year one Berckau from Joachimsthal came to the Prince with a proposition that the Prince should take the sale of the color into his own hands, as according to Berckau every year great quantities of color and cobalt were sent from Schneeberg to Hamburg and Holland, and from this the Prince only received a very small tribute, but everything for the manufacture of color was found in Saxony, and he, Berckau would guarantee to make good color glass out of the Schneeberg cobalt for half the price which it cost them in Holland and Hamburg. Moreover he said the Hollanders would far rather buy the glass than the raw oxide. If the Prince would take the sale of the color in his own hands he and an associate would take charge of it and produce yearly two to three thousand hundredweight of color glass. He gave two calculations as to the cost of color in Saxony and Holland as a basis for his proposition. The calculation as to the cost in Saxony was as follows:

	Florins.
100 cwt. of unstamped cobalt ore cost	300
Wood for roasting	9
Two workmen for 14 days	9
Loss 3 cwt.	9

therefore 100 cwt. as exported from here cost 327 florins, and add to this

	Florins.
50 cwt. flux	400
Wood to melt	42
4 workmen for the melting for four weeks at the rate of 2 florins per week per man	36
Other expenses	25

or a total of 830 florins for 100 cwt. He calculated in the same way the cost in Holland at 1,000 florins. Now as a hundredweight sold in Hamburg for 20 florins, therefore the profit was 100 per cent. The Prince should give him an advance of 5.000 florins for his works and they would take charge of it, but they must first take a trip to Holland and England in order to make contracts with the dealers for large amounts. As remuneration they asked 20 per cent. of the profits. The Prince did not consent to this proposition of Berckau's. The result of this proposition and consultations was the royal decree of 1609, in which it was made known that for the future the Prince would buy up all the cobalt made in Schneeberg, which was formerly taken by foreign merchants and sent out of the land. The purchase was to be made through the tithe collector. The works producing cobalt were directed not to sell their cobalt to any one else under a penalty of 500 florins, and all the dealers were forbidden under the same penalty to buy cobalt without the consent of the Prince, or to dispose of their stock on hand either in or outside of the country. The Schneeberg cobalt trade thus became a State undertaking.

SCHNEEBERG COBALT AND OXIDE TRADE AS A STATE UNDERTAKING

The first consequences of the change of the Schneeberg cobalt and oxide trade into a purely State undertaking were decidedly favorable. The stricter organization, and the greater capital which the new management could command, led in the first place to a rise in the price and increase of the sale. This operated in favor of the cobalt miners, even although it must always be kept in mind the money bags of the rulers profited by the change. In the course of time, however, the financial difficulties under which the Princes at that time almost always labored exercised a baneful influence. Their interests were always more and more put in the foreground, and they were willing to let the works get under control of capitalists who were able to make large loans. These concessions would be given for a period of years. It must, however, be acknowledged that, as a last resort, the mining office stepped in on behalf of the cobalt miners and the Prince generally followed the advice of these officials and remedied the most crying evils. Moreover, the terrible industrial crisis began to make its influence felt. This was brought about by the practice of clipping coins and by the Thirty Years' War. These circumstances led to a complete ruin of the Schneeberg cobalt mining and the oxide trade about the period of 1620-30. We will look into these circumstances more in detail shortly, but must first notice the organization of the cobalt and oxide trade as it existed after the conversion of the industry into a purely State undertaking.

Ordinance of 1609

According to the ordinance of the Prince in 1609, the tithe-collector in Schneeberg had to take over all the buying and selling of cobalt and oxide. The first task was to find a buyer for the cobalt purchased from the works and the dealer, Kreifinger, applied to the Prince for a fixed contract. The following agreement was made with him in 1610. It was for a period of six years: All oxide colors which were produced during these six years in Schneeberg and were of good quality were turned over to Kreifinger. He had the power to sell his oxide wherever he wished, but he must first supply the business houses of the Principality with these wares. Kreifinger had two Leipzig merchants as guarantors. The price per hundredweight was six gulden and ten groschen and notice had to be given half a year before expiry of the contract. Kreifinger had to advance the Prince 3,000 florins, and he was to receive back 500 florins per year and the interest. Some alterations were made in this contract afterwards to the effect that the oxide was divided into two classes. These changes were in consequence of complaints on the part of the contractors. They objected especially to the fact that all the oxide that was produced in Schneeberg should be accepted by them, and therefore every year fixed amounts were agreed on. The whole management of this business was left to the tithe-collector. He had to look after the purchase and taxing of all the cobalt ore delivered by the works, then deliver them to the contractors and carry out all the bookkeeping. There were numerous complaints on the part of the works that the tithe-collector estimated their cobalt too low. The bucket of cobalt ore was paid for at the rate of two to three florins, and the hundredweight of oxide three or four florins. This task soon became too great for the tithe-collector. He therefore requested assistance in his work, and a couple of officials were allotted to him. These two officials were to inspect and estimate the cobalt in the presence of the tithe-collector and agents of the contractors, to look after the roasting of the ore, visit the stamp mills weekly, weigh out the color for the dealers, and keep strict account of all color that was made.

An attempt was made to induce the Prince to cancel the contract with Kreifinger, He was accused of being a swindler, who had already been in jail. At the same time proposals were made to make the color in Saxony. In spite of these objections the Prince stood by the contract, and even renewed it for six years more. According to this later contract the Prince had to deliver yearly 3,500 hundredweight of oxide, 3,000 at 8 florins and 500 of inferior quality at 6 florins. Kreifinger, in consideration of this, made the Prince a further loan of 4,000 florins. These advances on the part of the contractors to the Prince were characteristic of all the concessions.

Troubles of the Miners

A few years after this, namely, in 1616, the cobalt miners petitioned for a remission of the tax on the ore and for a higher price for their cobalt, as mining was getting more expensive all the time, and the ore scarcer, and prices for necessary articles were always rising. The tithe-collector suggested an increase of half a florin on the bucket.

In 1617 the following ordinance was made:

1. All the cobalt ore must be inspected by the officials before it is rated and taken to the ore house in order to determine from which mine it came and to see whether good and inferior ore were not mixed together. For this inspection the mines had to pay each time two groschen. The previous taxes were maintained.
2. No robbing of the mine was to be practised.
3. No miner was to go underground more than two shifts in the day.
4. All the cobalt purchased from the works was to be kept separate and roasted by itself in order that the tithe-collector and the superintendent of the cobalt could settle correctly with the different works, and in order that the cullings-out could be replaced by the different works.
5. The assayer had to take a sample from each cask of oxide and this was to be kept in the office.
6. No cobalt ore was to be stamped either by night or on holidays.
7. Two buckets were to be kept and filled with ore by the works, one of which the tithe-collector was to receive and the other the mining office.
8. The officials had to inspect the color works weekly, and the ore-dressing plants, and no one had any right to enter the stamp mills without permission.
9. Every cask of color was to be weighed and stamped with the Prince's trade mark. The color was to be sold by the hundredweight to the merchants in Holland.

Unfortunately, however, these rules were not observed, and we see that shortly afterwards the works were complaining over the tithe-collector, Roehling's, practice of culling out. The cobalt that was delivered by the works was not kept separate, they stated, but all mixed together, and then the works were compelled often to replace more ore than was culled out than they had sent in the first place—for instance, one mine which had delivered 53 buckets of cobalt was ordered to replace 64 buckets, and moreover they said this ostensibly culled ore, which was often better than the cobalt that was accepted, was not sent back to them, but was taken sixty miles and farther sometimes—they would like to know why. They said that the tithe-collector was always in debt to the works, so that they were compelled, in order to carry on their mines, to borrow capital at high rates of interest. Therefore they requested that Roehling be ordered to cull out the ore from each work separately, and to give back what was culled out in order that they could pay off their workmen properly, and they also asked that the tithe-collector should pay them in full every half year, or if not, that the Prince should allow the works, after this contract was run out, to work up their cobalt to oxide themselves and sell it as they might. They offered to give the Prince, if the tax of one-twentieth was repealed, for every hundredweight of oxide one florin. They stated this would bring in more than came from the contracts now. The Prince promised to look into the matter of the excessive culling by the tithe collector, and to give them an answer about this open dealing after the contract expired. In the same year the works made another complaint about their being in arrears with their payments. They stated that they were no longer in a position to pay their workmen, and they had to keep on borrowing money at high rates of interest.

Coin Clippers Period

We come now to the time of the Thirty Years' War and to the general money crisis in Germany, which is known as the time of the Coin Clippers. The consequences of the war were noticed in Schneeberg after a few years, but the tremendous money crisis was felt at once. In Germany for some time there had been excessive clipping of coins going on, and in consequence of this currency of full value was vanishing, and the country was flooded with depreciated money, thereby bringing about a tremendous increase in the price of all articles. This money crisis was all the worse because it coincided with the Thirty Years' War, by which trade was crippled everywhere. In consequence of these two circumstances the production fell greatly, from over 8,000 buckets in 1620 to about 2,000 in 1639.

The cobalt miners regarded the contract which the Prince had forced on them as the sole cause of their desperate position. They were no more able to recognize the true cause of the industrial crisis than their contemporaries. Their object, therefore, was to have this contract cancelled and to obtain unrestricted trading in their cobalt and oxide without the intervention of the tithe office and foreign dealers. They therefore asked in 1619 for the granting of open dealing in cobalt, and the Prince told them that after the contract ran out in 1620 he would give them an answer. The Prince was, on his part, too much dependent on the support of these foreign dealers, as it was only with their large capital that he was able to undertake the extensive business involved, and the contractors, on their part, were quite content to have the concession as a guarantee for their debt. He therefore could not entertain the wishes of the miners.

The Prince renewed the contract with the Dutch for six years, but it was finally cancelled, as the contractors only wished to take yearly 3,500 hundredweight as before, while the Prince demanded the purchase of a larger quantity. In spite of this the Prince would not grant open dealing, but made another contract with some Leipzig merchants and others. The contract was for twelve years. The Prince agreed to deliver them yearly 6,000 hundredweight, and the contractors could deal with these either at home or in foreign markets, but they must first supply the dealers of Saxony. If the contractors could not get rid of the color afterwards they could keep it in Schneeberg in some of the offices, and in the meantime no one else should be allowed to deal in color, and the Prince would give a patent against cobalt smuggling. On their side the contractors must agree to take the 6,000 hundredweight yearly, even if war broke out, and stopped trade, and they must pay in cash 5,000 cwts. at 8 florins, and 1,000 cwt. of inferior quality at 6 florins. Payment must be made in good French money.

Loans from Contractors to Prince

In the autumn of that same year the Prince applied to the contractors for a large loan. He explained to them that he required 50,000 florins for a very important matter, and requested them to advance this money. They declared that it was at the moment impossible for them, but they would manage to do it in the course of six weeks, advancing the money at seven per cent. Some time afterwards they said that they were ready to advance the 50,000 florins if the oxide trade and the purchase of the cobalt was made hereditary and irrevocable to them, and that they should buy the cobalt by their own agents and work it up to oxide themselves without the royal tithe-collector having anything at all to do with it. For this privilege they would pay the Prince 4,000 gulden yearly. The Prince agred to this unheard-of demand without hesitation. The contractors were to make the payment and the tithe-collector to be notified of the fact.

Intervention of Mining Office

This doubtful step was not carried out however, as the mining office took a hand in the affair and explained to the Prince that this proposal was contrary to all mining rights; that the miners would leave, and then he would lose the 4,000 florins which he got from the contractors, while the cobalt mining had brought in the Prince yearly up to the present time about 6,000 florins. This concession was never formally withdrawn, but is never mentioned again, and matters remained as they were, the contractors lending the Prince 17,000 florins, which the Prince set down to the credit of the works. In the next year the works sent an urgent request to the Prince to pay them for their cobalt that was delivered, that there was 17,000 florins overdue from the tithe-collector, and they further asked for payment in good coin of the land, and not in copper coins from Brunswick, which they could not get rid of. They stated that all necessities and appliances were advancing at a terrible rate, the price being about three times what it was before, so that a great many had to leave on account of the expensive living, and finally they expressed a desire for open dealing again, and requested an extra payment for the cobalt. The mining officials agreed, or gave a favorable report on this petition, and suggested that they be repaid the 17,000 florins and get half a florin more per bucket for their ore. This was done by the Prince. The contractors, on the other hand, were not by any means satisfied. They had expected a greater profit for their undertaking than it really gave, and they complained continually about cobalt smuggling, further, they objected to the tithe-collector at Schneeberg,—that he delivered them oxide that was no good. The Prince therefore ordered a strict inspection by the mining office, as these complaints had become too frequent. The remonstrances, however, continued till finally the Prince ordered an investigation. In consequence of this investigation the Prince took away the control of the outside works entirely from the tithe-collector, and put them in charge of a new officer. This concession did not satisfy the contractors; in the meantime, in order to get rid of the contract, they had made an agreement with one Brandenstein, and in consequence of this they stated that they had everywhere found opposition, and reverses with their contract, and they feared great loss, if not complete ruin. Therefore they requested the Prince to hand over their contract to Carl Brandenstein.

The Prince was heavily in debt to Brandenstein, who was a money-lender of the worst kind. He had lent 22,000 florins of depreciated money to the tithe office, and probably he expected to recoup himself with the oxide trade of Schneeberg. He did not succeed in this, however, as his inconsiderate treatment of the miners overshot the mark, so that he had to abandon the contracts. He had asked the Prince for the most complete and untrammelled powers in the direction of the business for twelve years. According to the contract Brandenstein would take over the purchase and the preparation of oxide. All the directors of the color works and all the employees of the Prince, except the mining officials in the mining office and tax collectors were to be put under the direction of Brandenstein, and he had the power to dismiss them or fill their places, after notifying the mining office. The new officials would then be engaged by the Prince and turned over to Brandenstein, who was to pay their salary. The cobalt ore was to be paid only in good coin, but the works had to deliver good pure material. Material that was worth less than 3 florins need not be paid for at all. Any ore that was not good would be put aside and could not be sold. All good cobalt Brandenstein was forced to accept, but he need not pay for it at a higher rate than five florins, and he must pay in good coin. All the color works and stamp works which were in bad repair Brandenstein was to take over and he would be recouped for the expense of repair after the expiry of the contract. He was to receive wood out of the Prince's forest at the usual price and in addition to the stamp work he might build a new cobalt works, the cost of which would be refunded to him. He should have the stamp works belonging to the tithe office as long as he wished for one gulden weekly rent; in consideration of his previous advances the whole stock of oxide, etc., and 16,900 buckets of cobalt were handed over to him. He could make this up to color and sell it wherever he wished, and in consideration of this he had to pay the works the money that was due, but they had to first replace the ore that had been culled out with good cobalt. After the expiry of the contract Brandenstein or his heirs had a prior right to a renewal of the contract. If the supply of cobalt ore failed the contract would be cancelled and Brandenstein had to see that the various taxes were all paid.

Disputes between Miners and Contractors

We see that by this means the Prince had handed over the trade in oxide, which had ben very profitable to the Treasury, to Brandenstein for a period of twelve years without any further consideration except that the Pricne was free from the responsibility of paying his debts to the works. Immediately after the signing of this contract a bitter quarrel began between Brandenstein and the works. They demanded payment of the balance of over 30,000 florins which was due them for cobalt which they had delivered. Brandenstein put every obstacle in the way; he demanded the replacing of the ore which was culled out, and stated that the stock on hand was a great deal smaller than was represented to him at the time when the contract was made. The works, on their part, objected to the excessive culling. They would have to close down their mines and send off all their men, who already lived in the most wretched state of poverty. They stated some were even dying of hunger. Their creditors were threatening to evict them from their mines, and the adit was in danger of caving in, as they had no means to keep it in order, and furthermore they complained especially about a wilful underrating of their cobalt and of the low price. In spite of the efforts of the higher officials of the office to induce Brandenstein to accept some of the lower grade cobalt and to pay up the outstanding amounts to the works, he obstinately stuck by the letter of the contract, and complained that he was losing by it. The works did not let the matter rest. In spite of a sharp notice from the Prince about their inopportune grumbling they continued to send complaint after complaint, always about the same points, and with the same conclusion, namely, that they should be allowed open dealing for their cobalt. Brandenstein finally gave way to this uproar raised by the works, which was backed up in the most essential points by the officials in the mining office. He therefore voluntarily cancelled his contract with the Prince and the Prince gave permission to the works to make up the cobalt to oxide themselves, and to deal with it as they wished, but they had to pay the regular taxes, and in addition to that one florin for every bucket of cobalt made up to oxide. Smuggling in cobalt would be punished by a fine of 500 gulden.

Open Dealing Not a Success

The cobalt works had reached the desired goal, and they hoped that with that all their difficulties would be at an end. But very soon the opposite became evident, and although the management of the State might have been a great deal to blame for what had happened in the last few years, it was not the only reason for the decline of the Schneeberg cobalt mining. It was rather dependent on the general industrial and political crisis under which all trade and industry languished, and the general purchasing power of the public greatly diminished. This was especially noticeable in an article which was not absolutely necessary, such as the color, and in times like this it was the small works and those with less capital which necessarily suffered most. We hear, therefore, a few weeks after open dealing had been allowed, strong complaints on the part of the works. They stated that in addition to the tax they should not be required to pay one florin for every bucket of cobalt,—that Brandenstein had ruined the whole business and no human being was willing to buy any color from them. The cost of mining a bucket of cobalt was two or three florins, and if the expenses were so great they would have to discharge their miners, and therefore the Prince should remit the one florin on the bucket of cobalt. The Prince granted this request in part, and an inspection was ordered of all the works by the tithe-collector, and that the adits should be kept in repair where there was any danger of a cave-in or other damage, and they were further to see that the barren rock did not remain in the adit, but should be brought out to the surface. For the purpose of collecting a tax they should inspect all the mines which were producing every two to four weeks, and be present when some of the ore was hoisted, and should cull the cobalt in proper manner and measure it up. The works were not satisfied with this. The Prince pointed out that the office, the mining officials and the works had made representations about excessive taxation, and that the works had said they were ready to pay these taxes if they got open dealing, and that they stated they would find enough buyers who would take their cobalt at ten florins which they were forced to sell at five. Now they said the very opposite. They were to blame themselves. In spite of this he said that he was willing in the future to take the tax of one florin a bucket and remit the mining taxes.

As soon as an opportunity offered the Prince made one more effort to close a new contract. Two men offered to negotiate; one was the merchant, Hans Friese, and the other was from Frankfort, Daniel de Briers. Both declared that they had bought a great quantity of oxide, but the business had not succeeded, as in the previous years a great deal of very bad material had been made, still they were willing to go on with the venture if a monopoly was given for from one to three years. The Prince seized this opportunity immediately and made a contract without consulting the Schneeberg cobalt works. It was for six years. According to this the two contractors were to take yearly from Schneeberg and Neustadtlein 3,000 buckets of cobalt. The payment should be made according to four grades. The No. 4 grade was to be considered as absolutely worthless, and the first three grades were to be paid respectively with 3, 2½ and 1½ reichstaler. The samples were to be kept in Shcneeberg and the cobalt was to be taxed according to them. The cobalt, as soon as it was taxed, was to be delivered to the two contractors, who could make oxide of it and deal with it at home or abroad, as they liked. The payment for cobalt was to be made to the works immediately by the contractors in cash without any deductions, that is, neither the Prince nor the tithe office had anything to do with it as formerly. The latter had nothing more to do with the trade, but merely inspected it through the mining office. Moreover, the contractors were to take the cobalt ore which was paid in to the Prince as mining taxes by the works, and also that which was mined in his own mines, at the price of 3 florins a bucket. At first the contractors were not to export their cobalt and oxide from Schneeberg, in order that the business might recover its reputation again, and all dealing in oxide and cobalt was strictly forbidden to all other persons during this period of six years, but in consideration of this the contractors were bound to take yearly 3,000 buckets, even if war broke out and stopped trade, and if more than 3,000 buckets were mined in one year the excess would be kept for the next year. For this privilege the contractors were to pay yearly 1,000 thalers into the Prince's exchequer, making it in two equal payments, and also pay rent for the works belonging to the Prince which they took over. If the contractors, after the six years, did not wish to renew the contract, they must give a half-year's notice; on the other hand, if they wished to go on they would have the refusal over others.

Contract versus Open Dealing

This contract was submitted to the works, who immediately opposed it, as they declared that it would mean the certain ruin of the whole mining industry. They straightway came to the Prince with a petition about the contract, and to request the retention of open dealing, and they especially complained of the small quantity of cobalt which was to be bought, namely, 3,000 buckets, and of the low pice, stating that, under these conditions, they were doomed. They begged, therefore, to have the contract cancelled, and to stick to open dealing. They promised to pay the tax most punctually, and to abstain from any smuggling on their part. In order to meet the works somewhat in this respect the two contractors stated in writing that although they were not, under the existing circumstances, in a position to take more than 3,000 buckets, nor to pay any more for it, they would be willing, if the conditions improved to buy a greater quantity of cobalt and pay a little higher price. This declaration on the part of the contractors, which was not really of any value, did not remove the opposition of the works, but it had the effect that the works now divided into two parties,—one which declared that they would like the contract provided there was a greater quantity bought, and the price were a little higher, while the other party still opposed the contract. The party which was irreconciliably opposed to the contract persisted that if they got open dealing they would give the Prince, instead of the tax of one-twentieth, every tenth bucket, while the other party stated that this offer could not be accepted, and wished for a fixed contract, however, with the conditions mentioned above. Negotiations in this matter dragged on for some time. The contractors finally agreed to take 4,000 buckets annually, but stated that an increase in the price was impossible at present. The mining office stated that the prices offered to the works by the contractors were not reasonable, as the costs in mining were too high. However, offers and counter-offers were made, and as a final result the Prince asked for a vote from the works of "contract" or "open dealing." All the works which were producing ore must state in writing whether they were for a contract or for open dealing. The result was that 30 persons, representing 87 mines, voted for the contract, and 43 persons, representing 132 mines, voted for the open dealing. In consequence of this majority for open dealing the Prince decreed that the contract was cancelled and permitted open dealing again, with the condition that every tenth bucket of good pure cobbed cobalt ore should be paid into the Treasury, and in addition to this some other taxes, which could be paid in money or cobalt. Those of the works which had received advances from the contractors, or had ore to their credit, should settle the matter with them.

Crisis in the Industry and Effect of War

We come now to the saddest time for Schneeberg cobalt mining. In 1629 the works requested, instead of every tenth bucket, that they should give every twentieth, as they could not get ready cash for their cobalt no matter how cheap they were willing to sell it. This request was repeated in 1632, and at the same time they petitioned for the establishment again of a fixed contract. This, however, considering the bad position of all commerical and political matters, was an impossibility, especially as all the foreign contractors had had bad experiences with their contracts, and were not willing to bind themselves for any length of time. A good idea is given of the conditions and the position of the Schneeberg cobalt mining at this time in a report of the chief official of the mining office in the year 1631. According to him the works since about 1628 had found almost no sale for their oxide because the Dutch had withdrawn entirely from this trade, and they were the ones that had bought up most of the oxide before. Moreover, the war had been spreading all the time, so that all the passes in the mountains were guarded, and all trade was blocked. The works had sought to sell their goods themselves, but they had to dispose of them at a very low price, and at a loss. Sometimes they were not paid for in cash, but in goods, which they could not sell again without a loss, and they had been compelled to pay their workmen in the mines with cobalt, which they had to sell dirt cheap in Bohemia in order not to die of hunger. It was true that a decree had been made that the workmen were to be paid with money, but there was so little of it in the country that they were afraid that if this decree was observed the mining must be stopped altogether. In addition to this misfortune it seems that about this time Shcneeberg suffered directly in the war. In 1632 the Croatians swept down on Schneeberg, took the town and sacked it and ruined many of the mines. At that time the population of Schneeberg was only about 2,000, whereas it had been over 3,000 in the year 1600. In consequence of the lack of money they had neglected to carry on the necessary repairs in the adits, and as a result many of the mines were flooded. The deepest adit caved in about that time, and they were not able to mine any more in consequence of an inrush of water, and the production of cobalt fell off. It is believed that shortly after this there was not a single mine in Schneeberg which made any profit, as at the very most they could only get about 25 groschen for a bucket of ore, while the mining of it cost a florin or more, and in addition to that they had to pay some tax. The only exceptions to this were three mines, which made a little because they had some bismuth.

THE PROSPEROUS TIME FOR THE SAXON BLUE COLOR WORKS

After the year 1628, instead of a fixed contract the cobalt works were allowed to deal with their ores as they wished without improving the position of affairs at all. We have seen, moreover, that the conditions for mining just at this very time were exceptionally bad. The production of the mines had sunk considerably, and did not begin to increase until after the forties. This was brought about, as we saw, by the depreciation of the coinage. That and the blocking of all trade with foreign countries because of the war, and the other devastations which the war brought with it, had brought the Schneeberg mining into a desperate state, from which there did not seem to be any escape. This unfortunate period had caused most of the works to see that their position was better under the cobalt contracts which they had fought so hard against, even although they did not receive the principal advantage themselves, which went rather to the contractors, because when they had open dealing and the times were uncertain the works which lacked capital depended altogether on foreign dealers. Moreover the worst of the storm of war was past. It is true that in 1642 Schneeberg was sacked again by the Swedes, but on the whole more peaceful times were dawning, and moreover the cobalt mines had been producing better ore for some time. As the result of all these causes a gradual wish began to be expressed for a general contract and the establishment of color works in Saxony, a plan which, if successful, would probably give cobalt mining a sounder foundation than the sale of cobalt and oxide to foreign dealers. Some offers were made by different parties which were not accepted, as there was no guarantee that they would be able to carry out the contracts, and after some considerable discussion and negotiation the Prince summoned the principal officials of the mining office, the civic officials and whatever contractors were willing to bid, to meet together and lay their proposals before him, to see if they could make a contract by which the works could sell a fixed amount of good, medium and low-grade cobalt, the payment to be in cash, according to the assays of the ore. The small works, too, which could only mine a little cobalt, were to receive consideration, and moreover all the wages were to be paid in money, and not with color or cobalt. The sale of cobalt to Joachimsthal in Bohemia was to be absolutely forbidden, and if they did not succeed in closing a contract the Prince was to receive a report as to how far they advacned, together with advice as to what should be done in the meantime. Before these officials had finished the task set them by the Prince an advance was made towards this goal from another quarter. In March, 1641, the Hamburg dealer, Hans Friese, made a private contract with six of the cobalt mines in Schneeberg. This agreement was filed in the mining office, and it contained express provision that the contract should be cancelled immediately the Prince succeeded in making a new one. The substance of it was as follows: Friese was to take from the works in question for three years 300 cwt. of cobalt, and was to pay them in cash immediately on delivery at the rate of two thalers and six groschen; the works could receive a part of their payment from Friese in goods and should the works mine more cobalt, this excess was to be offered to Friese first, and if he did not wish to take it they could sell it in any way they liked. The cobalt should be pure and thoroughly cobbed out, without any hornstone, slate or pyrites. The first delivery was to be made at Easter, 1641, and then every six weeks following—smaller contracts were made by others with different mines. In the meantime the officials who had been commissioned by the Prince to make a contract had not been successful. This was due chiefly to the opposition of Hans Burkhardt, and therefore the mining office ordered that a temporary contract should be made, and for this temporary contract Hans Friese and Schnorr made a bid. Schnorr had, a short time before that, built a small color mill, and wished to work up the Schneeberg cobalt there, and he stated that he was willing to contract for a year on condition that during this time no blue color work should be built in Saxony. This contract was actually agreed on between these two and twenty-three of the works. In consequence of this further development of matters, Burkhardt gave up his former opposition and declared that he was willing to take part in the contract on condition that he should receive permision to erect a blue color works. The only opposition now was from Röhling, one of the contractors. He said that he had made a former contract with some of the Dutch, which he must adhere to, as the Dutch dealers had made him an advance, and if he cancelled the contract the money would have to be refunded. After his contract had elapsed he said he would be willing to join. The mining office, however, believed that it was not necessary to pay any attention to him, as his contract with the Dutch dealers was not recorded in the mining office, and was, therefore, not binding.

Local Customs Works, 1642

As a result of the conference, lasting several days, between the Prince and three of the contractors, namely, Friese, Schnorr and Burkhardt, an agreement was made which embraced all the Schneeberg works. It contained the following points: The agreement was between all the works which existed at Schneeberg and Neustadtlein and the contractors Hans Burkhardt, Hans Schnorr and Hans Friese, and made with each of the three individually and not jointly, for a period of six years. The three contractors above-mentioned were to take from all the works, including the Prince's and their own, yearly a quantity of 2,400 hundredweight, and they were to pay according to samples which were to be kept in the mining office. The payment was to be in good money and at the rate of 3 thalers 18 groschen per hundredweight for No. 1 grade, 2 thalers 18 gros. for No. 2, and 2 thalers for No. 3. Cobalt ore which was better than these three grades or not equal to it, should be paid by the contractors according to the decision of the mining office. Each of the contractors was to take 800 hundredweight. The mines, on their part, were required under penalty of a heavy fine, to refrain from dealing in cobalt or oxide with any one else during the period of this contract. If one of the contractors should die his heirs would be bound to carry on the contract until it expired. Friese had permission to export his cobalt, Burkhardt was allowed to build a color mill in Saxony, and Schnorr was to be also allowed to build one there and work up his cobalt. The agreement was finally confirmed by the Prince in 1642, and a decree was made against cobalt smuggling. In this decree every sale of cobalt in violation of the agreement, especially the sale into Bohemia, was to be punished by a fine of 500 florins, and if the fine could not be paid, corporal punishment would be substituted. The informant would receive one-half of the goods which were confiscated and the other half would be used for maintenance of the adit in Schneeberg. In accordance with the royal permission, Hans Burkhardt settled in Oberschlema, near Schneeberg, where he had picked out a site for his color mill. It is true there was some opposition from the town council of Schneeberg, which regarded this as an encroachment on their rights and jurisdiction, but on account of the concession granted by the Prince it was allowed to stand

This new contract soon met with difficulties which endangered its permanence. At the very outset the works and the contractors were in dispute about the assessing of the cobalt according to the assays that were made. The contractors complained that the mining office assessed the samples which were better than No. 1 too high, and that they had introduced intermediate payments. The Prince decided that these intermediate valuations should not be used, and threatened with severe punishment those who did not obey. The samples which were better than No. 1 should be graded as No. 1, and those which were better than No. 2 but not quite so good as No. 1, should be graded as No. 1. If the differences were much greater, then they were to be paid according to the next lowest grade, and all ore which was not up to No. 3 grade need not be paid for at all by the contractors. The works were advised that by care they would almost always reach that grade. The Prince also warned them that they must keep the contract or they would not find any one to buy their cobalt.

A more serious danger threatened the industry in the following year. This was due to the death of Hans Friese. According to the terms of the contract his heirs were bound to carry it on, and as a matter of fact his widow tried this, but on account of lack of capital she was unable to carry out her obligations, and finally one of the principal creditors, Oehme of Leipzig, took over Friese's contract. A few years later, in 1647, after the expiry of the contract, which was made in 1641, all the success that had been achieved hitherto was jeopardized. Burkhardt refused most positively to make a new contract, even although the Prince threatened him if he persisted in his refusal to cancel his right to have blue color works, but Schnorr and Oehme stated that without Burkhardt's assistance they were not in a position to buy all the cobalt from all the mines, and they would therefore make provisional contracts with individual works. The works on their side, were not satisfied with that, and requested again for permission to have open dealing, as they could not get any other contractors. The Prince against his will granted their request and allowed for a short time open dealing again, with the exception, however, that all trade with Bohemia was prohibited, because the Bohemian works, on account of the scarcity of their ore, were only able to exist with the help of the Saxon cobalt, which was of better quality. They then competed with Saxony in the color business. Not very long after this another individual named Schindler, purchased a site in order to build blue color works, and in conjunction with the mining office and with the Prince's permission, he stated his willingness to enter into a contract. Finally an agreement was made for six years in 1649, according to which the four owners of the four Saxon color works, namely, Burkhardt, Oehme, the widow of Schnorr and Schindler were associated. The amount of cobalt which they agreed to take yearly was the same as before, namely, 2,400 hundredweight. The price remained the same as before, with the exception that one higher grade was introduced which was called No. 1 and was paid at the rate of 4 thaler 6 groschen per cwt. In all other points this agreement was the same as the previous one. Each one of the contractors was to take 600 hundredweight yearly. Both the works and contractors were forbidden most strictly to deal either in ore or oxide with Bohemia, and all the pearl ash, that is potassium carbonate, which was produced in Saxony was to be delivered to the four works in equal portions. This contract was ratified by the Prince in 1649.

Contract of 1649

By this means a fixed and certain contract was brought into existence again. In the place of frequently changing foreign contractors, four subjects of Saxony acted, each of whom was in possession of a color mill, and therefore had an interest in the preservation and continuation of the contract. The only one who had previously been opposed to this was Hans Burkhardt because he was able without any contract to supply his works with his own cobalt ore. Thanks to the energetic efforts of the Prince and his officials Burkhardt finally yielded. It is true that some concessions were made to him in the new contract. It was therefore of great importance that in the year 1651 the Crown Prince, Johann George, came into possession of the Oberschelma works and Burkhardt's cobalt mines. Burkhardt had died without heirs or relations, and in his will he had left to the Prince his four mines and all his works. The only reason that he gave for this was that the mining and the color business might remain as it was. By this means the Prince had more direct interest in the mining and color industry than he had before.

At the same time a request came from some foreign company that they should receive permission for the erection of blue color works. The four contractors, of course, opposed this and requested that for a period of twelve years no new color works should be built in Saxony. They stated that the production would be overdone if further concessions were given, and the individual works would only ruin one another. They stated that there was an example of this in Bohemia, where after the erection of several mills, they had all been ruined except one, and moreover they stated that the pearl ash which was produced in Saxony was not sufficient for the four works which existed. They had to import two thirds of their pearl ash from Bohemia.

The mining office agreed with this request of the contractors for the reasons given above, and advised granting a concession for twelve years on the condition that the contractors after the expiry of this contract should be willing to make a new one. It was certainly, under these circumstances, a good thing for the other proprietors of color works that the Prince himself was interested in one of the four. After some hesitation and urging on the part of the mining office, the Prince agreed that no new rights to build any color works should be given in Saxony. On their part the contractors were bound not only to keep the present contract strictly, but after its expiry to make a new one under more reasonable conditions "in order that the work which had so well begun should come down to posterity and flourish in vigor."

We see that by this means the foundations were laid for an industry which has lasted to the present time, for after the twelve years had elapsed, although there were some attempts to build new works in Saxony the four works that existed at this time were rooted so firmly that every attempt to encroach on their privileges was bound to fail

CONCLUSION

The Period from 1653 to the Present Time

According to the agreement mentioned above there were four works, each of which was bound to take a certain quantity of ore yearly. One of these works was considered as a double one, and therefore the whole quantity was divided into fifths. The Oberschelma work was the double one. It will be noticed that one of the works belonged to the Prince and the other three were private. The three private works, which had been originally quite independent, in the course of time gradually came out of the control of single individuals into companies, which became more closely related to one another. As far back as 1659 the holders of the different works were agreed on the following points:

1. All the works bind themselves to a fixed price for color below which no color may be sold. The common color cost 5 thalers per cwt. and the best color 10 thalers at the works. At Leipzig it was half a thaler per cwt. higher, and increased with the distance from the works.

2. None of the works during the period of the contract was to make more than 24 cwt. of color weekly.

3. Each of the works had to brand its casks of color with a certain brand in order that they could distinguish their domestic color from the foreign or Bohemian.

Later on, in 1845, the three private works were amalgamated into one and concentrated at Niederpfannenstiel. The works belonging to the State at Oberschlema remained as it was. Both these combinations are in union and form the so-called blue color trust. This owns all the Schneeberg mines, as well as the mine and works at Modum in Norway. Between the two works the old arrangement with regard to the disposition of the cobalt and the sale of cobalt still exists, viz., two-fifths and three-fifths. In all matters concerning the cobalt business they act in concert and exchange experiences, and experiments are undertaken at the common expense.

Leaving Bruchmueller's work and turning to the annual official reports it appears that the two works employed last year 225 men, including office staff, and that the product amounted to about 674 tons in weight and about $836,000 in value. (Jahrbuch fuer Berg und Huettenwesen).

Present State of Mining in the District of Schneeberg, Saxony

The chief characteristics of the vein systems are given on preceding pages (157, etc.)

Taking the only mines which have any production at all worth mentioning, and looking at the reports of the last ten years or so, it is evident that the character of the vein filling has changed since the early days. Bismuth now occupies an important position, as, wherever the contents of ore are given the percentage of bismuth stands high. Quotations from the Annual Reports show this. (See Jahrbuch fuer Berg und Huettenwesen in Koenigreich Sachsen). Silver is quite insignificant in amount, less than two per cent. of the value being credited to this metal. Thus in the report of 1893 (later reports give the value of silver, cobalt, nickel and bismuth together) the amount assigned to silver, etc., reduced to our currency, is as follows:

Silver	$2,700 00
Cobalt, nickel and bismuth	157,335 00
Uranium	1,666 00
Quartz, specimens and tailings	1,080 00
Total	$162,781 00

In the report of 1905:

Silver, cobalt, nickel and bismuth	$148,581 00
Quartz, specimens, etc.	1,855 00
Total	$150,436 00

The value per ton was about $570.

The result of all the development work being carried on now, consisting of drilling, drifts, crosscuts, rises, and sinking,—in short, trying in every way to open up veins known to be productive formerly or discover new ones,—is that here and there a rather small body of good pay ore will be found. Evidently the early productive period is long past. Occasionally they encounter difficulties due to striking old excavations, with accumulations of water or to the caving in of old works. Most of the work appears to be carried on at a depth of less than 1,000 feet.

Below are given translations of extracts from the Annual Reports, extending back about ten years. The reports are all on one mine, or rather, group of mines which was referred to above as being the only one of any importance. It is called Vereinigt Kobalt feld. About half a dozen veins are mentioned throughout the reports. Some of these were exploited in the early period of mining in that district.

In the report of 1893:

"On the Junge Zeche Spat, (one of the most productive veins in recent times) in a drift of about 280 feet in length for a distance of 83 feet, solid bismuth ore sometimes ten inches wide with 30 to 50 per cent. bismuth was found, also concentrating ore along a distance of 183 feet. The minerals were bismite, native bismuth, smaltite, chloanthite, native silver, ruby silver, argentite, galena in vugs with mimetite (arsenical lead chloride), eulytite (silica of bismuth), cobalt bloom, chalcopyrite, chalcocite, and cinnabar."

"The most important strike in the whole district was made on a vein which was 16 to 24 inches wide and carried very rich bismuth cobbing ore for 52 feet in length and then concentrating ore for 296 feet."

"A body of ore 45 feet long with a considerable amount of roselite (lime cobalt arsenate) was found."

In report of 1900:

"Exploration of the most important vein, Junge Zeche, was undertaken. The productive portion of the vein ended at a depth of about 330 feet from the surface. (This was the case with most of the veins)."

Report of 1901:

"In a crosscut 770 feet from the shaft a strike of rich bismuth ore, sometimes with disseminated ruby silver, also cobalt bismuth ore associated with pitchblende (uranium ore) and niccolite was made."

"A strike was made in the granite[9] over 230 feet from the slate contact, of rather a large bunch of bismite, with native bismuth. Near the contact the bismuth ore was richer and was ten inches wide."

"Another discovery was made in a drusy quartz vein over three feet wide where solid cobalt nickel ore was found on the hanging, and bismuth on the footwall."

Report of 1902:

"Junctions of veins proved especially rich in native bismuth. Along with bunches of bismuth ores were associated cobalt-nickel ores and uranium."

Report of 1903:

"From an area of vein surface of about 270 square yards about fifteen tons containing 19 per cent. bismuth, 4.3 per cent. cobalt and 2 per cent. nickel was taken," (the width of the vein not given in this case). "Another ore body containing 20.6 per cent. bismuth and 3.6 per cent. cobalt was found. The contact again proved favorable."

"In a vein 44 inches wide bunches of bismuth ore occurred."

Other strikes mentioned contained 7.3 per cent. bismuth, 5.6 per cent. cobalt; another 33.9 per cent. bismuth, 2.6 per cent. cobalt, and 1.3 per cent. nickel.

1904 report:

"Strike was made 24.2 per cent. bismuth, and 4.1 per cent. cobalt."

"A stringer was found containing pucherite (vanadanate of bismuth) showing throughout all the ore."

Report of 1905:

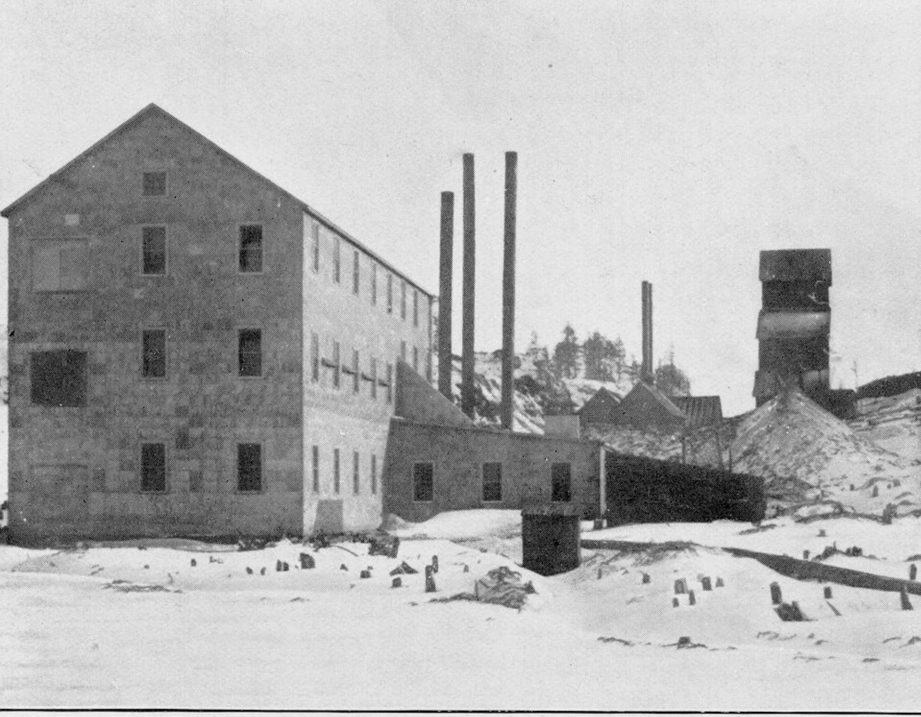
"Strike of ore was made 25 feet long (width not given) with 21.4 per cent. bismuth and 2 per cent. cobalt. Another strike of bismuth ore of shipping quality 28 feet in length and about 35 feet of concentrating ore. The vein was about 20 inches wide, consisting of quartz, hornstone with bands of bismuth ore and contained 28.6 per cent. bismuth as taken out."

These rare minerals and their associations are mentioned in order that those interested in the Temiskaming district may look up the descriptions of the various minerals and be on the watch for them.

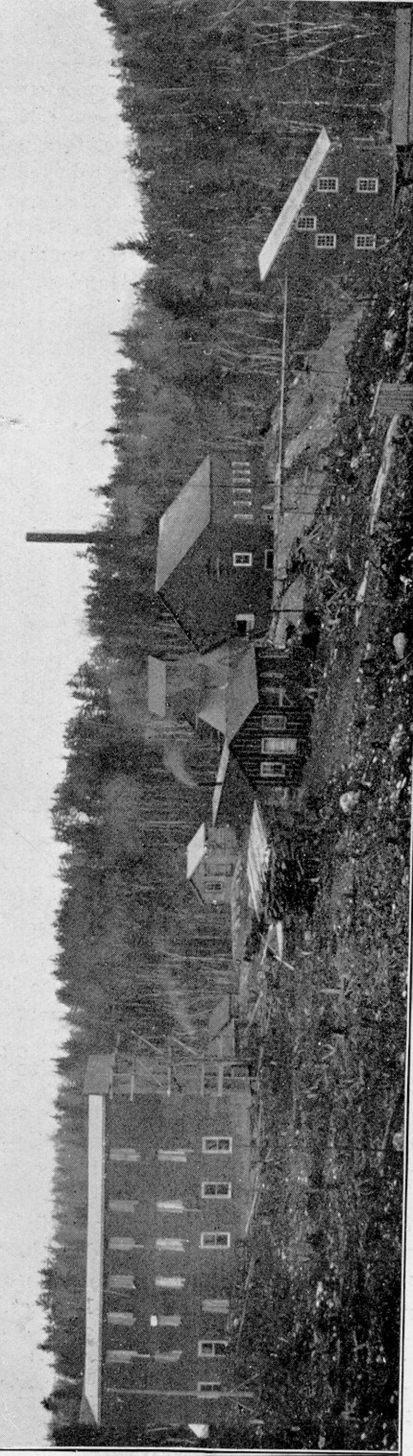
It is remarkable that of all the metal mines, some hundreds in number, which once produced ore in Saxony, and which played such an important part industrially, and also technically, in the development of the art of mining, concentration and smelting, the cobalt-bismuth-silver mines of to-day are the only ones which are not operated at a loss.

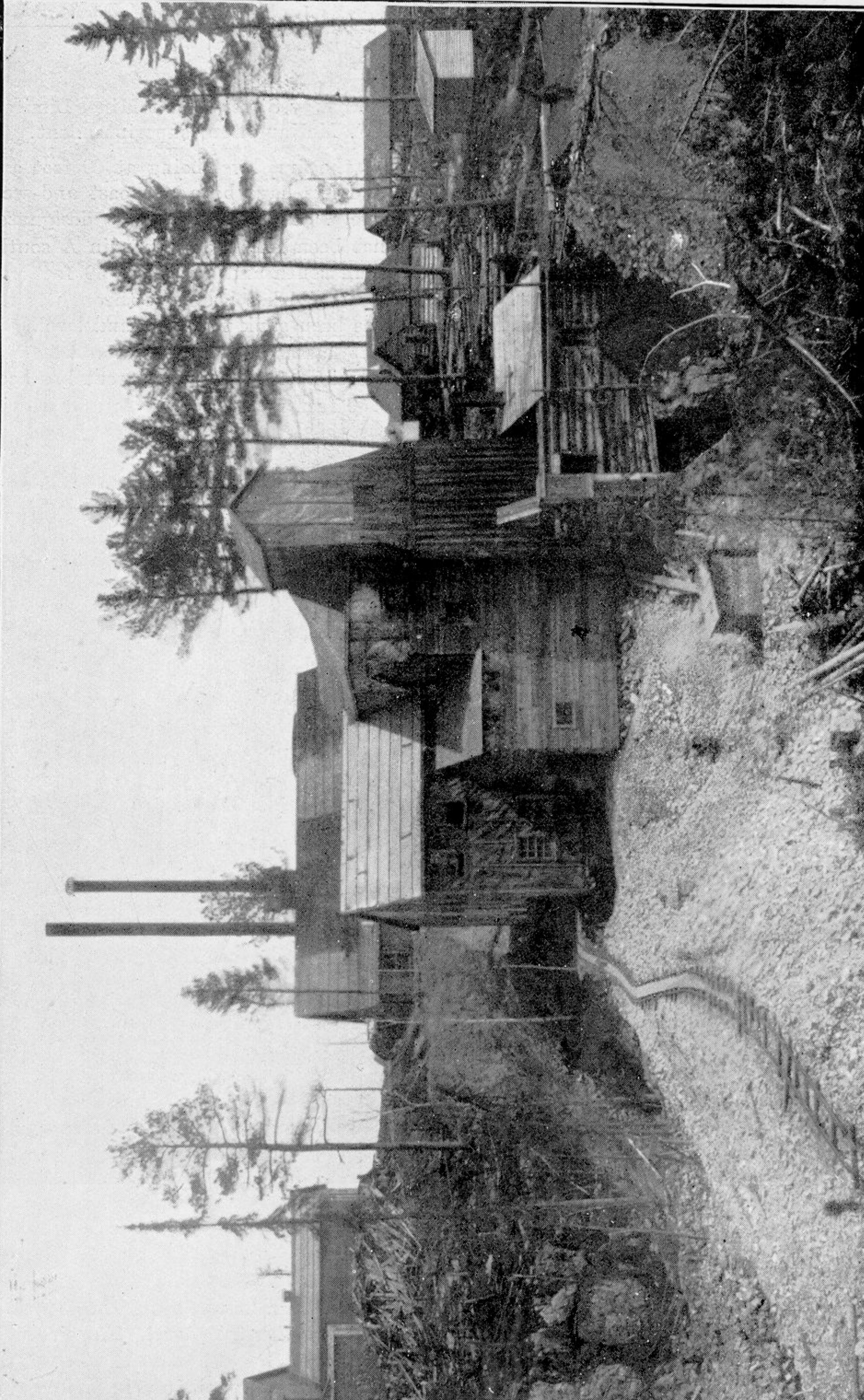
[9] The granite is younger than the schists in which the veins are found, and underlies them.

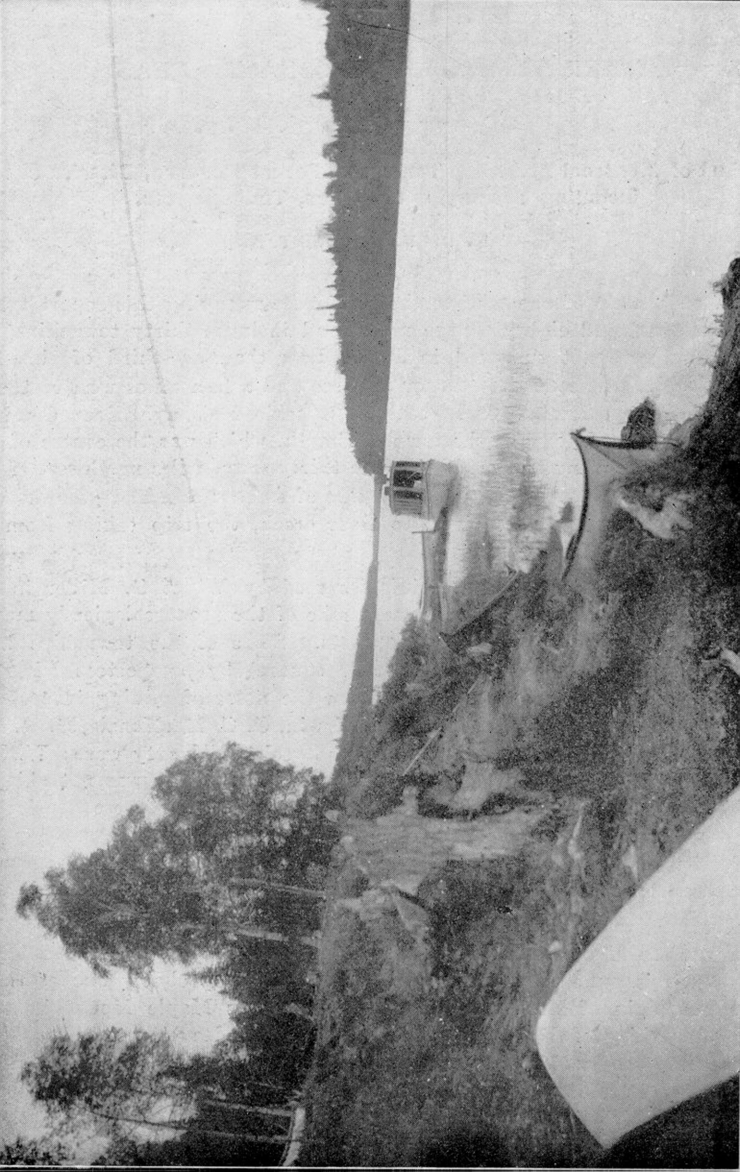
INDEX

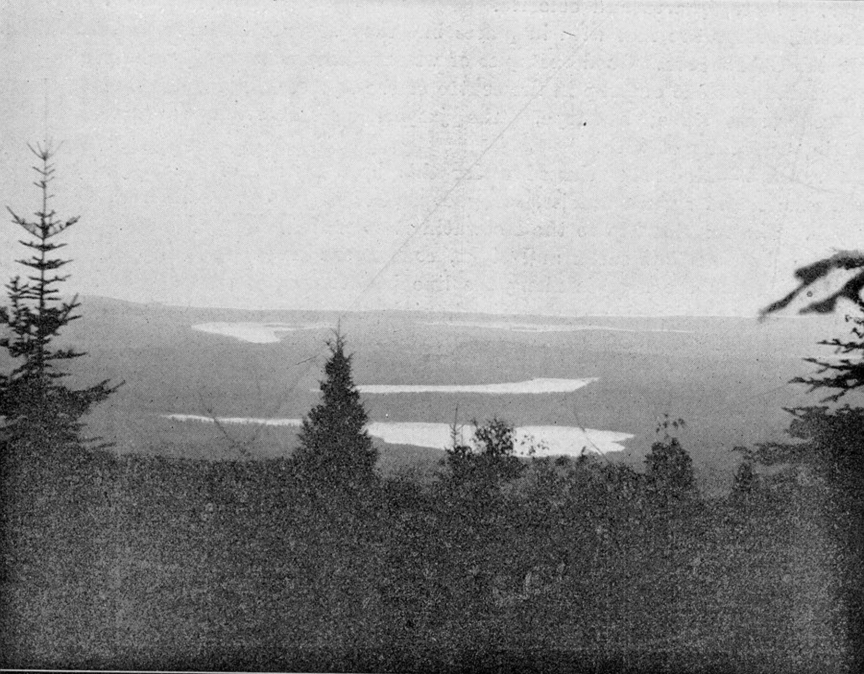


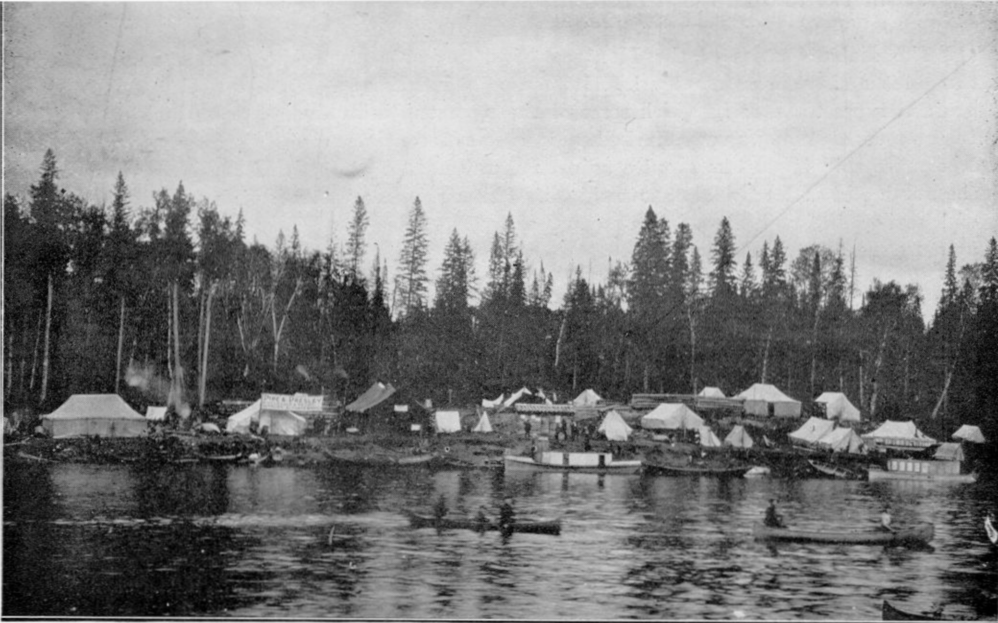

SILVER
COBALT
SILVER

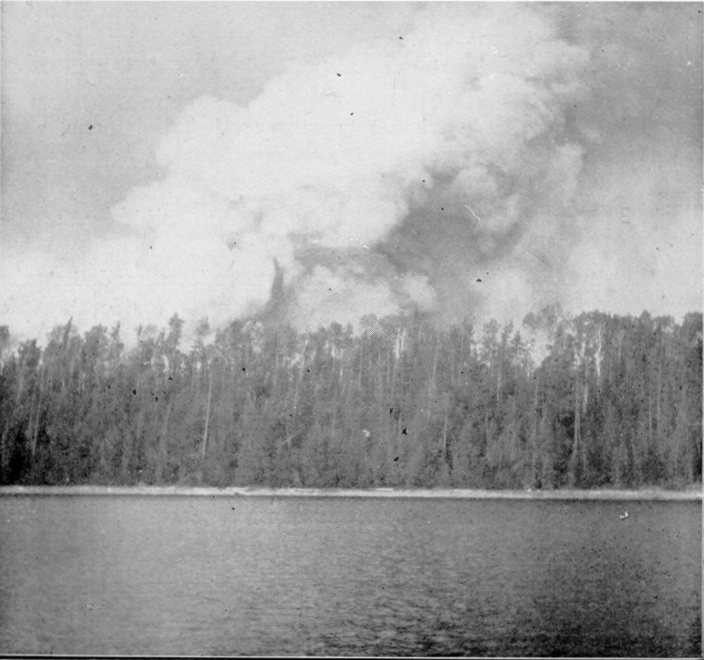


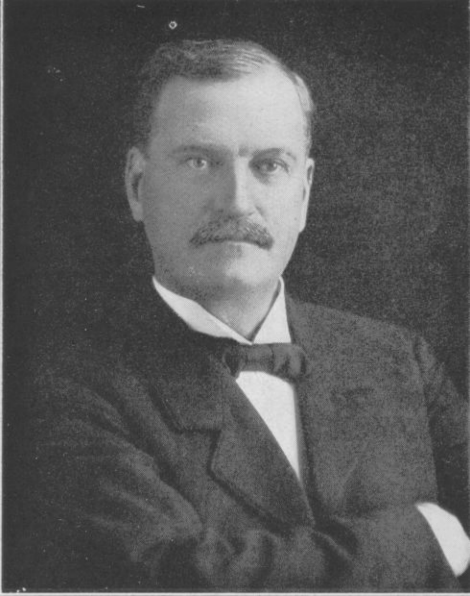


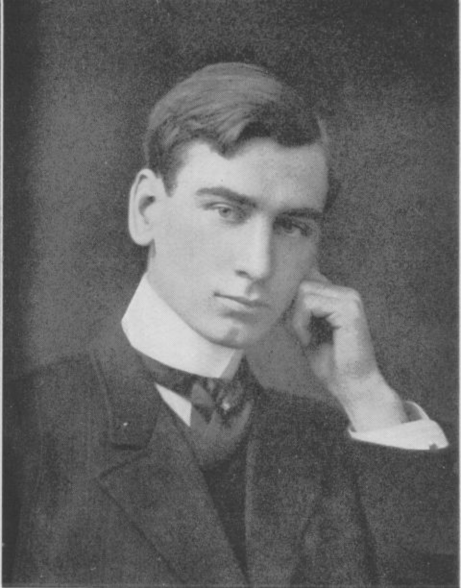


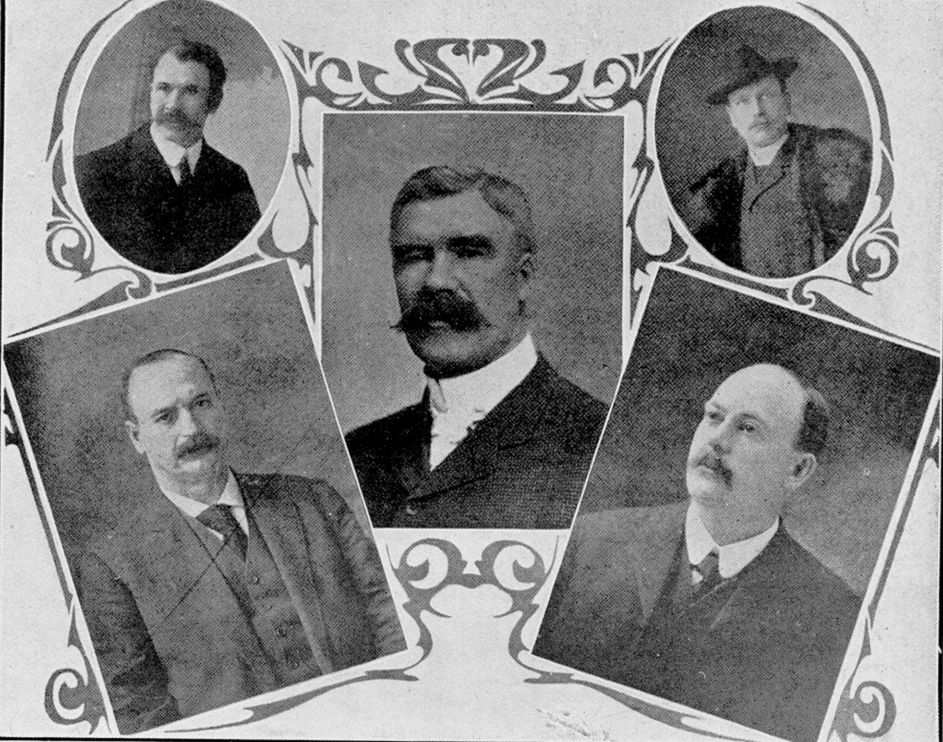


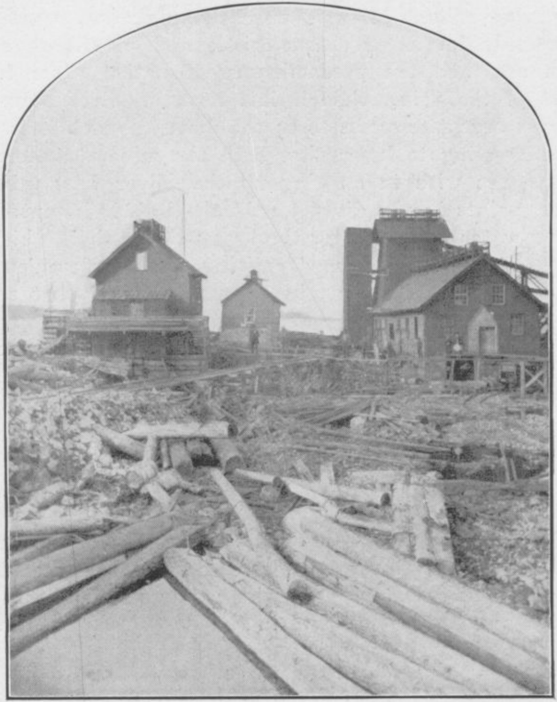


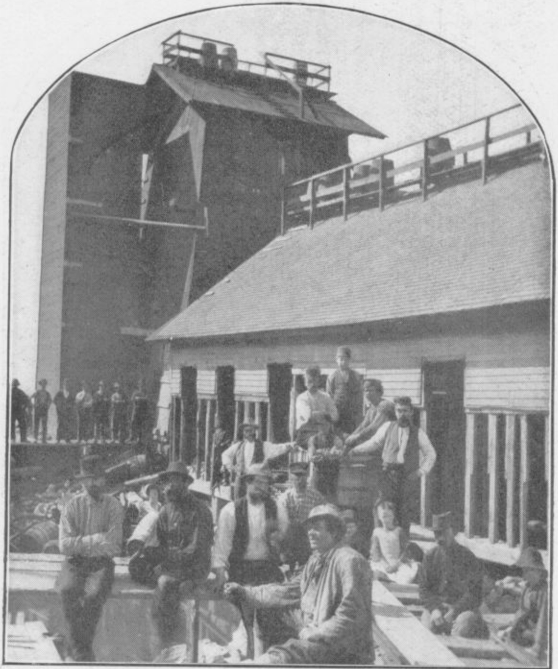




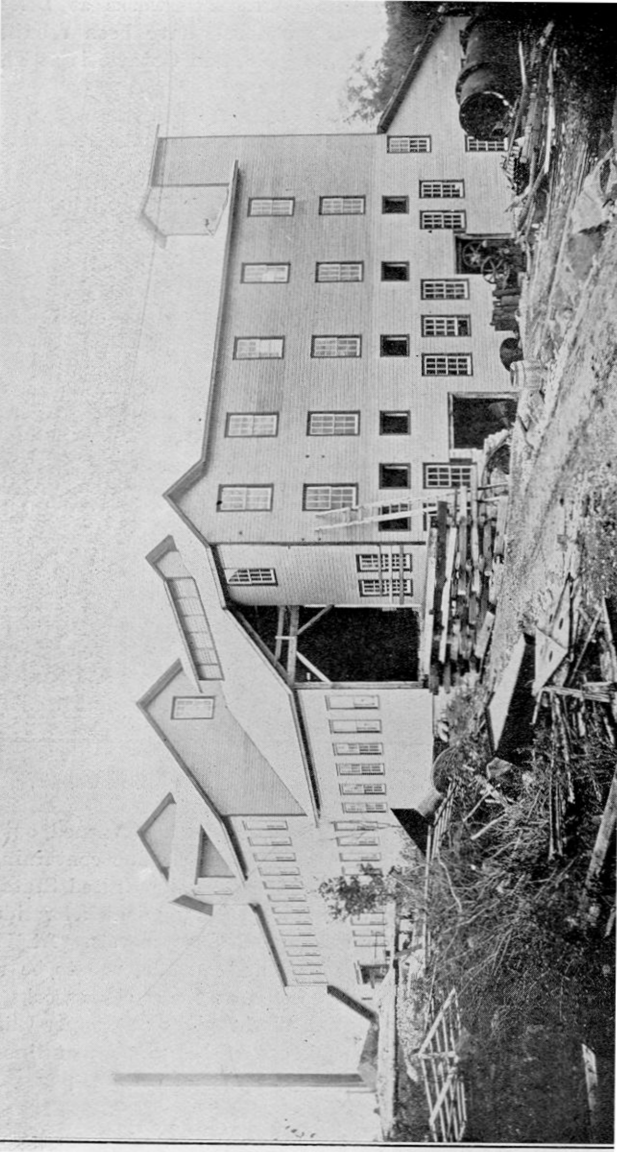


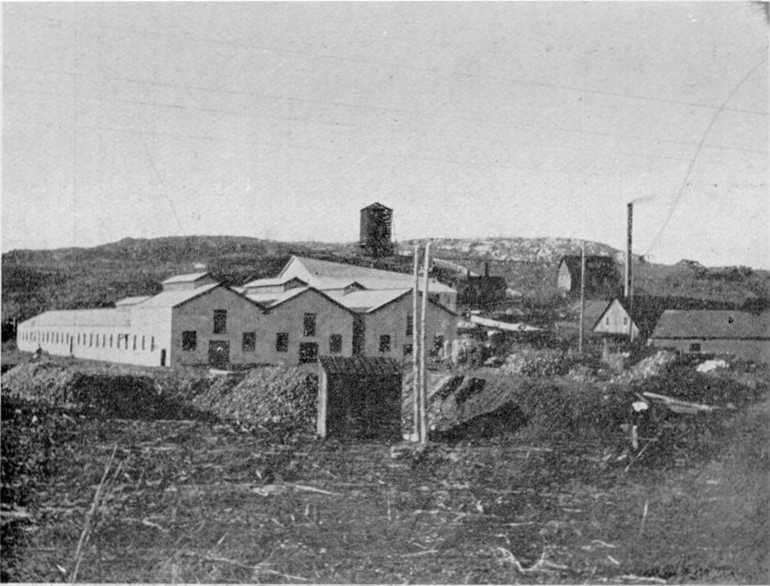


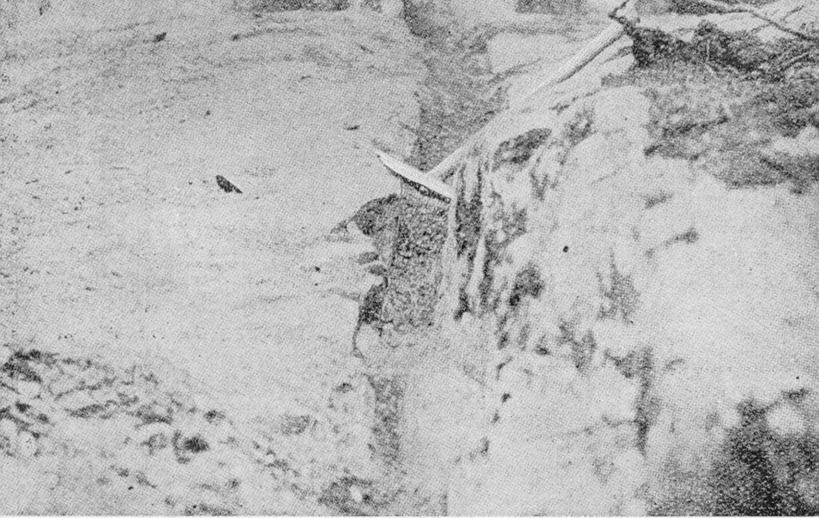


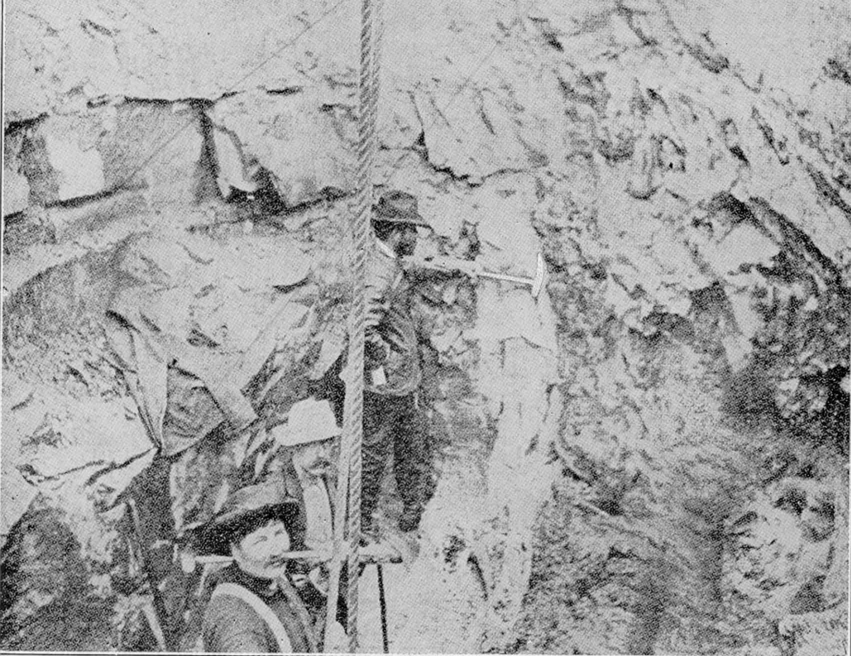


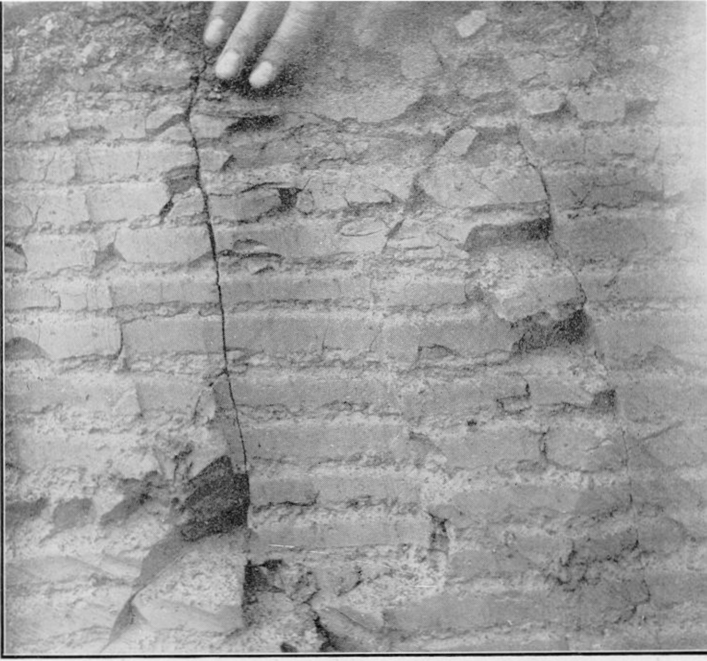

The Coniagas Reduction Co.
Thorold
Ont
May 1908

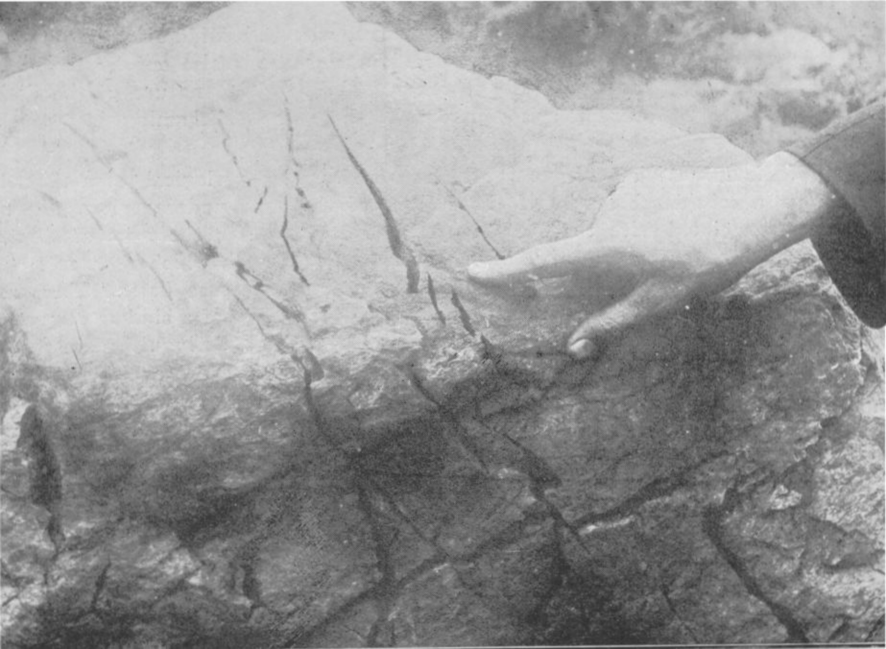


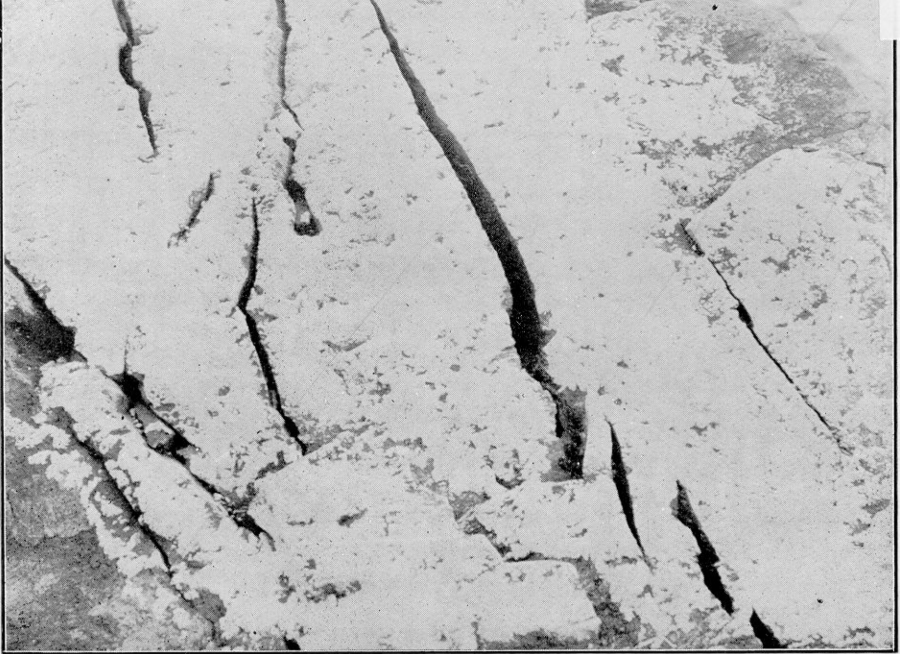


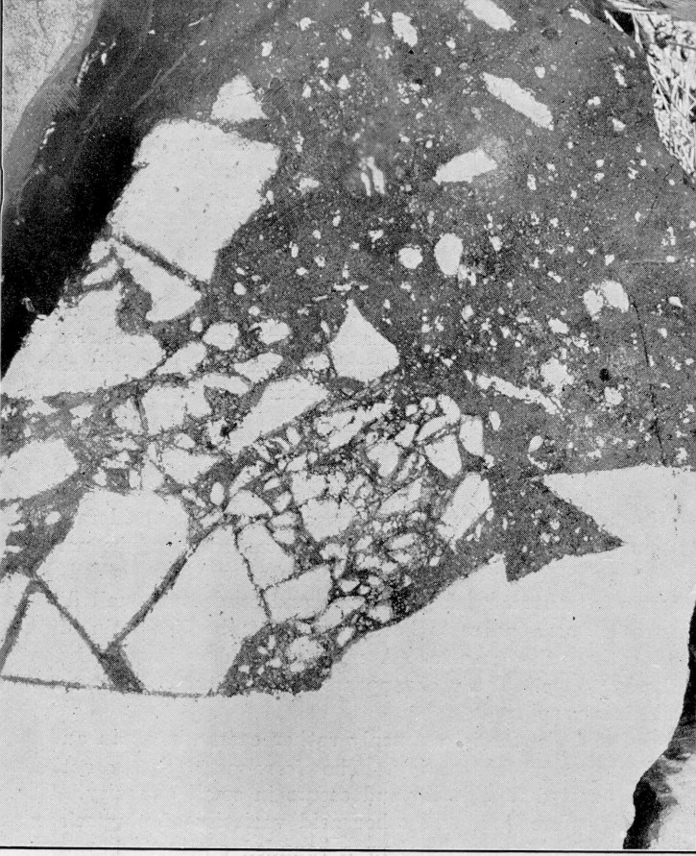


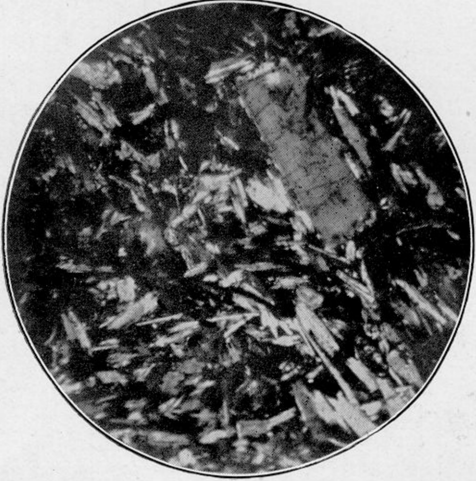


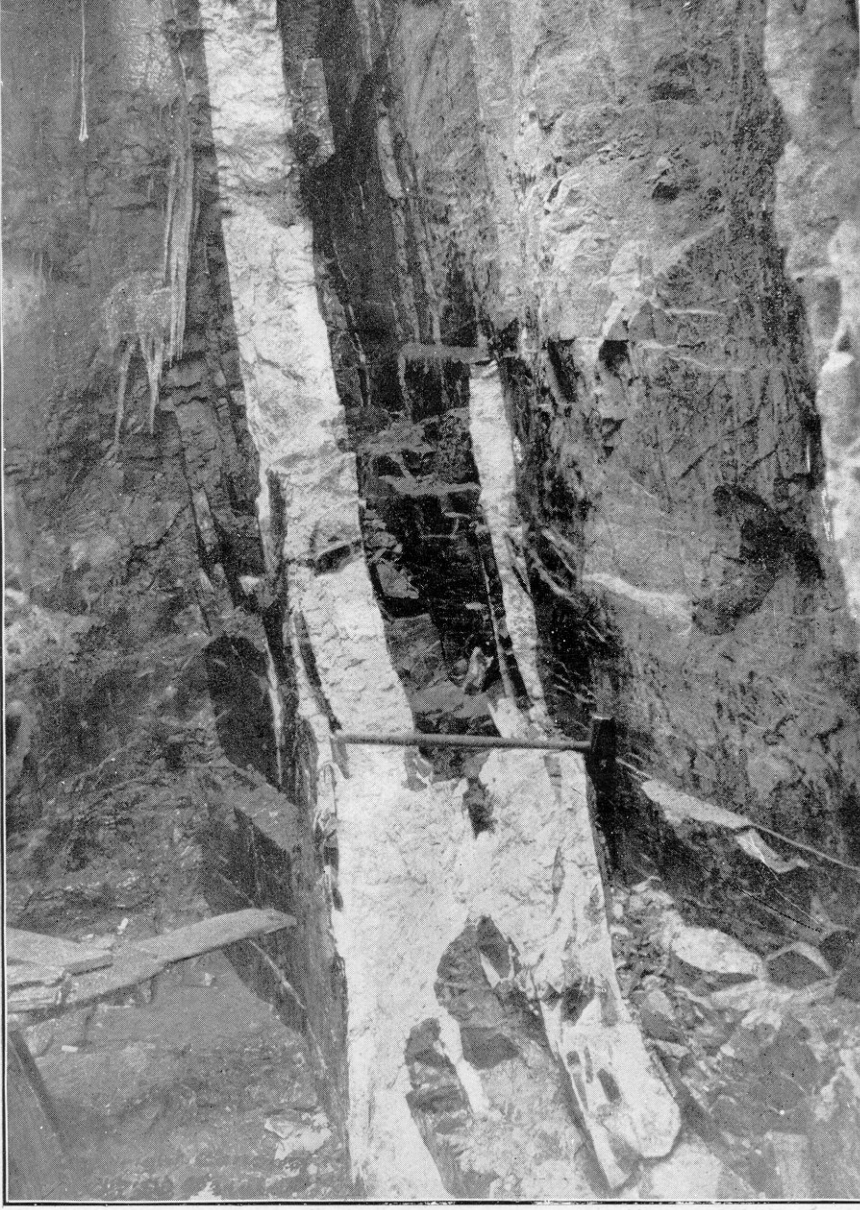


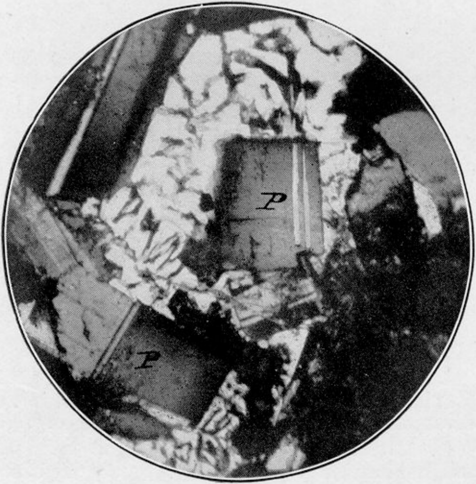




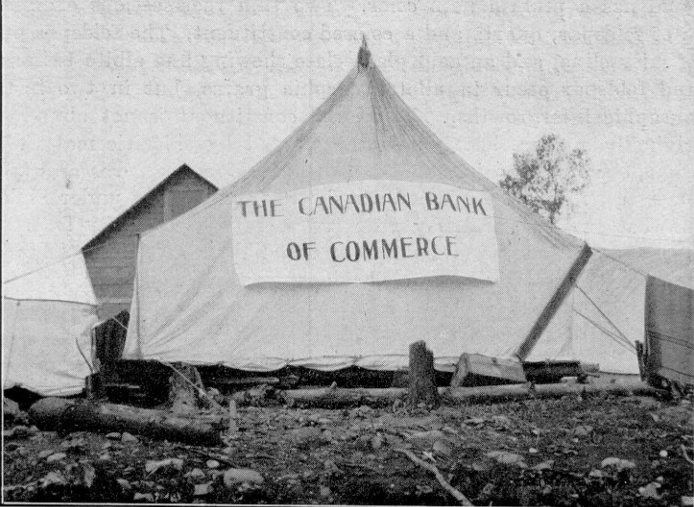


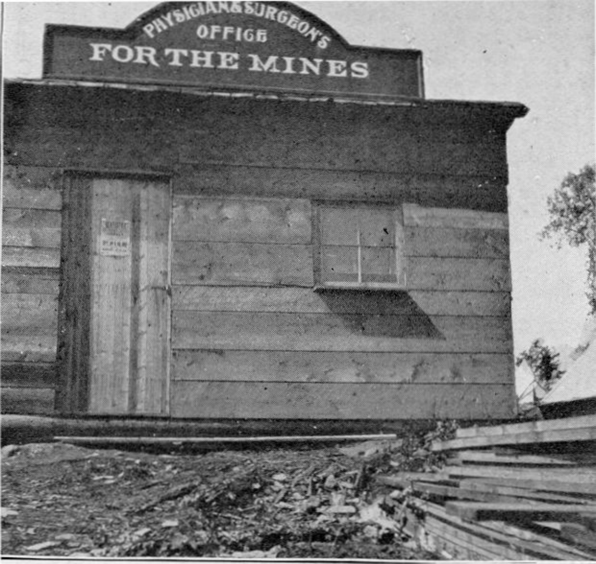


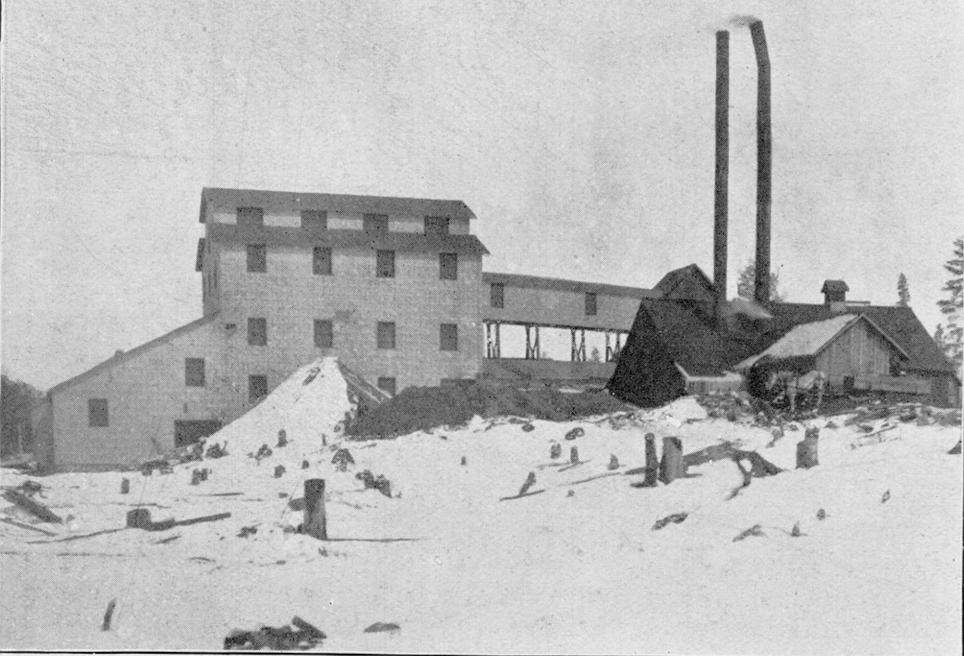


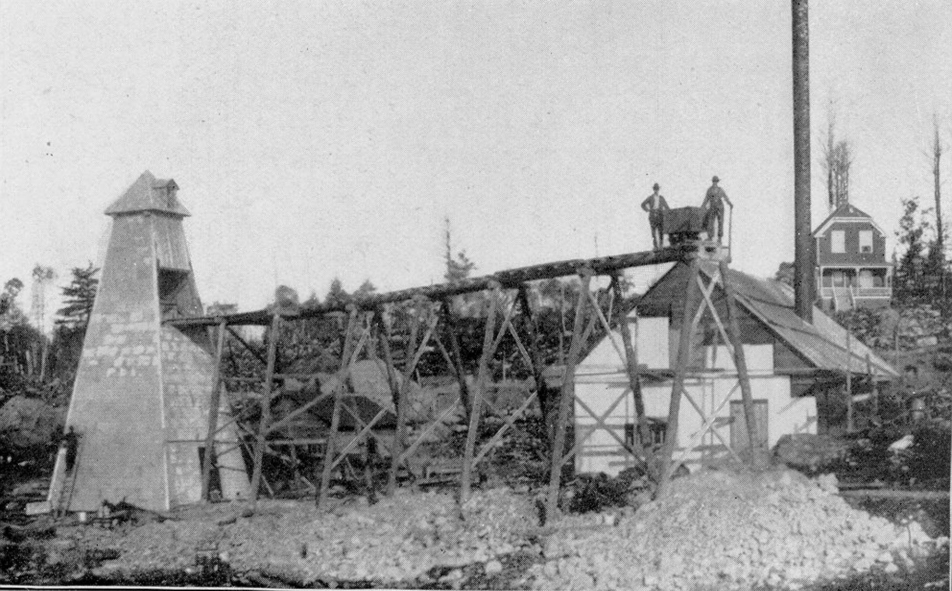

P
P

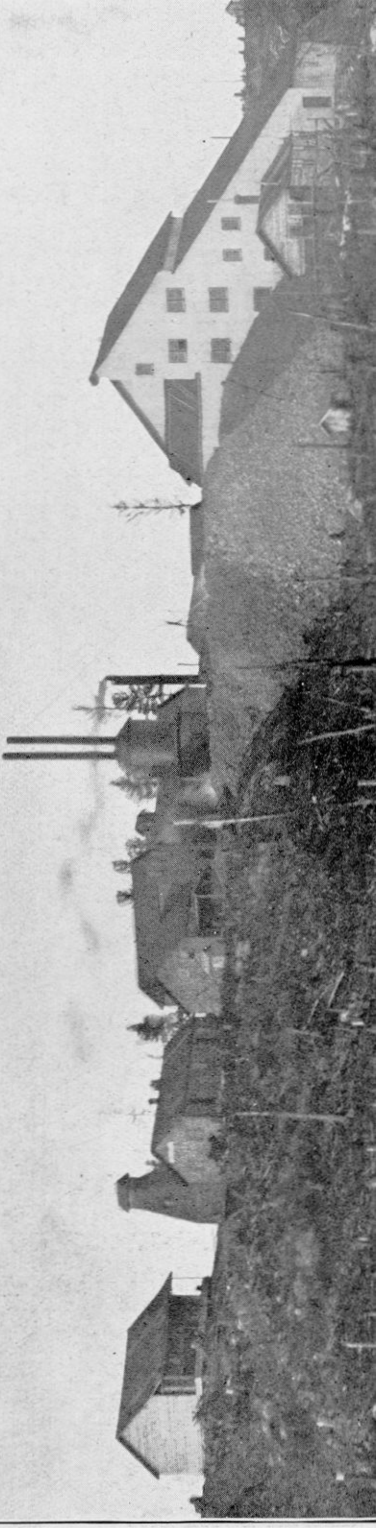

Q
P
P
Q
Q


THE CANADIAN BANK
OF COMMERCE


PHYSICIAN & SURGEON'S
OFFICE
FOR THE MINES








GENERAL VIEW OF CONIAGAS MINE
PAINT SHOP