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REPORT ON MINING OPERATIONS IN THE PROVINCE OF QUEBEC DURING THE YEAR 1912

Province of Quebec, Canada

DEPARTMENT OF COLONIZATION, MINES AND FISHERIES

MINES BRANCH

HONOURABLE C. R. DEVLIN, MINISTER; S. DUFAULT, DEPUTY-MINISTER;
THEO. C. DENIS, SUPERINTENDENT OF MINES.

REPORT

ON

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IN THE

PROVINCE OF QUEBEC

DURING THE YEAR 1912

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PROVINCE OF QUEBEC

DEPARTMENT OF COLONIZATION, MINES AND FISHERIES

MINES BRANCH

MR. S. DUFAULT,

Deputy-Minister of Colonization, Mines and Fisheries,

QUEBEC, P.Q.

DEAR SIR,—

I have the honour to transmit herewith the Annual Report on the Mineral Industry of the Province of Quebec during the year ending December 31st, 1912.

In February, a Preliminary Statement on the same subject was published. This was mainly statistical and the figures were given subject to revision. The final compilation is now given, as well as the reports of the field work done during the summer of 1912.

Yours very obediently,

THEO. C. DENIS,

Superintendent of Mines.

Quebec, May 26th, 1913.

NOTE

In the Statistical tables and in the review of the mining industry of the province during the year, the term "production" is synonimous to "Quantity sold, or shipped," and does not necessarily represent "output." The ore, and other mineral products remaining as "Stock on hand" at the end of the year, are not included in the production figures.

The ton used throughout is that of 2,000 lbs.

The year referred to is the calendar year, ending December 31st unless specially stated.

We endeavour to give values of the mineral products, raw or manufactured, as estimated at the point of shipment or at the pit mouth. This, however, is sometimes difficult to obtain.

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DEPARTMENT OF COLONIZATION, MINES AND FISHERIES

To the Honourable C. R. DEVLIN, M.L.A.,

Minister of Colonization, Mines and Fisheries,

QUEBEC, P.Q.

SIR,—

I beg to submit to you the Report of the Superintendent of Mines on the Mineral Statistics and Mining Operations in the Province of Quebec for the year ending December 31st, 1913.

I remain,

Your obedient servant,

S. DUFAULT,

Deputy-Minister.

Quebec, May 26th, 1913.

MINING OPERATIONS

IN

THE PROVINCE OF QUEBEC

DURING THE YEAR 1912

The total mineral production of the Province of Quebec during the year 1912 reached a total value of $11,187,110. Those figures represent the revised compilation of the returns received direct by the Quebec Mines Branch from the producers.

In the previous year the value of the products of our mines and quarries was $8,679,786. We therefore record an increase of $2,507,324 for 1912, or a proportional increase of 28.9%.

The collecting of our mineral statistics is done as carefully as possible, and we have now a list of producers of nearly one thousand names. These comprise mines, quarries and brick-yards. But it must be understood that, in spite of all the care exercised, the figures which are given in the table are not complete, more especially as regards structural materials. It is almost impossible to keep track of all the small brick-yards, quarries opened for local purposes, lime kilns which operate desultorily, etc., and no allowance is made in the figures of production for such gaps. The table gives strictly the compilation of the figures received by the Quebec Mines Branch direct from the producers.

Table of Mineral Production of the Province of Quebec During 1912

Substances	Number of Workmen	Salaries	Quantities	Value	Value in 1911
Asbestos, tons....	2,910	$1,377,444	111,175	$3,059,084	3,026,306
Asbestic, tons.....	....	....	25,471	23,358	19,802
Copper & Sulphur Ore, tons......	205	112,215	62,107	631,963	240,097
Gold, oz..........	30	14,989	980	19,924	11,800
Silver, oz.........	....	....	26,526	14,591	11,500
Bog Iron Ore, tons.	....	....	....	....	4,041
Ochre, tons.......	53	13,374	7,054	32,010	28,174
Chromite, tons....	....	....	....	....	2,469
Mica, lbs........	109	51,820	499,981	99,463	76,428
Phosphate, tons...	5	2,000	164	1,640	5,832
Graphite, lbs......	156	45,209	1,210,278	50,680	33,613
Mineral Water, gals	17	3,345	99,452	39,854	65,648
Titaniferous Ores, tons...........	16	3,720	1,127	4,024	5,684
Slate, squares.....	25	....	1,894	8,939	8,248
Cement, bbls.....	1,063	926,064	2,684,002	3,098,350	1,931,183
Magnesite, tons...	5	800	1,714	9,645	6,416
Marble...........	282	141,832	....	252,041	143,457
Flagstone........	4	550		600	500
Granite..........	637	268,762	....	358,749	308,545
Lime, bush'l.......	294	130,759	1,705,937	455,570	284,334
Limestone........	1,547	768,562	....	1,363,555	1,128,402
Bricks, M........	1,443	483,509	154,546	1,284,232	1,129,480
Tiles, Drain & Sewer pipe, Pottery, etc	154	67,750	....	203,100	142,223
Quartz...........	....	....	....	....	1,125
Kaolin...........	67	15,256	40	520	....
Feldspar.........	5	2,000	110	2,200	600
Peat............	10	....	500	2,000	700
Sand............	99	20,222	....	170,600	62,000
Glass Sand.......	....	....	....	....	1,179
Phonolith, tons...	4	228	170	418	....
Totals.......	9,140	4,450,410		$11,187,110	$8,679,786

On glancing at the table of production it is noticeable for what a small proportion the metallic minerals enter into the total figures of the mineral production of the Province of Quebec. In 1910 they only represented 2.16%, in 1911 this pro portion increased to 3.17 whereas in 1912 it reached 6.09. This is insignificant when compared with Ontario, where in 1912 the metallic minerals made up 74% of the total mineral production of the province. As it was pointed out in our preceding report, practically the total mineral production of the Province of Quebec is from the old settled portions of the province, but as the same geological conditions prevail in the northern part of Quebec as in northern Ontario, it is quite justifiable to foresee developments of the mineral industry in the northern parts of our province in a near future, owing in part to the active movement of railway construction which will open up vast areas. By the National Transcontinental direct communication will soon be established between Quebec and the Abitibi region, and it is expected that within two years the North Railway will be open for traffic between James bay and the Transcontinental, following the valleys of the Nottaway and Bell rivers. It is true that the conditions in that part of the province are rather trying for the prospector. For, although the underlying rocks belong to Archean formations, which in other parts of Canada have proved mineral bearing, still it is a fact that all the region lying north of the height of land was at the close of the glacial period, submerged under an immense sheet of water in the bottom of which was deposited a heavy burden of clays, silts, and sands, which now cover the rocky floor of the ancient lake. However the strong current of colonization which is now being directed towards these regions, which are eminently fitted for agriculture, will doubtlessly bring about mineral discoveries which will help to increase the proportion of metallic minerals produced in the Province of Quebec.

The following table gives the annual value of the mineral production of the Province of Quebec for the last ten years :—

Year.	Value.
1903	$ 2,772,762
1904	3,023,568

1905	3,750,300
1906	5,019,932
1907	5,391,368
1908	5,458,998
1909	5,552,062
1910	7,323,281
1911	8,679,786
1912	11,187,110

NEW QUEBEC TERRITORY.

On May 10th, 1912, an order-in-council was passed by the Governor-General whereby the territory of Ungava was formally added to the Province of Quebec from the 15th of May of that year. This was the last of several measures, both federal and provincial, concerning the annexation of this large northern territory to the Province of Quebec.

During the first session of the 13th Legislature of the Province of Quebec a bill was passed changing the name of Ungava to that of New Quebec Territory. This bill further provided that:

3.—"All grants of lands, or other rights whatsoever in New Quebec, before the 15th day of May, 1912, the date of the coming into force of the proclamation of the Governor-General in Council,—except those relating to the Hudson's Bay Company, or to the rights of the Indian inhabitants, if such rights exist, the whole as mentioned in the Act of Parliament of Canada, 2 George V, Chapter 45,—shall be notified to the Provincial Secretary, within twenty-four months of the coming into force of this act, under pain of absolute nullity.

"Such notice may be given by registered letter, and shall be accompanied by a copy of the title, if any, evidencing the grant."

Therefore if any persons, company or syndicate hold lands, timber rights, mining rights, water power rights or any other rights (apart from those relating to the Hudson Bay Company) in virtue of grants made prior to May 15th, 1912, it devolves on the grantees to record such rights within two years from December 21st, 1912, date on which the law was assented to.

The territory thus annexed to the Province of Quebec does not include the islands, which are specifically reserved by the Federal Government, nor does it comprise the narrow strip of North-east coast, which under the name of Labrador, falls under the jurisdiction of Newfoundland.

The area of the Province of Quebec is thereby doubled. From 351,873 square miles previous to May 15th, 1912, it has increased to 703,653 square miles.

The new territory lies mainly north of latitude 53° and owing to its northern situation cannot be counted upon for agriculture and colonization purposes. Apart from the timber resources of the valley of the Hamilton river, the value of New Quebec lies mainly in its mineral and fisheries possibilities. From these standpoints it is practically "terra incognita." .The explorations of A. P. Low in the interior and on east coast of Hudson Bay, and the observations of Dr. Robert Bell on the shores of Hudson Strait were made on such broad lines that they can only be called geological reconnaissance work. They give a mere inkling of the probability of the existence of areas, and patches of mineral-bearing formations, and the time has now arrived to do more detailed geological work which will guide the prospectors more definitely and which will delineate the areas which are most likely to give him returns for his expenditure of energy in the field, and his outlay of money.

To accomplish such work to the best advantage will require a systematic plan of campaign extending over several years. It also requires a trained staff which cannot be improvised. In this connection it might be opportune to mention that the Geological Survey of the Federal Department of Mines is the best equipped organization to undertake such work, and it might not be out of place to here draw the attention of that well known and distinguished body to the benefits which they would bestow on the mining public by choosing the territory of New Quebec as one of their fields of action. The study of the mineral possibilities and the development of the mineral wealth of Canada are of national scope, for the discovery of new mining fields is a source of national wealth. The Geological Survey could therefore very justifiably continue in Northern Quebec the widening of the trail so well blazed by Low.

FIELD WORK.

Two field parties were sent out by the Quebec Mines Branch during the summer of 1912. These were under the same field officers as the parties sent out the previous year .

Dr. J. A. Bancroft, professor of geology at McGill University, continued the study of the geology and mineral resources of the region of Montigny (Kienawisik) and Kewagama lakes. After spending one month on this work Dr. Bancroft made an exploration of parts of the basins of the Harricanaw, Bell and Nottaway rivers. This work was deemed necessary in order to obtain some knowledge of the natural resources of, this region which will soon be traversed by a railway. It is said that the Quebec North Railway will without delay begin the railroad from the Transcontinental Railway to the mouth of the Nottaway on James Bay. A short report on this exploration was printed separately in October, 1912, and distributed. For the present report Dr. Bancroft has written a more detailed account of this work.

Mr. Dulieux, professor at Ecole Polytechnique, continued the investigation of the iron resources of the province. His preliminary report of the summer's work is given further on. Mr. Dulieux will prepare a separate report in which will be given a more detailed account of his two summer's work.

The Assistant Inspector of Mines, Mr. J. H. Valiquette, was detached from the Mines Branch from the first of April, 1912, until October, to take full charge of road construction work in the Abitibi region for the Colonization Branch. The Superintendent was therefore the only technician on the staff during the greater part of the year.

CHEMICAL LABORATORY.

The Provincial Chemical Laboratory, which is now operated in connection with the Mining Department of Polytechnic School, at Laval University, gives entire satisfaction.

The public can send to the laboratory samples of ores and minerals from the Province of Quebec, and they will be analysed or determined with the greatest care at prices very low for this class of work. The trained chemists and the well equipped laboratory ensure accurate and reliable results. The tariff of fees for analyses is given at the end of the report.

During the year ending in June, 1912, which is the end of the fiscal year of the Quebec Government, the following number of analyses were performed in the Provincial Government Laboratory :—Gold and silver, 330; copper, 43; nickel, 8; iron, 82; sulphur, 28; arsenic, 2; silica, 48; alumina, 24; lime, 17; magnesia, 17; titanium, 50; phosphorus, 14; molybdenum, 2; platinum, 8; lead, 4; zinc, 1; graphite, 6; magnetic concentration, 1; moisture, 6; combustions, 9; qualitative determinations, 34; identification of minerals, 50.

MINING OPERATIONS

ASBESTOS

Asbestos in 1912 heads the list of mineral products of the province. After passing through a rather critical period the asbestos industry is now regaining its balance, and the outlook for the future is bright. The following table gives details of the production of asbestos in the Province of Quebec during the year 1912.

PRODUCTION OF ASBESTOS FOR THE YEAR 1912

Qualities	Number of Men Employed	Wages paid	SHIPMENTS			STOCK ON HAND	
			Tons	Value	Average value per ton	Tons	Value
Crude No. 1			1,941	510,785	263.16	867	221,215
Crude No. 2			3,766	379,445	100.76	2,867	310,596
Mill Stock No. 1			3,682	237,203	64.42	2,370	137,106
Mill Stock No. 2			32,689	1,018,960	31.17	8,234	301,774
Mill Stock No. 3			69,097	912,691	13.21	6,838	131,515
Totals	2,910	1,377,444	111,175	$3,059,084	27.52	24,176	1,102,206

Quantity of rock mined, 1,870,608 tons.

For the two previous years, 1911 and 1910, the figures are given in the two tables given under.

PRODUCTION OF ASBESTOS FOR YEAR 1911.

	SHIPMENTS			STOCK ON HAND	
	Tons	Value	Average value per ton	Tons	Value
Crude No. 1.......	1,400	$ 388,224	$277.30	1,358	$ 360,304
Crude No. 2.......	3,382	382,980	113.68	3,368	431,548
Mill Stock No. 1...	6,340	415,559	65.54	3,794	207,403
Mill Stock No. 2...	35,991	1,091,684	30.33	12,272	379,523
Mill Stock No. 3...	55,111	747,759	13.57	12,959	204,298
Totals......	102,224	$3,026,306	29.60	33,751	$1,583,076

Quantity of rock mined during year 1911, tons 1,759,064.

PRODUCTION OF ASBESTOS FOR 1910.

	SHIPMENTS			STOCK ON HAND on Dec. 31st. 1910.	
	Tons	Value	Value per ton	Tons	Value
Crude No. 1.......	1,817	$ 471,649	$259.57	1,763	$ 447,227
Crude No. 2.......	1,612	196,382	121.82	3,181	440,884
Mill Stock No. 1...	10,313	627,635	60.88	4,938	313,053
Mill Stock No. 2...	44,793	1,141,374	25.48	24,417	612,065
Mill Stock Mo. 3...	22,070	230,789	10.46	6,920	99,694
Totals......	80,605	$2,667,829	$33.10	41,159	$1,921,923

Quantity of rock mined during year 1910, tons 2,035,705

The classification adopted by the Quebec Mines Branch is an arbitrary one. Each mine has its own grading, and there is no uniformity between the products of the different mines. In the tables above given the values of the various grades have been grouped as follows:

Crude No. 1—Hand-cobbed asbestos valued at $200 a ton and over.

Crude No. 2—Hand-cobbed asbestos valued at less than $200 a ton.

Mill Stock No. 1—Products of mechanical separation valued at $45 and over.

Mill Stock No. 2—Valued at between $45 and $20.

Mill Stock No. 3—Valued at less than $20.

It is interesting to note that in 1911 and 1912, the shipments exceeded the output of the mining and milling operations for each respective years. This shows a steady evacuation of the stock on hand which had accumulated during 1910, when an abnormal production had caused a congestion of the market.

Therefore the balance between the output and shipments is gradually readjusting itself, and as the consumption is steadily increasing, the future of the industry is hopeful.

The following table shows the growth of the asbestos industry since the year 1900 :—

Year	Tons.	Value.
1900	21,408	$ 719,416
1901	33,466	1,274,315
1902	30,634	1,161,970
1903	29,261	916,970
1904	35,479	1,186,970
1905	48,960	1,476,450
1906	61,675	2,143,653
1907	61,985	2,455,919
1908	65,157	2,551,596
1909	63,965	2,296,584
1910	80,605	2,667,829
1911	102,224	3,026,306
1912	111,175	3,059,084

The year 1912 therefore shows a new high record for both tonnage and total value. However, it must be pointed out that although the tonnage in 1912 increased 8.75% as compared with 1911, the total value only increased 1.07%.

There is an increase in the demand for long fibre asbestos and a corresponding decrease for the lower grades. Spinning stock and shingle stock, which must be of clear and fibrous asbestos, find a much readier market than paper and mill-board stock which are now much more difficult to get rid of. For this reason only the mines which are able to produce an appreciable quantity of the better stocks were operated this year. As a consequence of this state of things all the mines of the Broughton district were shut down during the whole of 1912. The serpentine rock in this district contains as a rule a high percentage of asbestos; this, however, is not in veins, but in the shape of short fibre disseminated throughout the rock. In the Robertson district, where the asbestos rock is of an intermediate nature between that of Thetford and that of Broughton, two mines were worked part of the time.

In Thetford and Black Lake, there was a serious shortage of labour which somewhat hampered operations.

One of the important features of the year in the asbestos industry has been the reorganization of two of the large operating companies. In both cases, the principle adopted in the reorganization has been the reduction of the bonds by converting part of these into common stock, thereby reducing the fixed charges. In these reorganizations, the names of two companies, The Amalgamated Asbestos Company and The Black Lake Asbestos Corporation, have been changed respectively to Asbestos Corporation of Canada, Ltd., and The Black Lake Asbestos and Chrome Company, Ltd.

Returns of shipments of asbestos were received from nine producers as follows:—

Asbestos and Asbestic Co., Ltd., Danville, P.Q.

Asbestos Corporation of Canada, Ltd., Thetford Mines and Black Lake, P.Q.

B. & A. Asbestos Co., Robertson, P.Q.

Bell Asbestos Mines, Thetford Mines, P.Q.

Berlin Asbestos Co., Rumpelville, P.Q.

Black Lake Asbestos and Chrome, Black Lake, P.Q.

Jacobs Asbestos Mining Co., Thetford Mines, P.Q.

Johnsons Co., Thetford Mines, P.Q.

Martin, Bennett Asbestos Mines, Ltd., Thetford Mines, P.Q.

The Asbestos Corporation of Canada operated four of their mines, the Kings and the Beaver mines at Thetford, and the British Canadian and the Standard mines at Black Lake. The fifth mine, the Dominion at Black Lake, was not reopened.

The Black Lake Asbestos and Chrome Co., Ltd., have actively worked the Union and the Southwark mines. Their large mill has a capacity to treat 1,000 tons of rock per 10 hours. The motive power is electricity.

The Bell Mines are the only ones in the district who have done much underground development by means of tunnels. These aggregate in the vicinity of 20,000 lineal feet, which have developed a large reserve of asbestos-bearing rock.

The mill has a capacity of 900 tons of rock per 10 hour shift. In their mining and milling operations the Bell mines use 1,200 H.P., of which about one-half is electric power, and one-half is furnished by steam boilers.

The Asbestos and Asbestic Company, Ltd., are the only ones working in the Danville district. They operate the Jeffrey mine, at Asbestos. This company was in continuous operation during 1912. There are two well equipped mills, of a capacity of 1,000 tons of rock each per 10 hours. Provision is made for about 2,000 H.P., partly steam and partly electricity.

The Johnson's Company operate two mines, at Thetford and Black Lake respectively. Each mine has its own mill, and both were in continuous operations during the year.

At both mines and mills steam-power is used exclusively. The capacity of the Thetford and Black Lake mills of the Johnson's Company aggregate 750 tons of rock per 10 hours.

The Jacobs Asbestos Mining Company operate on lot 28 in the sixth (VI) range of Thetford. Their well equipped mill has a capacity of 600 tons of rock per 10 hours. Electric power is used exclusively in operating both the mines and the mill. The H.P. used is about 700.

The Martin-Bennett Asbestos Mines, Ltd., is the latest addition to the Thetford mines. This company acquired the Ward-Ross property situated near the Johnson mine. It had been lying idle for a great many years owing to litigation. The new mill, which is very complete and efficient, was put in operation in the spring of 1912. It has a capacity of 900 tons of rock per 10 hours. In their mines and milling operations steam power is used exclusively.

The B. & A. Asbestos Company operate on lot 9 in the fifth (V) range of Thetford, at Robertsonville. The mill has a capacity of 450 tons per 10 hours. Electric power, 600 H.P., is used exclusively in both mining and milling operations.

The Berlin Asbestos Company have their mine and mill on lot 2 in the fifth (V) range of Thetford. The mill has a capacity of 450 tons per 10 hours. The mining and milling operations require 400 H.P. The two last mines were only operated during a part of the year.

The electric power is distributed in the asbestos districts by two electric power companies, The Continental Light and Power Company, and The St. Francis Hydraulic Company. The first of these obtain the power from Shawenegan Falls, on the north side of the St. Lawrence river. Two lines of 80 miles deliver 9,000 H.P. in Thetford, Black Lake, Robertson, East Broughton and Danville.

The second company has its plant at the falls of the St. Francis river, two miles above Disraeli. They develop 3,000 H.P. and have an auxiliary steam plant of 2,000 H.P.

The price of electric power in these districts averages $25 per H.P. for eight months during the year, as generally during the winter months mining operations are considerably reduced.

It is noteworthy that there is now a growing tendency towards using steam power in mining and milling operations. The contention is that although electric power at the rate at which it is delivered would be cheaper for continuous operations, as there sometimes occur long interruptions in the work owing to various causes, such as shortage of labour, sluggishness in the asbestos market, unfavorable weather to work in the asbestos pits, etc., it is more profitable to install a boiler plant and produce steam power. The price of good steam coal on the cars at Thetford or Black Lake during 1912 was $5.00 per gross ton.

ASBESTOS IN FOREIGN COUNTRIES.

RUSSIA.—The main deposits of Russian asbestos are situated in a belt of serpentine and allied rocks, some thirty miles long and two or three miles wide, in the Ural Mountains, to the north-west of Ekaterinburg. The general direction of this belt is constant, north and south. The rocks consist of chloritic and talc schists, diabase, porphyrite and serpentine.

The asbestos is distributed throughout the serpentine in a sort of stockwork. The veins run in all directions and the dip varies from the horizontal to the vertical. These serpentine massifs which occur at various intervals in the main zone are ellipsoidal in shape, the main axis reaching one mile in one case, while the width is as great as 1,000 feet. The mining is done entirely by open quarries which are only operated during a limited period each year.

Mr. de Hautpick in an article on the Russian asbestos deposits in the Mining Journal, London, (August 3, 1912), gives the following analyses of the asbestos and the Ural olivine rock from which it is derived :

	Serpentine.	Olivine Rock.
Silica	41.40	36.30
Magnesia	41.06	34.84
Ferric oxide	2.03	5.28
Alumina	1.11	1.12
Water	14.37	15.25
Chromic oxide	.....	7.95

In 1912 the production of asbestos in Russia was about 16,000 metric tons, of which 85% represented the production of three mines of the Ekaterinburg district. In 1911 and 1910, the production was 15,182 and 10,847 metric tons respectively.

Asbestos was discovered in this district of the Ural Mountains some two hundred years ago, and mining was begun shortly afterwards. For a certain number of years a small textile industry was carried on here for the manufacture of gloves, bags, socks, etc. This was abandoned and for many years the asbestos deposits failed to attract attention. Work was resumed actively in 1883 and since then the Russian asbestos industry has been developing slowly.

According to an authority on the subject the yield of asbestos of this serpentine varies much up to a maximum of 50 lbs. per cubic yard of rock, the average being 28 to 33 lbs. It may be remarked that the Quebec asbestos quarries mined in 1912 a quantity of 1,970,268 tons of rock which yielded 101,500 tons of asbestos, or an average of 103 lbs. per ton of rock.

According to the latest definite figures obtainable on the Russian asbestos, the production for the last seven years, 1906-1912, has been as follows:—

1906	7,835	metric tons
1907	8,690	" "
1908	10,609	" "
1909	13,026	" "
1910	10,847	" "
1911	15,182	" "
1912	16,000	" " (approx)

For the last five years, 85% of the production of Russian asbestos can be credited to three mines.

At the end of the year 1912, an amalgamation of the principal producers of asbestos of the Ekaterinburg district was in process of formation, under the name of the Ural Asbestos Syndicate. The following mines are stated to have joined the syndicate. Their approximate annual yield of asbestos is also given in poods (1 pood—36,112 lb.)

Voznesenky Asbestos Mines	172,000 poods
Yakooleff, Successors	100,000 "
Poklievsky-Kozel, Successors	300,000 "
Korevo Asbestos Mines	150,000 "
Girard de Soucanton	200,000 "
Russo-Italian Asbestos Co	100,000 "
	1,022,000 poods

or 16,350 metric tons.

Union of South Africa.—"Asbestos is produced in Cape Province, in the Kurman, Hay and Prieska divisions. Twelve companies were working during 1911. These concerns work largely on tributary system, purchasing the asbestos from individuals who win the material as best they may." (Report of Dept. of Mines, for 1911,—Union of S. Af.) There is also a little asbestos produced in Natal. During the year 1911, Cape Province produced 1,253 tons, valued £20,765 and Natal, 38 tons, valued £74.

WEST AUSTRALIA.—Asbestos is known to occur at Soansville, in the Pilbara gold field. The deposits are in a serpentine, intruded by dolerite dikes. The serpentine forms a belt of rock exposed at the surface for a maximum width of half a mile, and a length of two and a half miles.

Although seams of asbestos have been found in many places on this area, prospecting has practically been concentrated in two deposits on the northern end. These deposits are respectively on the western and on the eastern side of the main dolerite dike.

The veins of asbestos are lying close to the dolerite dyke and run parallel to it, forming a zone of two to three feet in thickness. The fibre is short and of milling quality, although some "crude" is found.

The worst feature, from an economic standpoint, is the narrowness of the deposit, which would mean high mining cost.

From the report on Colonial and Foreign Statistics of the Home Office, London, the following figures are gathered:

WORLD'S PRODUCTION OF ASBESTOS IN 1910.

(Apart from Quebec.)

	Metric Tons.	Value.
Cape Colony	1,273	£ 23,143
Cyprus	442	2,754
India	3	6
Rhodesia	301	3,320
Natal	2	15
Transvaal	70	2,595
Russia	10,936	82,000*
United States	3,350	14,036
	16,377	£127,869

*Approximate only.

These total figures are slightly inferior to those of the previous year 1909. For 1910 the figures for Quebec according to the same report were 73,124 metric tons, valued at £548,184, which represent 82% in quantity and 81% in value of the world's total production of asbestos.

COPPER AND SULPHUR ORE

The world's copper market after a long period of sluggishness began to show signs of activity at the beginning of 1912. This improvement steadily kept up throughout the year, with the result that the average price of electrolytic copper in New York for 1912 was 16.34c. per lb., whereas in 1911 it had been 12.37. As a consequence of this increase, the pyrites mines of the Eastern Townships showed great activity, and as both the Eustis mine at Eustis and the McDonald mine at Weedon had taken advantage of the quietness of the market in 1911 to devote more attention to development and blocking out ore, we have to record this year a large increase in both tonnage and value

The yearly shipments of cupriferous pyrite from mines in the Province of Quebec since 1900 are given in the table below:

Year.	Tons.
1900	37,791
1901	22,732
1902	31,938
1903	26,481
1904	23,729
1905	28,644
1906	32,527
1907	29,574
1908	26,598
1909	35,100
1910	24,040
1911	38,554
1912	62,107

These ores run between 40 and 45% in sulphur contents and from 2% to 6% in copper. They are used for the manufacture of sulphuric acid and the cinders are sent to smelters for the recovery of the copper.

They also carry small values in silver, ¼ to 1 oz. per ton and 15 to 30 cents in gold.

Although a good deal of prospecting and reopening work was carried on in various places in the Eastern Townships on old mines, shipments of ore were effected only from the Eustis and the McDonald mines. The Eustis mine is in the Township of Ascot. It is situated seven miles south of Sherbrooke city, and has been working for thirty-five years. The slope is now 3,400 feet, on an angle of 38°.

The ore which consists of a mixture of iron and copper pyrites, with subsidiary values in gold and silver, is concentrated in a well equipped mill of a capacity of one hundred tons per ten hours. This at times is congested and plans are being elaborated for the installation of an Elmore oil concentrator. The richer ore is crushed and screened, and goes to the bins, the leaner ore is concentrated by wet process. (See report for 1911.) The wet ore goes to the dump pits, as well as the excess from the loading bins. Under these stock piles which sometimes attain a very large tonnage, timber tunnels have been disposed, in which run belt conveyers for loading direct into the cars. A 30 ton car can be loaded in eight minutes by this means.

The McDonald mine, at Weedon, shipped very actively this year. Reference was made to this property in the reports of 1910 and 1911, and the developments have fully come up to the expectations. The main incline is down over 300 feet, on the dip of the ore body, 45°. There are three levels of a total length of over 1,200 feet. The ore is conveyed from the mine to the Quebec Central Railway, by a Bleichert aerial tramway of a capacity of 200 tons per ten hours. As a matter of fact, the possibilities of the tramway are higher. Its length is 19,500 feet, its cost $1.75 a foot. It is very effective and no difficulty was experienced to work it during the winter.

A large tonnage of ore has been developed, and blocked out in the McDonald mine; the principle is followed to keep the reserves well ahead of mining.

A great deal of prospecting, including a considerable amount of diamond drilling, was done on lots adjoining the McDonald mine, but the results were disappointing.

At Eastman development work was continued at the Ives mine. The old shaft which was 100 feet deep, has been sunk 40 feet further vertically. The vein which they are following is narrow, but the ore is high grade chalcopyrite, and offers possibilities. This mine had been abandoned for about thirty years

At the Huntingdon mine, which is about three miles south of Eastman, Mr. Pierre Tetreault, of Montreal, was installing a concentrating mill, with the intention of working over the old dumps of the mine.

The Huntingdon and the Ives mines had a very successful career for several years in the early seventies. The ore is said to have been 8 to 10% copper at the former and 14% at the Ives mine.

Mr. A. O. Norton went on with development work at the Suffield mine, Ascot Township, but no shipments of ore were effected.

Some very active prospecting was done by the Garthby Copper Mining Company, on lot 19 in the second (II.) range of the township of Garthby. Some ten men were employed for three months, opening up a vein of chalcopyrite. The results are said to have been very encouraging and it is intended to push the work during 1913.

GOLD.

The gold production in 1912 was 980 oz., valued at $19,924. This is an increase of $8,124, as compared with the previous year. As was the case last year, part of this production is to be credited to the copper and sulphur ores of the Eustis and the McDonald mines, and the balance comes from the hydraulic mining operations carried on near Beauceville on the Ruisseau des Meules, by the Cie des Champs d'Or Rigaud-Vaudreuil.

This company owns the mining rights on the whole of the Rigaud-Vaudreuil Seigniory, some 70,000 acres, and they have been working for two seasons. Operations begin in the early spring, and continue until the setting in of winter, or about seven months.

A short description of the plant was given in the Report on Mining Operations in the Province of Quebec for 1910. This was supplemented by notes in the Report for 1911.

The workings are on Ruisseau des Meules, a small tributary of Mill river, this latter stream emptying into the Chaudière at Beauceville. The bank of the creek which is being worked is about one mile from the mouth of the Mill river, and half a mile from the confluence of the latter stream with the Ruisseau des Meules.

The gold is found in a yellow compact gravel resting on bed-rock and more or less cemented by a clay bond. These yellow gravels are of pre-glacial origin, and are, in all likelihood, remnants, in places sheltered from glacial action and subsequent erosions of the disintegration and deposition, practically *in situ* of the country rock. The general country rock here is shales of late Cambrian age, probably of the Sillery formation. The thickness of the gold-bearing gravel, as revealed by the workings, varies from a trace to eight or ten feet. This is covered by a heavy mantle of boulder clay and other material which at the furthest point reached in the bank shows a face of over 60 feet of material to remove from bed-rock to top of bank. This is as far in as it is practical to work for the present, and the operations can extend up and down the stream, for the presence of the underlying yellow gravel has been proved by preliminary borings for a considerable distance along the banks of the creek. The bed-rock has been much disturbed. Its attitude is usually almost vertical.

The rock fragments of the gold-bearing gravel are nearly all of local origin, and, as a rule, appreciably angular; slate and diabase predominate. Extensive outcrops of the latter rock occur in the region. As a clue to the possible origin of the gold, it is interesting to note that the Raleigh Gold Syndicate have been carrying on extensive prospecting work on Stoke mountain, on lot 1, range IV., Dudswell, and lot 13, range VI., Westbury, near East Angus, where the occurrence of alluvial gold has been known for many years, and they report gold contents in a porphyry rock traversed by numerous veins and stringers of quartz. Assays of the porphyry are said to have yielded up to $9.80 and the quartz has given results as high as $90.00. Some specimens show visible gold. According to the geological maps of the eastern townships, accompanying Ell's reports, the geological conditions in the two places are very similar, which would tend to support the contention of the local origin of the gold, concentrated vertically from the disintegration of a great thickness of superincumbent rocks.

It may also be added that in Marsborough, near Lake Megantic, where the presence of alluvial gold has also been noted, quite an excitement was created in 1906 and 1907 by the discovery of gold in a rock which Dresser described as a "fine grained granite, slightly porphyritic in structure occurring in the form of dikes in the Cambro-Silurian Slates." An assay of a specimen of this rock collected by Mr. Dresser gave $7 of gold. (*)

Although no production of gold is reported from the northwestern part of Quebec, it is gratifying to note that the region which was examined in 1912 by Dr. Bancroft, offers great possibilities. His report which is given in full further on is encouraging.

IRON.

For the first time in many years, we have no production of iron ore to record for the year 1912. Small quantities of bog iron ore had been steadily produced every year and charged into the charcoal furnaces of the Canada Iron Corporation, at Radnor, and at Drummondville, but this year there has been a complete cessation of both bog iron ore production and blast furnace operations.

The Drummondville furnace was supplied from local sources and from a deposit at Vaudreuil, above Montreal.

The furnace at Radnor forges derived the bog iron ore

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*Note.—See 'Report on a gold discovery near Lake Megantic, Geol. Survey of Can. Pub. No. 1028.

Also, Sum. Rep. Geol. Survey 1911; p. 303.

mainly from Lac à la Tortue, which had been partly drained, uncovering a wide tract along the shores, from which the ore was gathered. A dredge was also operated on the lake itself which is a shallow body of water of some three miles by one, forming the central part of an immense swamp. Although ore is found over the whole area of the bottom of the lake, it is at the mouths of the principal creeks that the richest ground was worked. Moreover this ore in the lake bottom grows. This has been explained by the fact that the streams which flow into the lake are charged with salts of iron derived from various sources such as ochre beds, iron sands and iron bearing rocks, which all abound in the region. The water of the lake thus charged with ferrous salts takes up oxygen from the surface, resulting into the conversion of the soluble iron salts into insoluble ferric salts and their precipitation on the bottom of the lake.

The local supply of ore was not sufficient for the needs of the Radnor furnace, and had to be supplemented by magnetite which came mainly from Ontario. The pig iron made, both at Drummondville and Radnor, was exclusively charcoal pig iron of high grade, used for special castings, mainly railway car wheels. As such, the price it brought was about double that of ordinary pig iron.

Professor Dulieux, of Polytechnic School, continued his examination of the iron ore resources of the province, for the Mines Branch. This examination was begun last year, and a preliminary report of ninety pages was published in the report for 1911. A report of his work done during 1912 is given further on. Professor Dulieux will give the final results of his two seasons' work in a special separate work on the "Iron resources of the Province of Quebec, and their utilization," which is now in course of preparation.

ZINC AND LEAD.

Two operators have reported active development and prospecting work on deposits of zinc and lead ores in 1912. They are the Calumet Metals Co. and Pierre Tetreault.

The Calumet Metals Co. have done some developing work on Calumet Island, at the Bowie mine, and have endeavoured, by a new shaft 90 feet deep and some surface stripping, to trace the deposit of zinc and lead. A concentrating mill to treat 150 tons per 24 hours has been installed, but is not operated steadily. Trial runs have been made, which have suggested changes in the machinery. The mill is equipped with jaw crushers, coarse rolls, screens, fine rolls, jigs, Huntingdon mill, Wilfley and Overstrom tables. As was mentioned in our last year report the deposits of galena and zinc of Calumet Island are irregular and pockety, but by careful and judicious management, and by keeping development work well ahead of actual mining, they could probably be the source of a successful local industry.

M. Pierre Tetreault has carried on development work on the lead and zinc deposits south of Notre-Dame des Anges in Portneuf county, which were mentioned in our last report. The ore is here found in a contact zone of crystalline magnesian limestone, probably at the junction of a pyroxenite intrusion with the gneisses which constitute the main country rock of the region. The limestone, in places, is strongly impregnated with zinc blende and galena. This band of carbonate rocks is very persistent and well mineralized; widths of forty feet were noted. It has been followed by trenching and outcrops for a distance of 3,000 feet,—from lot 38, range I., of Montauban township, to lot 46 of the same range and township. The development work has been concentrated on lot 40, where an open cut has been made into the side of a low escarpment of the crystalline limestone. A concentrating mill was erected during the year, installed according to the Joplin practice, to treat 150 tons of ore a day. Owing to various delays in the construction, the mill could not be started before winter set in, but in the spring of 1913 mining and milling work will be actively resumed.

MICA.

Somewhat better prices ruled for mica in 1912 as compared with the preceding year. Returns received from 12 producers give a total value of $99,463 for the mica shipped in 1912 from the mines; this is an increase of $23,035 over 1911.

Nothing of note has developed in the mica mining industry during 1912. Mica mining in the Province of Quebec is practically limited to the region lying north of the Ottawa river between the valleys of the Lievre and Gatineau rivers. Occurrences of mica, however, are liable to be found anywhere in the large territory occupied by Laurentian and other pre-Cambrian rocks, which is known as the great Canadian shield or protaxis. Only those favourably situated for transportation have been developed. Mica deposits are very irregular, and it is very difficult to keep the development work much in advance of actual mining. Practically all the mica mined in the Province of Quebec is phlogopite or amber-mica. The dark grades, as well as the very light coloured ones of this mica, are not as much prized as the medium coloured mica. The silvery amber-mica is more elastic and splits better, and commands better prices than either the dark or the light mica.

From the returns received at the Quebec Mines Branch, the following prices ruled during the year 1912:—

Size, inches	Price per lb.
1 x 1	5c.
2 x 1	10c. to 14c.
3 x 1	18c. to 25c.
3 x 2	40c. to 55c.
4 x 2	60c. to 75c.
5 x 3	75c. to $1.00
6 x 4	$1.00 to $1.20
8 x 5	$1.25 to $1.65

The technology of Canadian mica has been very fully given in a monograph published in 1912, by the Mines Branch of the Department of Mines.(*)

*Mica, its occurrence, exploitation and uses, by Hugh S. de Schmid, Mines Branch, Department of Mines of Canada, Ottawa.

A very interesting paper on "The India Mica Industry," by Abner F. Dixon, was read before the American Institute of Mining Engineers at the New-York meeting, 1913. (*)

From this paper, the following extract is reproduced, giving some information on the London mica market :—

"Mincing Lane, London, is the market for nearly all the mica produced in India. Every three weeks there is a sale in London by the produce brokers. Two days before the sale, the brokers have samples of various grades of mica from each shipment on show at a warehouse. These samples are carefully inspected by the mica buyers, and the shipments are sold at auction on the third day. At these sales, Indian mica predominates; smaller lots from South Africa, Australia, Ceylon, Japan, Mexico, Bengal, and Canada are sporadically offered. Most of the mica imported into New York is purchased in London, but mica is sold on contract by large purchasers in India to Germany and the United States direct. On account of the personal factor in grading mica, there can easily be an honest difference of opinion whether a lot is up to standard or not; and to sell by any other method than open auction is a matter of some difficulty. At nearly every sale some utterly worthless mica appears, shipped from some out-of-the-way corner of the world by some ignorant but hopeful individual, who has heard of the value of mica, but does not understand the qualities required to make it marketable. Most of the Indian shipments are made by 10 or 12 firms who mine for themselves and purchase from the small producers. The artificial fluctuation brought about by the speculators and the fluctuating demand for each variety make it difficult for even the best informed to give more than a rough estimate of what a given lot of mica should bring. Giving statistics of the value of mica by the ton without regard to size or quality, as is the custom, may be interesting, as showing the state of the industry, but can give no one an idea of what a particular lot will fetch.

The price of mica in shillings per pound sold at auction in London on September 11, 1912, by Edward Davis & Co., is:

*See Bulletin of the American Inst. of M. E. No. 77, May, 1913.

BENGAL RUBY.

No.	Clear.		Slightly stained.		Stained.	
	s.	d.	s.	d.	s.	d.
No. 1..........	8	9	......		6	6
No. 2...........	7	9	7	3	4	8
No. 3...........	6	0	5	0	4	4
No. 4...........	4	6	3	9	2	10
No. 5...........	2	1	1	3	......	
No. 6...........	0	5¾	......		......	
No. 5, Splittings.	0	7	......		......	
No. 6, Splittings.	0	4½	......		......	

In January, 1911, the prices obtained at a sale in the same place were:—

Special	8	0	5	0	......	
No. 1...........	6	0	4	0	......	
No. 2...........	5	6	3	6	......	
No. 3...........	4	6	3	0	......	
No. 4...........	3	0	1	6	......	
No. 5...........	1	0	0	7	0	9
No. 6...........	0	5	......		......	
No. 5, Phur..	0	5	......		......	
No. 6, Phur.....	0	4	......		......	

During 1910 the United States imported 1,192,221 lbs. of mica, valued at $721,541, of which 10 per cent was Canadian phlogopite, and the rest largely from India."

India mica is graded according to size as follows:—
Specials—Over 36 square inches.
No. 1—From 24 to 36.
No. 2—From 15 to 24.
No. 3—From 10 to 15.
No. 4—From 6 to 10.
No. 5—From 3 to 6.
No. 6—From 2 to 3.

From the report of the "Home Office" on Colonial and Foreign Mineral Statistics, the following figures are taken:—

MICA PRODUCTION OF THE PRINCIPAL COUNTRIES IN 1910

India	£177,152
Canada	69,219
United States	39,120
German East Africa	16,000
Argentine Republic	6,200
Nyasaland	2,561
Transvaal	142

These values are of course very vague, and only give an idea of comparison of the relative importance of the mica industry in the various countries given. From official reports we find that the imports of mica from India into Great Britain in 1911 amounted to $496,410, and the imports of this substance from all countries into the United States in 1912 amounted to $745,399. The imports of mica into the United States practically all come from India and Canada.

GRAPHITE.

Returns of shipments were received from four firms, and they aggregated 1,210,278 lbs., valued at $50,680. Although this is an increase as compared with the preceding year, yet it must be said the anticipations and hopes for 1912 had been much greater.

The Dominion Graphite Company's mill was started in the spring of 1912, and ran continuously until August. It was then closed down pending a reorganization of the company.

The Peerless Graphite Company worked for four and a half months. They closed down in May, 1912, and have not resumed.

The Bell Mines worked both the mine and the mill the whole year round. They report 300 days work.

A great deal of development work was done by the Quebec

Graphite Company, Limited, who are opening up a mine and erecting a mill near Buckingham. They have the mining rights on parts of lots 1, 2, 3, 4 and 5 of Range IV., Buckingham Township. The work has been done under the management of Mr. A. Geister.

The Canadian Graphite Co., Ltd., continued their development work on lot 1, Range IV., Township of Wentworth, Argenteuil County. The results are encouraging and very good graphite ore has been uncovered.

At St. Remi d'Amherst, "Graphite, Limited." actively pushed the development of their mine and the erection of the mill. The mill is expected to be ready to start operation in the early part of 1913.

The graphite industry of the Province of Quebec has had a very checkered career. As far back as 1847, attempts were made to work the disseminated graphite of the Buckingham region, and since then various companies have followed each other in this field.

That graphite-bearing rocks occur in very large quantities has been proved beyond doubt. But the graphite is in the shape of flakes disseminated through a sillimanite gneiss, although in places, the mineral is in crystalline limestone. The proportion of graphite varies, up to a maximum of 30% or even more. A large quantity of 10 to 15% ore can be counted upon. The great difficulty has been the concentration of the graphite, and the complete elimination of the accompanying minerals, more especially mica. The products of the Buckingham mills have to compete with the Ceylon graphite in the markets of the world, and under the present conditions it is difficult for them to do so successfully. The Ceylon occurrences of graphite are in the form of veins and lenses of the solid mineral; although the size of these veins and lenses are often very small, yet the native labour is so cheap, that it permits mining, cobbing, sorting and preparing by hand at very low costs. Ceylon graphite rules the world's markets and prices.

Nevertheless the Quebec graphite deposits offer great possibilities. Operators are continually experimenting and improving methods of concentration and separation. Eventually a prosperous industry will, in all probability, emerge from these experimental stages.

The United States, in 1912, imported from Ceylon alone, graphite to the value of $1,379,587, whereas their domestic production was only $207,033.

The following remarks by Edson S. Bastin, in the Report on the Mineral Statistics of the United States for 1911, published by the U. S. Geological Survey, are very interesting. They refer to the graphite industry of the United States, but, in part, apply to the Quebec graphite industry :—

"The cause of the unsatisfactory condition of the domestic industry is to be found in (1) the superiority of much of the Ceylon graphite to any graphite that is mined in this country; (2) the low cost of labour in Ceylon, which permits cheap mining, careful sorting, rubbing up, and blending of the product; (3) the facts that the largest domestic deposits are schists which carry small flakes of graphite disseminated through them and that the separation of the graphite from the accompanying minerals, especially mica, in such rocks is a problem of unusual difficulty. The one firm which can be said to have become firmly established in the treatment of such graphite rocks, the Joseph Dixon Crucible Co. possesses important advantage over other firms in that it manufactures much of its product into graphite paints, graphite grease, etc., before placing it on the market. When the margin of profit is small, such control of markets becomes of vital importance.

To-day there are more abandoned graphite mines and mills in the United States than there are in operation. The number of times that some of these properties have changed hands in the course of a few years evinces a record of misrepresentation and disappointment that can hardly be equalled in any other branch of mining, and many properties have been notoriously associated with stock manipulations of doubtful character. It should be clearly understood by anyone who contemplates the development of one of the flake-graphite deposits that the technology of concentrating such materials is yet in its infancy; that there are no well-established systems of treating the materials, such as exist, for example, for the treatment of gold or copper ores; and that the product obtained is variable in quality and in market value and subject to severe competition with foreign graphite. The largest part of the foreign graphite that comes into this country is brought in by American firms who either control or own the foreign mines or have purchasing agents abroad, and are, therefore, in a position to take immediate advantage of any change in the markets at home or abroad. In general, the cost of producing flake graphite is so high and the price at which it is sold so low that even under the most economic conditions the margin of profit is small. Moreover, certain rocks that carry graphite contain other minerals which preclude any possibility of successful concentration—such for example, are rocks in which graphite flakes are interleaved with mica—and a careful study of the material by an expert should precede any attempt at development."

PEAT.

The Peat Industries, Ltd., has now passed the experimental stage and is producing peat fuel on a commercial scale. This company has secured an area of 1,200 acres of excellent peat bog, at Ste. Brigide, five miles from the town of Farnham. The work done on this bog by the Peat Industries, Ltd., comprises a main drainage ditch, 1,500 feet long, 10 feet deep, 7 feet at the top, 2 feet at the bottom; over 6,000 feet of smaller ditch 3 feet deep and 2 feet wide.

The equipment in the field consists of a peat machine of the Anrep type, but modified to meet the local conditions. It is worked by a 45 H.P. gasoline engine which operates the excavator, the macerator, the endless cable to which are clamped the cars, and the spreading machine.

The plant has a capacity of 40 tons of dried peat in ten hours.

The peat is entirely air-dried, as it is now recognized that this is the only practical and economical way of producing peat-fuel. The dried peat is conveyed to the Central Vermont Ry., which crosses the bog, by small cars running on 24″ gauge tracks. The plant requires seven men for its entire operation.

The peat was sold in 1912 at the rate of $4 a ton f.o.b. Ste. Brigide.

It is to be regretted that the whole of the summer of 1912 should have been extremely unfavourable to the production of air-dried peat. The continual rains greatly interfered with the operations, but it is hoped that the 1913 campaign will be a successful one.

OIL.

A syndicate, The Eastern Canada Company, under the management of Mr. C. B. K. Carpenter, has resumed the search for oil in the eastern part of Gaspé peninsula, south of Gaspé basin. A boring rig of the latest design, made in Bradford, Pa., is at present in full operation, and in May, 1913, No. 1 hole, begun in January, had reached a depth of 2,500 feet. The hole at the surface is 14″, reducing to 8″ and finishing with 6¼″ diameter.

STRUCTURAL MATERIALS.

Under this heading are comprised quarry and clay products, such as cement, limestone, brick, lime, granite, tiles and earthenware, marble, building sand, slate, flagstone, etc. The above enumeration is given in the order of importance of the figures of production.

The statistical data of these substances are necessarily very incomplete. Only a very small proportion of the crushed stone used in road-making, in concrete work, in railroad construction, etc., is included in our figures. Likewise our figures for sand are practically limited to the permits issued on government land. The limestone used in the manufacture of cement does not, of course, appear in the limestone figures, as this would be duplicated under the heading "Cement."

To illustrate the tremendous growth of the structural materials industry in the Province of Quebec, we give hereunder the values of the production of the principal items for the last four years :—

Product	1909	1910.	1911.	1912.
Cement	$1,314,551	$1,054,646	$1,931,183	$3,098,350
Limestone	457,143	503,173	1,128,402	1,363,555
Bricks	584,371	906,375	1,129,480	1,284,232
Lime	105,489	279,306	284,334	455,570
Granite	149,064	291,240	308,545	358,749
Marble	130,000	151,103	143,457	252,041
	$2,740,618	$4,085,843	$4,925,401	$6,812,497

Taking the total of these six items, we notice that in four years, the increase in value has reached 150%. Such figures are indicative of the development of the country, much more so than an increase in the production of the metalliferous mines.

CEMENT.

The cement production for 1912 is the highest ever recorded. It also heads the list of structural materials. The increase in quantity in 1912 as compared with 1911 has been 1,097,719 barrels of 350 lbs., or 69.1 per cent. The total production is the output of three cement mills, of which one is located in Hull, capacity of 2,000 barrels per 10 hours, and two are in Montreal with a combined capacity of 5,300 barrels per 10 hours.

The per capita production of cement in the Province of Quebec in 1912 reached 468 lbs. This is very high indeed, as the Canadian average per inhabitant is 343 lbs.

The remarkable development and expansion of the cement industry in the Province of Quebec cannot be illustrated better than by the following table :—

TABLE OF CEMENT PRODUCTION IN PROVINCE OF QUEBEC SINCE 1901

Year.	Barrels.	Value
1901	17,000	$ 28,000
1902	36,000	61,000
1903	40,000	66,000
1904	33,500	50,250
1905	254,833	408,000
1906	405,103	625 570
1907	415,580	640,000
1908	801,695	1,127,335
1909	1,011,194	1,314,551
1910	1,563,717	1,954,646
1911	1,588,283	1,931,183
1912	2,684,002	3,098,350

It may be mentioned that owing to an unprecedented demand for cement in 1912, the Federal Government made a remission and refund of one-half the duty on cement and hydraulic lime from the 12th of June to the 31st October of that year. The effect of this measure is apparent in the figures of imports of cement into Canada which jumped from 661,916 barrels in 1911 to 1,434,413 barrels in 1912.

BRICK.

There are of course numerous brickyards scattered in various places of the province, but two-thirds of the total production in 1912 came from two brick manufacturing centers, viz: Laprairie and Deschaillons.

At this latter place, Mr. Victor Mercier, of the Quebec Mines Branch, from a personal visit, reports the presence of twenty-three brick yards, having a daily capacity of output 310,000 bricks, which give employment to 342 men for six and a half months during the year. The material used at St. Jean Deschaillons is the blue Leda clay of Pleistocene age, so abundant in the valley of the St. Lawrence. At Laprairie, Utica shales are used as raw material.

A fact which may have importance in the development of the Abitibi district now traversed by the National Transcontinental Railway is that a large proportion of the clays of the region is eminently suited to the manufacture of brick and drain tiles. The mantle of clay is very widespread on both sides of the railway, and owes its origin to an ancient lake which at the close of the glacial period had as south shore the height of land between the rivers flowing to the north and those flowing to the south, and as northern limit, the retreating ice front which gradually receded northward towards James bay. The strati fied clays and sands, which are present as an almost universal covering, have been deposited from the waters of this historical lake.

The following is a report of tests made by Mr. J. Keele. of the Geological Survey, of samples of clays collected by Mr. J. H. Valiquette, of the Quebec Mines Branch. The samples came from the central part of the village of Amos, at the crossing of the Harricanaw river and the Transcontinental Railway. Sample No. 1 is from the upper part of the clay deposit, about 4 feet thick, laminated in beds of ¾in. thickness, containing very few pebbles. Sample No. 2 is from a bed of clay, several feet thick, in layers rather thicker, than No. 1, immediately underlying No. 1. This bed also contains a few pebbles.

Mr. Keele's Report.

"Lab. No. 90 is sample marked No. 1 taken from the upper part of the deposit.

Lab. No. 91 is from the lower part.

Both samples are from the stratified clays of the Clay Belt in Northern Quebec. They are light grey in colour when dry, and fine grained, so that 80 per cent of the clay passes through a 200 mesh sieve. No pebbles or coarse particles of grit were detected in either sample.

The upper part of the deposit is slightly calcareous, but the lower portion contains a rather high percentage of lime.

Lab. No. 90.—This clay required 28 per cent of water for tempering; it is fairly plastic and works easily, but makes a rather "short" or flabby body. It can be dried quickly after moulding, in any type of commercial drier, without cracking. The drying shrinkage was 5 per cent, and the tensile strength of the raw clay was 84 pounds per square inch.

The burning tests are as follows:—

Cone.	Fire shrinkage.	Absorption.	Colour.
010	0	19.3%	lt. red
06	0	16.6%	red
03	2.0	12.3%	"
02	5.6	5.2%	dark red

The clay burns to a good red, steel hard body at cone 03 (about 2,000° F.)

Some short lengths of 3 inch pipe were made from this clay in a hand screw press, and burned to cone 05 (1,922° F.) The results of this test are good, and show that the clay will make an excellent field drain tile. In fact it made one of the smoothest and soundest drain tiles of any of the Quebec surface clays that were tested.

The clay will make good building brick by the sand moulded process, and will probably also make wire cut brick. The addition of sand is not necessary, as the clay works easily and the shrinkages are low.

It could also be used for making porous fire-proofing or terra cotta lumber, but is not suitable for the manufacture of vitrified products.

The clay compares favourably both in working and burning qualities with any of the surface clays worked in the older settled portions of the Province; but in order to obtain the best results, it will have to be burned to a higher temperature than the clays of the St. Lawrence valley.

Lab. No. 91.—This clay requires 26 per cent of water for tempering. Owing to its silty character, it has only medium plasticity, and makes a very flabby body when wet. It is what brick-makers call a "lean" clay.

It can be dried as quickly as desired after moulding. The drying shrinkage was 4 per cent, and the tensile strength of the raw clay was 60 pounds per square inch. In burning it behaved as follows:—

Cone.	Fire shrinkage.	Absorption.	Colour.
010	0	19.0%	Pale red.
06	0	18.0%	" "
03	1.7	14.0%	Red.

The colour of this material is poor, and the body too porous when burned at the ordinary temperature usually employed when making common brick. As there is an abundance of the upper clay in the district, the use of the under clay is not advisable.

A series of burned samples accompany this report."

(Signed) J. KEELE.

MARBLE.

The figures of the marble production do not adequately represent the possibilities and the future of the industry. The imports of marble into Canada are in the vicinity of $400,000. For many years, our marble resources lay unnoticed and idle, but within the last five years, they have been the object of more attention.

In 1912, there were two marble quarries in active operation, and two others were developing and erecting dressing works.

The Missisquoi Marble Co., which began operation in 1907 works a quarry at Phillipsburg. Its quarrying, dressing and polishing plants are very modern and up-to-date. Moreover they have a lime kiln in which the refuse from the quarry is converted into lime. The marble takes a very fine polish and can be supplied of various colours and shades. Among the important buildings lately erected in which Missisquoi marble was used in the decoration may be mentioned the Transportation Building, in Montreal; the Central Station, Ottawa; the Union Station, Winnipeg; the Parliament Buildings, Edmonton.

The Dominion Marble Co., after two years of development and construction, have now a well equipped quarry at South Stukely, and a fine modern mill and polishing plant near Montreal, at Turcot, on the Lachine Road. The marble of the South Stukely quarry is very sound, and large blocks can be quarried. Quite a variety of colours can be obtained, the company having appropriately named some of them, Rose Royal, Vert Royal, Dominion Blue, Jaune Royal. The grain of the marble is fine and it takes a very high polish. South Stukely marble was used in decorating the Chateau Laurier at Ottawa, one of the finest hotels in Canada.

Two other marble quarries were in process of development. The Pontiac Marble and Lime Company are opening a quarry on lot 141 Corporation of Portage du Fort, in a deposit of white crystalline limestone of the Grenville series. The stone is more of a dolomite, as it contains over 40% of carbonate of magnesia. Blocks of practically unlimited size can be extracted. The dressing mill comprises circular saws, rubbing bed, etc. The stone is a white marble, rather coarsely crystalline, but taking a good polish. The Canadian Northern line, from Ottawa to Pembroke, under construction and almost completed, passes close to the quarry and will afford good shipping facilities.

A large amount of development and construction has been done by La Compagnie de Marbre du Canada on a deposit near St. Thècle, Champlain County. The marble deposit is on lots 200, 201 and 202, Range B North, Price Seigniory, in the Parish of St. Thècle.

It is a band of crystalline limestone of Laurentian age, as the country is essentially constituted by rocks of that formation. Judging by the outcrops and the work done on the deposit, the band appears to be at least 1,000 feet long and 200 feet wide. A bore hole was put down on lot 200, and at a depth of 40 feet, there was no change in the nature of the rock.

The stone is a crystalline marble of various colours. Blocks of almost any dimension, and remarkably free from fissures can be extracted, as the deposit is very massive. Although the grain is rather coarse, the marble takes a good polish. The deposit has been opened on the side of a slope, and the conditions are very favorable to work it economically. A well equipped sawing and polishing mill is in course of construction.

MAGNESITE.

The magnesite deposits of Grenville Township were worked as in the past by the Canadian Magnesite Co. The calcining kiln erected last year was operated and gave satisfactory results.

KAOLIN.

The presence of this substance on lot 5, Range VI., of Amherst Township, is mentioned for the first time in official reports in 1895. In the report of the Department of Crown Lands for that year, Mr. Obalski draws attention to the discovery, made at a depth of 15 feet while digging a well for water.

The deposit, which is situated two miles from the village of St. Remi d'Amherst, lay idle for a long time, but, in 1911, it was secured by the Canadian China Clay Company, who, after spending the summer of 1911 in prospecting and experimenting, have now erected a washing plant, which is said to give very satisfactory results and to produce kaolin free from grit and other deleterious substances. The intention is to supply kaolin to paper manufactures as a filler rather than establish pottery works.

ACCIDENTS IN MINES

Mr. J. H. Valiquette.

During 1912, fifteen accidents occurring in mines, quarries and mills, caused the death of 16 victims. Ten of these accidents occurred in mines, and caused the death of eleven men; the five other fatalities resulted from five accidents in stone quarries and clay pits.

Before analyzing these accidents and establishing the ratio of victims to the number of men employed in the mining industry, it may be stated that our calculations are based on an average of 300 days work per man per year. We can arrive at these figures without difficulty, for our return forms sent out yearly to all producers call for the average number of men employed, number of days in operation, and total amount paid in wages during the year. With these data, where work was carried on for part of the time only, the number of men is reduced proportionately, as if operations had been continuous for 300 days. Thus a mine having employed 100 men during 150 days, would be taken in our calculations as having employed 50 men during 300 days. When either the number of days of operation or the number of men, or both are omitted from the returns, we calculate them from the total wages paid at the average price of labour ruling in the district.

On this basis, during 1912, there were 3,166 men employed in or about the mines, and of this number 11 lost their lives through accidents, which gives a ratio of 3.47 men per 1,000 employed. In the quarries, clay-pits, brick-yards and cement mills, on the same basis, 4,481 men were employed, of whom five were killed as results of accidents. The ratio is 1.11 men killed for 1,000 men employed.

ACCIDENTS DUE TO EXPLOSIVES.

Three of the fatal accidents were due to explosives. Two deaths resulted from a premature explosion, and one from drilling into unexploded dynamite while block-holing. In the case of the premature blast, which resulted in the death of two men, it may be stated that this was not in the mine itself, but while doing some prospecting in a new part of the property. The holes had been drilled and charged and were to be fired by means of dry cells. An accidental premature contact resulted as above.

The use of dry cells for firing blasts is always dangerous, more especially if the men handling the wires have the slightest tendency to carelessness. To fire blasts by electricity, a blasting machine should always be used. Of these, there are several types, well tried and approved.

As to the accident which occurred while block-holing, it can only be reiterated that too much care can never be exercised in cases of misfires or unexploded remnants of charges. It is a well known fact that it is very difficult to make miners recognize the danger of careless practice, and the utmost severity should be exercised for the observance of the regulations and advice.

FALLS OF EARTH AND ROCK.

Falls of earth and rock have caused three deaths in 1912. In two cases, rock fell from the quarry face and struck the victims who were working in the bottom of the pits. In the third case a man was buried under a slide from a clay bank. We regret to say that, in many cases, there is not enough supervision exercised. It is true that it is not always possible to ascertain the natural or safe slope of various materials, for each case presents a different problem, but foremen and engineers who have the responsibility of the lives of the workmen under them, should err on the safe side.

It is true that regulations and rules involving minutiae would almost certainly be disregarded by the great majority of workmen, more especially when the work is done on contract basis, as is often the case. Nevertheless there are some principles which should invariably be observed.

1st. Avoid all overhanging working faces.

2nd. Allow vertical faces only in cases of solid rocks, and limit the height of such vertical faces according to the amount of fissuring of the rock. And in cases of rocks with a large number of seams, liable to be affected by weathering, frosts, etc., the working faces should be in several benches, each of limited vertical height.

3rd. In sliding material, earth, clay, etc., the natural slope of rest should of course never be exceeded; the height of each slope should be limited, and in the case of a long slope, it should be divided into benches, with floors sufficiently wide to protect the lower benches from slides which may occur in the upper ones.

HAULAGE ACCIDENTS.

Four fatalities occurred from accidents on traction or haulage systems. In two cases, the victims were crushed between loaded cars; in the two other cases, the cars having run off the track, overturned on the man at the brake.

MISCELLANEOUS ACCIDENTS.

Six other accidents of various characters resulted fatally, as follows:—One man fell eighteen feet off a ladder, in a quarry, another fell from a ladder in a mill; a man fell down an inclined shaft, which was being deepened. A workman had an arm crushed by cog wheels of which injury he subsequently died Another man fell into a clay grinder, while shovelling clay into it, and had both feet and legs badly crushed, of which he died subsequently. The sixth victim was found lying on the floor of the mill, with concussion of the brain, of which he died, and it was not possible to determine the cause of the accident.

THETFORD MINES HOSPITAL.

The Thetford Mines Hospital is under the management of Reverend Sisters of St. Joseph, of whom Rev. Sr. St. Thomas d'Aquin is Lady Superior. A great many of the mine accident cases from Thetford, Black Lake and Broughton are treated at this hospital which renders very efficient service. A competent personnel is in charge of the institution, under the able direction of the Lady Superior.

We summarize in the following tables, the mine accidents, both fatal and serious, which occurred in 1912. Serious accidents are those which entail incapacity to work for a period of 10 days or more.

FATAL ACCIDENTS

Date 1912	Mine or Quarry	Name of Proprietor	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
Jan. 6	Quarry	Canada Cement Co.	F. Teynateskyl	30	Laborer	Concussion of brain	Fell 18 feet from ladder leading out of the quarry
Mch 19	Asbestos	Martin Bennett Asb Mines	Ferd Ainsley	24	Carpenter	Fractured skull	Falling from a height.
Apr. 5	Bell Asb. Mines	Bell Asbestos Mimes	William Doyle	65	Laborer	open fracture of right leg and right thigh	Premature blast above ground.
" 5	" " "	" " "	Pierre Leviner	44	"	Right leg broken left shoulder bruised and deep wound near left arm pit	Premature blast above ground.
" 17	Asbestos	Jacobs Asbestos Mining Co.	Jas. Thibaudeau	26	Handdriller	Thigh broken, both legs broken and internal injuries	A falling rock rolled and jammed the deceased against another rock.
" 26	British Canadian	Asbestos Corporation of Can	George Murray	47	Laborer	Struck on forehead by rock weighing 80 lbs	Rock rolled from edge of the pit.
May 21	Graphite	Dominion Graphite Co	Wm. Sadler	....	Mill hand	Struck head	Unknown; found lying on floor of mill
June 13	Jeffrey Mine	The Asbestos & Asbestic Co Ld	Nap. Therrien	34	Rock drill runner	Killed	Drilling a block hole when explosion occurred caused probably by drill strikng some unexploded dynamite
Aug. 1st	Quarry	Canada Cement	Guiseppe Petracio	40	Laborer	Crushed between 2 cars	Braking empty car by walking backwards in front of same when car struck another loaded car crushing between buffers.
" 22	Jeffrey Mine	The Asbestos & Asbestic Co Ld	John Dionne	22	Brakeman	Crushed	Car of rock ran off the track and upset upon the deceased.
" 26	McDonald Mine	East Canada Smelting Co	Geo. Fontaine	23	Mucker	Drowned	Fell from 2nd level to bottom shaft.
" 27	Jeffrey Mine	Asbestos & Asbestic Co.	Alan Morris	47	Pit Foreman	Crushed	Crushed between two ore cars

FATAL ACCIDENTS

Date 1912	Mine or Quarry	Name of Proprietor	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
Sept. 27	Asbestos........	Jacobs Asbestos Mines Co....	Jos. Corriveau....	21	Laborer........	Fracture of thigh spine and leg....	A fall of clay.
" 14	Quarry............	St. Lawrence Brick Co........	Urgel Tremblay...	60	Laborer........	Feet and legs crushed..........	Falling into the crusher.
" 22	Quarry............	Laprairie Brick Co. Ltd.......	W. Champagne..	**35**	Laborer........	Crushed...........	Steel car loaded with shale ran over block at end of trestle. Brakeman lost control of car.

NON-FATAL ACCIDENTS

Date 1912	Mine or Quarry	Name of Proprietor	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
Jan. 10	Bell Mine	Bell Asbestos Mines Incorp.	Joseph Fortier	25	Drill Helper	Right thigh broken "6" above knee	A piece of frozen material falling on his leg.
" 24	" "	" " " "	Frank Vallières	25	Laborer	Ankle of right foot sprained	Stepped on a rail crossing a railroad track and foot slipped.
Feb. 1st	King's Mine	Asbestos Corp. of Canada Ltd.	Théodore Landry	34	Driller	Sprained his right side	Landry was drilling at the wall and fell ten feet against the drill.
" 3	Quarry	Canada Cement Co.	F. Gaudin	24	Laborer	Bruised Instep	A large stone rolled on his foot.
" 17	Bell Mine	Bell Asbestos Mines Inc.	Philippe Hamel	43	"	Middle finger of right hand bruised	Finger jammed by a car door.
" 17	King's Mine	Asbestos Corporation	ohn Roberge	40	Carpenter	Sprained his right hand	While lifting timber.
" 21	McDonald Mine	East Canada Smelting Co Ltd.	R. Tétreault	30	Miner	Slight cut on arm and scratch on head	Dynamite explosion caused by breaking of lantern.
" 22	Graphite	Graphite Ltd	Fd Desruisseau	22	Driller	Broken Leg	Drill column slipping and falling upon his leg.
" 23	Quarry	Canada Cement Co	O. Lacroix	25	Laborer	Bruised hand	Hand being caught between bucket and car.
Mch. 5	British Can	Asbestos Corp. of Canada Ltd.	G. Turmel	42	Carpenter	Slight Injury	Sliding of drying tube.
" 26	Beaver Mine	Asbestos Corp. of Canada Ltd.	P. DeRouasseu	34	Mill man	......	Ran splinter into right hand
" 30	British Can	" " "	O. Laventure	25	Pit Laborer	Big toe of right foot crushed	Rock 400 lbs rolled on his foot.
" 30	Quarry	Laurentian Granite Co	A. Joannett	......	Laborer	Foot crushed	In handing heavy stone.
Apl. 5	Bell Mine	Asbestos Corp. of Canada Ltd.	E. Nadeau	20	"	Scalp and leg wounds	Premature blast.
" 12	British Canadian	Asbestos Corp. of Canada Ltd.	Jean Dion	29	Pit Laborer	Thumb cut and bruised	Tripped and fell on sharp rock.
" 12	King's Mine	" " " "	Frs. St. Pierre	56	" "	Bruise on foot	Foot caught between drawbars o car
" 13	" "	" " " "	Nacr. Belemare	45	" "	Bruise on eye	While breaking stone.
" 13	"	Laurentian Granite Co.	Henry J. Mayo	......	" "	Hand bruise	Caught between crane chain and granite block.
" 22	Quarry	Canada Cement Co.	N. George	27	Quarry man	Slight cut on head	Lever of clayscraper struck him.
" 27	British Canadian	Asbestos Corp. Ltd.	Geo. Tardif	56	Pit Laborer	Two toes of right foot crushed	Derrick box dropped on his foot.
" 30	" "	" " "	Jos. Ferland	21	Brakeman	Contusion of index of right hand	Coupling cars.

NON-FATTAL ACCIDENTS

Date 1912		Mine or Quarry	Name of Proprietor	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
May	4	Kings Mine	Asbestos Corporation	F. Perron	23	Laborer	Bruised leg	While breaking stone.
"	16	Quarry	Canada Cement	Unknown	34	"	Two toes bruised	Left foot crushed under rolling stone
"	21	Bell Asbestos	Bell Asbestos Mines	Moïse Leblond	47	Foreman	Fracture skull	Stone rolled down from end of pit
"	24	B. & A. Asbestos	B. & A. Asbestos	Louis Pomerleau	65	Laborer	Forearm and three ribs broken	Arm caught between strap & pulley
"	28	Quarry	Laurentian Granite Co.	Osias Girard	35	"	Foot crushed	Stone slipping off crane chain.
June	28	Berlin Mine	Berlin Asbestos	Joseph Vachon	....	"	Loss of eye, eye injured and body bruised	Premature explosion of dynamite.
"	28	Berlin Mine	Berlin Asbestos	A. Couture	......	"		
"	28	Quarry	Canada Cement Co.	B. Scruk	25	"	Hand and fingers bruised	While placing steel rail.
July	19	Quarry	Canada Cement	Geo. Kutger	30	Laborer	Two fingers slightly crushed	Cut in swinging bucket.
Aug.	2	....	Height of Land	W. Baumann	......	"	Hand cut	Cut with an axe.
"	7	Quarry	Canada Cement Co.	J. Nobert	46	Teamster	Left knee slighty bruised	Dumping horse wheel scraper.
"	10	Asbestos Mine	B. & A. Asbestos	Arthur Jacques.	31	Millwright	Contusion one finger	Lifting cyclone shaft.
"	26	Quarry	Canada Cement Co.	Alek. Moldowan	25	Laborer	Index finger right hand torn off	Hooking chain on bucket.
Oct.	11	"	Canada Cement Co.	M. Puskadrac	......	"	Hand injury	Unknown.
"	17	Kings Mine	Asbestos Corp. of Canada Ltd.	Henri Leblond	21	"	Head injury fracture of jaw and bruised to left shoulder	Struck on head by box of stones and knocked down in pit.
"	20	British Canadian	Asbestos Corp. of Canada	Rosario Drouin	18	Brakesman	Finger and thumb of right hand crushed	Coupling car.
"	26	....	Calumet Metals Co.	Onézime Leperre.	28	Laborer	Scalp wound	Small rock scaling off side of shaft.
Nov	3	Quarry	Canada Cement	M. Lubrey	42	"	Bruised leg	Loading buckets.
"	6	"	" "	John Hall	50	Power man	Injured foot	Foot caught while descending bucket.
	13	"	" "	W. Paquette	26	Laborer	Right hand inflamed	Right hand slipped on chain.
"	20	Kings Mine	Asbestos Corporation	Nap. Legaré	50	"	Left arm fractured	Loading carts of bags in shed.

Nov.	25	Quarry	Emile Lebelle	L. Archambeault	21	Clerk	Bruised leg	Explosion of dynamite in storage.
"	27	Asbestos	Johnson's Co.	Henri Dedrochers	20	Laborer	Right leg bruised	Struck on leg by heavy stones.
"	29	Beaver Mine	Asbestos Corporation	Mitas Zolick	40	"	Upper arm and wrist broken	Loading boxes.
Dec.	3	Copper Mine	East Canada Smelting Co.	Dan. McCloud	46	Timberman	Wrenched ankle	Rolling stone.
"	3	Asbestos	Jacobs Asbestos Mining Co.	A. Misbbok	25	Laborer	Brakeman	Earth slide.
Dec.	3	Asbestos	Jacobs Asbestos Mining Co.	N Fisbook	45	"	Dislocation of hip and broken leg	Earth slide.
"	9	Quarry	James Brodie	W. Croston	33	"	Broken rib	Stumbled and fell against car.
"	13	Jeffrey Mine	Asbestos & Asbestic Co.	David Boisvert	29	"	Fracture of right rib	Swinging box being lowered into pit
"	21	Zinc & Lead Mine	Calumet Metal Co.	Octor Lemairer	45	"	Two fingers of right hand crushed	In crushing rolls.
"	28	Copper Mine	East Canada Smelting Co.	E. Beaulé	17	"	Bruised foot	Rock dropped from car on foot.

LIST OF THE PRINCIPAL MINERAL PRODUCERS IN THE PROVINCE OF QUEBEC.

ASBESTOS

The Asbestos & Asbestic Co., Ltd.,
James R. Pearson, Manager, Asbestos, P.Q.

Asbestos Corporation of Canada, Ltd.,
R. P. Doucet, Secretary, 263 St. James Street, Montreal, P.Q.

The Bell Asbestos Mines,
Geo. R. Smith, V. P., and Manager, Thetford Mines, P.Q.

The B. & A. Asbestos Co.,
J. A. E. Audet, Manager, Robertsonville, P.Q.

The Berlin Asbestos Co., Ltd.,
W. Rumpel, Manager, Rumpelville, P.Q.

Black Lake Asbestos & Chrome Co., Ltd.,
J. E. Murphy, Manager, Black Lake, P.Q.

Frontenac Asbestos Co.,
East Broughton, P.Q.

The Jacobs Asbestos Mining Co. of Thetford, Ltd.,
W. R. Leventritt, Manager, Jacobs Building, Montreal.

Johnson's Company,
A. S. Johnson, Manager, Thetford Mines, P.Q.

Ling Asbestos Co.,
J. J. Penhale, Manager, East Broughton, P.Q.

The Martin-Bennett Asbestos Mines, Ltd.,
H. E. Peters, Secretary, Thetford Mines, P.Q.

Robertson Asbestos Mining Company,
Thetford North, P.Q.

OCHRE

Thos. H. Argall,
P.O. Box No. 2, Three Rivers, P.Q.

Canada Paint Co., Ltd.,
Jos. Bradley, Manager, 572 William Street, Montreal, P.Q.

Champlain Oxide Co.,
P. D. Carignan, Manager, Three Rivers, P.Q.

Francois Ouellet,
Ste. Gertrude, Co. Nicolet, P.Q.

COPPER

East Canada Smelting Co., Ltd.,
L. D. Adams, Manager, Weedon, P.Q.

Eustis Mining Co., Ltd.,
L. M. Adsit, Manager, Eustis, P.Q.

The Garthby Copper Mining Co.,.,
T. Lapointe, Manager, Garthby, P.Q.

A. O. Norton,
Wm. Jenkins, Manager, Coaticook, P.Q.

MAGNESITE

Canadian Magnesite Co., Ltd.,
C. L. Higgins, Manager, 708 Eastern Townships Building, Montreal.

CHROME

Black Lake Asbestos & Chrome Co., Ltd.
J. F. Murphy, Manager, Black Lake, P.Q.

The Dominion Chrome Co.,
A. C. Calder, Manager, 86 Notre Dame Street, Montreal.

MINERAL WATER

Abenakis Mineral Springs Co., Ltd.,..
W. E. Watt, Manager, Abenakis Springs, P.Q.

Alfred Ferland,
St. Benoit, Co. Deux-Montagnes, P.Q.

The Radnor Water Co.,
Geo. C. Kemp, Manager, Mark Fisher Building, Montreal.

Cyp. Roy,
St. Germain, County Kamouraska, P.Q.

St. Leon Mineral Water Co.,
St. Leon, Co. Maskinongé, P.Q.

Veuillet & Frere,
St. Généviève, Co. Batiscan, P.Q.

PHOSPHATE

Blackburn Brothers,
H. F. Forbes, Manager, 202 Creighton Street, Ottawa, Ont.

Electric Reduction Co.,
W. A. Williams, Manager, Buckingham, Co. Labelle, P.Q.

R. J. McGlashan, ..
W. McGlashan, Manager, Wilson's Corners, P.Q.

O'Brien & Fowler,
Bush Winning, Manager, Cumming's Bridge, Ottawa, Ont.

IRON

The Canada Iron Corporation,
Imperial Bank Building, Montreal, P.Q.

International Tool Steel Co., Ltd.,
603 Standard Bank Building, Toronto, Ont.

GRAPHITE

The Bell Graphite Co., Ltd.,
C. Kendall, Manager, Buckingham, P.Q.

The Buckingham Graphite Co.,
H. P. H. Brumell, Manager, Buckingham, P.Q.

Canadian Graphite Company,
T. W. P. Patterson, Manager, 207 Coristine Building, Montreal.

Dominion Graphite Co.,
H. P. H. Brumell, Manager, Buckingham, P.Q.

Graphite Limited,
220 Board of Trade Building, Montreal.

The Peerless Graphite Co.,
H. W. Ham, Manager, 64 Clinton Avenue, Rochester, N.Y.

The Quebec Graphite Co., Ltd.,
A. Geister, Manager, Buckingham, P.Q.

MICA

Wm. Argall,
Laurel, Co. Argenteuil, P.Q.

Blackburn Bros.,
H. L. Forbes, Manager, Ottawa, Ont.

The Capital Mica Co., Ltd.,
W. Ahearn, Manager, Ottawa, Ont.

H. T. Flynn,
108 Mountain Street, Hull, P.Q.

J. B. Gauthier,
Buckingham, Que.

Kent Bros.,
H. McCadden, Manager, Kingston, Ont.

The Laurentide Mica Co., Ltd.,
Corner Queen and Bridge Streets, Ottawa, Ont.

Rinaldo McConnell,
175 Cooper Street, Ottawa, Ont.

R. J. McGlashan,
Wilson's Corners, P.Q.

O'Brien & Fowler,
Bush Winning, Manager, Cummings Bridge P.O., Ottawa.

W. L. Parker,
Buckingham, Que.

The Vavasour Mining Association,
T. F. Nellis, Manager, 22 Metcalfe Street, Ottawa.

Wallingford Mica and Mining Co., Ltd.
E. Wallingford, Manager, Perkins Mills, P.Q.

TITANIFEROUS IRON ORE

Baie St. Paul Titanic Iron Ore Mining & Export Co.,
J. O. Paré, Manager, Baie St. Paul, Co. Charlevoix, P.Q.

J. E. Globensky,
215 St. Catherine Street West, Montreal.

The Loughborough Mining Co., Ltd.,
G. W. McNaughton, Manager, Schenectady, N.Y.

GOLD

La Compagnie Champs d'Or Rigaud-Vaudreuil, Ltd.,
Room 425 Transportation Bldg., Montreal.

Raleigh Gold Mining Syndicate,
Walter Raleigh Kerr, Manager, East Angus, P.Q.

SAND

Cumming-Lawlor Sand & Supply Co., Ltd.,
H. F. Cumming, Manager, Cor. Ottawa and Seminary Sts., Montreal.

Dominion Sand & Stone Co., Ltd.,
J. E. Levasseur, Manager, 703 Canadian Express Building, Montreal.

The Montreal Sand & Gravel Co., Ltd.,
J. B. Galarneau, Manager, 270 Ottawa Street, Montreal.

The Touzin Sand Co., Ltd.,
Jos. Touzin, Manager, 1371 Cadieux Street, Montreal.

PEAT

Peat Industries Ltd.,
Imperial Bank Building, Montreal.

SLATE

New Rockland Slate Co.,
377 St. Paul Street, Montreal, P.Q.

BRICK

L. Auger, M.D.,
St. Tite, Co. Champlain, P.Q.

Ernest Beaudet,
St. Jean Deschaillons, P.Q.

Lucien Beaudet,
St. Jean Deschaillons, P.Q.

Zéphirin Beaudet,
St. Jean Deschaillons, P.Q.

Jos. Bernier & Cie,
821 rue Iberville, Montreal.

Narcisse Blais,
12 Marie de l'Incarnation, Quebec.

C. Bourdon,
605 Davidson Street, Hochelaga, Montreal.

Victor Charland,
St. Jean Deschaillons, P.Q.

Eugène Chrétien,
St. Jean Deschaillons, P.Q.

Citadel Brick and Paving Block Co.,
76 St. Peter Street, Quebec.

La Compagnie de Briques de L'Islet, Ltd.,
L'Islet, P.Q.

Pierre Desjardins & Cie,
Ste. Thérèse de Blainville, P.Q.

The Eastern Townships Brick & Manufacturing Co.,
Lennoxville, P.Q.

Grand Nord Briqueterie,
Ville St. Tite, Co. Champlain, Que.

Lafontaine & Martel,
St. Tite, Co. Champlain, P.Q.

Alexandre Laliberté,
St. Jean Deschaillons, P.Q.

The Laprairie Brick Co., Ltd.,
Laprairie, P.Q.

Napoléon Loiselle,
Granby, P.Q.

D. G. Loomis & Sons,
Sherbrooke, Que.

Mount Royal Brick Co.,
Varennes, P.Q.

Paradis & Letourneau,
Stadacona, Que.

Ulderic Paris,
St. Jean Deschaillons, P.Q.

F. Rinquet,
Rimouski, P.Q.

St. Lawrence Brick Co., Ltd.,
M. W. Davidson, Manager, Laprairie, P.Q.

LIME

Arnaud & Beaudry,
Joliette, Que.

The Dominion Lime Co.,
Marbleton, Co. Wolfe, P.Q.

C. A. Gervais,
1460 Cadieux Street, Montreal.

Z. O. Limoges,
1323 St. Catherine Street East, Montreal.

Olivier Limoges, Sr.,
477 Papineau Avenue, Montreal.

The Montreal Lime Co.,
31 Prenoveau Street, Montreal.

Naud & Marquis,
St. Marc des Carrières, P.Q.

Joseph Robert,
Beauport, Que.

Sovereign Lime Works,
58 St. James Street, Montreal.

Standard Lime Co., Ltd.,
Joliette, P.Q.

Wright & Co.,
Hull, Que.

CEMENT

The Canada Cement Co., Ltd.,
Herald Building, Montreal.

MARBLE

La Cie de Marbre du Canada, Ltd.,
St. Thècle, P.Q.

Dominion Marble Co., Ltd.,
Henry Brown, Superintendent, Turcot, Montreal.

The Missisquoi Marble Co., Ltd.,
631 Coristine Building, Montreal.

The Pontiac Marble Lime Co., Ltd.,
193 Sparks Street, Ottawa.

GRANITE

Argenteuil Granite Co., Ltd.,
42-44 Craig Street West, Montreal.

James Brodie,
Graniteville, P.Q.

James Brodie & Son,
Iberville, P.Q.

La Compagnie de Granit de Megantic, Ltd.,
Lake Megantic, P.Q.

M. P. & J. T. Davis,
14 St. Peter Street, Quebec.

I. A. Lacombe,
St. Sebastien, Co. Frontenac, P.Q.

Laurentian Granite Co., Ltd.,
Room 94, 224 St. James Street, Montreal.

S. B. Norton,
Beebe Junction, P.Q.

Jos. Perron,
Rivière à Pierre, P.Q.

Rogers & Quirk,
1701 Iberville Street, Montreal.

Stanstead Granite Quarries Co., Ltd.,
Beebe, P.Q.

Fortunat Voyer,
Rivière à Pierre, P.Q.

LIMESTONE

Ernest Beaupré,
Village Bélanger, Co. Laval, P.Q.

The Chateau Richer Quarry Co.,
Sault à la Puce, Co. Montmorency, P.Q.

Georges Chateauvert & Cie,
St. Marc des Carrières, P.Q.

La Cie des Carrières,
St. Marc des Carrières, P.Q.

La Commission des Champs de Bataille Nationaux,
Quebec, Que.

La Compagnie de Briques de Quebec, Ltd.,
Beauport, Que.

DeLorimier Quarry Co.,
1952 Iberville Street, Montreal.

The Deschambault Stone Co.,
St. Marc des Carrières, P.Q.

John P. Dixon,
Villeray Quarry Co., 848 Du Rosaire Street, Montreal.

The Felix Labelle Quarry Co., Ltd.,
Terrebonne, Que.

The Fleming Dupuis Supply Co., Ltd.,
340 Sparks Street, Ottawa.

Joseph Gingras,
St. Marc des Carrières, P.Q.

Joseph Gravel,
488 Duluth Avenue East, Montreal.

Haney, Miller, Quinlan & Robertson,
Montreal, P.Q.

Haney, Quinlan & Robertson,
Montreal, P.Q.

Emile Labelle,
35 Notre-Dame Street West, Montreal, Que.

Louis Labelle & Co.,
St. Francois de Sales, P.Q.

Elz. Laforce,
St. Marc des Carrières, P.Q.

Laurin & Leitch,
5 Beaver Hall Square, Montreal.

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477 Papineau Avenue, Montreal.

O. Martineau & Fils, Ltd.,
Alfred Martineau, Manager, 371 Marie Anne Street, Montreal.

Damase Naud,
St. Marc des Carrières, P.Q.

W. J. Poupore & Co., Ltd.,
124 Board of Trade Building, Montreal.

The Standard Quarries, Ltd.,
Room 507, New Birks Building, Montreal.

Rogers & Quirk,
1701 Iberville Street, Montreal.

Joseph Rheaume,
907 Desjardins Avenue, Maisonneuve, Montreal.

Stinson Reeb Builders Supply Co., Ltd.,
E. T. Bank Building, Montreal.

Wright & Co.,
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W. & D. Bell,
1286 St. Valier Street, Quebec.

Canadian Trenton Potteries Co., Ltd.,
W. C. Campbell, Manager, St. Johns, P.Q.

I. T. Farrar,
Iberville, P.Q.

The Montreal Terra-Cotta Lumber Co.,
Hubert Desjardins, Manager, Lakeside, P.Q.

The Standard Clay Products, Ltd.,
W. C. Trotter, Manager, 157 St. James Street, Montreal.

PROVINCE OF QUEBEC
GOVERNMENT ASSAY LABORATORY

(Under the Direction of the Department of Mines of the Province of Quebec as an Aid to the Development of the Mineral Resources.)

TARIFF OF FEES FOR ASSAYS AND ANALYSES

DETERMINATIONS		Less than 5 samples. Each:	For 5 samples or more Each:
		$ Cts	$ Cts
Moisture		0..25	0..25
Combined water		0..50	0..50
Gold and Silver		1..00	0..90
Silica, Copper, Iron	1 constituent	1..00	0..90
	2 constituents in same sample	1..75	1..50
Graphite, Alumina, Lime, Magnesia, Sulphur, Lead, Nickel, Cobalt	1 constituent	1..50	1..35
	2 constituents in same sample	2..50	2..25
Antimony, Zinc, Manganese, Chromium, Titanium, Arsenic, Phosphorus, Platinum, Bismuth	1 constituent	2..00	1..80
	2 constituents in same sample	3..50	3..15
Commercial analysis of an iron ore comprising determination of silica, iron, phosphorus, titanium and sulphur		6..50	5..85
Commercial analysis of a limestone or cement comprising: silica, lime, iron, alumina, magnesia, and sulphuric acid		6..00	5..40
Commercial analysis (proximate analysis) of a fuel comprising: ash, volatile, combustible, fixed carbon, moisture		3..00	2..70
Calorific power of a fuel		1..50	1..35
Radioactivity of a mineral		1..00	0..90
Radioactivity of a mineral water		2..00	1..80

Determination of Minerals.—For a nominal fee of 25c for each sample the laboratory will make determinations of ores and minerals provided rapid tests will allow it and issue a report on probable contents and commercial value of specimens and samples.

Terms.—Money in payment of fees by registered letter, postal notes or orders must invariably accompany the samples in order to insure prompt return of certificate.

ECOLE POLYTECHNIQUE
Mining Department

Professor E. DULIEUX,
In charge of Laboratory.
No. 228 St. Denis St.
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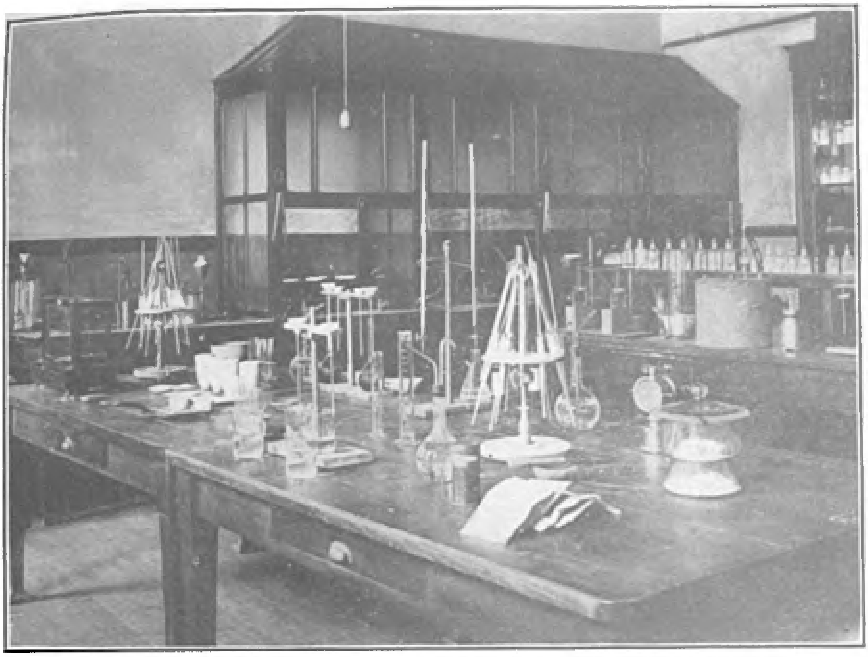
Copies of this tariff may be obtained in French or English



PROVINCIAL GOVERNMENT LABORATORY, MONTREAL.

PROVINCIAL GOVERNMENT LABORATORY, MONTREAL.—Assay room.

PRELIMINARY REPORT ON SOME IRON ORE DEPOSITS IN THE PROVINCE OF QUEBEC *

(By E. Dulieux, M. E.)

INTRODUCTION.

This report is a sequel to the preliminary report which has already appeared in the "Report on Mining Operations in the Province of Quebec during the year 1911."

It contains a description of nearly all the important deposits of iron that are at present known in the Province and not mentioned in the previous report. All these deposits were personally visited by the writer.

The following descriptions are given in the order in which the deposits were inspected. The Bureau of Mines of the Province of Quebec intends, however, to publish in a more elaborate work all the descriptions given in the two preliminary reports. That work, which is now in preparation, will contain a complete study of the iron ore deposits of the Province of Quebec, some geological notes giving the precise nature of the various deposits and also some metallurgical notes on what use can be expected to be made of the ores, more especially of the titaniferous ores.

REGIONS VISITED.

The two months I devoted to field work were unfortunately mostly occupied in travelling from one place to another, and the time I could usefully employ in inspecting each deposit was necessarily very limited.

*Translated from the French by Mr Crawford Lindsay.

The last fortnight of June was spent in an examination of the Ivry and Desgrosbois deposits in the vicinity of St. Agathe. The first ten days of July were spent in inspecting the Grondin mine at St. Boniface de Shawinigan and the Batiscan-Champlain sands. Between the 10th and the 21st July, I examined various deposits along the outlet of Lake St. John (the Saguenay river). From the 25th July to the 3rd August I was in the Gaspé peninsula, near Newport, whence recent discoveries of hematite were reported. The remainder of the month of August was spent in examining some deposits in the Eastern Townships (the Beauceville, Leeds and Spalding mines) and also some deposits near Ottawa (the Baldwin, Forsyth, Haycock and Bristol Mines.)

I was accompanied in all these inspections by Mr. André Lefeuvre, an engineering student of the Polytechnic School in Montreal, whose intelligent work was of great assistance to me.

IVRY MINE.

LOCATION :—The workings of the Ivry mine are on lots 37 West and 38 of range V, Township of Beresford. They are marked A on plan Fig. 1.

They are reached, from Ivry station (67 miles north of Montreal on the Montreal and Mont-Laurier Railway) by a road about 3¼ miles long running past the Lake Manitou post office.

The country is somewhat broken ; rounded hills separate the streams and deep-bayed lakes. Thus, the workings indicated by the letter A on plan 1 are scattered over the slope of a rather steep hill, rising from 300 to 330 feet above Lake Manitou.

The dotted lines on the plan approximately represent the contours ; they are equi-distant about 70 or 80 feet. Their sole object is to give an idea of the country's relief.

GEOLOGY :—The rocks of the area shown on plan Fig. 1 are very uniform in character. They form part of the anorthosite mass which has been called "the Morin Mass" since Dr F. D. Adams' report.(*) In the vicinity of the Ivry mine the

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* Report on the geology of a portion of the Laurentian, by Frank D. Adams.—Geol. Surv. of Can., 1896.

anorthosite is massive, generally sound and with no traces of foliation. Its colour is deep, varying between a more or less dark gray and brownish pink. The most frequent ferro-mag-

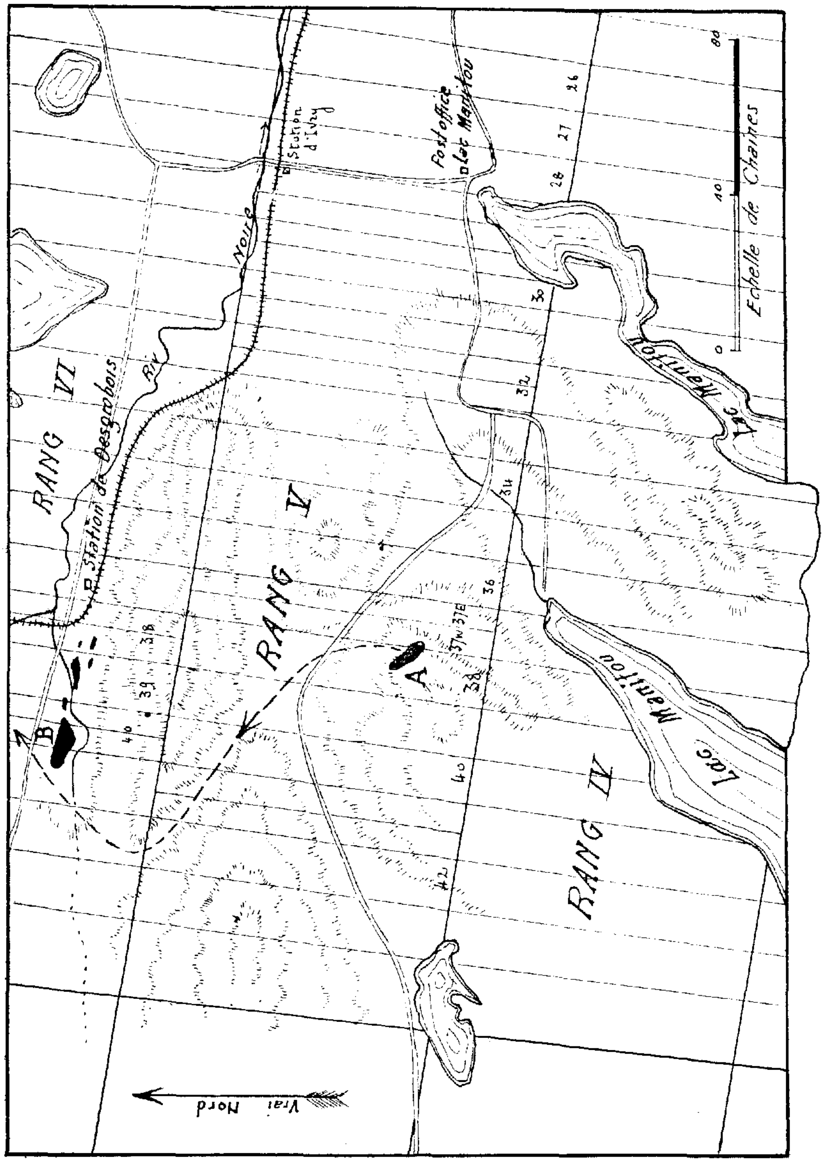


Fig. 1—Location of Desgrosbois and Ivry mines, Beresford township, Terrebonne county.

nesian element, accompanying the plagioclase feldspars which are the chief constituents of the mass, is a more or less diallagic pyroxene.

As will be seen further on, the titanic iron ore occurs in segregated masses in the anorthosite. As is usually the case with anorthosite, these masses are always clearly outlined from the encasing rock and the transition from ore to rock is abrupt without any trace of crushing by friction of one mass against the other.

It is not unusual to find amidst the iron ore (particularly on the edges of the masses) perfectly outlined feldspar crystals. All these features would therefore lead to the conclusion that the consolidation of the anorthosite and titanic iron was effected, if not simultaneously, at least at very close intervals and that the anorthosite was the first to crystallize.

Nature and Extent of Deposits—

The deposit is revealed by a series of prospecting trenches or the northeast slope of a hill whose upper half is covered with timber. The rock is generally hidden under a layer of gravel and sand covered with vegetable mould so that no natural outcropping of ore is visible.

Plan Fig. 2 shows the site of the various workings.

The most important are two open cuts (C and D) and a large trench (K.K.)

Cuts C and D:—Cut C, about 10′ x 14′, has been made in fairly good ore which, however, is not continuous on all the sides of the excavation. Anorthosite tongues appear amidst the ore while the latter itself is charged with feldspar crystals or grains very visible on the weathered surfaces.

Cut D, about 30 feet above the foregoing, is, on the contrary, in pure ore which can be followed the whole length of the cut (about 30 feet) from the working face, and is found 20 feet further to the southeast under the moss. Anorthosite shows at the base of the working face, with titanic iron beneath.

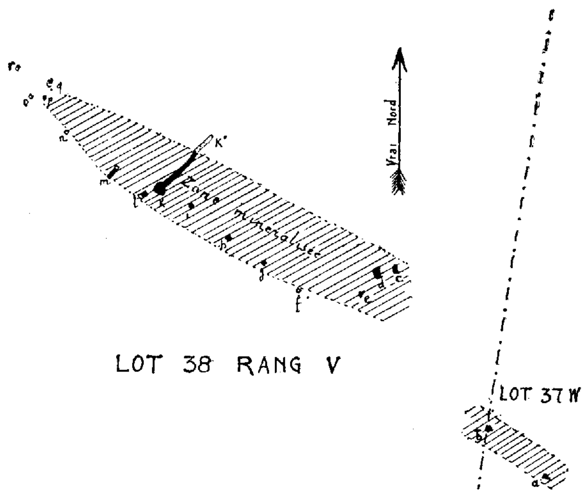


Fig. 2—Workings of Ivry mine.

TRENCH K. K :—This trench is about 150 feet long and follows pretty closely the greater slope of the hill at this point. It widens at its head and forms a hole dug almost entirely in titanic iron. The ore runs nearly 100 feet from the head of the trench. The last 50 feet consist of anorthosite with some grains of titanic iron.

A small hole (marked l), about 20 feet higher, shows a contact of titanic iron with anorthosite so that the width of the titanic iron mass at this point may be put at 120 feet.

Other Workings—

These consist of small pits from 2 to 3 feet wide and from 3 to 5 feet long, with a depth of from 2 to 5 feet through the layer of gravelly clay.

The showing of these pits at the time of my visit, was as follows :—

PIT F :—The floor consists of a rock charged with black mica and titanic iron.

PIT G :—Full of water ; titanic iron debris on the edge.

PITS H. AND I :—Floor of fine titanic iron.

TRENCH M :—Ten feet long, showing 7 feet of titanic iron between a true anorthosite on one side and an anorthosite impregnated with iron on the other. The contact of the true anorthosite with the iron is very well defined.

PIT N :—Full of water.

WORKING P :—A small stripping showing good ore.

WORKING Q :—A fairly large stripping showing a mixture of anorthosite, titanic iron and pyrites.

We prospected towards the southeast for the prolongation of the deposit revealed by the pits. By removing the vegetable mould at points where the rock was not too deeply buried, we uncovered some outcroppings of titanic iron, as for instance at points A and B (plan Fig. 2) on lot 37W. It will be noticed that the ore comes in contact with the anorthosite there and that the contact lines seem to run northwesterly.

By co-ordinating these various results, it may be inferred that all these discoveries belong to one mineralized zone perceptibly trending from W.N.W. to E.S.E. According to plan Fig. 2, this zone, rectilinear for the greater part of its length, would seem to deflect so as to join the outcroppings A and B. As a matter of fact we have no precise knowledge of its real shape; the outcroppings A and B may be detached from a main tongue or be merely isolated accidents. In any case, the minimum length of this zone may be given as 750 feet, which would extend to 1,100 by including the outcroppings A and B, and its width at 120 feet (at least at one point K. K.)

There is little probability that this zone is but one continuous mass; on the contrary, there must be a series of segregated masses doubtless extending in the same direction as the zone and separated from one another by anorthosite tongues.

It is difficult to give an estimate of the quantity of ore in that zone on account of the covering of gravelly clay and vegetable mould concealing the solid rock everywhere. Prospecting will perhaps bring to light great masses of anorthosite between the various masses of ore; a wider mineralized area may likewise be found by the same means around C and D. In any case, the quantity is amply sufficient to justify of mining being started and prospecting carried on.

Nature of the Ore—

The ore is a normal titanic iron absolutely similar both as regards composition and appearance to that of Baie St. Paul. Two samples were taken: Nos. 4 and 5 are average samples of the ore found on dumps at the side of the cut C and at the head of the trench K. K. respectively. An analysis gave:—

	No. 4	No. 5
Fe O	61.78	61.53
Ti O_2	30.28	31.64
Corresponding to iron..	48.05	47.86
Titanium	18.18	19.00

It is probable that by hand-picking, the percentage in iron and titanium might be remarkably increased.

It is titanium ore suitable for the production of ferro-titanium in an electric furnace.

Some samples, especially on the edge of the mass, contain small grains of pyrite.

Economic Data—

This deposit is favourably situated as regards both mining and the shipment of the ore. The outcrops so far discovered are on the slope of a hill close to the road leading to Ivry Station and to Ste. Agathe. The slope is steep (from 50 to 60 feet at the cuts C and D) so that it would be easy, with an open cutting to load carts on the road directly from the ore bins by gravity.

If the daily output attained fifty tons, it would be impossible to haul the ore in carts and the best way to reach the railway would be by means of an aerial tramway.

According to plan Fig. 1, an outlet should be sought in the direction of Desgrosbois and the dotted line from A to B shows that all hills can be avoided by that route. Owing to the difference of level between A and B, only a slight motive power would be required for working the hauling cable. The distance would be about 2 miles. (*)

* Since my visit a company has undertaken to mine that deposit. On the 1st February, 1913, 1600 tons had been shipped to the Titanium Alloy Company, of Niagara Falls, N.Y., having been conveyed in carts to Ivry Station.

DESGROSBOIS MINE.

LOCATION:—The outcrops of titaniferous magnetite which I include under the name of "Desgrosbois Mine," are on lots 39, 40 and 41 of range VI., Beresford township, County of Terrebonne. They are marked B on plan Fig. 1. The line of the C.P.R. between Montreal and Mont Laurier runs a few hundred feet from there and Desgrosbois Station is only 2 or 3 lots away. The nearest village, Ste. Agathe, is seven miles distant. The Rouge river, before falling into the Noire river, winds through a valley whose swampy flats extend over a width of from 200 to 400 feet. On the right bank of the stream the ground rises in a kind of plateau before the high hills are reached, -which constitute to some extent the boundary between ranges V and VI. The outcroppings are on the edge of this plateau.

When I visited the spot, no work had been done on lots 40 and 41; only a few blasts had been fired in an ore outcropping behind Beauchamp's house. I made a rapid survey around this showing with the dip-needle, and noted the dips at various points on lots 40, 39 and 38. As the southern portions of lots 38 and 39, where the needle dipped, were wooded, and it would have taken some time for a magnetic survey, I merely examined the portions of lots 39 and 40 adjoining the road. A hasty magnetic survey was made on a rocky mound covered with soil and clay, but where the needle dipped considerably.

GEOLOGY:—Here again, the rock consists of anorthosite and the ore is present in masses. The Desgrosbois masses are less clearly defined than the Ivry ones; in the mineralized zone, the rock is often impregnated with ore and the ore in the masses frequently encloses feldspars and rhombic pyroxenes.

Nature and Extent of Deposits—

LOT 39:—At the date of my visit (June, 1912), the only discovery on the lot consisted in an outcrop of magnetic iron ore about 260 feet south of Joseph Beauchamp's' house at the foot of the low anorthosite plateau I have already mention-ed. A few blasts had been fired and ore uncovered over a

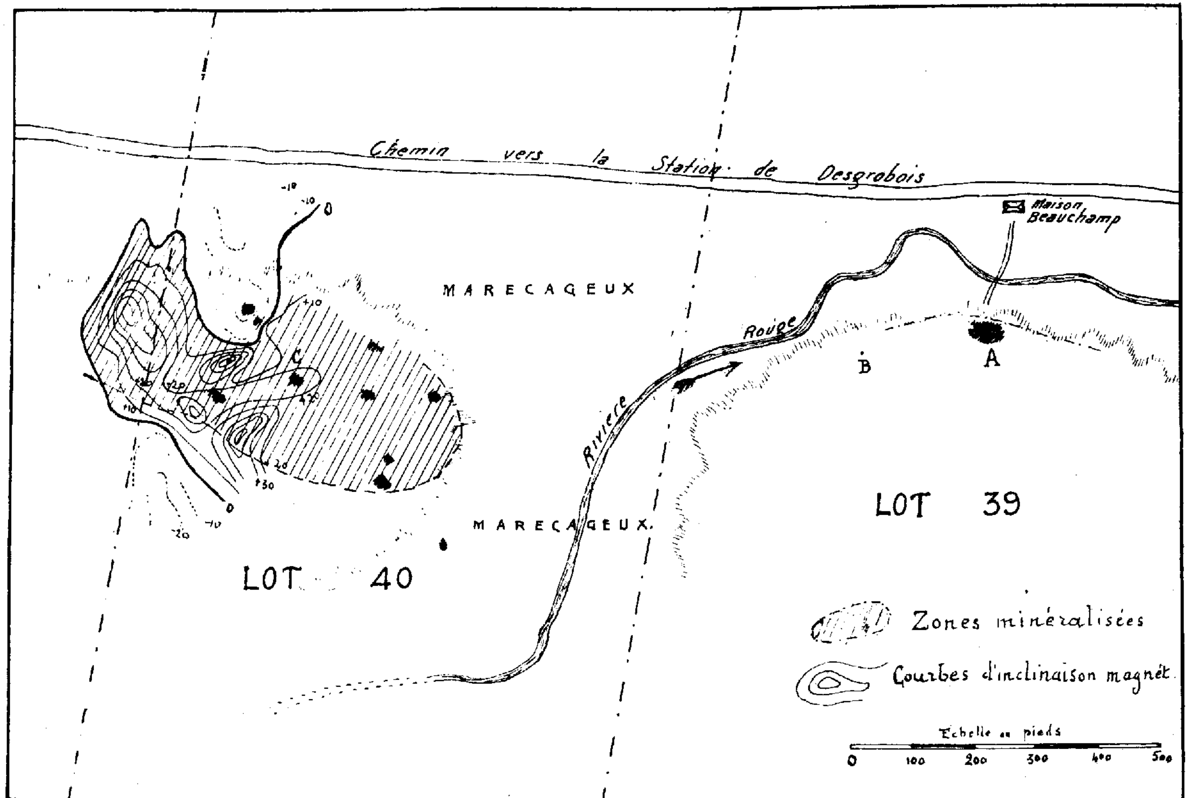


Fig. 3—Details of Outcrops at Desgrosbois mine, Beresford township.

length of 22 feet and a depth of 5 feet. A trench, 10 feet long and 2 feet wide, on the mound, also uncovered ore.

By removing the vegetable mould to the east of this prospect, over a length of 27 feet (N.S.) and a width of 22 feet (E.W.), we discovered the edge of a lens of magnetic ore. In fact, the 16 lower feet of the 27 feet in length uncovered consisted of ore, and the 11 upper feet of anorthosite.

These two outcroppings seem to form part of the same lens, probably extending in a direction parallel to the river and would thus be found over a length of from 60 to 70 feet and a maximum width of 27 feet. The observed portion of this lens is shown on plan Fig. 3 at the letter A.

By digging other prospecting pits, west of this outcrop forming the edge of the lower plateau, we found that all mineralization ceased at the point marked B and west of it, and that nothing but anorthosite was met with. Between A and B, some pits gave us anorthosite while others showed ore. Thus, half way between A and B, a series of small holes dug in a circle with a 17 foot radius, always showed ore.

The lens A does not consist solely of compact magnetite; barren beds appear from time to time; these are intrusions of schistose rocks made up mostly of feldspar and titanomagnetite. Such intrusions are, however, of slight importance.

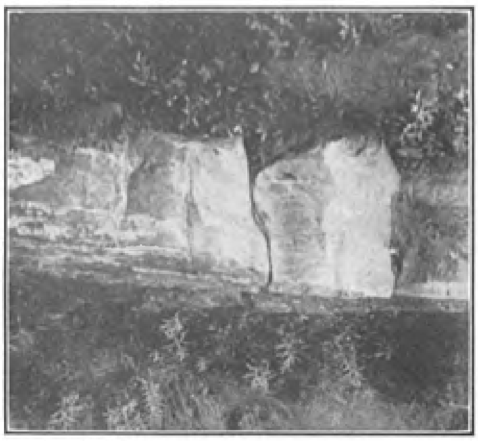
LOTS 40 AND 41:—Plan No. 3 is a summary of the results of our prospecting on a sort of anorthosite mound standing a few feet above a swampy flat. The various outcroppings of titanomagnetite which we uncovered by removing a thin layer of vegetable mould, are shown in black. No outcrop could be followed for any great length and the dimensions of the lenses to which they belong, are probably very limited.

The largest outcropping we noticed is at the point marked D on plan Fig 3. Around a small boss of magnetic iron, 4 by 6 inches, a mineralized mass, 47 feet long and 27 feet wide, may be seen. This mineralized mass is far from being of pure ore; it is heavily charged with feldspar, and, as will be seen further on, the sample taken from the surface to roughly represent an average ore, gives but rather low averages in iron. The dimensions of other outcrops (as at C) are from 10 to 15 feet.

Prospecting Pits, Desgrosbois Mine.

Ivry Mountain.

Outcrop of Ore-beds, Leeds Mine.



Zonal structure of ore (magnetite and quartz) Leeds Mine.

The ore outcroppings shown on plan Fig. 3 are those we found by removing the vegetable mould. It was impossible to connect them together through lack of systematic prospecting work.

A little further West, as one approaches the fence between lots 40 and 41, the covering of earth and gravel becomes thicker and the bed-rock cannot be reached without digging rather deeply. We surveyed with the dip-needle, taking the readings at the angles of squares with 30 foot sides. The results are combined in the shape of curves. It will be observed by the latter that, if the mineralized zone is rather extensive, the masses of true ore represented by attraction areas exceeding 50 degrees, are of somewhat limited dimensions.

To sum up, the deposit occurs as a series of segregated masses due to generally successive enrichments in the midst of an anorthosite. The ore being magnetic, portions of the richly mineralized zone might be mined and high grade ore be obtained by rapid magnetic concentration on the spot. Possibly also prospecting might reveal the presence on lots 40 and 41 of masses of ore, which could be utilized without concentration.

Nature of the Ore—

The ore belongs to the class of titanomagnetites, that is of titaniferous magnetites.* It is attracted by the magnet but less strongly than normal magnetite.

As will be observed by the analysis, the percentage in iron is rather low; this is due to the fact that there are nearly always feldspars and pyroxenes (sometimes biotite) admixed to the ore.

	Sample No. 8	Sample No. 10	Sample No. 14	Sample No. 15
FeO	52.48	55.16	59.97	56.70
TiO_2	7.48	11.25	30.12	8.48
Corresponding to:				
Iron	40.76	42.85	46.59	44.04
Titanium	4.49	6.73	18.09	5.09

* We make a distinction between titanic iron ores (ilmenite) containing from 18 to 24 per cent of titanium and the titaniferous magnetites containing from 4 to 10 per cent of titanium. The former are titanium ores and the latter are special iron ores.

Samples No. 8 and No. 15 were taken on two different occasions in the mineralized portion which we uncovered at A. Sample No. 10 comes from the heap of ore already taken out at A. Sample No. 14 comes from one of the outcroppings around C.

We wished to ascertain whether it were possible to enrich the iron ore or to eliminate titanium by megnetic classifying. To that end we made the following tests on ten kilogrammes taken from the ore heap at A.

The ore was pulverized with a Braun disc-crusher until it could completely pass through a 20 mesh screen; then it was separated into 3 sizes: 20 to 40 mesh; 40 to 80 mesh, and smaller than 80 mesh. Each of these sizes was then magnetically separated by means of a small laboratory apparatus consisting of a horizontal wire cylinder revolving around an electro-magnet. The magnetic grains stuck to the revolving cylinder and were not carried away. The magnetic concentrates were weighed, and assayed for iron and titanium. The results are given in the following table:—

Magnetic concentration test of Desgrosbois titanomagnetite.

Analysis of raw ore:

Iron.........................	42.85%
Titanium......................	6.73%

From 10 kilogrammes of ore pulverized and screened through a 20 mesh screen, the following three sizes were obtained:—

(*a*) 916 grammes between 20 and 40 mesh—say						......	9.16%
(*b*) 2757	"	"	40 " 80	"	"	......	25.59%
(*c*) 6327	"	smaller than 80		"	"	......	63.27%

(*a*) 20 *mesh sample:*

Ore before treatment.........	Iron.........	49.50%
	Titanium	4.37%
Concentrates—out of 900 gr. (2 lbs)	Iron.....	57.32%
802 gr. obtained, say 89.11%	Titanium.	3.69%

Tailings—out of 900 gr. (2 lbs.) 98 gr. obtained, say 10.89%	Iron..........	27.30%
	Titanium.....	13.57%

(*b*) 40 *mesh sample:*

Ore before treatment.........	Iron.........	43.25%
	Titanium.....	6.27%
Concentrates—out of 1000 gr. 745 gr. obtained, say 74.50%	Iron..........	54.60%
	Titanium......	6.65%
Tailings—out of 1,000 gr. 254 gr. obtained, say 25.40%	Iron...........	15.28%
	Titanium......	5.52%

Loss in dust—1 gramme, say 0.10%

(*c*) 80 *mesh sample:*

Ore before treatment.........	Iron..........	41.85%
	Titanium.....	7.25%
Concentrates—out of 1000 gr. 828 gr. obtained, say 82.80%	Iron...........	47.32%
	Titanium.....	6.77%
Tailings—out of 1000 gr. 170 gr. obtained, say 17%	Iron..........	17.47%
	Titanium......	10.52%

Loss in dust—2 grammes, say 0.20%

Of course the information obtained from these tests is not perfectly complete. They might have been made quite differently. For instance a portion of the ore might have been crushed so as to pass through a 20 mesh screen and then magnetically concentrated; another portion of the ore crushed to pass through a 40 mesh screen and then magnetically concentrated. Other lots might have been treated likewise to pass through 80 and 120 mesh screens. Such a test would have more closely approached what is done in industrial practice, but the products obtained in the laboratory would not have been so clean.

In any case our tests enable us to note the following:—

1. That classifying by sizes produces enrichment in iron and a lowering of the percentage of titanium;

2. That the percentage of titanium becomes lower in the concentrates of the largest size;

3. That a comparatively small proportion of tailings is obtained in the three classes, and consequently a considerable quantity of concentrates. The percentages of these concentrates, in iron, were: 51.32%, 54.60% and 47.32%; and in titanium, 3.69%, 6.65% and 6.77%; so that there is little or no lowering of the percentage of titanium in the concentrates of the finer classes. By noting that the finest class is the largest in proportion, it will be observed that the result as regards lowering the percentage of titanium is very slight in our tests.

The Desgrosbois mine will not become really valuable unless considerable and continuous masses are discovered by prospecting and unless it be shown by more thorough tests than ours that a higher percentage can be obtained by concentration.

ST. BONIFACE DE SHAWINIGAN.

LOCATION:—St. Boniface de Shawinigan is a fairly large village in the county of St. Maurice on the line of the Canadian Northern Railway from Montreal to Quebec. It is 82 miles from Montreal and 94 from Quebec. Shawinigan Falls and the village of Shawinigan Falls on the St. Maurice are about six miles from St. Boniface.

The surrounding country is almost uniformly flat; the depressions in the rock surface are generally filled with quaternary sands and the region may be considered a plateau dissected by rivers which have eroded their beds more or less deeply through the superficial deposits. Thus the St. Maurice river, below the falls, flows between high terraces of sand and clay.

From time to time, however, rocky outcrops appear through the sandy overburden. Thus the iron deposits now referred to lie among a series of small rocky mounds rising some half-score, in some cases a hundred, feet above the general level of the ground.

The deposits are on lots 22 and 23 of range VII., Shawinigan township (see plan Fig. 4.) A fairly good waggon road, about 4 miles long, runs from St. Boniface to the place.

GEOLOGY:—Nearly all the country around St. Boniface consists of rocks connected with the Grenville series: gneiss, amphibolites and crystalline limestones. About 3 miles west of St. Boniface, however, a basic eruptive mass outcrops. It is shown on the Ottawa geological maps under the name of Anorthosite, with a length N.S. of 7 miles and a width E.W. of 2 miles. The deposits known as the "Shawinigan mine" or "Grondin mine," are in this mass.

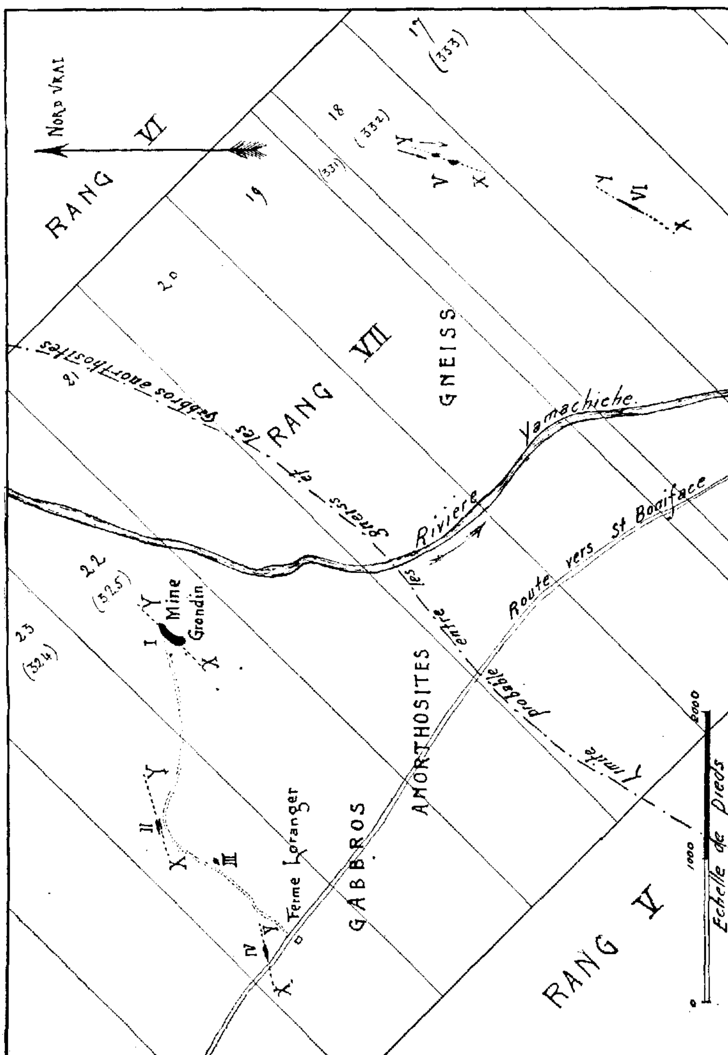


Fig. 4 Location of Grondin mine.

We had not sufficient time to ascertain the exact nature of this mass in all its details and it is quite probable that it should be associated with anorthosites, but, in the vicinity of the deposits, the rock is so charged with ferromagnesian constituents that it should more properly be associated with gabbros. All along the path leading from Loranger's house to the Grondin mine (deposit I of plan Fig. 4), the rocks consist of a mixture of feldspars, pyroxene and titanic iron very distinguishable from one another even to the naked eye on the altered surfaces. The feldspars change to chalky white; the pyroxenes appear in scaly grains (diallage or bronzite) while the unaltered titanic iron shows out in the shape of black grains.

This gabbro contains inclusions of two kinds.

The first kind seems rather to be a differentiated product of the eruptive magma. It is a rock of gneissic structure plainly laminated and in strong contrast with the gabbroic country-rock which is massive. It consists chiefly of feldspars, monoclinic pyroxenes, some rhombic pyroxenes, a little black mica and a variable quantity of titanic iron. The ferromagnesian elements are not in excess proportionately to the feldspar.

The second kind of inclusions occurs in the shape of very elongated lenses or blackish grey bands, very fine-grained, rough to the touch and very hard. Under the microscope the rock possesses all the characteristics of hornstone.

The first inclusions, those having a gneissic appearance, are closely associated with the mineralized masses. Thus the bands of ore marked II on plan Fig. 4 are directly derived from the gneissic complex by the successive enrichment of certain bands in titanic iron. A feature similar to that already mentioned in describing the titaniferous magnetites of the Rivière des Rapides at Seven Islands, is observable here: titaniferous magnetites are found with an ultra basic rock inclosed in the anorthosite gabbros. From a genetic standpoint there must have been in the magma, while still in a liquid or pastry state, a differentiation of some heavy rock very rich in ferromagnesian or titaniferous elements which might be called a pyroxenite with titano-magnetite. When the dynamic effects (pulling out, pressure, etc.) were produced, of which action the feldspars show traces, a mixing and flattening took place resulting in the encasing, in an anorthosite and a gabbro, of parallel lenses, regular long narrow zones of ultrabasic rocks, passing into a real titaniferous iron ore in some places.

The direction of the straight lines X.Y., giving in the case of each deposit the orientation of the elongation of the lenses, shows that the dynamic action produced a flattening varying in direction from southwest to south-southwest. It is interesting to note that this direction is pretty much the same as that of the line of contact between the anorthosite and the gneiss and also of those of the strip of augitite (shown at V, Fig. 4) and the vein (No. VI.) of magnetiferous pegmatite.

The diallage hornstone represents inclusion originating outside the magma. This may be a patch or outlier of the rocks invaded and broken by the intrusion of the anorthosite gabbro.

Nature and Extent of the Deposits—

The greater portion of lots 22 and 23 is bush-covered so that I could inspect only what had been uncovered by the prospecting done.

The largest deposit is that called "Grondin mine," the position of which is indicated by the numeral I on plan Fig. 4. The only excavation consists of a trench 22 feet long, 10 feet wide and 6 feet deep. It is in good ore (see further on for assays), and from it was obtained, some thirty years ago, the ore which a local company tried to smelt on the spot. Proceeding eastwardly ore can be seen at several places showing through the coating of vegetable mould and sand. The largest outcrop is at D, where the ore can be followed along a small ridge 10 feet high and 50 feet wide.

As the ore was magnetic, we tried to make a rapid magnetometric survey with the dip-needle, but our instruments were out of order and we could not obtain very accurate results. We succeeded, however, in ascertaining with some degree of certainty the limits of an area where the attraction exceeded 60°. It is in the shape of an irregular ellipse elongated in a N.E. to S.W. direction, with a length of 175 and a width of about 60 feet.

At II. is a small rocky mound containing some streaks of titanomagnetite, but which is chiefly interesting from a petrographic standpoint. The uncovered rocks over a width of about 100 feet show in parallel strips trending about W.S.W. From west to east there are first of all a gabbro of massive diallage, then a complex of gneissic structure which is merely a peculiarly basic facies of the same gabbro. This gneissic complex has already been described and consists of feldspars, pyroxenes, rhombic pyroxenes, diallage and titanic iron. This latter, in some bands of this gneiss, preponderates to such an extent as to become a true ore. The titanomagnetite may be said to constitute from 40 to 50 per cent of the mass on a breadth of 25 feet and over 75 per cent on a breadth of 18 inches.

In this complex also the hornstone intrusions already mentioned make their appearance.

At IV. is an excavation made by Mr. Loranger in a meadow adjoining the road. It is 15x15x4 feet and has uncovered a lens of magnetic titanic iron only a few feet wide on the surface, but which seems to widen in depth. To ascertain the size and above all the bearing of the elongation of this mass, we noted some dips of the needle. The maximum line of intensity (XY on plan Fig. 4) runs almost from S.W. to N.E. The area of attraction exceeding 60° is small.

As a rule, the needle is affected along nearly the whole of the path between Loranger's house and the Grondin mine, showing the existence of mineralized masses beneath the coating of vegetable mould. One of these masses outcrops at III. and they would certainly be located by a systematic magnetic survey. It should, however, be observed that the fact of there being an attraction is not sufficient to establish the existence of a deposit. A gneissic gabbro heavily charged with titanomagnetite may have a very pronounced effect on the needle and not be a workable deposit. The needle can only indicate points where something might be discovered by prospecting and definite information can be obtained by pits, trenches, borings, etc.

Nature of the Ore—

We made an attempt at magnetic concentration, as with the Desgrosbois ore, after crushing and sorting the ore by sizes. The results are given in the following table: —

GRONDIN ORE

Composition { Iron............41.55
Titanium........ 5.44

Ore before treatment. | Concentrates and tailings

	Fe%	Ti%		Fe%	Ti%
A.—From 20 to 40 mesh 29.40%	42.04	5.42	Magnetic concentrates 71.42%	49.62	4.69
			Non-magnetic tailings 28.53%	23.12	7.68
B.—From 40 to 80 mesh 28.90%	2.47	7.10	Magnetic concentrates 52.60%	58.45	2.95
			Non-magnetic tailings 47.40%	23.32	11.82
C.—Smaller than 80 mesh 41.50%	41.21	4.24	Magnetic concentrates 53.42%	53.40	2.33
			Non-magnetic tailings 46.58%	29.43	5.16
D.—Loss 0.20%					

Historical Notes—(*)

An unsuccessful attempt to smelt this ore was made some thirty years ago. In 1878, one Grondin organized a local company to mine and smelt the ore on lot 22. A square blast furnace in masonry, with blowers driven by water-power, was built on lot 17 on the right bank of the Yamachiche river. It was charged with a mixture of wood charcoal, limestone and ore

(*) From verbal information obtained on the spot.

taken from pit I on lot 22. Very liquid slag was collected for 3 or 4 days, but the furnace soon became blocked. After cooling, it was emptied and the hearth was found full of a mixture of pig-iron and solidified iron ore. After being repaired, it was again blown in with a charge of bog-iron ore from St. Paulin, a little titanic iron and limestone. Pig-iron of excellent quality was obtained and shipped to Three Rivers. At the end of two months the furnace was allowed to blow out and the enterprise was abandoned owing no doubt to the cost of transporting the product to Three Rivers which was very high in the absence of a railway at the time.

Other Prospectings for Iron Ore in the Neighbourhood—

The most extensive prospectings for the discovery of iron ore throughout the region are those indicated by V. on plan Fig 4 on lot 18, at the foot of a rocky slope, consisting of two large excavations from 8 to 18 feet deep and from 15 to 18 feet wide in a black and heavy rock, probably augitite.

The adjacent rocks are a gneiss of which the direction of the lamination is shown by small arrows. The fact of the two excavations being in an almost parallel line to that direction would lead one to believe that they are sunk in a belt of augitite interstratified in the gneiss.

This augitite is of no value and it is a pity that so much useless work should have been done, (several hundred tons were got out) through lack of technical information which could easily have been obtained.

To the W, on a rocky hill some blasting was done among lenses of a very curious pegmatite. In some places the latter is full of large magnetite crystals, sometimes as much as three inches wide. Unfortunately this vein of pegmatite is merely a mineralogical curiosity, and has no economic importance. The lenses are from two to three feet wide and from six to eight feet long; their trend is nearly S-S.W.

SAGUENAY RIVER.

It has long been known and various official reports have mentioned that more or less titaniferous magnetic iron deposits exist southeast of Lake St. John on both sides of the Saguenay between the lake and Chicoutimi.

The best known of these deposits are those in Kenogami township and Alma island. It is strange that not one of these deposits, as far as I could see, is really of any great economic importance and the only interesting deposit is an almost unknown one: that of St. Charles in Bourget township. It was pointed out to me by Mr. Obalski. The reports of the Quebec Bureau of Mines merely indicate its site.

All the deposits we will now mention are in the anorthosite which constitutes a great mass southeast, east and northeast of Lake St. John and its extent can easily be seen on the geological maps.

ST. CHARLES MINE

(Lot 44, range I., Bourget township.)

LOCATION:—The deposit is on lot 44, range I, Bourget township, about a mile and a half to the west of St. Charles village, whence a highway leads to Mr. Jean Brossard's house on lot 43.

The most visible and largest outcrops are a few hundred feet from the Saguenay river and form a kind of hill jutting out from the line of wooded heights overhanging the Saguenay.

St. Charles village can be reached either by leaving the train at Jonquieres Junction and driving the fifteen miles between it and St. Charles, crossing the Saguenay by ferry; or by getting off the train at Hebertville, crossing the Saguenay by the Alma bridge and following the Archambault road. The total distance by this route is 24 miles.

Nature and Extent of the Deposits—

The ore is a titanomagnetite present in enormous segregated masses in the anorthosite. The outcrops of these masses are the most remarkable, as regards size, of all I have seen in the Province. They appear at the foot of a hill bordering on the Saguenay and follow one another in a fairly continuous manner for about 700 feet, with a minimum width of 160 feet in the central parts.

The mineralized outcroppings are so clearly defined that we were able to survey them with a plane-table and plan Fig. 5, which is a reduction of that survey, shows how the mineralized masses occur on the ground.

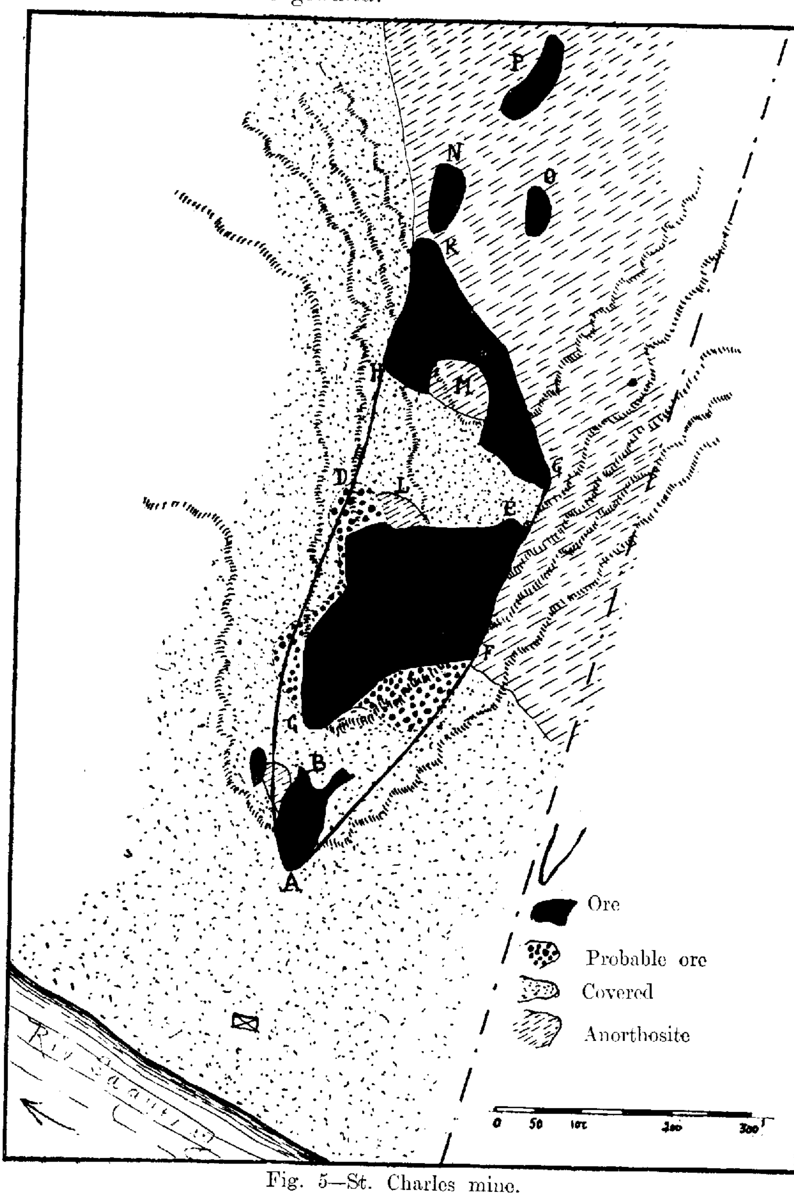


Fig. 5—St. Charles mine.

Starting from A, we find (plan Fig. 5) first of all a lens A.B. which soon disappears under the vegetable mould. At C, D, E, F an extensive diamond shaped outcrop appears, its dimensions being 326 by 200 feet. East and west of this outcrop the hill slopes consist of blocks of iron ore emerging from the vegetable mould, so that the lens must probably crop out with a greater width than that above given. On the plan we call this extension "probable ore." Between D, E and G, H, is a slight depression in the soil and the iron disappears under a layer of fine sand. But at G, X the titanomagnetite again crops out over a triangular area of about 1,000 square feet.

The anorthosite appears in a large mass only northeast of the line F. G. K., and consequently, on that side, it stops short against the mineralized mass. To the west, the mass disappears under fallen rock and may extend beyond the bounds shown on the plan.

On examination of the outcrops shown on this plan, one would be led to think that they all form part of the large lens whose main axis runs from north to south, along A. K. In this lens are imbedded masses of anorthosite, either isolated or in the shape of tongues shooting out from the anorthositic mass which constitutes the country rock. The largest of these masses outcrops at L. and M. and probably spreads out half-way between these two outcroppings, for there is a depression in the hill at that spot and experience shows that anorthosite is more friable than titanomagnetite in this region; the depression D. E. G. H. would then correspond to an intrusion of anorthosite in the ore mass.

Further north isolated lenses of limited dimensions appear amidst the anorthosite; such are lenses N. O. P. A. Then a kind of plateau fairly wooded and almost covered over with vegetable mould, is reached.

Elsewhere on this plateau are other important masses of ore comparing favorably, as regards extent, with those just rescribed and we found several in the course of a rapid examination. Unfortunately no resident of that section of the country has ever explored this plateau and the accurate locating of our discoveries would have entailed a survey for which we were not prepared.

Thus, on a line running 30 degrees north by west from P. and at a distance of from 600 to 700 feet is an outcrop running from S.W. to N.E., whose greatest length exceeds 300 and its greatest width exceeds 20 feet. Those dimensions were measured by pacing over ground mostly bare of vegetable mould and showing pure ore in all the outcrops. Another lens of about equal size was seen some distance further on, but, when we wanted to determine its exact position, it was impossible to find it in the midst of the woods.

The probable quantity of ore is considerable. If we estimate the two lenses C. F. E. D. and G. H. K. separately and calculate their probable volume, taking the depth as being equal to the apparent width on the surface we get:

$\frac{320 \text{ x } 200}{2} \times 200 = 6{,}400{,}000$ cubic feet for the 1st.

$10{,}000 \times 100 = 1{,}000{,}000$ cubic feet for the 2nd.

The density of the ore being 4.4 (as ascertained at the laboratory) that is 7½ cubic feet to the ton, these two outcrops would represent 1,000,000 tons of ore.

Now, if we consider, as is very probably the case, that the outcrops of A. B. C. D. E. F. and K. H. K. form part of the same mineralized mass and that the lateral extension to the west of the line C. D. H., makes up for the anorthosite inclusion L. M., we come to the conclusion that there must be a mass whose dimensions would be 700, 200 and 200 feet. Calculating, as before, the surface of the outcropping as diamond shaped, we get $\frac{700 \text{ x } 200}{2} \times 200 = 28{,}000{,}000$ cubic feet or a little more than 4,000,000 tons.

Lastly, by adding to this the balance of the masses on the north, one outcrop of which, 300x200 feet, would yield 750,000 tons, it will be seen that the St. Charles mine, may, with all the contingencies mentioned, contain over 5,000,000 tons. These results are all the more remarkable that no work, not even mere prospecting has ever been done.

Nature of the Ore—

A fairly large sample was taken from the mine. This was reduced to 5 kilogrammes at the Provincial Laboratory and the following assays were made. All the ore was crushed so as to pass through a 20 mesh screen and then classified in three sizes:

A. From 20 to 40 mesh.

B. From 40 to 80 mesh.

C. Smaller than 80 mesh.

Each of these sizes was magnetically separated. The analysis of the various samples obtained gave the results summarized in the following table:—

St. Charles Ore—

Composition { Iron—50.53% / Titanium—10.55%

	Ore before treatment					Concentrates and Tailings	
	Fe	Ti	S	Ph		Fe	Ti
A.—From 20 to 40 mesh 39.40%	52.97	9.32	0.020	0.21	Magnetic concentrates 72.24%	57.50	6.51
					Tailings not magnetic 25.86%	35.67	17.66
B.—From 40 to 80 mesh 34.28%	52.05	12.01	0.018	0.026	Magnetic concentrates 77%	59.68	9.39
					Tailings 23%	31.00	21.59
C. — Smaller than 80 mesh 26.32%	44.40	11.36	0.012	0.050	Magnetic concentrates 82%	50.02	9.36
					Tailings 17.40%	21.02	21.14

Loss 0.6%

The results of these assays are encouraging. The first two classes especially give concentrates fairly rich in iron and, setting the finest aside, we have in the coarse classes 26.43% of all the iron in the shape of concentrates with 57.50% of iron and 6.51% of titanium, and, in the middle classes, 26.39% of all the iron in the shape of concentrates with 59.68% of iron and 9.39% of titanium.

The percentage of sulphur and phosphorus is lower than the limit for Bessemer ore.

These assays are of course only an indication and it is probable that a closer examination of the magnetic concentration will give better results.

In any case, even without magnetic concentration, this titanomagnetite is a directly workable ore. In a future report we will study in detail the problem of the treatment of these kinds of ores and we shall see that, although most iron manufacturers have a prejudice against such highly titaniferous ores, very thorough experiments, made in actual blast furnaces, have demonstrated that the smelting of titanomagnetites can easily be done under certain conditions.

In view of the great extent of the St. Charles deposits, of the fact that they can be easily mined and their comparatively small distance from the port of Chicoutimi, there is reason to hope that the day is not far off when mining will be in full operation on the banks of the Saguenay.

Conclusions

To sum up what we have said, there are on the banks of the Saguenay four miles in a straight line from the railway between Chicoutimi, St. Gédéon and Roberval (Quebec & Lake St. John R.R.), about 18 miles from Chicoutimi, considerable deposits of titaniferous magnetite with 50% of iron and 10% of titanium which can probably be directly smelted in blast furnaces by selecting a suitable charge.

Owing to their shape and situation these deposits could easily be mined by quarrying; the ore could be conveyed by aerial tramway across the Saguenay and to the railway four miles away or again in the following way: By elevated railway or aerial tramway from the mine to the foot of the Grand Remoux rapids at the mouth of the Shipshaw river (14 to 15 miles) then loaded in boats at the Rivière au Vase, where the Government is at present having a wharf built.

DEPOSITS IN KENOGAMI TOWNSHIP

LOCATION:—These deposits are in range II. of Kenogami township on the line of the Quebec Canadian Northern Railway between Ratière station (213th mile) and that of Larouche (205th mile). The latter was formerly called Kenogami station. They are reached from Ratière station after a four mile drive over the road.

The country is mountainous and barren; there is practically no farming within a radius of from four to six miles from the deposits and the nearest village is that of Jonquière.

Nature and Extent of the Deposits—

Some pits and trenches have been excavated north of the railway between the 208th and the 209th mile. A description of these workings will suffice to show the slight importance of the iron ore deposits so far discovered.

Going from east to west, there is first of all, about 400 feet west of the 209th mile, a trench some 110 feet long cut from south to north in a rocky hill of anorthosite. The bottom of the trench is full of fallen debris, but the walls clearly show the distribution of the ore. Out of about 110 feet of the east wall, from 40 to 45 feet may be considered to be of titanic iron ore, the remainder being anorthosite. There is much less iron in the west wall and there is but a vague connection of outcrop between the two walls showing that there is but little continuity in the mineralized masses.

The deep-lying rock outcrops around this trench and especially on the north. It is an anorthosite sometimes consisting of large constituents, sometimes granular and at other times charged with pyroxene, but nowhere in the vicinity did we find any ore.

At a point 1,000 feet west of the trench and 50 feet north of the track, a pit 12x12 feet has been dug on the edge of a rocky slope. The bottom of this excavation is full of debris; the sides consist chiefly of anorthosite containing some lenses of titanic iron from one to two feet wide at most. The outcrops around this excavation consist of anorthosite except at one point 75 feet to the N.E., where an isolated mass of titanic iron, four or five feet in diameter, shows out.

At a point 3,300 feet west of the trench along the track and on the same side as the foregoing, a series of small pits (the largest is 10 feet in diameter) have been dug on the edge of a rocky declivity. We counted four within a length of about 80 feet. They are nearly full of debris, but by examining the sides and the debris thrown out on their edges it is easy to see that they have uncovered small masses of titanic iron of no importance. The largest mass may be about seven feet in diameter and even then it consists of a mixture of titanic iron, pyroxenes and feldspars.

About 450 feet west of this series of excavations, a sort of quarry 15 feet high and 25 feet wide has been opened on a rocky projection quite near the track. The working face of this quarry consists of a black and heavy rock, which looks like excellent ore from afar, but, on examination, is found to be a mixture of titanic iron and anorthosite.

A sample, which seemed to us to be an average one of the ore extracted from the quarry, had a density of 3.4 corresponding to a mixture of ilemnite (density 4.5 to 5), of feldspar (density 2.6) and pyroxenes (density of bronzite 3 to 3.5) Segregations richer in iron occur at some points, but their dimensions are limited.

A pit had been dug 45 feet from there, on ore of fairly good average, but the absence of any outcrop around this pit gave us no opportunity of ascertaining the size of the mass to which it belongs.

As a rule the outcrops tend rather to show that the rock in the immediate vicinity of these workings consists of anorthosite.

Nature of the Ore—

It is a titanomagnetite whose composition is similar to that of the St. Charles ore. A sample taken from the richer portions of the trench gave an analysis:—

Fe O	68.24
Ti O_2	20.76
Corresponding to:	
Metallic Iron	53.07
Metallic Titanium	12.47

ALMA ISLAND

This island lies in the outlet of Lake St. John and divides the Saguenay river into two branches known as the Grande Décharge and Petite Décharge.

There is a prevalent idea among the residents on this island that the sill of the cascades and rapids of these two branches consists of iron ore and that the island itself is rich in ore.

I inspected the deposits on the island and the result was most disappointing.

Deposit on lot 36, range II.—

On lot 36, range II., 800 feet north of the road crossing Alma island from east to west, in the midst of a coarse-grained anorthosite, are a series of lenses of hard, compact magnetic iron with clear cleavage faces. These lenses trend pretty much north to south and are of limited dimensions, the largest being 15 by 30 feet.

Mr. Gédéon Boivin, the owner of the mining rights on this lot, whom I afterwards saw, claims that iron can be seen over a length of 200 feet with a breadth of 15 feet in some places. This is probably a series of lenses in a straight line which Mr. Boivin presumes to form part of one and the same deep mass. In fact the prevailing idea in the region is that all the isolated outcroppings of titanic iron, however distant they may be from one another, join together below.

A sample (No. 72), on being analyzed, gave :—

Fe O	58.24
Ti O_2	19.88
Corresponding to:	
Metallic Iron........................	53.07
Metallic Titanium....................	11.94

EASTERN TOWNSHIPS.

Of the many iron deposits mentioned in the reports of the Bureau of Mines of the Province of Quebec, as existing in the Eastern Townships, we inspected three only, those which were considered the most important, namely: the Beauceville, Leeds and Spalding deposits.

BEAUCEVILLE DEPOSITS (BEAUCE COUNTY)

LOCATION :—These deposits are uncovered by some slight prospecting workings on a line three miles long, with a southwest to northeast direction between the Plante and Callway rivers, two tributaries flowing into the Chaudière river from the east.

A chain of small hills, almost completely covered with timber, lies between these two rivers. Prospecting is not easily carried on there and I had to content myself with inspecting the work already done.

The workings consist of two groups : :—

1. The group known as the Block Mine.

It is about 500 feet from the line separating the Ste. Corinne range N.W. from an unsurveyed one, the Block range and pretty much on the prolongation of the 11th farm (No. 1342) of Ste. Corinne range N.W. It is reached from St. Francois de Beauce or Beauceville (where one leaves the train) by driving four miles down the Chaudière river and 4½ miles on the road of Ste. Corinne range. The road is left at lot 1348 and then a path is followed along the lots and the Plante river is forded (about one mile.)

2. The St. Charles range group, lots 300 and 301. It is

reached by following the same road as above, but stopping before coming to the bridge over the S.E. branch of the Plante river.

I. BLOCK MINE

Nature and Extent of Deposit.

The workings of which the Block Mine consists, lie in a glade, in the midst of the woods, and cover an area measuring 200 feet in the greatest dimension.

Fig. 6 shows of what these workings consist. A. B. and C. D. are two barren trenches. E. K. L. M. N. O. P. Q. are trenches of slight depth which have uncovered ore. N. P. and R. are two excavations (R. being rather deep, about 10 feet). These workings were already of old date at the time of my inspection and I was not always able to say with certainty that such or such portion had been excavated in ore or in rock.

The ore occurs in irregular pockets in a serpentine rock. As a rule the transition from the serpentine to the ore is by a kind of rock heavily charged with amber mica against which the mineralized mass stops abruptly. Sometimes, however, there is an imperceptible transition and the originally compact ore changes successively to a serpentine heavily charged with iron grains and then to normal serpentine.

The outcrops of compact ore are shown in black on plan Fig. 6; the large black dots show the caved in portions of the workings, which do not seem to have been cut on the ore.

If it be admitted that all these outcrops belong to the same mass, it may be assumed that the latter is about from 100 to 110 feet long from northeast to southwest and about 40 feet wide. All is not ore in this mass as so defined; there are a great many rocky inclusions, as may be seen by the plan, so that it is impossible to estimate the tonnage.

As the ore is magnetic, we were able to make a magnetic survey. Readings were taken every 15 feet with a simple miner's compass. With the figures thus obtained, we drew the curves shown on the plan. Imperfect as our measurements are, they nevertheless agree pretty well with the surface indications.

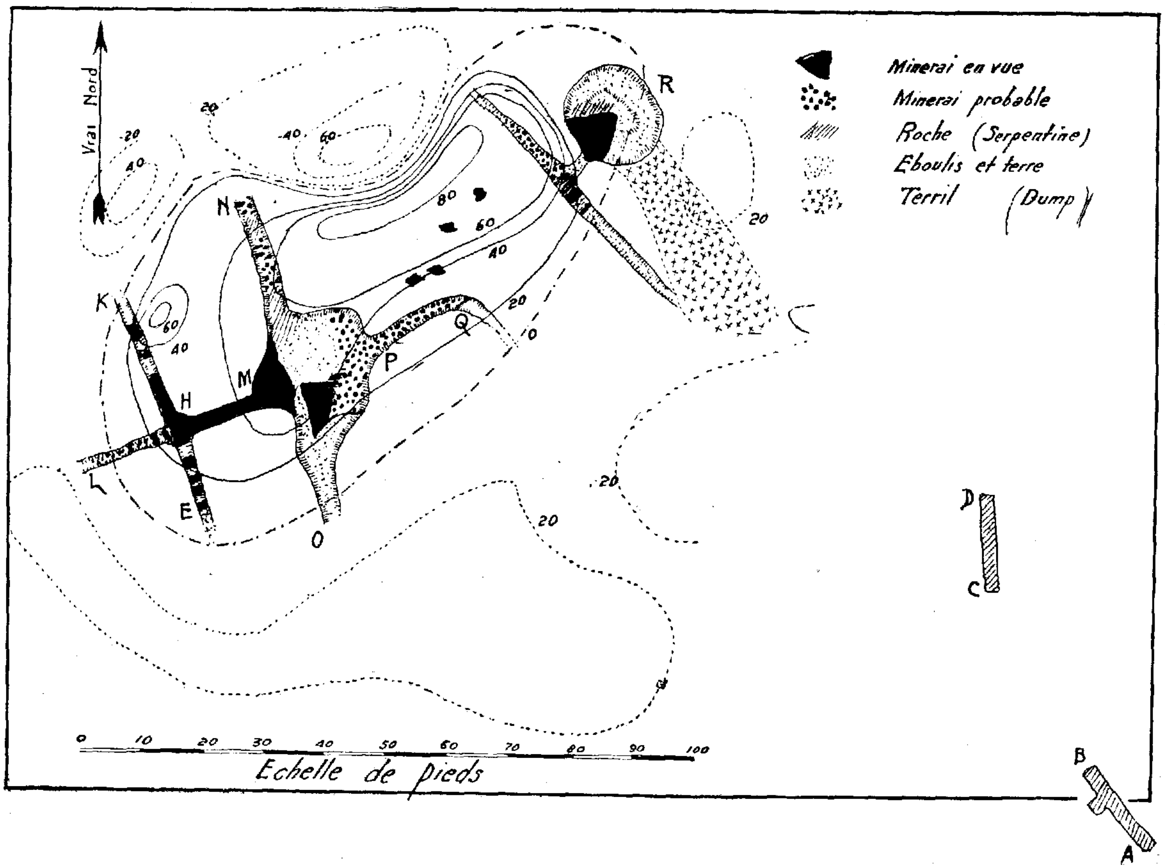


Fig. 6—Block Mine, Beauceville, Beauce county.

The ore being less magnetic than pure magnetite the 40% attraction areas may be considered as indicating the size of the mass. In the present instance the 40% attraction area is about 70 by 25 feet. The concentration of the isogonal curves towards the northwest shows that the mass dips sharply and to a fairly great depth at that spot.

It should be noted that the elongation of the mass is in a direction parallel to that of the mineralized band along which all the other discoveries have been made.

Nature of the Ore—

If, in appearance, the various outcrops seem to belong to the same mass, they in fact correspond to ores varying in composition.

In the excavation R, the ore is a chromiferous magnetite and contains but small quantities of titanium (Sample 115.) In the trenches E. K. and especially in H. (Sample 116), the ore is a titaniferous magnetite containing no chrome.

	Sample 115	Sample 116
$Fe\ O$	55.36	61.36
$Ti\ O_2$	0.16	16.28
Cr_2O_3	9.86	None
S	0.075	Not ascertained
Ph	0.045	"
Corresponding to:		
Metallic Iron	43.06	47.73
Chrome	6.80	None
Titanium	0.09	9.78

II. PROSPECTS IN ST. CHARLES RANGE

The Quebec Mines and Metal Company, to which the mining rights on these lots belong, had prospecting excavations and trenches dug some time ago on lots 301 and 302 of St. Charles range. Plate Fig. 7 shows their location.

Excavations 4 and 5 for asbestos were made in the serpentine. We will not deal with them as they are not within the scope of this report.

At 1 is a cut about 15 feet wide and 65 feet long. The rock in which it is made shows several different facies; on the northwest wall is a fine-grained black rock, rather easily scratched with a knife; on the southeast is a grey rock frequently laminated (parallel streaks of black elements). Under the microscope they are seen to consist of a mosaic of crushed and granulated quartz of saussuritized and granulated feldspars on the edges

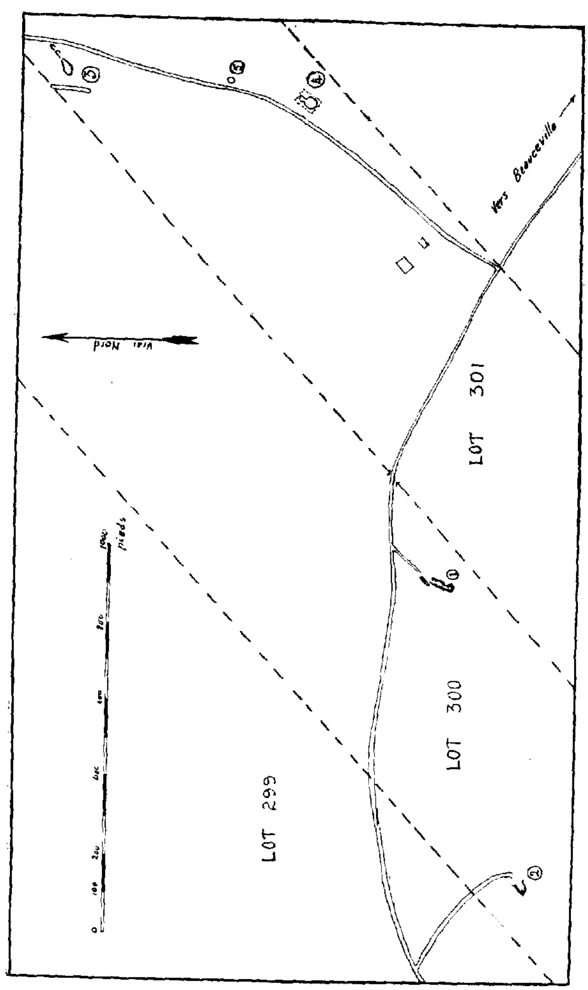


Fig. 7.—Prospecting work in St. Charles range. Beauceville.

and of a great many crystals of a mineral transformed into talc. Some samples contain black mica in streaks.

The relative proportion of these elements changes abruptly from one point to the other, and some thin sections show only minerals transformed into talc.

All these rocks contain a small quantity of iron ore. As there was no rock visible outside this excavation, it is difficult to define these rocks. They seem to form part of the contact of a dioritic or granitic mass with one of pyroxenite and peridotite, the whole being greatly crushed and decomposed.

The ore shows only at the head of the quarry on the face of the cut, in the shape of a lens from 10 to 12 feet wide. The transition from the rock to the ore is gradual and the lens has no well defined walls.

Very little ore can be seen in the present condition of the workings, but there are piles of rock and ore along the road leading to the quarry. The largest of the ore heaps may contain about 25 tons. Samples were taken from this heap and on analysis gave (Sample 108) :

Iron........	34.70
Titanium........	12.36

It is probable that a richer ore would have been obtained by more careful picking.

The pit marked 2 on Fig 7 is about 20 feet in diameter. It was full of water when I saw it, but it must be rather deep judging by the size of the dump.

The bottom of the pit may possibly be an ore-pocket; in any case, the face of the cut shows nothing but ore of rather poor appearance. There are local enrichments in some places, but their dimensions are limited.

A small portion of the material in the dump is well mineralized. A pile estimated to contain 12 tons may contain about 50% of ore.

At 3, on the slope of a rocky hill, is a series of trenches and excavations which unfortunately have uncovered no deposit of any importance. The three excavations have been made in fine-grained, black rock which greatly resembles ore from a distance, but which is only highly ferruginous greenstone in which are small pockets of ore (a few feet only in dimensions.) Sample 109 was taken from one of these pockets and gave an analysis :—

Metallic iron........	54.77
Titanium.....	7.49

It may be concluded from all the foregoing that no very encouraging results have been obtained from the prospecting work. The mineralized masses in the St. Charles range are very limited. (Although the ore is very magnetic the needle is affected only over areas of a few feet in the vicinity of the outcrops.

The mass in the "Block" is perhaps of some importance, but it is by itself insufficient for industrial operations.

Moreover it would be difficult to utilize, owing to the percentage in titanium.

LEEDS MINE

LOCATION :—This mine is on lots 7a and 7b of range V., Leeds township, county of Megantic. It is reached by driving to Kinnear's Mill, 14 miles from Robertson station on the Quebec Central Railway. The deposits are a mile and a half from Kinnear's Mill and seven miles from Leeds on the road from the former to the latter place.

The country is rather hilly and well cleared. There is still some standing timber especially in a narrow belt running from Kinnear's Mill to Leeds and the ore outcrops are in this strip through which the road runs.

GEOLOGY :—The rocks are metamorphic schists, very old and classified as pre-cambrian by R. W. Ells. Their facies vary from one point to another; they are generally chlorite schists in the immediate vicinity of the deposits.

Nature and Extent of the Deposits—

The ore occurs in layers (probably lenticular) interfoliated in the schists. Mineralogically speaking these layers consist almost solely of silica and finely streaked magnetite.

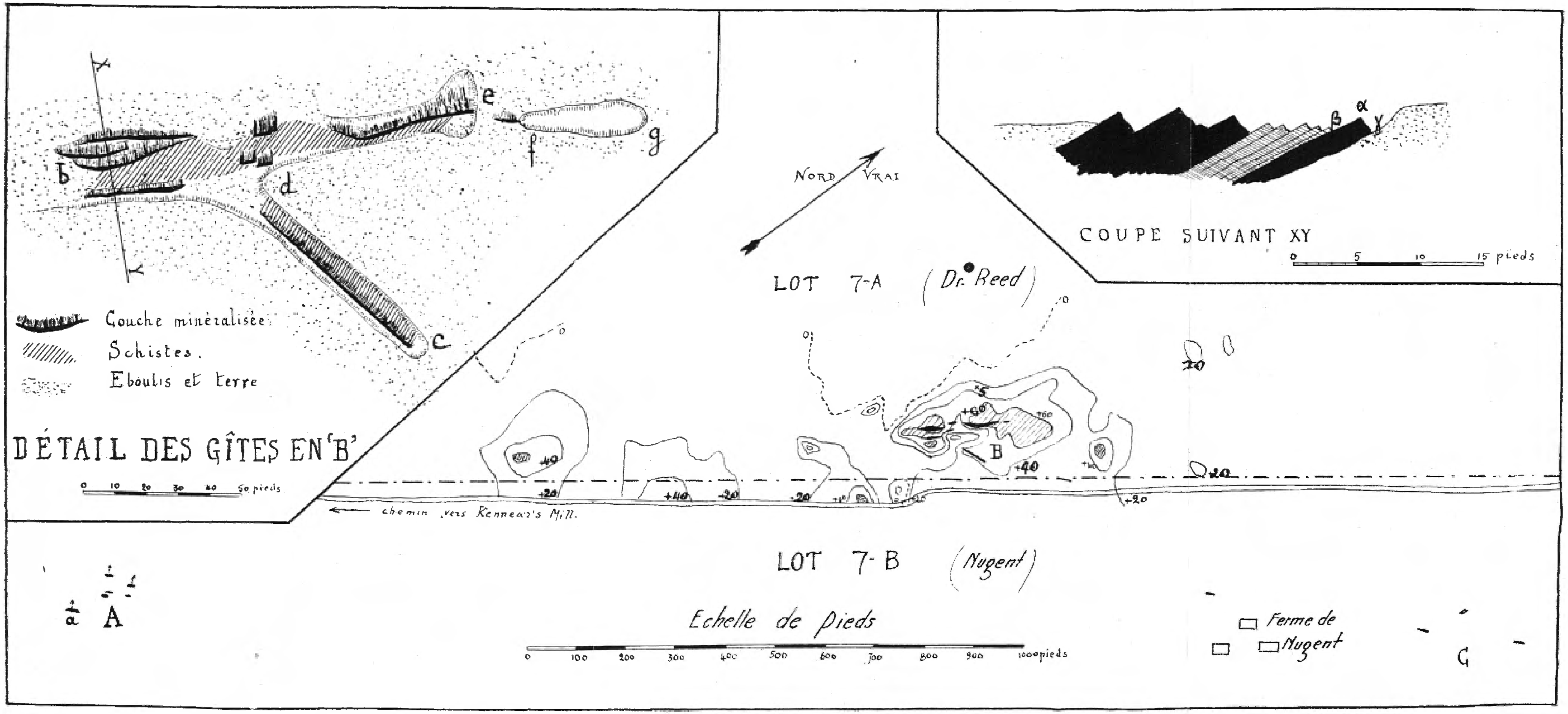


Fig. 8—Leeds Mine, Kinnear's Mills, Megantic county.

Fig. 8 shows the various visible outcrops. We have put them in three groups, indicated by the letters A. B. C.

The outcrops of group A (lot 7b belonging to Mr. Nugent), appear in isolated blocks in the midst of cultivated land on which hardly any rock appears in situ outside of those mineralized blocks. The five blocks shown on Fig. 8 are merely harder fragments (due probably to more complete silicification and mineralization) of ferruginous lenticular layers elongated in a northeasterly to southwesterly direction. All these blocks have the same characteristics; they outcrop in the shape of wedges or a double sloped roof; the northwest slope (as the arrowheads) is from 20 to 30 degrees to the horizontal, it probably corresponds to the surface of the parting plane between the mineralized layer and the enclosing schists. This surface is not level but slightly undulating. The opposite slope is almost at right angle to the foregoing, that is to say, it forms an angle of from 60 to 70 degrees with the horizon; it corresponds to a break in the layer perpendicular to its sides. The ore structure can best be seen in the planes of this fracture; while quartz and black magnetite show in cores or in parallel bands surrounding cores looking much like the fibres of a piece of wood cut obliquely. The percentage in magnetite varies from one point to another, but, as a rule, it constitutes at least one-half of the mass. Sample 130, whose analysis we give further on, represents an average of block A.

The length of block A is about 38 feet counting from the ridge line; it is the largest of all the outcrops around A. Its width from one side of the layer to the other is difficult to determine, but it is probably under six feet. It is easy to see on the ground that the various outcrops around A belong to separate layers.

The most important outcrops are around B; they are also the only ones on which work has been done. These workings, shown in detail in the left corner of Fig. 8, consist of a large trench b.c. (about 130 feet long) from which a rather narrow trench (about 75 feet long) runs out. At the end of the trench b.c. is a pit about 40 feet long and four feet wide, whence about a hundred tons of ore were taken out a few years ago.

The detailed plan and section X.Y. show the formation of the deposit; from E are a series of lenticular layers interstratified in the corrugated schists. The outcrops are always in the shape of a roof with a gentle slope towards the northwest, so that, when several parallel layers touch one another or, more correctly speaking, when the lens thickens, the ore forms a kind of series of oblique steps. The greatest swell is level with X.Y., about 14 feet horizontally. Taking into account the dip of about 30 degrees, the visible extent of the layer from side to side may be considered to have a thickness of seven feet. The other layers are much less thick; thus the layer along the trench C.D. has a thickness varying from 6 to 20 inches, and pinches out to nothing at C.

At C and around Mr. Nugent's' farm buildings, in the middle of the meadow, are small, pretty cleanly cut steep ridges. They correspond as a rule to fragments of mineralized layers which have become detached from the encasing barren schistose layers and which, being less affected by weathering, stand out saliently. Their direction is pretty much the same on the whole as that of the other layers; they dip a little more vertically. They are of no importance, being neither very thick (1½ foot at the maximum) nor very rich.

Quality of the Ore—

The ore is black, hard and strongly magnetic. Like many magnetites, it becomes slightly magnetopolar immediately after being crushed. Thus, by breaking the ore with a hammer, the dust can be attracted by an unmagnetized knife-blade or by the hammer itself.

Mineralogically speaking, it is magnetite mixed with a very small quantity of hematite.

From a metallurgical standpoint, it is a good siliceous ore, sufficiently low in phosphorus to be classed as Bessemer ore.

Two samples were taken: No. 130 represents an average of the outcrop a. (Group A); No. 133 consists of well mineralized pieces taken at X.Y. and is above the average as an iron ore.

	Sample 130	Sample 133
Silica and insoluble	39.30	21.80
Magnetic oxide	58.76	74.20
Sulphur	Not ascert	0.236
Phosphorus	Not ascert	0.042
By difference from 100	1.94	3.722
	100.00	100.00
Corresponding to metallic iron	42.58	53.77

An analysis made by the Geological Survey, Ottawa, and quoted by Mr. J. Obalski in "Mines and Minerals of the Province of Quebec (1889-1890)," gave the following results:—

Peroxide of iron	80.758
Protoxide of iron	13.588
Protoxide of manganese	0.056
Insoluble silica	0.012
Alumina	0.713
Lime	1.298
Magnesia	0.454
Phosphoric acid	0.471
Sulphuric acid	0.095
Titanic acid	0.000
Hygroscopic water	0.049
Water in combination	0.167
Organic matter	0.041
Insoluble matter	2.748
	100.450

Total metallic iron	67.099
Phosphorus	0.206
Sulphur	0.038

The average in iron is higher than in our analysis. The ore was doubtless taken from the lens uncovered by the pit F.G. and the analysis must have been made on selected specimens.

Magnetic Survey—

As the ore is very magnetic we thought of ascertaining the trend and extent of the deposit by means of the dip-needle. In 1905 a very careful magnetic survey of lot 7a was made by Mr. B. F. Haanel, Mining Engineer of the Department of Mines, Ottawa. The results were not published, but a chart was drawn up; Mr. Haanel kindly gave me communication of it and I have reproduced the curves of equal vertical intensity corresponding to the degrees 0, +20, +40 and + 60, reducing them to the scale. If we consider that the areas bounded by the + 60 curves are the only ones likely to contain ore in noteworthy quantities, this magnetic survey is not very encouraging. The largest area of attraction exceeding + 60 is about 180 by 200 feet. Taking into account the slight dip of the layers (30°) and their probable slight thickness, it may be inferred that such mineralized masses as exist there must be of extremely limited dimensions.

Similar results were obtained around A. We made a brief magnetic survey and found no area of attraction exceeding 60° whose dimensions were greater than from 50 to 60 feet.

A diamond drill hole was also put down some years ago about 100 feet northwest of the trench B.C. (on the plan), but we are not aware of the results.

Conclusions—

The Leeds deposit consists of a series of layers of magnetite with lenticular expansions interstratified in the pre-cambrian schists.

These layers are parallel, with one exception, and their trend is from southwest to northeast; they are in a zone nearly parallel to the road between lots 7a and 7b and about 500 feet wide.

None of these layers is of any great importance in itself; the thickness at the expansions is probably under 7 feet in the case of the widest and the length of the lenses is not more than from 60 to 80 feet on the outcrops.

The slight importance of the outcrops fully agrees with the limited extent of the areas of strong magnetic attraction so that, in the present condition of the discoveries, the deposit may be considered a small one. Although some samples have shown high percentages in iron, the proportion of siliceous gangue in the run of mine ore would be very great.

Lastly, remoteness from the railway renders all attempts at mining useless for the present.

SPALDING

A syndicate consisting mostly of Megantic residents had some prospecting for iron ore carried on in the vicinity of Spalding village. People in that region think that these workings revealed the existence of large quantities of ore, while in reality the discoveries are rather poor and can be described in a few words.

Location—

The workings visited are about 5½ miles from Spalding village on lots 10 and 11 of range VIII., Spalding township, county of Compton. The mining property (under license) belongs to the Megantic syndicate and comprises lots 6 to 14 of range VIII. and 8 to 14 of range IX.

The workings may be reached from Megantic railway station by the following route:—

From Megantic to Spalding (wagon road) 12 miles.

From Spalding to the last houses (carriage road) 2 miles.

From the last houses to the camp, bush road (through the bush) 2½ miles.

The workings are in the bush in broken country.

Condition of the Workings—

They are all on the surface and mostly of slight extent (pits of a few feet.) They are rather numerous and very scattered which makes them very difficult to find over so great an area of land, completely covered with timber. A private report by Mr. Obalski, dated 19th May, 1910, mentioned ten.

The most interesting are on lots 10 and 11 of range VIII., 8 or 9 arpents from the base line between ranges VIII. and IX.

At that place are two trenches, nearly at right angles on the slope of a rocky hummock; the trench N.S. being about 90 feet and the trench E.W. about 65 feet long.

The rock is a quartzite, sometimes schistose and sometimes massive. It is impregnated with grains of magnetite and of hematite which in some cases concentrate either in patches, or on the joint-planes. At times the enrichment in magnetite grains is such that real siliceous iron ore can be obtained.

Most of the ore has been uncovered along the trench E.W., the maximum richness being about at the intersection of the two trenches. This enrichment does not continue along the trench N.S., and the mass which may be said to consist of ore is small. The greatest length of moderately mineralized rock may be put at 15 feet along the trench E.W. By collecting about half a pound of ore every six inches over fifteen feet in length we obtained a sample which, on analysis, gave:—

$Si\ O_2$	54.47
$Ti\ O_2$	Nothing
$Fe_3\ O_4$	24.85
$Mn_3\ O_4$	7.11
Sulphur	0.667
Phosphorus	0.056
Corresponding to:	
Metallic iron	18.00
Metallic manganese	5.13

In the extension of the trench E.W. at the foot of the rocky mound, is a pit 10 by 7 feet with a depth of from 10 to 12 feet. It is sunk in a quartzite frequently cut by veinules of quartz from one to six inches thick charged with iron and copper pyrites. The rock itself contains pyrite crystals; it is at times impregnated with iron, either magnetite or a scaly hematite, but no true ore shows.

The same applies to another pit about 100 feet northeast of the foregoing, which is sunk in a blackish brown schist—becoming, when crushed, a greenish white sprinkled with small scales of hematite and which shows no mineralized mass.

There are small surface workings at other points on the property. Some have uncovered isolated ore-pockets, but they are all very small. Some pieces from them, which Mr. Obalski had analyzed, gave percentages varying from 40 to 68 of iron and from 0.62 to 5.56 of manganese.

These ores are remarkable for their percentage in manganese. It is a matter of regret that all the prospecting so far carried on has not yielded better results.

DEPOSITS AROUND OTTAWA.

West and north of Hull are deposits which have often been described. Mr. Fritz Cirkel has devoted a lengthy report to them.(*) They all consist of masses intercalated in limestone, gneisses or greenstones of Grenville age. The only ones we visited, and even then very superficially, were those of Bristol, Forsyth, Baldwin and Haycock.

BRISTOL MINE

LOCATION:—This mine is on lot 21, range II., Bristol township, county of Pontiac. It is reached from Ottawa via the C.P.R. running to Waltham, getting off at Wyman station; a branch railway line, now abandoned, connects the station with the mine, 1½ miles away; the distance by road is about six miles.

Historical Notes—

The first work at this place was done during the winter of 1872-1873 by an American syndicate. It consisted merely in prospecting and no ore was shipped. This first syndicate having allowed its option to lapse, a second one took over the property in 1884 and tried systematic operations. As the ore contained a great deal of sulphur, roasting furnaces had to be erected; two Taylor-Langdon furnaces and one Wetsman furnace (modified by E. Sjostedt), all three heated by gas (Langdon gas-producer.)

(*) Report on the Iron Ore Deposits along the Ottawa (Quebec side) and Gatineau rivers, by Fritz Cirkel, M. E., Ottawa, Mines Branch, 1909.

Operations were carried on more or less regularly until 1894 when the work had to be abandoned. Since then nothing has been done and the workings are flooded. Nevertheless, the deposits have been examined by various engineers on several occasions. In 1906 Mr. Cirkel inspected the mine and gave the results in his "Report on the Iron Deposits along the Ottawa and Gatineau Rivers. Department of Mines, Ottawa."

In the summer of 1909, Mr. E. Lindeman, M.E., of the Department of Mines, Ottawa, made a magnetic survey of the same deposit. The results were published in a brief report with an excellent map. (Iron Deposits of the Bristol Mine, Department of Mines, Ottawa.)

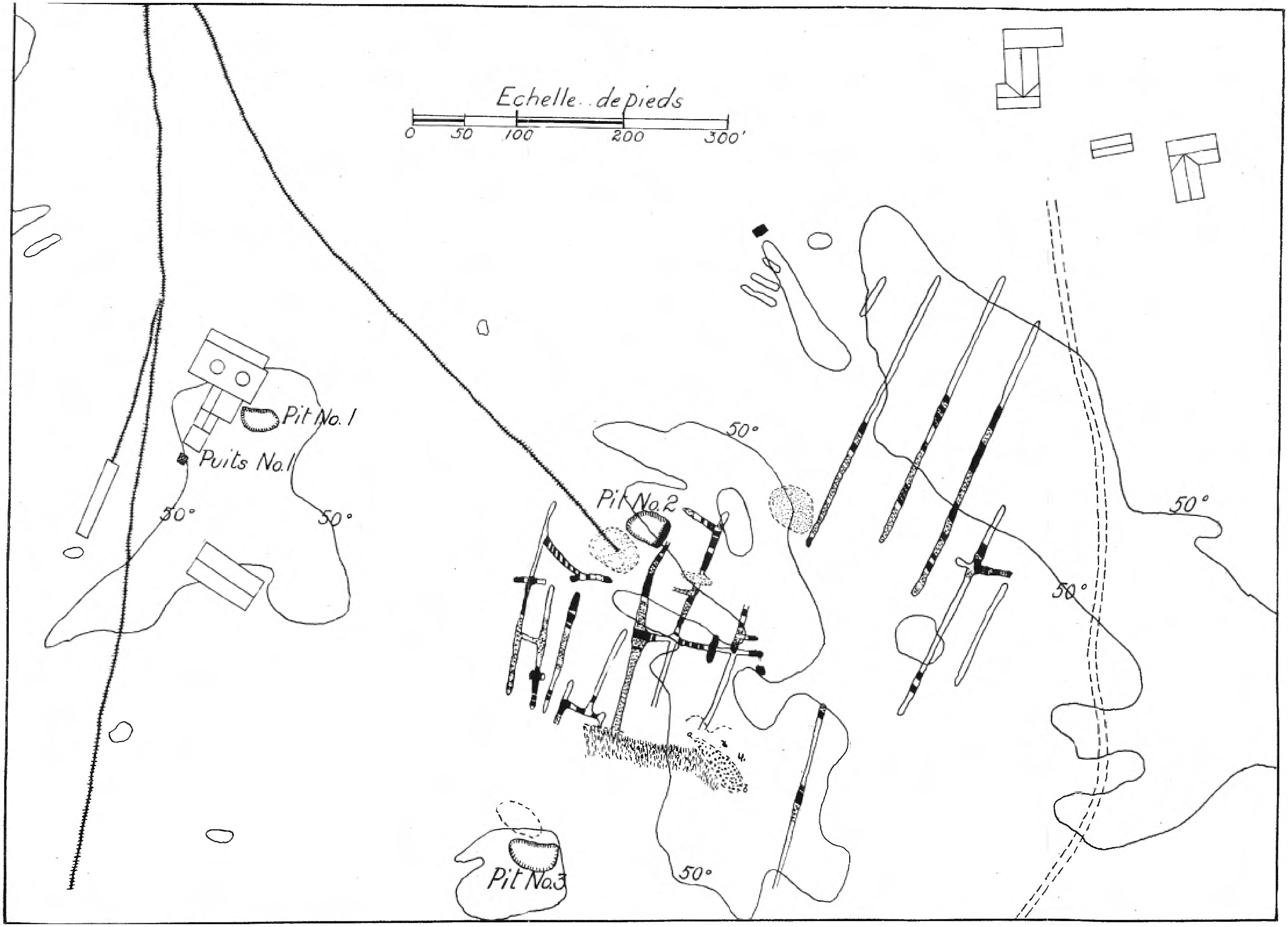
The latter report and map so clearly show the condition of the workings and the nature of the deposit that we should have nothing further to add were it not for the fact that, since Mr. Lindeman's report and on the indications given by his map, an American company, the Ennison Co., had some trenches excavated in the months of July and August, 1910, at the spots where there was a strong magnetic attraction. Although most of these trenches have caved in, we were able to see how the ore showed in some of them. After surveying the location of these trenches we noted them on Mr. Lindeman's map (see plan Fig. 9.)

Geology—

The rocks belong to the Grenville series, whose usual characteristics they possess. These are beds of gneisses, metamorphic arkoses, greenstones and schists, the whole greatly crushed, broken and intruded by slightly gneissic pink granites. Further south, towards the Ottawa river, beds of crystalline limestones appear.

Nature and Extent of the Deposits—

The ore occurs in pockets in greenstones and hornblendic or micaceous schists; it existed in these rocks prior to the granitic veins since the granite and its pegmatitic phases are seen cutting both the ore and the rocks.


Echelle..de pieds
0
50
100
200
300'
Pit No. 1
Puits No. 1
50°
50°
Pit No. 2
50°
50°
50°
Pit No. 3
50°

The mineralized mass first mined is that in excavation No. 1 (pit No. 1 on the plan) and in the incline shaft No. 2. This shaft is said to have been carried down to a depth of 200 feet and to have served three levels. On coming out of the shaft the ore was carried up an inclined plane directly to the roasting furnaces.

The shaft is full of water, but to the east a compact ore can be followed for a length of about 40 feet on a width of 18 feet. Several other outcrops appear in the vicinity, but they are of small dimensions.

According to Mr. Lindeman, pit No. 2 was 30 feet deep and yielded very clean ore. A fairly large quantity of good ore can be seen on its southeast face and in the neighbouring trenches.

Pit No. 3 was 70 feet deep, but only an insignificant deposit was found.

Pit No. 4, which is 600 feet southwest of pit No. 3, outside the bounds of our plan, was sunk in ground covered with clay. Judging by the nature of the ore in the dump, the ore in this pit is similar to that in pit No. 1.

There is a shaft, No. 2, about 600 feet northwest of shaft No. 1, which is said to be 100 feet in depth and at that level a cross-cut was run in a westerly direction which came upon ore.

There are many and considerable ore dumps in the vicinity of these workings. The largest is that from pit No. 1. Mr. Lindeman took samples, analyses of which are given further on, from these dumps.

Although the trenches dug in 1910 in the layer of clay covering these rocks had mostly caved in when I made my inspection, the portion of the bed-rock which remained visible showed interesting indications.

On plan Fig. 9 accompanying this report, the portions indicated in black in the trenches represent the ore, the portions stippled represent the barren rock, whether granite or metamorphic greenstone; the blank portions show where the earth has caved in and where the bed-rock is not visible.

It can be seen at first sight that not one of these trenches came upon a compact mass of ore exceeding a length of 30 feet.

Very frequently the ore is closely blended with the rock and it is not unusual to see rock and ore alternating in more or less distinct beds. Thus the large outcrop marked a.b. corresponds in reality to a micaceous, feldspathic, and amphibolitic complex, strongly corrugated and impregnated with iron ore in the shape of pockets and tongues. This complex stops abruptly. against an intrusive mass.

The trenches around this excavation No. 2 have caved in the least, and show the iron ore better. There are rather important mineralized masses there.

The trenches to the south have greatly caved in and show hardly any indications.

A series of parallel trenches were also dug on lot 22 which had never been prospected. Unfortunately they have caved in and only incomplete indications can be obtained from them. Nevertheless, it can be seen here also that although there are areas of strong attraction, the ore is not in large pure masses, but occurs in small masses intercalated in the rock.

All these trenches are parallel and run perpendicularly to the general foliation of the rocks. In fact it is easy to see on the ground that all the masses just mentioned are elongated in a direction varying between W.N.W. and N.W.; consequently the mineralized lengths visible on the trenches correspond to the small dimensions of the mass.

Magnetic Survey—

The annexed plan shows a portion of the curves of equal vertical magnetic intensity obtained by Mr. Lindeman and which were published as maps in Bulletin No. 2 of the Ottawa Department of Mines.

It will be seen that there are three large areas of intensity exceeding 50°. The first, estimated at 25,000 square feet, is near shaft No. 1 and excavation No. 1. It corresponds to the first two masses uncovered and mined. The second, estimated at 60,000 square feet, extends south of excavation No. 2. The third is estimated at 90,000 square feet and is entirely on lot 22.

The existence of such great areas of strong magnetic attraction encourages prospecting, but one must not be led into the error of believing that such areas correspond to masses of similar dimensions. With a strongly magnetic ore, such as the Bristol ore, a highly impregnated rock, a series of alternately mineralized and barren bands may affect the magnetometer, when in large masses, in the same manner as a continuous mass of ore. These remarks are justified by the nature of the outcrops uncovered by the trenches. Nowhere, not even in the areas of greatest intensity, was any continuous mass of ore found whose dimensions could compare with those of the areas of great magnetic intensity.

A magnetic survey is indispensable for deposits of magnetic iron covered, as in the case of the Bristol mine, by a layer of light soil. It enables certain portions of the prospected territory to be set aside at once and indicates the mineralized portions. But such magnetometric survey must be followed by prospecting either by trenches or by borings, which alone can determine the position, extent and commercial value of the deposit.

Nature of the Ore—

The ore is a mixture of magnetite and hematite, the former predominating. It is low in phosphorus, but high in sulphur.

While the Ottawa Department of Mines was having a magnetometric survey of the deposit made, it had some samples collected. Five of them, taken from the dumps were analyzed and we cannot do better than reproduce the results:

	1	2	3	4	5
Ferric oxide	51.71	63.880	42.36	52.31	52.505
Ferrous oxide	25.33	9.640	22.31	22.95	25.84
Sulphide of iron	3.32	4.530	5.48	2.83	2.76
Protoxide of manganese		0.120			
Alumina		0.680			
Lime	1.32	5.700	3.30	3.50	1.27
Magnesia		1.200			
Silica	10.11	6.670	8.17	8.15	9.47
Phosphoric acid		0.006			
Titanic acid		0.220			
Water		0.360			
Carbonic acid and undet.		6.994			
		100.000			

Metallic iron	57.230	54.350	53.740	55.720	58.180
Sulphur	1.780	2.410	2.920	1.510	1.480
Phosphorus	0.001	0.003	0.007	0.006	0.008

. . . .

Samples 1 and 5 represent the ore from shaft No. 1.
Sample No. 2 comes from excavation No. 2.
Sample No. 3 comes from excavation No. 3.

. . . .

The Department of Mines also sent two lots of ore from the Bristol mine to the Kingston School of Mines in Ontario. These two lots were magnetically concentrated after having been crushed and properly classified.

The first lot came from the dump of shaft No. 1 and consisted of lumps of ore taken as they came, without paying any heed to the pyrites that might be in them either in small veins or in nodules. This lot was divided into two parts which were respectively subjected to dry magnetic concentration and to magnetic concentration under water. The results of these tests made by Mr. Geo. C. Mackenzie, B. Sc., will be found in Bulletin No. 2 of the Mines Branch of the Ottawa Department of Mines. We will merely give a summary of the results of the first lot :—

	Raw Ore	Concentrates	Tailings
Iron	53.73	62.77	10.34
Insoluble	18.08	8.96	67.94
Sulphur	2.57	1.01	
Phosphorus	0.012	0.0010	

Thus, by this concentration, the percentage in iron was raised from 53.73% to 62.77%, corresponding to a recovery of 96.46% of the iron (taking into account the respective weights of the ore and of the concentrate.) The percentage in sulphur was lowered from 2.57% to 1.01% and, if the details of the assays be examined, it will be seen that in certain classes, especially in that of ore crushed for 40 meshes, the percentage in sulphur was lowered from 2.25% to 0.202%.

The second lot was taken from a small dump at excavation No. 2 after careful picking; the ore of this dump was somewhat decomposed and mixed with barren rock and did not represent the average ore taken from the excavation. The ore is slightly different from that of the first lot and contains a notable proportion of hematite.

This second lot was subject to two tests similar to the foregoing: Dry magnetic concentration and magnetic concentration under water.

The results of the first concentration may be summed up as follows:—

	Raw Ore	Concentrates	Tailings
Iron....................	51.87	58.10	44.92
Insoluble................	10.99	7.63	15.92
Sulphur.................	2.780	0.870	
Phosphorus..............	0.007	0.002	

Taking the respective weights of the raw ore and of the concentrates into account, this concentration corresponds to a recovery of 61.68% of the total iron. The concentration under water gives a recovery slightly over 66.78%.

These figures are less satisfactory than those for lot No. 1. This was to be expected because the greater proportion of the iron is in the form of hematite.

Quantity of Ore—

Although there is no plan of the old workings—which would have been very useful for obtaining an idea of the extent of the deposits—and no prospecting borings were tried, it can be seen, by inspecting the visible outcrops and the portions of the trenches that have not fallen in, that there are no very large masses of pure ore. The greatest lengths of pure ore that could be followed without coming upon a rocky intercalation, are 40 feet. On the other hand experience has shown that the areas of greatest attraction in nowise corresponds to a compact and continuous mass of pure ore.

The Bristol mine seems to consist of a succession of lenticular masses of ore, of limited widths (40 feet at the most) and of short lengths, intercalated in metamorphic rocks and cut by granite. The rocks themselves are often strongly impregnated with magnetite and should in some cases be taken into account in working the mine.

Considering the irregular character of these masses, the existence of ore impregnated in the rocks, the encouraging results of the magnetic concentrations made by the Ottawa Department of Mines, the deposit of the Bristol mine can be utilized only with a view to magnetic concentration.

Such concentration would enable:

1. The masses to be more easily mined by getting out not only the pure portions, but also the strongly impregnated rocky portions;

2. The percentage in sulphur to be lowered to a limit acceptable by metallurgists;

3. The production of concentrates with a high percentage of iron (56 to 62%) having a good commercial value.

This magnetic concentration should of course be followed by briquetting (Grôndal process) or nodulizing the ore by baking at a high temperature in a revolving cylindrical furnace.

FORSYTH MINE

LOCATION:—The Forsyth mine is on lot 11, range VII., Hull township, about five miles N.W. of the city of Hull, and the old workings are a few feet from the road called Thibodeau's road.

Historical Notes—

In his "Report on the Iron Deposits along the Ottawa and Gatineau Rivers," Mr. Fritz Cirkel, M.E., gives a detailed description of these deposits with historical information which we summarize below.

The deposit is mentioned for the first time in the report of the Geological Survey for 1845-1846 and a company called the "Forsyth Company," of Pittsburgh, was formed for working the mine. The ore (magnetite) was shipped to Pittsburgh via the Rideau canal, the St. Lawrence and the Great Lakes to Cleveland. In 1855 about 5,000 tons of ore are said to have been so shipped. After some years' interruption, operations were resumed in 1858 and 8,000 tons shipped contained an average of 60.70 per cent of metallic iron.

In 1867 a blast furnace was built, which was in operation in 1867 and part of 1868. In 163 days (from the 27th April to the 6th October, 1868), 1,895 tons of ore were treated in that furnace and 1,040 tons of pig iron obtained, which, deducting the small quantity of scrap iron (7.2t), which passed through the furnace, gives a daily production of 6.5 tons of iron and a yield of 54.5% from the ore. The fuel used consisted of a mixture of wood charcoal, coal, coke and peat.

Nature and Extent of Deposits—

The ore deposits are revealed by the old workings. Plan Fig. 10, made from Mr. Cirkel's drawings (p. 41 of his report) shows where they lie. A. B. C. is a large cut about 700 feet long, from 40 to 70 feet wide and from 25 to 50 feet deep. It has two levels corresponding to two stages of mining operations. A small bridge (a.b.) is thrown across the bottom working on the lower level. A wide shaft (c.) has been sunk in the upper level, but it is full of water and no indications can be obtained from it.

The ore obtained was taken from this cut by the first operations. It is excavated in crystalline limestones of the Grenville series and follows a lens of magnesian and ferruginous rocks. The whole is somewhat disturbed and it is possible that one of the walls of this lens may correspond to a fault plane. In any case at (b), near the small bridge, and at (e) there are traces of slickensides.

The bottom of this cut is overgrown with vegetation so that the character of the rocks can be ascertained only on the steep sides. Mr. Cirkel's report contains a detailed description of the mineralized outcrops along the walls of this cut. We will merely indicate the successive outcrops of the rocks at a single point and give a summary of the observations made elsewhere.

At f.g., where the lower level ends, is a rocky projection clear of all vegetation on which the following can be seen successively from south to north :—

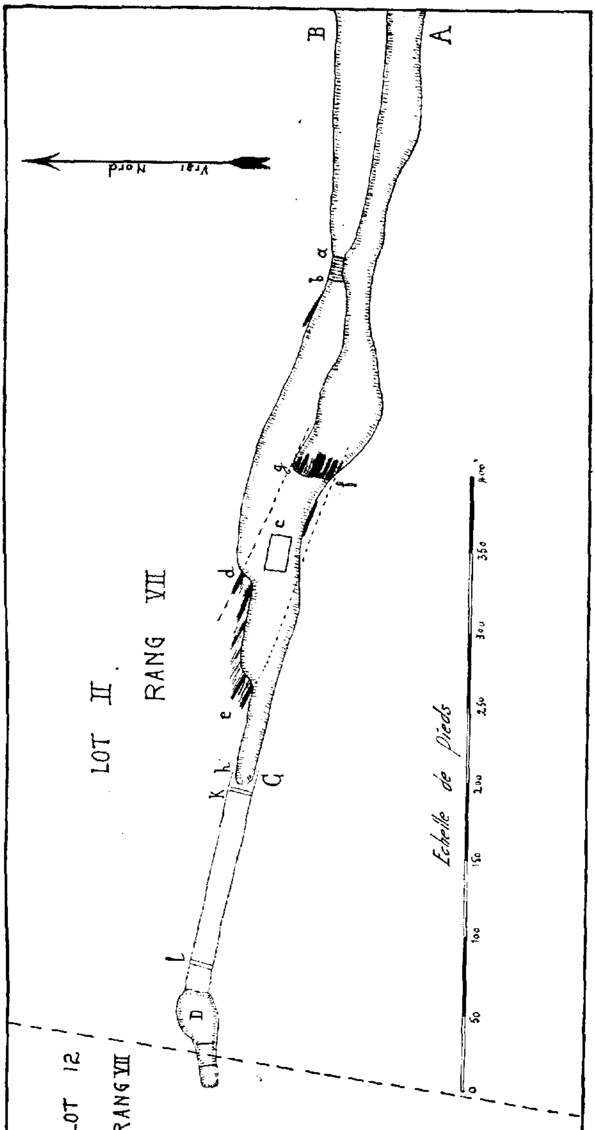


Fig. 10—Main cut of Forsyth mine, Hull township.

Seven feet of rock high in hornblende and mica, poor in iron at first, but gradually becoming an almost pure iron ore at the contact with the limestone.

One and one-half foot of a calcite lens showing some specks of ferromagnesian elements;

Two feet of a kind of gneiss with feldspar mica, hornblende, magnetite and pyrite;

Two feet of calcite impregnated with iron in patches;

Eight feet of good iron ore (Sample 142);

Three feet of calcite impregnated with iron;

Three and one-half feet of amphibolite, charged with iron;

One foot of amphibolite;

Five feet of fairly good iron ore;

One foot of amphibolite;

Two feet of good iron ore;

One foot of calcite.

Total, 37 feet.

At (d.) and (a.) similar rocks appear with beds of iron ore, mica schists, chloritoschists and amphibolites (see pages 45 and 46, Cirkel's report).

It is easy to see from the trend of the rocks that these various ore outcrops belong to a lens markedly trending from northeast to southwest. We have indicated the probable sidewalls of this lens by dotted lines on the plan.

No outcropping of iron ore shows out between (e.) and (h.)

The trench extends on the surface of the hill in which it is cut by a kind of sunken road C.D., along which it is difficult to see the bedrock. When Mr. Cirkel inspected the mine, he had two small cross-ditches dug, marked K. and L. on the plan. At K. he found a band 24 feet wide containing 15 feet of iron ore. The ditches were filled up when I was there, but the presence of so great a quantity of iron ore at that point under the conditions indicated by Mr. Cirkel leads to the conclusion that there must be a fault and a throw of the main lens from e. to K.

At D. is a large excavation 80 by 12 feet, at the lower point d. e. of which is a shaft now full of water. From verbal information we obtained, this shaft would be over 100 feet deep.

Ore in the rock shows out only on the west wall and in small quantity.

Walking along the extension of the sunken road, about 650 feet from the extremity C. of the trench one comes upon a small trench on lot 12 cut in the side of a rather steep rocky slope. This working has uncovered only somewhat small pockets of a magnetite with pyrrhotite, the whole being of no importance

Quality of the Ore—

The ore is a fine-grained magnetite, which, to the eye of an inexperienced observer, is easily confounded on the ground with the enclosing beds of rock amphibolite, but is easily discernible by its magnetism and its dust which is black while that of amphibolite is rather greenish gray.

Many analyses of this ore have been made and given in the official reports. Some of them are reproduced below :—

	I	II	III	IV
Magnetic oxide $Fe_3 O_4$	73.90			57.21
Ferric oxide $Fe^2 O_3$		46.09	57.31	
Ferrous oxide Fe O..........		30.73	26.40	
Oxide of Manganese $Mn_3 O_4$ ..				0.45
Titanic acid Ti O_2				0.96
Silica......................	20.67	16.00	11.00	22.36
Alumina....................	0.61			
Lime......................				
Magnesia..................	1.88			
Water.....................	3.27			
Phosphorus.................	0.027	0.025	0.014	0.111
Sulphur....................	0.085	0.44	0.39	0.932
		93.286		
Metallic iron...............	53.20	56.650	60.46	41.43

I. Black ore passed through the furnace. Sterry Hunt Report of Progress, 1866-69. Pages 255-256.

II. Ore at e. (Mr. Cirkel's report p. 45.)

III. Ore at k. (Mr. Cirkel's report, p. 46.)

IV. Sample 142, representing about an average from 8 feet of depth (taken at f. g.)

Conclusions—

The present condition of the workings does not allow of the true extent of the deposit worked by the old operators being ascertained. It would seem, however, to be merely a lens,some 30 feet wide at the most, interstratified in the limestones. Its length is unknown to us. Magnetic surveys will doubtless enable its being determined and will give information as to the existence of masses in the vicinity.

Although the quality of the ore is excellent, this deposit can hardly be considered one of great importance.

BALDWIN MINE

This name is given to a series of small excavations on lot 14, range VI., of Hull, about a thousand feet from the Forsyth mine.

Mr. Cirkel's report on the iron deposits along the Ottawa and Gatineau rivers contains a detailed description of these workings and we refer the reader to it.

Iron ore appears throughout in the shape of isolated pockets in crystalline limestones, gneiss and amphibolites. No mass of any extent has been uncovered by these excavations; pure ore is seldom met over a continuous length of several feet. There are some lenticular bands from 10 to 12 feet wide, strongly impregnated with iron ore, but they cannot be considered as true ore.

HAYCOCK MINE

The property known as the Haycock mine is on lot 28, range XI. of Hull, and lots 27 and 28, range VI. of Templeton. A long description of it is given in Mr. Fritz Cirkel's report, but the information to be obtained from an inspection of the spot may be summed up in a few words.

Within a radius of about 200 feet around an old furnace are traces of former prospecting work, the most important being: Two excavations about 40x7 feet and 20x50 feet and the beginning of a tunnel, 15 feet long. Other small pits, trenches, etc., are still visible.

Notwithstanding all my searches, I was unable to find a mass of ore of any importance. The rocks are, however, impregnated with magnetite; on the ground around the pits ore may be seen in the shape of patches or little pockets either in the gneiss or in the amphibolite, but such pockets are very limited and it is difficult to find any larger than 8 or 10 inches in diameter.

According to a statement (reported by Mr. Cirkel) made by Mr. Darby, one of the original owners of the mine, 2,000 tons of ore were taken from one of these pits, the ore being shipped by a small narrow-gauge railway, traces of which still remain. It is possible that there may have been a mass there, but nothing is now visible and the rocks around the pits are practically barren.

GASPESIA.

On several occasions the Quebec Mines Branch had received reports mentioning the existence of iron ore in the Gaspé peninsula. Fine specimens of hematite had been sent to it from Newport in particular. I went there and, with the assistance of Mr. R. E. Lenthall, who had been prospecting in that region for several years, I was enabled to ascertain in a short time that the discoveries made so far are not of economic importance.

SEA-SHORE AROUND NEWPORT.

The iron veins stated by prospectors to be considerable hematite deposits are in the schists classified as cambro-silurian by Mr. R. W. Ells (Report of the Canadian Geological Survey for the years 1878 and 1879.) These are gray schists which are at times white, having lost their original character by metamorphism probably of a dynamic nature. The stratification is sometimes visible, however, in the shape of ferruginous beds.

The iron veins are at times stratification beds, and are at other times bands in which it is impossible to find a conformity with any stratification. They all have a common characteristic: an abundance of silica either in the vein itself in the shape of brown or red jasper nodules, or in the country rock in the shape of stringers of white quartz.

In fact, no bed or band of iron ore contains hematite in a continuous manner, and they always consist in reality of a mixture of jasper and hematite. Everything indicates that these beds have been filled and the formation of these bands has been effected by the circulation of silicious and ferruginous waters along certain more porous beds (sandstone beds) or along certain fissures.

Many iron veins may be connected with beds, but their dimensions are quite insignificant, being only a few inches in width and some ten feet long.

A little to the east of Grand Pabos, the facies of the grey schists alter and the latter pass into schists and conglomerates. In a grey ground mass, quite similar to that of the foregoing schist, are red nodules of hematite and jasper. Sometimes iron is so abundant that the nodule consists almost solely of hematite. These nodules at times have a diameter of from one to two feet, but, in such cases, jasper is the major constituent. The most curious of these conglomerate bands, that which led to the belief that a large iron deposit existed, is about three-quarters of a mile east of the wharf of L'Anse à l'Ilot on the sea-shore. This band, of an average width of two feet, begins to show as a true conglomorate with hematite nodules, elongated and aligned parallelly to the walls; then the nodules become more and more numerous and join together to form a compact rock of jasper and hematite, measuring 16 inches at its greatest thickness. A slight crumpling has faulted this band which is almost vertical and which disappears on one side through impoverishment in ferruginous nodules and, on the other side, under the vegetable mould overlying the rocks.

The origin of this conglomerate is rather obscure. The simplest explanation would be that it is an old detritic conglomerate with ferruginous boulders, but if we consider the active part the waters charged with silica and oxide of iron must have played in order to give rise to a very compact rock of jasper and hematite at a certain point of the band, we may rightly come to the conclusion that these bands corresponded to sandstones—which were perhaps very coarse, but in every case permeable to probably already ferruginous waters—along which the silica and oxide of iron were precipitated in the shape of nodules.

Inland, some hundred feet from the shore, exactly 200 feet N.W. of the railway line and one mile from the level crossing of Pabos Centre, a pit 6 x 4 x 3 feet was dug on a vein of ferruginous jasper. This vein, of a fine red colour, was thought to be a vein of iron ore; in fact it contains hematite, but in a quite insignificant quantity.

PEMBROKE CREEK.

Along this creek Mr. Lenthall is said to have discovered the largest iron deposit in the region. We proceeded there with two guides by the following route: From Newport Centre to the New Road range, 6½ miles by a wagon road; from the latter to the camp on Lac à la Roche, by an abandoned shanty road (8½ miles); from the camp to the mine, 6 miles.

Pembroke creek starts from the northwestern angle of Newport township and falls into the West river. The deposit lies about a mile from the confluence of the two streams. Owing to the heavy rains at that season of the year, Pembroke creek was bank-high and we could not easily examine the ferruginous outcrops which are clearly visible and dry when the water is low, but are covered when it is high.

Proceeding up the creek from its confluence with the West river, the number of ferruginous boulders continues to increase until the deposit is reached. Judging by the samples I took and the portions of outcrops I was enabled to examine, this deposit seems to consist of a bed of very ferruginous sandstone in the midst of metamorphic grey schists similar to those on the sea-shore. The clastic origin of this bed is beyond doubt, but the cementing of the sandy elements has been effected by a ferruginous cement which forms beds of hematite in some places along certain fissure planes. When the rock breaks along one of such planes, it looks as if there were pure hematite, but the sections perpendicular to the beds show the sandstone structure.

Owing to high water I was unable to ascertain the trend and extent of this iron deposit; it does not seem, however, to be of much importance.

A sample of this ferruginous rock gave :—

Sample 88	
Silica insoluble in acids...............	48.28%
Iron oxide.........................	46.76%
Say metallic iron...... 32.73%	

A sample of hematite from one of the jasper and ferruginous beds on the sea-shore, gave on being analyzed :—

Silica and insoluble.....................	11.35
Sesquioxide of iron	85.42
Lime.................................	0.56
Magnesia.............................	0.51
Phosphorus...........................	0.011
Alumina..............................	0.98
Not ascertained.......................	1.159
	100.000
Metallic iron	59.79

To sum up: Apart from a few local concentrations, the ferruginous beds observed both on the sea-shore and on Pembroke creek are not iron ore deposits and until fresh discoveries are made, which is always possible in a region so little explored, it must be admitted that no iron deposit is known to us there.

Gaspesia is practically an unknown land from a mineralogical standpoint and it is to be hoped that earnest prospectors will explore that immense country inhabited only along the shore line by a population of fishermen not very likely to recognize minerals.

NOTES ON PAINT CLAYS.

At several points on the coast in the vicinity of Newport and along the West river, clays exceedingly soft to the touch and variously coloured are to be found in the shape of beds intercalated in the schistose rocks. Some are milky white, others are pink or blood-red. The latter in some instances being especially fine: their colouring power is intense and they leave an enamel red coat when dried. In paste they are oily and look as if they had been mixed with linseed oil; in the dry state they feel like soap to the touch. These are very probably mixtures of kaolin, oxide of iron very finely divided and talc.

These clays are due to decomposition "in situ" of metamorphic schists. A series of white, pink or red beds, each representing a different schistose bed, is not unfrequently found over a width of some feet.

Unfortunately not one of these beds is sufficiently thick nor, above all, sufficiently continuous in depth. The decomposition of the schists is entirely superficial and at a very slight depth nodules or scales of serpentine, patches of quartz surrounded by talc, etc., are met with.

At the foot of cliffs are patches of red ochre, due to the washing and carrying away by water of the clays interfoliated in the schists. These patches, which are of no depth, have led to the belief in the existence of beds of ochre.

CHAMPLAIN AND BATISCAN MAGNETIC SANDS.

Between the villages of Champlain and Batiscan (county of Champlain) and beyond them the lands along the St. Lawrence present two different aspects:—

1. A flood plain from 2-3 of a mile to 2½ miles wide, only a few feet above the river. This plain is of very recent formation and when the country was first settled it was flooded when the water was high. Even at present the farms along the road are regularly inundated every spring.

2. A horizontal plateau forming a terrace from 60 to 100 feet above the plain. The rise from the plain to the plateau is rather steep and the face of the declivity frequently slides down allowing the white sand of the plateau to appear.

Some prospecting for magnetic sands has been done on the river bank, on the edge of the flood plain and on the high sandy terraces.

SANDS ALONG THE RIVER BANK.

The only place where there is sand in any great quantity is near the boundary between the two parishes of Champlain and Batiscan on the site of the former mouths of the Champlain river. Not very long ago that river flowed into the St. Lawrence after a series of windings through the alluvium it had carried down. The alluvial deposits extended every year, as is usually the case, so that when the last bend but one encroached upon the narrow strip of land separating it from the St. Lawrence, a high tide or a gale of wind broke the dyke and gave the Champlain river a new mouth. In the course of time, the river has had to abandon two or three of its windings and it now falls into the St. Lawrence at lot No. 14, range I, Visitation, about 2,000 feet above the sandy point now under consideration and which is opposite lots 319 to 324 of range I. of Batiscan.

The magnetic sands found at that spot were brought down and deposited by the waters of the Champlain river. Plan Fig. 11 shows their present position. At A. B. on the edge of an old channel, still filled at high tide, are small beds of black sand interstratified with white sand and placed there by the tidal currents. Samples 1 to 5, taken there a few feet from the beach at depths varying from two to four feet, gave averages varying from 2.91% to 6.84% of magnetic concentrates.

From C, going towards the left of the plan, the beach rises in a gentle slope from the river to a kind of small plateau (a few scores of feet wide) covered with alder-bushes. Black sand is often found on this plateau over a width of from 20 to 60 feet. The table given below shows the results obtained from the samples taken on the surface at various points of the plateau.

On the slope of the beach near the river is a superficial bed of black sand called tidal sand, whose formation is of the present day and is due to the washing of the beach by the waves. (See Moisie sands—Report of the Mines Branch, Quebec, 1911.) This washing has sometimes produced fine concentrates, especially between points 11 and 12, where almost pure black sand can be seen with a depth of six inches over a width of 12 and a length of 20 feet.

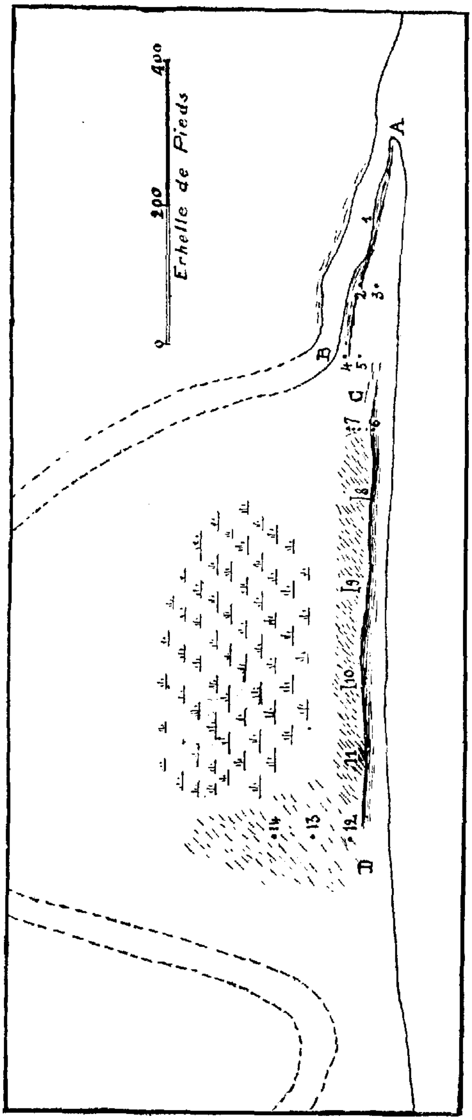


Fig. 11—Black sands, along St. Lawrence river, Batiscan.

The table below (samples 12, 13, 14) also shows the results of the borings in a bank of earth covered with grass.

Table of the samples taken from the sands on the beach of the St. Lawrence, at Batiscan, Champlain :—

No. of Sample (see plan fig. 11	Depth at which Sample was taken	Proportion of magnetic concentrates	Remarks
1	21″	2.91%	3 feet from channel.
2	26″	5	do
3	34″	5.80	do
4	48″	6.84	Quite near channel.
5	41″	5.85	
6	6″	16.66	Represents a width of 10 ft. and a depth of 6″ (grit).
7	30″	7.10	Represents a width of 60 ft. and a depth of 30″ (sand from alder covered plateau.)
8	12″	10.45	Represents a width of 60 ft. and a depth of 12″ (sand from alder-covered plain.)
9	6″ to 8″	24.45	Represents 20 ft, depth 6″ to 8″ (sand from alder-covered plain)
10	3″	24.93	Represents 20 ft by 3″ (sand from alder-covered plain.)
11	10″	24.10	Represents 24 ft. by 10″ (sand from alder-covered plain.)
12	60″	22.34	60″ boring down to clay.
13	44″	18.10	50″ boring down to clay (6″ of vegetable mould deducted.)
14	34″	6.30	40″ boring down to clay (6″ of vegetable mould deducted.

On being analyzed, the magnetic concentrates of Nos. 9 and 12 gave :—

	Concentrates 9	Concentrates 12
Metallic iron................	65.20	68.10
Titanium...................	1.46	1.12
Sulphur....................	0.013	not ascert.
Phosphorus.................	traces	do

Summing up these observations, it may be said that the quantity of beach sand, properly so-called (tidal sand), is small; there is a strip 600 feet long, from three to four feet wide and a few inches thick. The sands on the alder-covered plateau constitute a mass which is interesting owing to its richness in magnetite (7.10% to 24.93%). In some places the width and thickness are fairly great, but the length of the strip is unfortunately limited and a calculation of the corresponding tonnage shows that there may be a sufficient quantity of black sand there for extensive tests, but quite insufficient to be really utilized.

It is possible that borings may reveal the existence of magnetic sands especially along the extension of the line 12, 13, 14 or at other points between the former windings of the Champlain river, but it is not probable that any great tonnage will be found.

When I visited the spot, a Toronto syndicate, the International Tool Steel Company, was putting up a small concentrating mill a few hundred feet from the former channel of the Champlain river.

THE HIGH SANDY TERRACES

These terraces follow one another on a line parallel to the river for a distance of several miles. Prospecting companies are said to have made borings there. Owing to the short time at my disposal, I confined myself to making some borings at one spot which the local residents pointed out to me as the richest.

The C.P.R. runs along the foot of these terraces a little above the level of the alluvial plain and the borings were made at the 100th mile-post of the line.

Terraces of White Sand, Batiscan.—On left is flood plain of St. Lawrence river.

The line of the borings 1, 2, 3, 4 is at right angles to that of the railway.

Boring No. 1 :—50 feet from the crest of the terrace on the terrace itself; depth 10 feet; apart from a depth of 4 inches, on the surface, which is not stratified and slightly mixed with iron, the sand taken out is white.

Boring No. 2 :—110 feet from the crest of the terrace; depth 10 feet 4 inches. The first four inches (quick sand) gave 1.52% of concentrates.

The next four feet gave 1.70% of concentrates.

The next six feet gave 1.83% of concentrates.

Boring No. 3 :—170 feet from the crest. We first dug a pit 5 feet 6 inches deep which gave sand of similar appearance to the foregoing ones. At the bottom of the pit we bored a hole eight feet deep which brought out sand giving an average of 1.74% of magnetic concentrates.

Boring No. 4 :—340 feet from the crest, a boring 10 feet deep which brought out sand similar to the foregoing.

Two other borings were also made on a flat spot half-way up the slope; they were 10 feet deep and gave only white sand.

On the other side of the railway track, in a straight line with the previous borings at the junction of the sandy slope and the alluvial plain is a rather curious surface deposit of black sand.

Drawing Fig. 12 gives a section at right angles to the railway track. Before the track was laid, the terraces *a. a.* were connected with the plain *f.f.* by the line *a. b. c. d. e.* But the railway company cut away the side of the hill for its line in such manner that there remained only a small slope at *e*, which has gradually grown larger under the effects of the wind; the latter in fact drives the sand against the slope; the posts at its summit help to keep the sand in place and a dune is formed little by little. The sands driven by the wind contain magnetite, garnets and hornblende; a classification is brought about by the wind's action, the light white sands being more easily carried away than the heavy sands, so that there is at present a surface mass of black sand on the slope of a small artificial dome facing the St. Lawrence.

This mass is not very large, its dimensions being: Length 350 feet, width 30 feet, depth 16 inches. This depth varies

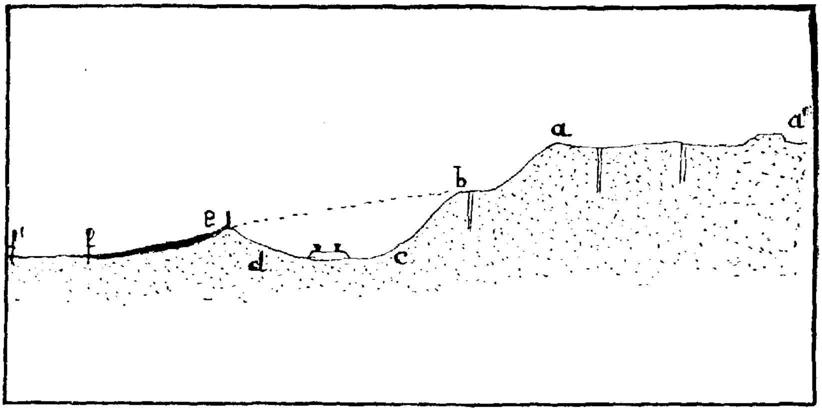


Fig. 12—Section of Sand Terraces, Batiscan, at Mile 100 of C.P.R. Line.

greatly and is very slight at many points. Two samples were taken, being a rich sampling of these superficial black sands. They gave 25.49% and 49.20% of magnetic concentrates, the latter containing:—

Iron	64.80%
Titanium	1.80%

Red Chute, at the outlet of Olga Lake.

A REPORT ON THE GEOLOGY AND NATURAL RESOURCES OF CERTAIN PORTIONS OF THE DRAINAGE BASINS OF THE HARRICANAW AND NOTTAWAY RIVERS, TO THE NORTH OF THE NATIONAL TRANSCONTINENTAL RAILWAY IN NORTHWESTERN QUEBEC.

DEPARTMENT OF GEOLOGY, MCGILL UNIVERSITY.

Montreal, April 12th, 1913.

TO MR THEO. DENIS,

Superintendent of Mines.

Quebec, P.Q.

SIR :—

I beg to submit herewith my report on the geology and natural resources of portions of the drainage basins of the Harricanaw and Nottaway rivers in Northwestern Quebec. This report is the result of two months of geological reconnaissance within the region.

I have the honour to be,

Sir,

Your obedient servant,

J. AUSTEN BANCROFT.

INTRODUCTION.

Recently attention has been attracted to this area because of the projected North Railway, by which it is planned to connect Montreal with the mouth of the Nottaway river on James Bay. Moreover, during the past year, access to the area described within this report has been made easy by the construction of the National Transcontinental Railway, which now crosses the Harricanaw, Natagagan and Bell rivers flowing towards James Bay. Under instructions from Mr. T. C. Denis, Superintendent of Mines, about two months were spent in making a rapid trip of geological reconnaissance in order to collect data bearing upon the possibilities of the occurrence of valuable minerals within that portion of the region traversed. In addition, certain observations with reference to other natural resources may prove to be of interest. Numerous photographs were taken, but, owing to almost continuous wet weather, together with a slight accident, the majority of the plates were damaged by moisture.

The writer was fortunate in having the assistance of Mr. A. O. Dufresne, a graduate of the Ecole Polytechnique, Montreal. Four Indians were engaged as canoemen for the entire trip. The services of two extra men with a canoe were secured to assist in transporting the necessary outfit down the Harricanaw river and across the long portage to the Allard river.

ITINERARY.

The National Transcontinental Railway crosses the Harricanaw river at Amos, 141 miles eastward from Cochrane, Ont., and 62 miles due east from the western boundary of the Province of Quebec. Leaving Amos on July 8th, the expedition followed the Harricanaw northward for about 72 miles, where a portage 4½ miles in length, extends to the headwaters of the Allard river, which flows into the western end of Matagami lake. Upon reaching this lake, the party was divided, Mr. Dufresne passing eastward to explore Gull and Olga lakes, while the writer descended the Nottaway river for 100 miles to a point

10 miles below Kelvin lake and about 35 miles from the tidal water of Rupert Bay. Unfortunately, the time at our disposal did not permit a visit to James Bay. Returning to Matagami lake, the party united in careful examination of its shores, and after ascending the Bell river for about 50 miles came up its large tributary, the Natagagan river, arriving at the railway on September 4th. A track survey was made of the Natagagan river from its mouth to a point about 17 miles from the railway, down stream to which point a survey of this river was made by W. J. Wilson, of the Geological Survey of Canada, in 1906.

PREVIOUS WORK.

The Bell and Nottaway rivers, Matagami, Gull and Olga lakes had been previously examined from a geological point of view by Dr. R. Bell, formerly Acting Director of the Geological Survey of Canada.*

With the exception of that portion pertaining to the Bell river, the topographic maps of this region, on a scale of four miles to the inch, are very deficient in detail and, locally, are distinctly and seriously wrong. Since the time at our disposal was limited, corrections to the topography upon these maps were restricted to a few sketches, elimination of some islands shown upon the map which do not exist, the insertion of some others, and the results of a rapid track survey of the Natagagan river. Portages and rapids were placed in their proper relative positions.

CHARACTER OF THE DISTRICT.

TOPOGRAPHY.

This area is a portion of a vast plain sloping gradually from the height of land on the south to sea-level at James Bay. In

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*Summary Report, Geol. Surv. of Canada, 1895, pp. 74-85 A.
" " " " " 1896, pp. 64-74 A.
"Geology of the Basin of the Nottawav River", Geol. Surv. of Canada, Vol. XIII., 1902, pp. 1-11 K.
Geol. Map of Basin of Nottaway River, 10 miles to 1 inch, 1900.

crossing the Harricanaw river, Peter Brown creek, the Natagagan and Bell rivers at elevations of 998.5, 1024.38, 1028 and 1024 feet (*) above sea-level, respectively, the Transcontinental Railway traverses the southern portion of this plain at a distance of from 180 to 190 miles in a straight line from the nearest portions of James Bay. Within 120 miles northward from this railway the surface of the plain descends about 400 feet, while in the remaining 60 or 70 miles, the slope becomes more readily perceptible with a descent of 600 feet. The southerly and more gently sloping portion of the area lying between the N. T. Railway and the outlet of Soskumika lake on the Nottaway river, and extending eastward to include Olga lake, is situated within what is frequently and appropriately called the Clay Belt of the North.

It is an extremely level or slightly undulating region underlain by a heavy blanket or stratified clays and sands, from beneath which a few low rocky hills and ridges protrude to elevations which very seldom exceed 200 feet above the surrounding country. In fact, elevations of much less than 100 feet above the average level form very prominent landmarks. One may travel for many miles without having a single topographic irregularity upon the horizon.

In general terms, low rocky ridges are of somewhat more frequent occurrence northward from Matagami lake, where the country is underlain by granites and gneisses. In the vicinity of Obalski lake and immediately to the south of Matagami and Gull lakes, hills or "mountains" are more numerous than in districts of corresponding size elsewhere within the area. The highest points in the whole region are situated to the south of Matagami lake, where a range of mountains, five miles long and trending nearly east to west, culminates in the summit of Mt. Laurier with an elevation of 670 feet above the lake, or 1285 feet above sea-level. Next in order of prominence are the Dalhousie and other mountains to the south of Gull lake.

From the summit of Mt. Laurier one gains a wide horizon within which no mountains of similar altitude can be seen ; from

*These altitudes refer to "the base of the rails."

its southern margin, low land—much of which is swampy—extends to a great distance. The most prominent hills to be seen from the top of Mt. Laurier lie far upon the horizon in a direction about S. 20° W. In general, the rocky ridges represent some of the more resistant portions of the basement upon which the superficial deposits rest, or possibly they have occupied fortuitous positions with reference to the development of the drainage systems that have in times past reduced this region to its present level condition.

Were it not for its widely scattered, low, rocky hills, its shallow lakes—some of which are very large, and the presence of numerous rapids along its rivers and streams, this country would be very monotonous. In the major portion of the area, the land stands but a few feet above the waterways, but locally, as along certain portions of the Allard and Nottaway rivers banks of stratified sands and clay, often 10 to 35 feet high. rise quie abruptly. Widespread swamps or muskegs are of frequent occurrence, especially toward the headwaters of streams, as along the Allard river and in the vicinity of the two unnamed lakes which discharge into the northern arm of Soskumika lake on the Nottaway river. In general, the land northward to Matagami lake is better drained than in the vicinity of the height of land to the south. Apart from expenses in connection with bridge construction, it should be possible to extend a railroad in almost any direction at a comparatively low cost.

DRAINAGE AND WATER POWERS.

It is a region of large rivers and lakes with smaller tributaries. Southward from Soskumika lake, long stretches of the rivers and streams possess little or no current, winding sluggishly over this old lake bottom while descent is accomplished chiefly by rapids or chutes. The combination of both old and youthful qualities in individual rivers and streams is the most striking characteristic of the drainage of this Clay Belt. Although the current is almost imperceptible for considerable distances, the waters of the Harricanaw, Natagagan and the lower course of the Allard rivers are milky or of a coffee colour because of the fine clay which they carry in suspension. Twelve miles below Lake Obalski, the Harricanaw river becomes a succession of rapids and small cascades for a distance of three or four miles. At certain points these rapids could be improved to form efficient water powers without flooding much, if any, of the low-lying land above. Since they are only about twenty miles in a straight line from the railroad at Amos, they may be of some immediate importance.

The Natagagan river affords a superior canoe route northward for about 90 miles to its junction with the Bell river, 50 miles from Matagami lake. For the first fifteen miles of its course below the railway, it is comparatively narrow, becoming rapidly wider below this until at its mouth it is two to three chains in width. There are no lakes (hence no danger of being wind bound) and but seven short portages, of which the two longest are half a mile and 12 chains respectively.

For fifty-five miles north-eastward from the portage to the Harricanaw river, the waters of the Allard river are very much clearer than those of either the Harricanaw or the Natagagan; below this it becomes muddy, discolouring the waters of Matagami lake in the vicinity of its mouth. In its course of 74 miles, from the long portage to Matagami lake, only four portages are necessary, three of which are very short, and a fourth of three-fourths of a mile.

The waters entering the eastern end of Matagami lake from Olga and Gull lakes are clear, as are also those of Waswanipi river. Although there are no bad rapids along the Waswanipi river for 16 miles, from Waswanipi lake to Gull lake, its current is very swift for about six miles.

Below Soskumika lake, rapids and cascades are numerous on the Nottaway river, there being others in addition to those located on any existing map. The river is so rough that it is avoided by those knowing the district, unless they are desirous of reaching James bay quickly. Although very much longer, the preferable route follows eastward from Matagami to Olga and Gull lakes, thence northward through an excellent chain of waterways to Evans lake, subsequently either down the Broadback river or across the Nemiskau portage and down the

PLATE II.

Mt. Laurier, as seen from the eastern side of the large northern bay toward the western end of Matagami lake.

PLATE III.

Matagami Lâke, as seen from the summmit of Mt. Laurier.

Rupert river. The Rupert or Broadback rivers are preferred by the authorities of the Hudson Bay Company in transferring supplies from Rupert's House to their post on Waswanipi lake.

The best water power in the region traversed is that known as Iroquois chute, where the Nottaway river, at a point about 35 miles below Soskumika lake, makes an almost direct plunge of 35 feet. With little effort these falls can be improved to produce much more power than they now represent.

Five miles below Kelvin lake, a continuous succession of heavy rapids and cascades produces a drop of about 130 feet within a distance of four miles . At Bull rapids, about 20 miles above Iroquois chute, at the smaller cascades about two miles below Soskumika lake and those about five miles below the outlet of the northern arm of Matagami lake, as well as at many other points on that portion of the Nottaway which was traversed, improvements can be made to produce water powers of importance. All of these water powers are subject to great fluctuation in volume. Although much rain fell during the past summer, the Nottaway river fell about six feet between July 23rd and August 19th.

Red chute, situated at the outlet of Olga lake, is also a water power of very considerable importance. It has an enormous reservoir to draw from, and can be developed very easily. Attention might also be attracted to some water powers of minor importance along the Natagagan river and the lower course of the Bell river.

The waters of Matagami, Olga, Gull and Soskumika lakes are usually clear and their long sandy beaches form a pleasing contrast to the muddy waters and clay shores of the lakes near the height of land. The sandy beaches are frequently continuous for several miles without interruption. The sands are resting upon a basement of clay so that during low water when the marginal portions of the beaches are exposed, where the coating of sand is thin, one may be frequently surprised when landing upon sand to find that he sinks in sticky clay. That for the most part these lakes are very shallow is evidenced by the fact that during a storm their waters soon become rough and muddy. Especially is this true of the western end of Matagami lake, the southern portions of Olga lake, and the whole of Soskumika lake. During a medium stage of the water, one may touch the bottom of the latter lake over large areas, while the water weed (*Potamogeton Richardsonii*) (Rydd) grows profusely at distances of a mile or more from the shore. In many places, these lakes are gradually becoming larger because of the wearing back of clay banks by waves and by ice in the winter and spring. Matagami lake (25 miles in length and with a maximum width of 8 miles near its western extremity) with its long sandy beaches and a group of picturesque mountains along its southern shore, must be one of the most beautiful of the Laurentian lakes.

SOIL AND CLIMATE.

The Clay Belt proper extends northward to a few miles below Soskumika lake and eastward to include Olga lake. Within this portion of the region the soil is practically the same as that which may be seen along the N. T. Railway from Harricanaw to the Natagagan river. Stratified lacustrine clays occupy by far the major portion of this area. Locally, sandy tracts are present. It may be said that apart from comparatively small areas where rocky ridges are congregated together or where the surface soil is sandy, and the more extensive areas where swamps and muskegs occur, the land is generally suitable for agricultural purposes. Northward from Soskumika the soil, in general, becomes more sandy. Stratified sands, often containing large boulders, here occupy considerable areas. Lake Kelvin is surrounded by stratified sands and very sandy clays. In general, it may be said that northward from Soskumika lake the land is not inviting for agriculture, while judging from the appearance of the vegetation and our own experience, the breezes seem to be colder than from Soskumika lake southward. Toward the east, Gull lake is surrounded by sands and gravels, locally containing many boulders. Along the Waswanipi river to the lake of the same name, the soil becomes a good clayey loam and is drained better.

There are very considerable areas in the vicinity of Soskumika, Matagami and Olga lakes that will be suitable for farming. In ascending a creek flowing into the eastern end of Matagami lake, arable land seemed to become better because, at least in this direction, the land becomes higher and enjoys better drainage. Practically the whole of this northern country is heavily covered with mosses. Northward from the Matagami lake the moss cover becomes somewhat more universally heavy than to the south. Where fires have burned the forests, it is remarkable over what large areas they have completely removed the mosses and have exposed the soil beneath.

It will be difficult and in some cases impossible to drain some of the extensive swamps and peat bogs.

In the vicinity of Laval and McGill lakes, peat has accumulated to great thickness; for considerable distances the shores are margined by banks of this material up to six feet high, and in places the clay basement upon which the peat rests is not exposed. Between these lakes and the great northern bay, near the western end of Matagami lake, the land is very low. Since locally peat also appears upon the shores at the bottom of this bay, it is highly probable that a very large percentage of this low intervening area is occupied by heavy deposits of peat. Similar deposits of peat must be of frequent occurrence between Laval and McGill lakes and the western shores of Soskumika lake. They also occupy a considerable percentage of the flat area in the vicinity of Kelvin lake. Less extensive peat bogs were observed in places along the western shore of Matagami lake, and on Elizabeth bay of Olga lake.

Nevertheless, when all the disparaging features have been considered carefully, there remain very wide areas between the N. T. Railway and the outlet of Soskumika lake which, in so far as the soil is concerned, will make excellent farming land. The most continuous stretches of good land encountered during the traverse are situated along the Allard and Natagagan rivers, especially along the former. In crossing from the muddy, coffee-coloured waters of the Harricanaw to the clear waters of the upper Allard, the verdure becomes of a brighter green, plants appear to be more thrifty and wild flowers, as the rose, honeysuckle, orchids, etc., were growing profusely in the middle of July.

The climate is a more important factor than the soil. The region examined lies between latitudes 48°30′ and 50°50′. Fortunately the decrease in elevation offsets the increasing latitude, so that throughout the larger part of this area, at least nearly if not quite as far north as Matagami lake, the mean annual temperature must be approximately the same as in the vicinity of the National Transcontinental Railway.

During the two months, overcast skies and drifting showers prevailed, there being only three or four continuously fine days. The total rainfall must have been very considerable during this period, but Indians and others with long experience declared the summer to be very exceptional. The erratic occurrence of frosts is the most dangerous feature from an agricultural point of view. During the nights of July 16th and 19th, spent on the upper waters of the Allard river, frosts were so heavy that in the morning everything was covered by hoar frost, while films of ice were formed over water in pails. These films of ice were of such firmness that fragments three or four inches across could be taken in the hand. On August 16th, while camped on the margin of a very extensive swamp about eight miles south of the northern arm of Soskumika lake, a heavy frost was experienced.

It is remarkable that during these frosts the more delicate forms of natural vegetation simply droop a little, while they are looking as fresh as ever after the sun has risen for an hour or two. No more frosts were noticed until on the first of September while ascending the Natagagan river. Within this region, frosts frequently occur in the vicinity of widespread tracts of low lands or swamps at a time when slightly higher lands and those in the neighbourhood of the large lakes do not experience them. It is stated by those of long experience that even during midsummer ice may be found at a depth of three feet or more within some of the muskegs. During the past summer this statement was corroborated in a few localities by Mr. J. H. Valiquette, Assistant Inspector of Mines, who was supervising the construction of roads in the vicinity of Amos on the

Transcontinental Railway. In such localities, the presence of the ice at depth does not have a retarding effect upon the prolific growth of plants and shrubs at the surface.

Throughout this whole region, settlement should be encouraged, first in the vicinity of the largest lakes or upon the somewhat higher lands, where the diurnal range of temperature is subject to the least fluctuation, and where even the faintest air currents have a chance to circulate more freely. Experience leaves no doubt that clearing the land, draining some of the swamps and ploughing fields will tend to make these frosts of less frequent occurrence. It does not seem probable that scattered settlement, such as would result from opening up alternate lots, will have as beneficial a result in this respect as the occupation of whole townships. Moreover, the former method increases the danger of bush fires.

Each year potatoes and other vegetables are successfully raised at the Hudson Bay Co.'s post on Waswanipi lake, situated in latitude 49°36′, about 100 miles north of the National Transcontinental Railway and at an elevation of 680 feet above the sea. In 1911 seed was planted on the last day of May, and during the latter days of September yielded 180 bushels of excellent potatoes; during that time frost never injured their growth. At the time of my visit to this post on August 5th, potatoes were passing out of flower and gave every promise of another large crop, while a few peas and turnips were also flourishing. Last spring the ice began to break up on this lake on May 5th and had almost completely disappeared on May 21st.

Dr. Robert Bell, in describing his visit to this post on the 12th of August, 1896, writes as follows:—"Mr. D. Baxter, the gentleman in charge of Waswanipi post, kindly agreed to make some experiments with wheat, oats, barley and a variety of other seeds, which I obtained from Dr. Saunders of the Central Experimental Farm, and sent to him during the past winter. When we visited his post, the various grains looked well. They had headed out some time before and would soon be ripe. New potatoes were as large as hen's eggs, turnips six inches in diameter, and carrots and some other vegetables ready for use. Indian corn was showing its silk, tobacco plants were growing well, and almost every kind of garden crop grown in an average district of Canada was flourishing under Mr. Baxter's care." In his report on "An Exploration of the East Coast of Hudson Bay," (*) Dr. A. P. Low inserts the following footnote:—"In 1896 and 1897 wheat ripened at Waswanipi, in latitude 49°45′ or 122 miles south of Rupert's House, from seed sent by Dr. Robert Bell to the officer in charge of that post."

During the past summer, at the mouth of the Bell river, Messrs. W. W. Taberner and D. H. Moore, who were prospecting for diamonds, were successful in growing both lettuce and radishes. The profuse growth of wild grasses in favourable localities indicates that hay would yield a heavy crop. Frosts seriously injured potatoes and other crops on the Harricanaw river near the Transcontinental Railway when no frosts were experienced in the vicinity of these large lakes of the north.

Personally, I believe that the antiquated but more or less popular conception, which considered this region to be a part of the "Frozen North," has preserved a heritage for present or future, in many parts of which potatoes, turnips and other vegetables, hay, oats, barley and rye can be successfully raised. It does not seem probable that it will become a wheat-raising district. When its long winters are considered, it is a country which will demand thrift and endurance from its inhabitants, two qualities which never have proved to be injurious to public welfare. If at some time in the future, the Government decides to open these lands for settlement, it would be advisable, somewhat in advance, to establish a few experimental farms in suitable localities and under competent management.

FLORA.

Viewed from some elevation, the whole landscape has a most sombre aspect, owing to the comparatively small number of deciduous trees. The majority of the rivers and streams are bordered, more or less continuously, by a hedge-like growth of alders (*Alnus incana*, Moench), low willows (*Salix longifolia*

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*Can. Geol. Surv., Vol. XIII., 1900, p. 14 D.

Muhl), with other shrubs as the meadowsweet (*Spiraea salicifolia*, L.), the red osier dogwood (*Cornus stolonifera*, Michx), and the western mountain ash (*Pyrus sitchensis*, Roem). Behind this fringe, poplars (*Populus tremuloides*, Michx, and *Pop. balsamifera*, Linn.) up to 28 inches in diameter are frequently present for a distance inland depending upon the lowness of the land. Farther away from the waterways, the occasional presence of a few poplars and white birch (*Betula papyrifera*, Michx.) break the otherwise uniform monotony of coniferous types.

Black spruce (*Picea mariana*, (Mill) B.S.P.), white spruce (*Picea canadensis* (Mill) B.S.P.), jackpine (*Pinus banksiana*, Lam.) and the balsam (*Abies balsamea*, Linn.) comprise apparently much more than ninety-nine per cent of this forest. Of these the black spruce is by far the most numerous, while south of the outlet of Matagami lake areas occupied chiefly by jackpine are of frequent occurrence. Immediately along the Nottaway river, no jackpine were observed, although eastward from here its occurrence is known to extend far northward into Ungava. Individual trees of white spruce were noticed near the southern end of Soskumika lake with a maximum diameter of 30 inches, and along the upper part of the river flowing from Gull lake with a diameter of 32 inches. Trees of this size are very exceptional. The largest trees are those which are more or less isolated along the margins of the waterways.

A few gnarled and stunted white cedar (*Thuja occidentalis*, Linn.) occur in places along the margins of the largest rivers, but especially in the vicinity of lake shores. Locally the white birch is an important tree, occasionally having a diameter of two feet. In descending the Allard river for 74 miles to its mouth, not more than two dozen white birches were noticed. In areas which have been burned some years ago, as to the south of Matagami lake and to the east of Soskumika lake, there is a profuse second growth of small poplars and birches. A widely scattered growth of thrifty young tamarac (*Larex laricina*—Du Roi—Koch) is appearing, but all large trees of this species were killed by the ravages of the grub of larch saw-fly from 1893-96. No white or red pine were observed within the region.

It is impossible to mention in detail those areas where the forest is especially valuable. From the nature of our work, they were chiefly judged from their appearances along the waterways. It is essentially a pulpwood country. Considering the region as a whole, there is a great wealth of most excellent pulpwood, but there are large and small areas where especially the spruce and jackpine are suitable for lumbering purposes. The most extensive areas of trees suitable for pulpwood and timber were noticed along the Harricanaw and Allard rivers, especially along the latter. A view from the summit of Mt. Laurier embraces coniferous forests broken here and there by brulés and by muskegs, in which the trees are small and scattered. From experience gained in making many traverses through the bush in the vicinity of the height of land, it frequently happened that when poor along the streams, areas of good pulpwood and timber occur at variable distances from the waterways. Those short traverses which were made in the bush, together with views obtained from elevations, lead to the conviction that the same statement may be made concerning this region.

Northward from Soskumika lake, a few small patches of fairly good timber were noticed, but apart from areas where the trees are suitable for the manufacture of pulp, the muskegs with small scattered trees are larger, and there are many localities where the trees are tufted toward the top as if the struggle for existence had not been easy. At the most northerly point reached on this river spruce trees were observed up to 14 inches, balsam 13 inches and white birch 12 inches in diameter. Considering that portion of the area between Soskumika lake and the Transcontinental Railway, it seems a conservative estimate that owing to the ravages of fire and the presence of muskegs where the trees are small and scattered, within about forty per cent of this area the forests are of no value at present.

A small collection of flowering herbs and shrubs was made during the summer and was submitted to Prof. C. M. Derick in the Department of Botany, McGill University. The list, as prepared by her, appears as an appendix to this report. The ranges given in this list are for Canada, although many forms extend into the United States. This small collection was made in the hope that the time of flowering of these plants in this northern region might be compared with that of the same plants farther south. A record of dates and locations was kept, and Professor Derick states that the average time of flowering is about two or three weeks later than in the most southern portions of Quebec

In so far as could be determined spring comes, at least in that portion of the region southward from Matagami lake, four or five weeks later than in Montreal. The growth is then very rapid, it requiring but a comparatively short time for leaves to develop to full size. Labrador tea (*Ledum groenlandicum*, Oeder) and laurel (*Kalmia angustifolia*, L.) form a large percentage of the undergrowth. The high bush cranberry (*Viburnum pauciflorum*, Raf.) and the bilberry (*Amelanchier canadensis*) are abundant in some localities. Wild roses, orchids, iris, bush and twining honey-suckles, tall meadow-rue, bluebells, laurel, twinflowers, bunchberry and wild peas are some of the most striking and numerous flowers. The last of the wild roses on the Nottaway river were observed on August 5th. Wild gooseberries were abundant and large enough to be edible along the upper portion of the Allard river in the middle of July. Large blueberries were very plentiful on the slopes and summits of Mt. Laurier on August 26th. At that time there was a fair percentage of green berries. On August 29th raspberries were practically all ripe and very abundant at the Island portage on Bell river.

Forest fires have devastated large areas. Some of the areas which apparently have been burned over during the past six or seven years may be mentioned. At intervals of about 5, 16 and 22 miles below Lake Obalski, burned zones cross the Harricanaw river, the widest of which extend for 5 or 6 miles along the river. About 26 miles below the railroad on the Natagagan river, large burned areas appear; and upon descending about five miles further, a brûlé begins which extends for 12 miles either along or near the river. It seems probable that these brûlés on the Natagagan and Harricanaw rivers are connected inland. In its length of 74 miles north-eastward from the long portage, the Allard river is crossed by four brûlés. Within the past three years, a fire burned a wide area eastward from Matagami lake to Olga and probably to the northern end of Gull lake. Along a stream entering the eastern end of Matagami lake, which was ascended for 12 miles, there is scarcely a green tree to be seen. Here this fire has been so vigorous that it would require comparatively little labour to make the land ready for cultivation. Mt. Laurier to the south of Matagami lake and the Dalhousie mountains, south of Gull lake, have been swept by fire. An extensive brûlé crosses the Nottaway river in the vicinity of Bull rapids. Other burned areas within the region might be mentioned, but sufficient has been written to emphasize the serious damage that has been done. During the past summer, the region has been practically free from fires. Three very small bush fires had been started from abandoned lunch fires along the Nottaway river, two of which were extinguished by the rain and the third by members of our party.

A study of the annual rings of individual trees shows that the growth of the forest has been very slow. Especially is this true of the stunted trees in the swamps and muskegs. It is apparent that the natural re-forestation of an area which has been devastated by fire will demand a period of time equal to, if not greater than, a human generation before any of the trees attain a size which is reasonable for pulpwood.

FAUNA.

From a few miles to a distance of sixty or seventy miles north of the National Transcontinental Railway, moose are numerous, but farther northward they are not so frequently seen. Signs of the presence of a few caribou were noticed northward from Matagami lake. The black bear is abundant, especially in the vicinity of Matagami, Olga and Gull lakes; although never hunting for them, eleven bears were seen by members of the party. Their tracks were especially fresh and numerous upon the sandy shores of these lakes. Fur-bearing animals are not as plentiful as might be expected. Either specimens or traces of the presence of marten, mink, otter, beaver, fox, wolf, ermine and muskrat were observed by those connected with the party. Marten are fairly numerous, and the quality of their fur in the northern portions of this region is especially prized. Beaver and otter are scarce, and are reported to be rapidly disappearing. During the past winter, only a few red foxes were trapped by the Indians of Waswanipi post, while in the previous winter five silver foxes were taken. A few lynx and wolves are said to be present. Ground hogs, rabbits and red squirrels are quite plentiful. Mice are very numerous, speedily establishing themselves in the vicinity of a storehouse or cache.

Ducks, especially the black duck and varieties of the merganser or saw-bill, are more abundant than in the vicinity of the height-of-land to the south. Very large numbers of ducks were seen along the river connecting Laval and McGill lakes, which discharge into the western arm of northern Soskumika lake. Partridges are very scarce. During the two months the party did not see more than two dozen. Of other large birds, gulls are numerous, while a few loons, fish-hawks, owls, crows, ravens, three bald-headed eagles and two heron were seen.

Fish are abundant in all of the waters. The most edible varieties are whitefish, pike, pickerel and sturgeon, while suckers and chubs are also abundant. Sturgeon are present in large numbers along the lower course of the Allard river and in Matagami and Waswanipi lakes, while it is probable that they are also present in the other large lakes and at least some of the rivers. Matagami lake is known by some of the Indians as "Sturgeon lake." Pike frequently attain a size from 6 to 12 lbs. Whitefish are very abundant; large numbers of them were noticed playing in the foam of some of the rapids on the rivers connecting Matagami, Olga and Gull lakes. During low stages of the water, the curious heaps of small pebbles which are constructed by the chub in the spawning season are exposed in some places along the margins of the smaller rivers and the streams. Apparently trout and bass do not exist within the region. The fresh-water clam (*Hyridella siliquoidea*, Barnes) is locally present in large numbers. Its empty shells are frequently scattered in profusion along river banks, as a testimony to the fact that the muskrat considers their soft parts to be a delicacy on his menu.

GENERAL GEOLOGY.

Within this area the blanket of superficial deposits is so heavy that it conceals many of the geological relations of different portions of the rock basement which the observer becomes desirous of unravelling. By a careful study of the more or less isolated outcrops, some of these problems are solved; others may be made clear by an examination of wider areas. It is a region where through prolonged erosion, accordant levels have been established almost entirely irrespective of differences in rock composition and structure, and upon this rocky platform glacial and lacustrine deposits have accumulated to considerable thickness. Even after most detailed work has been done in such a region, geological boundaries pertaining to the bed rock will always be more or less conjectural. Although an examination of all outcrops along or near the waterways gives an excellent conception of the regional geology, an attempt to project geological boundaries, so many of which are called upon to delimit intrusive granites, etc., is little better than trying to delineate the confines of brûlés of similar age which have been encountered upon streams that are miles apart.

In common with many other extensive portions of the Laurentian plateau, the bed-rock of this area carries us back to the very earliest chapter in the geological history of North America. That portion of the area lying northward from Matagami lake, along the Nottaway river, is chiefly underlain by granite which usually displays gneissoid structures. Between the Transcontinental Railway and Matagami lake, the Keewatin formation has been invaded by large batholiths and smaller intrusive bodies of granite. Erosion has been so profound that in many places where Keewatin rocks are exposed at the surface, the basement of intrusive granite and gneiss must lie at comparatively shallow depths. Although subject to local variation in the vicinity of the intrusive batholiths of granite and gneiss, the regional strike of the schistose and gneissoid rocks is generally very nearly west to east, or slightly north of east.

A feature of special geological interest is the band of metamorphosed sedimentary rocks, with a maximum width of slightly more than half a mile, which outcrops upon certain prominent points on the northern shore, on some of the small islands, and on the eastern portion of the southern shore of Matagami lake. Although including bands of schistose conglomerate containing abundant pebbles of granite, these sediments are older than an extensive batholithic invasion of granite, for towards the eastern end of the lake, granite is in intrusive contact with them. What relation the granites toward the eastern end of this lake bear to granites and gneisses exposed elsewhere within the area was not determined. These facts demonstrate that within this area the "Laurentian formation" comprises granites of at least two different ages.

Moreover these sedimentary rocks, both with respect to geological relations and lithological character, resemble very closely those south of the Transcontinental Railway, which are typically displayed on the Kinojevis river, two miles above Kinojevis lake, in the vicinity of Keekeek lake, and extend eastward about two miles to the south of Kienawisik lake. The schistose conglomerates, arkoses and greywackes within this wider band have been described in a previous report. (*) Dr. M. E. Wilson, of the Geological Survey of Canada, informs the writer that in the vicinity of Kekeko lake, west of the Kinojevis river, he believes these rocks to be overlain unconformably by the Lower Huronian "Cobalt Series."

The youngest rocks which were found *in situ* within this area are olivine-diabase, quartz-diabase and a porphyrite which in the form of large dykes intersect all other rock types. Boulders of yellowish-gray or buff-coloured limestone are strewn in abundance along the lower course of the Allard river, along the shores of Matagami, Soskumika, Olga and Gull lakes, and less frequently along the lower course of the Bell and on the Nottaway river. They contain fossils which show them to be of Silurian age, very probably from the Niagara formation.

The following table of formations displays in a concise manner the geological sequence recorded within the area examined.

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*Report on Mining Operations in the Province of Quebec, 1911, pp. 176-178.

1. QUATERNARY.—Glacial and lacustrine clays, sands and gravels. Stratified clays of englacial Lake Ojibway occupy by far the larger portion of the areas.

Very great unconformity.

2. (?) SILURIAN.—Niagara limestone. Although not found *in situ*, it seems possible that outliers of this formation may be concealed beneath the superficial deposits.

Very great unconformity if the Silurian is present.

3. KEWEENAWAN.—Large dikes and small stocks of quartz and olivine-diabases and gabbros: one occurrence of porphyrite, and two of augite-kersantite.

Igneous Contact.

4. LAURENTIAN.—Batholiths of granite, much of which is gneissoid, with allied dike rocks. Diorites and hornblendites are of subsidiary importance. Undoubtedly the Laurentian includes granites of at least two ages

Igneous Contact.

5. MATAGAMI SERIES.—Schistose conglomerate and fine-grained feldspathic sandstones which have been altered to quartz-biotite and hornblende-schists. The granitoid rocks of the Laurentian must be in part older and in part younger than this series.

Unconformity (?)

6. KEEWATIN.—A complex of ancient lava flows, chiefly quartz-porphyries, porphyrites and basalts, usually schistose, together with narrow bands of highly altered sediments. Intrusive into these and schistose in part are gabbros, diorites, porphyrites, quartz--porphyries, etc. Since the latter rocks are more resistant, they constitute a very large percentage of the outcrops. Intrusions of diorites or gabbro-diorites assume the proportions of batholiths. These rocks are always in igneous contact with the Laurentian granites and granitoid gneisses.

KEEWATIN.

The oldest rocks within this region belong to this formation. They comprise a complex of igneous rocks, both extrusive and intrusive, together with narrow bands of altered sedimentary rocks. They occupy structurally depressed areas between those portions of the region where extensive batholiths of granite and granitoid gneiss are exposed at the surface. In the vicinity of the periphery of these batholiths, as well as in places far removed from them, the Keewatin rocks are penetrated by dykes and small irregular bodies of granite, showing that, as in other parts of the Laurentian plateau, the Keewatin formation is resting upon a basement of intrusive granite. When one observes the manner in which batholiths advance by progressively stoping the rocks above and completely or partially absorbing the fragments thus removed, there is no justification to the belief that the Keewatin is the oldest formation that has existed.

Ancient lava flows, varying in composition from rhyolites to basalts, have been metamorphosed to different varieties of schists. Bands of sedimentary rocks are of extreme subsidiary importance when compared with the vast outpourings of lava at this time. The intrusive rocks of the Keewatin include gabbros, gabbro-diorites, diorites, hornblendites, diabase and porphyrites. Some of these intrusive rocks also have been rendered schistose in part. They appear usually in the form of dykes and small stocks, but in certain localities the intrusions of gabbro-diorite have attained the dimensions of batholiths.

Even where massive, the original mineralogical character of these rocks has been changed and modified to such an extent that sometimes it is difficult and in many cases impossible to determine, other than within rather wide limits, what their true character must have been. Within this, as well as in other widespread areas of the Laurentian plateau, the Keewatin must have been a period during which lava flows were so rapidly pouring forth into the sea that very little opportunity was afforded for the accumulation of sediments. Volcanic ashes accumulating at intervals became interbedded with these lava flows and later became consolidated into tuffs. Repeatedly these rocks have been subjected to more or less intense metamorphism preceding and attending their injection by intrusive rocks, and especially during the advance of the batholiths of gabbro-diorite, granite and granitoid gneiss. Not only were the Keewatin rocks largely altered to schists but were bathed with heated vapours and gases emanating from the intrusive bodies of magma while cooling, which partially or completely rearranged, and in some cases modified their original composition. Quartz, pyrite and an iron-bearing carbonate, derived at least in part by the breaking down of basic silicates, were carried by these solutions and deposited in a widespread manner throughout these rocks. The presence of these minerals is coincident with the extent to which these solutions migrated. The majority of the innumerable and usually small quartz veins traversing the Keewatin carry more or less of the iron-bearing carbonate, and frequently a little pyrite, while these minerals are present within a large number of rock-types and especially where the schistose structure has been developed to perfection. In quartz porphyries and rhyolites, especially on the western and southern shores of Matagami lake, this iron-bearing carbonate, intermediate in composition between dolomite and ankerite, becomes abundant along certain highly schistose bands, some of which are irregularly lenticular in form, and its oxidation imparts different shades of red to weathered surfaces. Pyrite and secondary quartz, some of which has been derived from the breaking down of original minerals within the rock containing them, some deposited by these solutions, are widely disseminated in the majority of rock types, and especially the schists. Small crystals of tourmaline frequently appear along planes of schistosity or within the schists themselves.

These **heated solutions and vapours** were the cause of the widespread development within these rocks of chlorite, sericite, secondary hornblende, epidote, zoisite, calcite and leucoxene. Even the massive rocks of the earlier bodies of plutonic rocks, as the gabbros, hornblendites and diorites, were so efficiently attacked by the magmatic waters of the later granite batholiths, that in places scarcely a vestige of their original mineralogical constitution may be seen under the microscope. In those localities, as in places along the northern and eastern shores of Matagami lake, where diorites and hornblendites have been evolved toward the margins of the batholiths of granite, these rocks have been more or less altered by magmatic waters escaping during the prolonged period when the interior parts of the batholith were cooling down.

Except where subject to local variation in direction in the vicinity of the margins of bodies of intrusive rocks, and especially batholiths, the strike of the schistose rocks is usually east to west or slightly north of east, while their dip is exactly or very nearly vertical.

All of the volcanic and the majority of the intrusive rocks within the Keewatin are pale to dark green in colour because of the prevalence of chlorite, green hornblende, epidote and zoisite. The volcanic rocks include rhyolites, quartz porphyries, quartz porphyrites, porphyrites, andesites and diabase. They have been altered quite generally to chlorite-' hornblende-, biotite- and sericite-schists. Where massive, occasionally they display a remarkable development of the ellipsoidal or pillow structure which is believed to have been formed by the pouring forth of these lavas into the waters of seas or possibly lakes. Most remarkable is this pillow structure as exhibited in the greenstones to the west of the mouth of the Bell river, on the western bank of the Allard river about eight miles from its mouth, and on an island on Olga lake near the mouth of the river entering from Gull lake. At the mouth of the Bell river the ellipsoids vary in size up to those possessing a maximum diameter of ten or twelve feet. The somewhat irregular outlines of the ellipsoids are very prominent, since they are enwrapped by narrow bands of a darker colour than the remainder of the rock. Within these bands chlorite is relatively much more abundant. Often this structure is preserved more or less after the rocks have become schistose. Unfortunately, these rocks were not studied in thin section under the microscope, but in the field resembled certain very much altered fine grained andesites or basalts.

Quartz-porphyries and quartz-porphyrites, almost invariably schistose, are a very important group of rocks within this area. Dark varieties pass gradually into those of lighter colour.

As a group, they are characterized in the field by the presence of small phenocrysts of quartz up to the size of a pea, which frequently are slightly bluish in colour. The phenocrysts are distributed within the rock in a very irregular manner. These quartz-porphyries, together with rocks of similar composition (although no phenocrysts of quartz are discernible within them and hence appropriately called rhyolites), form a large proportion of that band of Keewatin rocks extending from the lower portion of the Allard river eastward along the southern shore of Matagami lake, in places on the shores of Olga lake and along the river flowing from Gull lake. They were also observed on Obalski lake and at other places within the area.

In thin section under the microscope, phenocrysts of quartz, frequently traversed by cracks, granulated and often assuming the form of small lenses, occasionally with phenocrysts of either orthoclase or plagioclase, lie within a groundmass composed chiefly of minute grains of feldspar and quartz. Sericite is a very common alteration product of the feldspar, with increasing amounts of this mineral the rock passing into a sericite schist within which little or no feldspar remains. Small flakes of biotite are very abundant in a few of the quartz porphyries. In all of them there is usually present more or less chlorite, iron-bearing carbonate, a little epidote and small disseminated grains of black iron ore and pyrite. In some instances, chlorite is present in large amount.

Hornblende chlorite schists and amphibolites comprise a very large proportion of the Keewatin rocks within this region. They are extremely variable in petrographical composition and appearance, and include many rocks the original character of which, when with present knowledge they are considered by themselves, must be more or less a matter of conjecture. In a study of less schistose equivalents of some of these rocks, definite or modified characteristics may be observed which make certain that they chiefly represent squeezed diabases, basalts, augite and hornblende porphyrites, diorites, diorite porphyrites and probably andesites. Some of them are undoubtedly highly altered tuffs, yet they include many puzzling types.

Rocks possessing characteristics which mark them as of an originally sedimentary character were observed in a few localities. At the cascades on the Harricanaw river, about four miles above the point where it is joined by its tributary the Shi Shi-Shi river, a band of slaty schists crosses the river striking about N. 80° E. and dipping up to 70° toward the north. A specimen of one of the most slate-like specimens when examined under the microscope was found to consist almost entirely of hornblende with a little quartz and small particles of sphene and black iron ore. Another specimen is composed of hornblende (actinolite, as in the last specimen) within a fine mosaic of recrystallized quartz grains, dust-like particles of black iron ore, a small amount of epidote and a few small grains of pyrite. A vein of granular calcite, of irregular width up to about a foot, which follows a plane of schistosity, is exposed on the east side of the river below the cascade. The exposures of this locality are, unfortunately, widely separated from others along this river. A narrow band of black carbonaceous slates intercalated with schistose Keewatin volcanics is exposed on the western shore and about a mile within the largest bay on the southern side of Matagami lake.

Prior to the intrusion of the granite and granitoid gneiss, large batholiths of gabbro-diorite invaded the Keewatin. Along the Bell river from two miles above the first rapids at its mouth to the Island rapids, a distance of about 20 miles, the exposures are of a gabbro-diorite. Although subject to great variation in petrographical character, the most prevalent type is coarsely crystallized and pale grey or green to a chalky white in colour. In the specimens of this rock examined, none of the original ferromagnesian minerals remain, the rock being composed of much epidote and zoisite with calcite, a small amount of unaltered plagioclase of very basic character and a little chlorite. It is probable that this rock originally was an anorthosite and may be related to that period of igneous activity when the anorthosites of the Chibougamau region (*) were intruded. In places, at the Seven Channel rapids, the rock assumes the appearance

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* "Report on the Geology and Mineral Resources of the Chibougamau Region, Que.", by A. E. Barlow, J. C. Gwillim and E. R. Faribault. Bureau of Mines of P. Q., 1911, pp. 154-162.

of a coarse diabase. At the Cold Springs rapids it is, in general, dark in colour but banded or blotched in appearance, because of the segregation of hornblende into bands or irregular aggregates. At the Island rapids it is a dark diorite containing, in places, much visible black iron ore.

Similar rocks, subject to as irregular variations in petrographical composition, were observed by Mr. Dufresne in places along the southern shore of Olga lake, the southwestern shores of Gull lake and on the Dalhousie mountains. He found these mountains to be composed of this gabbro-diorite invaded by a fine grained biotite-granite, the former rock being very much brecciated by the latter. So traversed and broken through by the granite are these rocks in this vicinity that he states it would require very detailed mapping to distinguish them, and they have been represented upon the map as Laurentian granite. A specimen of the diorite from Dalhousie mountains was found to consist chiefly of dark green hornblende and plagioclase. Small amounts of biotite, chlorite and muscovite, abundant epidote, and a few grains of sphene and black iron ore are present. The plagioclase was found to be basic labradorite. A specimen from Elizabeth bay is of much lighter colour. It was found to be a gabbro-diorite, being composed chiefly of the plagioclase feldspar, bytownite, with hornblende, small amounts of diallage and biotite and a few minute crystals of apatite and zircon. The feldspar is partially altered to epidote, calcite and sericite.

Mt. Laurier is composed of diorite which through metamorphism has been altered in part to amphibolites. A specimen typical of the highest portion of this mountain was found to consist chiefly of hornblende with plagioclase, some quartz and disseminated grains of black iron ore, sphene and epidote. Just east of the summit of this mountain, a dyke of diorite porphyrite was observed traversing the amphibolites.

Serpentinous peridotites were observed to be present within the most southern portions of the area. On the eastern shore of Obalski lake, at a point about a mile and a half north of the entrance of the Harricanaw river, an exposure of peridotite is traversed by a few irregular veins of stiff-fibred asbestos of no economic value, possessing a maximum width of about half an inch. An exposure of similar rock is reported as being "on a hill a short distance north of the railway line, seven miles east of the Harricanaw river," and "containing small threads of asbestos, not exceeding a quarter of an inch in length."

Dykes and small intrusive bodies of hornblendite, uralitized gabbros, diorites and porphyrites are of quite frequent occurrence within the Keewatin. In so far as could be determined, they were injected in approximately the order of increasing acidity. About four miles east of the mouth of the Bell river on the southern shore of the Matagami lake, intrusive quartz porphyrite, somewhat schistose, extends for about one hundred yards eastward. It seems to be a large dyke striking parallel to the enclosing schists. In hand specimens phenocrysts of quartz and feldspar are prominent. Under the microscope the phenocrysts of quartz and plagioclase are found to be within a groundmass of interlocking grains of quartz and orthoclase with a very small amount of biotite, a few grains of black iron ore and pyrite, and minute crystals of zircon and apatite. Minute flakes of sericite, an iron-bearing carbonate and a little hematite are present as secondary minerals. A few outcrops of this rock were observed at intervals farther eastward along this shore, and also by Mr. Dufresne in places on the shores of Olga lake.

MATAGAMI SERIES

This name is given to the band of altered sedimentary rocks which occupies some of the prominent points on the northern shore of Matagami lake, a few of the small islands eastward from the large northern bay, and appears upon the southern shore toward the eastern end of this lake. Lithologically these rocks may be described most simply as having been conglomerates and fine grained feldspathic sandstones with shaly parting. Possibly they included some beds of fine volcanic ash. Through metamorphism, they have been converted into quartzose-biotite and quartzose-hornblende schists which locally contain deformed pebbles. Those outcrops displaying these rocks where they have suffered least from the processes of metamorphism are situated on Interesting point, which marks the beginning of the eastern shore of the large northern bay near the western end of this lake, on a small island less than half a mile south of this point, and on another small island occupying an isolated position near the middle of the lake and about three miles eastward from the first.

A portion of the outcrop on Interesting point is shown in Plate V. Here the bedding planes may be seen distinctly, the series striking a few degrees south of east and dipping very steeply southward. The rocks are dark grey or greenish-grey quartzose-biotite-schists. In thin section under the microscope they are seen to be composed essentially of flakes of biotite disseminated through a gritty mosaic of minute clear grains of quartz and a few of orthoclase feldspar. Small particles of pyrite are also present. Some of the biotite has been changed to chlorite. A few yards south of where this photograph was taken, a large dyke of quartz-diabase intersects these rocks in a direction approximately parallel to the planes of schistosity. The contact on one side of the dyke is exposed, and here the adjacent rocks have been baked to hornstone for a distance of only a few inches. This series is traversed also by a few small veinlets of quartz which assume the same direction as the schistosity, which corresponds with that of the stratification.

Upon the two islands mentioned, similar rocks contain a few pebbles of granite and quartz. On the western end of the little island south of Interesting point, a glaciated surface of remarkably level and smooth character displays well the manner in which these pebbles occur. They are widely scattered, there usually being several feet or yards between a pebble and its nearest neighbours. The largest of them has a maximum diameter of five to six inches. Because of the pressure to which the series has been subjected, the majority of the pebbles are somewhat elongated, the longer axes corresponding to the direction of the planes of schistosity.

About four miles eastward from the entrance to the long northern arm of Matagami lake, the same series outcrops at intervals upon the northern shore for a distance of three miles. Maintaining the same strike, the rocks here are much more

PLATE IV.

Looking eastward on Matagami lake, from the western side of the entrance of largest bay on its southern shore.

PLATE V.

The Matagami Series.—On Interesting point, northern shore of Matagami lake schistose. They were observed to contain pebbles at Conglomerate point about due north from the western side of the entrance of the largest bay on the southern side of the lake. At least sixty to seventy per cent of the pebbles in this locality are of granite; the others include diorites, aplites and a few of biotite- and hornblende-schist. Here all of the pebbles have been compressed into elongated lenticular forms, the largest of them having a maximum diameter of seven or eight inches. They are distributed within the schistose matrix in a very irregular manner. Upon the western end of this outcrop, they are dispersed so as to suggest the former presence of false bedding.

When removed from the schists, some of the pebbles were found to have acquired scratched surfaces because of the movement of the gritty matrix about them while they were being squeezed into their present shapes. The regularity with which the scratches trend in the direction of the longest axis of the pebble thus producing a slickensided appearance, and the manner in which the schist enwraps the pebbles suggest this origin for the scratches. This is corroborated by an examination of a thin section cut in such a manner as to include the periphery of a pebble in conjunction with the matrix, when it becomes plain that the matrix has *flowed* about the pebble in the direction corresponding to that of the scratches. In some instances, adjacent to the pebbles much biotite has developed within the matrix. Under pressure the pebbles have behaved in a manner identical with the phenocrysts in augen-gneisses. The pebbles of biotite granite show extreme granulation of the quartz and feldspar toward the peripheral parts and especially at the ends of the lenses. Towards the centre of the pebbles, granulation becomes progressively less. Granulation has been accompanied by partial recrystallization of the smaller individual grains. In some instances the smaller pebbles have been almost completely obliterated because of extreme pressure accompanied by more or less consequent recrystallization. Under the microscope, the schistose matrix of the conglomerate is seen to be composed of a fine mosaic of clear colourless grains, most of which are quartz, and very few of orthoclase feldspar. A large number of small shred-like flakes of biotite and a few small crystals of actinolite accentuate the foliation. Minute particles of epidote and a few grains of pyrite are also present.

About three miles farther eastward and on the southern shore of the lake, a few pebbles of granite were found within the schist that had been smeared out to such an extent that some of them are now represented by very narrow and long streaks of more quartzose character and lighter colour. It seems probable that some pebbles through extreme processes of metamorphism have merged with the schistose matrix.

The other rocks included within this series are similar to the matrix containing the pebbles. All of them are now fine grained quartz-biotite and quartz-hornblende schists. In some places, little grains of quartz stand out upon weathered surfaces similar to some sandstones. A comparative study of these rocks under the microscope discloses every stage from partial to complete recrystallization. The amounts of hornblende and biotite in different bands within the series are very variable, sometimes one of these minerals occurring to the exclusion of the other.

A specimen collected on the northern shore of the lake, a little more than a mile eastward from Conglomerate point, has a similar microscopic appearance to the matrix of the conglomerate described above, except that upon close examination very small needle-like crystals of hornblende are discernible upon the planes of schistosity. Under the microscope it is seen to be composed of needles of actinolite dispersed through a partially recrystallized mosaic of grains of quartz and a few of orthoclase feldspar. A few small flakes of biotite and some grains of black iron ore are also present. The hornblende, in the form of thin prismatic crystals, is so abundant that the rock is appropriately named an actinolite schist. A specimen of actinolite schist collected from the next outcrop west of this was found to consist of hornblende, quartz and a little orthoclase with a small amount of calcite and many minute particles of zoisite. In this instance, the hornblende is ragged in outline. From other exposures specimens may be selected in which the rock is composed of flakes of biotite enwrapping grains of colourless quartz and turbid orthoclase, with a few irregular grains of epidote, black iron ore and pyrite. In a few instances, the biotite and hornblende have been altered so universally to chlorite that an appropriate name for the rock is chlorite schist.

In so far as could be determined, the rocks of this series owe their present position to a tight syncline extending in a direction about east to west and parallel with the length of the lake. Unfortunately at no point were they observed to be in direct contact with the Keewatin. Toward the eastern end of the lake they are cut off by the batholith of granite which appears upon both the northern and southern shores. At the base of the long narrow peninsula on the southern shore to the east of which the river from Olga lake enters, and also upon two small islands about two miles west of the end of the peninsula, these schists may be seen in contact with the main mass of the intrusive granite. In contact with the granite, the sedimentary series has been completely recrystallized into quartz-biotite schists or paragneisses. Usually the planes of foliation are covered with flakes of biotite imparting to the schist a glossy appearance. Under the microscope, a specimen from the base of the narrow peninsula mentioned above was seen to consist of quartz, orthoclase, plagioclase, an abundance of biotite, a few irregular crystals of hornblende and a few grains of epidote and pyrite. This rock may be appropriately called a granulite.

Whether or not it has received additions from the granite magma is a difficult question, for in different parts the sedimentary series is very variable in composition, and the outcrops are so situated that one cannot trace the schistose equivalent of a definite horizon.

The most interesting feature in connection with the series pertains to its being invaded by a great batholith of granite and yet containing pebbles of granite within its conglomerate bands. It is to be hoped that when the area is more thoroughly studied, batholiths of granite of at least two different ages may be distinguished.

Mr. Dufresne reports that he observed a small outcrop of schistose conglomerate on the western side of Gull lake about five miles and a half south of the outlet. The schistose rocks here have an exceptional strike of S. 48° E. Near the granite contact on the northern shore of the large bay at the southern end of this portion of Gull lake, and approximately in direct line of strike with this outcrop of conglomerate farther north, there is an outcrop of schists of light grey colour. In hand specimen abundant crystals of hornblende and a much less amount of biotite in parallel orientation impart a gneissoid appearance to this rock. A few small red crystals of garnet are also discernible. In thin section under the microscope it was found to consist of an orthorhombic hornblende, biotite, plagioclase, quartz, a few garnets, widely disseminated grains of sphene and black iron ore and a few minute crystals of zircon. The orthorhombic hornblende is strongly pleochroic ranging from pale yellow to quite a dark bluish gray. Since it proved to be optically positive, it corresponds in its properties to anthophyllite. In so far as can be ascertained, this is the second occurrence of an orthorhombic hornblende reported from Canada. A rock consisting of the aluminous variety of anthophyllite, (gedrite.), "in association with garnet, cordierite, subordinate amounts of quartz, biotite, iron ore and rutile" has been described from the Haliburton area in Ontario by Drs. F. D. Adams and A. E. Barlow. (*)

Geological investigation of widely separated areas of the Laurentian plateau in Ontario and western Quebec is progressively revealing the presence of very important series of highly altered sedimentary rocks that are older than the Cobalt Series (Lower Huronian) and younger than the Keewatin proper. Recorded within literature are descriptions of numerous occurrences of sedimentary Keewatin iron formation, reported as belonging to the upper portion of the Keewatin, of the Temiskaming series of the Cobalt and Porcupine districts, the Seine series of the Rainy lake district, the Fabre series on the eastern side of Lake Temiskaming in Fabre township, P.Q., the comparatively wide band of highly altered sediments, called the Pontiac group by M. E. Wilson, extending from Kekeko lake eastward across the Kinojevis river through Keekeek lake and passing about a mile south of Kienawisik lake in western Quebec, and this Matagami series. With the exception of certain

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* "Geology of the Haliburton and Bancroft Areas" by Adams and Barlow. Geol. Surv. of Can., Memoir No. 6, 1910, pp. 170-172.

occurrences of the iron formation, conglomerates are reported as forming an integral part of the different series in all of these localities. With the exception of the Temiskaming series, these are apparently the most ancient of conglomerates known in the Pre-Cambrian of North America, and they contain granite pebbles.

Although it is plainly inadvisable at the present time to correlate these occurrences, it is gratifying to recognize that they contribute to the construction of a bridge across that otherwise great break in the geological record between the Keewatin and the Lower Huronian.

"Notes on the Cobalt Area," by W. G. Miller, Eng. & Min. Journ., Sept. 30th, 1911, pp. 645-649.

"The Porcupine Gold Area," by A. G. Burrows, Ont. Bur. of Mines, Report, 1912, Part I., pp. 219-221.

"The Archean Rocks of Rainy Lake," by A. C. Lawson, Summ. Report, Geol. Survey of Canada, 1911, pp. 240-243.

"Geology of a Portion of Fabre Township, Pontiac County, P.Q.," by R. Harvie, Dept. of Mines of P.Q., 1911.

"Kewagama Lake Map-Area, Pontiac and Abitibi, Quebec," by M. E. Wilson. Summ. Report of Geol. Survey of Canada, 1911, pp. 275-276.

"Report on the Geology and Mineral Resources of Keekeek and Kewagama Lakes Region," by J. A. Bancroft. Report on Min. Oper. in P.Q., 1911, pp. 176-178.

LAURENTIAN

This formation includes granites and granitoid gneisses together with other rocks of plutonic character evolved by processes of differentiation. As in other areas of the Laurentian plateau, these rocks are in igneous contact with the Keewatin formation. Since they also intrude the Matagami Series, which includes certain beds of conglomerates containing granite pebbles, it is evident that the Laurentian includes granites of at least two different periods of batholithic invasion.

The Laurentian formation occupies a large proportion of the whole area. Northward from the entrance to the long northern arm of Matagami lake, a wide expanse of Laurentian rocks extends to the mouth of the Nottaway river. Within this area they frequently include narrow and comparatively unimportant bands and of biotite- and hornblende-schists. Other areas of granite lie toward the eastern end of Matagami lake, the southern half of Olga lake and from here extending eastward and almost completely surrounding Gull lake. Five miles northward from the portage, three-fourths of a mile in length, the Allard river crosses an area of granite which is probably a western extension of that which is traversed by the Bell river from the mouth of its large tributary, the Natagagan river, to two miles below Lake Taibi. From a point about eleven miles below Lake Obalski, the Harricanaw river flows across granite for thirteen miles farther northward. It is probable that this area of granite connects to the eastward with that which is crossed by the Natagagan river. In many other localities, small bosses and dykes of granite intersect the Keewatin, but are not large enough to represent upon the accompanying map.

Biotite-granite and granitoid biotite-gneiss are by far the most common types of rock. In comparatively few localities, a little hornblende is associated with the biotite; still less frequently hornblende is present with very little, if any, biotite. The hornblende seems to have developed more readily toward the peripheral parts of the batholiths, or in the neighbourhood of the ribbons or bands of hornblende- or biotite-schists. Similarly toward the margins of the batholiths, in the vicinity of bands of schists and where probably the roof of the batholith has not been far above the present surface, processes of differentiation, possibly aided by absorption, have evolved different varieties of diorites and quite coarsely crystallized hornblendites. In such places, the diorites often display very different petrographical appearances within very small areas. The hornblendites and diorites very rich in hornblende frequently occur near the immediate contacts of the batholiths. Occasionally these dark rocks are so impregnated with pyrite as to weather with a rusty, gossan-like appearance.

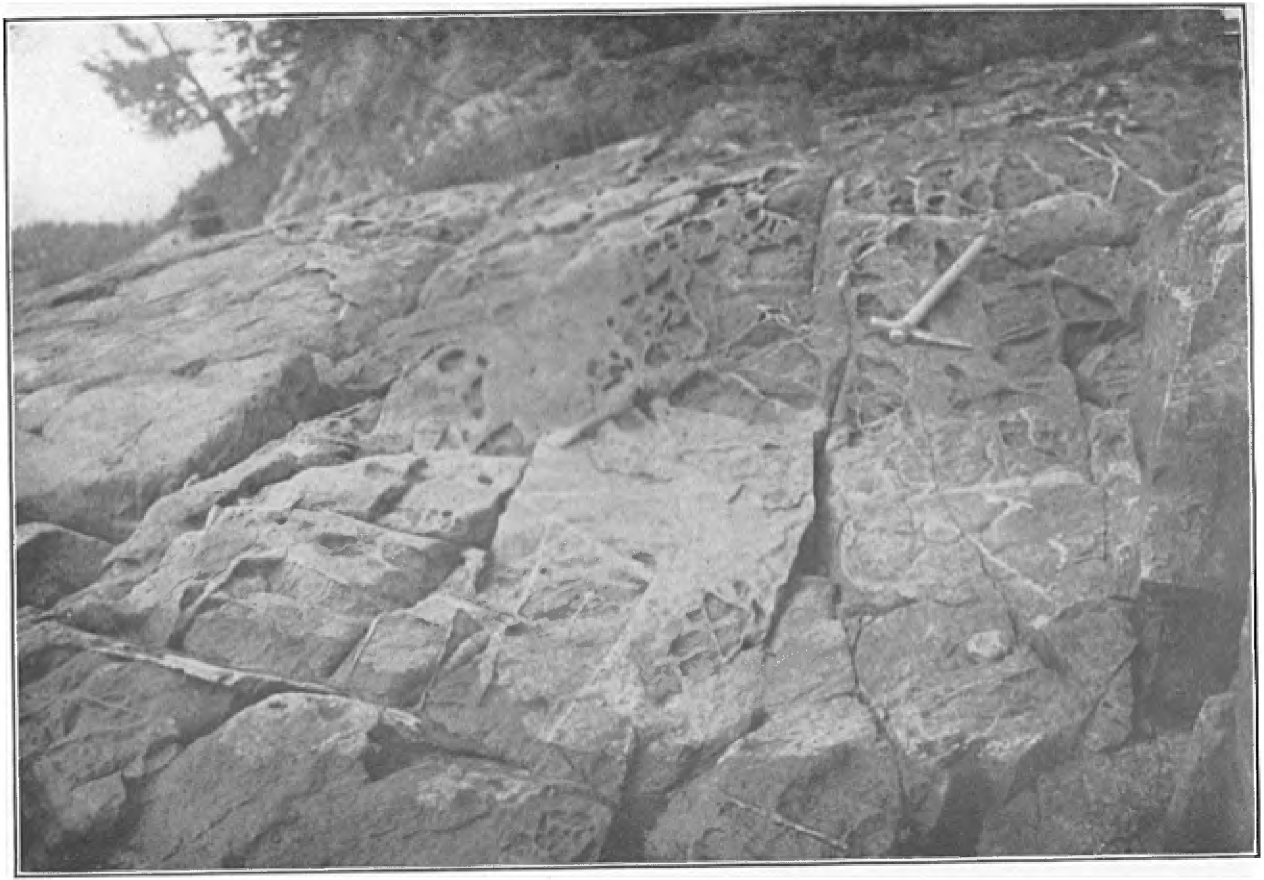
Toward the eastern end of Matagami lake, on its northern shore and also for a few miles northward from the entrance to the long northern arm of this lake, an excellent opportunity is afforded to study these relationships. Here may be seen the progressive manner in which the batholith advanced. Locally hornblendites pass gradually into diorites, and more frequently diorites into granites. Hornblendites have also been cut by diorites. In places, diorites are traversed by tongues or irregular intrusive bodies of other diorites. Diorites and hornblendites are intersected by granite. In a few localities, one type of granite was observed to be cut by more acidic granite. Aplite dikes and dikelets, often in a reticulating network, (see Plate VI.) intersect all of these plutonic rocks. The record is plainly one of decreasing acidity. The more basic marginal portions of the batholiths first cooled and were repeatedly injected by more acidic magma from the still liquid interior.

From analogy, it seems reasonable to believe that many of the intrusive stocks and dykes of diorites and hornblendites, which so frequently break through the Keewatin in areas removed from batholiths of granite, are genetically related to the granite. Some of the intrusives within the Keewatin undoubtedly represent the feeders of this predominantly volcanic series. Yet it seems probable that the Laurentian represents the prolonged plutonic phase which brought to a close that great and earliest period of igneous activity of which the Keewatin is the volcanic phase.

In many localities, but especially along the northern arm of Matagami lake, down the Nottaway river and in the vicinity of Gull lake, the plutonic rocks of the Laurentian locally include fragments or are traversed by ribbons or bands of dark biotite- and hornblendite-schists. As is plain from a study of contact relations, the inclusions represent much altered pieces which were stoped off from the roof beneath which the batholiths formerly cooled. The ribbons and bands of schist usually trend in a direction corresponding to the regional strike of schistose and gneissoid structures, viz., west to east or slightly north of east. A notable exception is a band of schists on the west side of Gull lake that strikes about S. 48° E. The dip is invariably vertical or very steep. The ribbons or slat-like inclusions of schist within the granitoid gneiss, which are of such frequent occurrence along the Nottaway river and the east side of Gull lake, have apparently been formed by parallel injection of the schists by the granitic magma. Remarkable are the contortions of the hornblende schist injected in this manner by aplite at the Bad rapids, about three miles above Iroquois chute on the Nottaway river. The broadest bands of schist along this river occur just below Kelvin lake where biotite-schists are intruded by granite, much of which is pegmatitic in texture, and are traversed by quartz veins of pegmatitic origin which carry a little pyrite. The largest quartz vein observed was about two feet in width. Locally the schists are irregularly impregnated with a little iron pyrites. Typical exposures occur on the east bank at the rapid where the river leaves Kelvin lake About a quarter of a mile above the first cascades below Kelvin lake, a band of schists on the east side of the river also contains sufficient finely disseminated grains of pyrite to impart a very rusty colour to weathered surfaces.

Typical hornblende-schist from a point on the east side of the northern part of Soskumika lake, just south of the westward bend toward its outlet, is so rich in hornblende as to be uniformly black or very deep green. It was found to be composed of hornblende, quartz, orthoclase, a little plagioclase, a few irregular grains of black iron ore and of sphene, and small needle-like crystals of apatite. The hornblende comprises approximately one half of the rock. It displays a marked tendency to definite crystal outlines, and is strongly pleochroic, ranging from deep green to very light yellowish-green. In thin section under the microscope, a typical glistening biotite-schist from a point on the eastern shore about six miles within the northern arm of Matagami lake was seen to be composed of biotite, a little hornblende, much quartz and plagioclase, a little orthoclase, a few grains of black iron ore and sphene, and minute crystals of apatite. Apart from the ferro-magnesian minerals, the mineral grains are of approximately the same size, forming a mosaic within which the biotite and hornblende are dispersed parallel to the foliation.

These ribbons and bands of these schists undoubtedly represent the tattered ends of "roof-curtains." Situated, as many of them are, far within areas of granite and gneiss, and having



Reticulating dikelets of aplite cutting diorite, on northern shore of eastern end of Matagami lake.

suffered complete recrystallization and possibly additions from the granitic magma, it is difficult to discuss what their original petrographical character may have been. Some of them, as, for example, certain of the hornblende schists and especially the band of less schistose actinolite rock which appears on the western shore of the large northern bay of Soskumika lake, are certainly much altered Keewatin greenstones. Some of the bands of biotite-schist, as those below Kelvin lake, resemble closely in petrographical character the most metamorphosed of the Matagami series.

At the contact between bands of these schists and the gneissoid granites, ribbons of schist, that have been separated or torn off by the advancing magma, may be observed which display different stages of assimilation by the magma. The last phase prior to complete absorption is represented by schlieren or darker streaks rich in biotite or hornblende within the gneiss. In many localities where bands or distinct ribbons of schist do not occur in the immediate neighbourhood, the gneiss displays accentuated foliation because of the presence of long and very narrow bands of ill-defined width, which are darker than other bands because of a larger percentage of the ferromagnesian minerals, especially biotite. Obviously, it then becomes difficult to decide whether the observer should attribute this phenomenon to differentiation of a viscous and slowly moving magma, or to differential absorption of schistose material. Partial and nearly complete assimilation of schists certainly produces this result. It seems probable that differentiation of the original magma is also a cause, but the proof is difficult and apparently must at present assume the form of belief.

Pegmatite and aplite dykes are of frequent occurrence within the areas of granite and gneiss, especially northward from Matagami lake. The pegmatites are chiefly composed of quartz and feldspar with varying amounts of muscovite, biotite and black iron ore. Often they are very quartzose. A fragment of pegmatite picked up on the shore of Soskumika lake shows that occasionally they contain a few small red garnets. No dykes were observed within which the component minerals are very coarsely crystallized. Though many of these occurrences were carefully examined, no minerals of economic value were noticed to be present within them.

A generalized description of the mineralogical character of the Laurentian formation as developed within this area would be a repetition of what has repeatedly appeared in print for the same formation in other areas. (*) Although usually a normal biotite-granite, or granitoid gneiss, these rocks vary so much in texture, in degree to which the gneissoid structure has been developed and in the relative percentages of minerals present, that a detailed description of hand specimens and thin sections would impart conception of only certain local phases. A study of a number of thin sections shows that they include hornblendites, diorites, diorite porphyrites, granodiorites, syenites, biotite, biotite-muscovite, biotite-hornblende and hornblende-granites and gneisses.

The following is a concise statement of the minerals present within these rocks:—

ESSENTIAL.—Quartz, Orthoclase, Plagioclase, Biotite and Hornblende.

ACCESSORY.—Microcline, Microperthite, Diallage, Epidote, Sphene, black iron ore which is usually magnetite though ilmenite appears in most basic types, Zircon, Apatite and Pyrite.

SECONDARY.—Muscovite, Sericite, Kaolin, Chlorite, Epidote, Zoisite, Calcite, Uralite and Leucoxene.

Muscovite is rarely present, its occurrence being associated with those localities where the more acid rocks display pegmatitic tendencies. Microcline is most abundant in those rocks exhibiting evidences of strain, and apparently has been formed chiefly, if not entirely, from orthoclase under the influence of pressure. Diallage occurs in some of the hornblendites.

The presence of the gneissoid structure is usually accompanied by evidences of pressure, such as strain shadows and

*See the excellent description by Dr. A. E. Barlow in "Report on the Geology, and Mineral Resources of the Chibougamau Region, Que.", pp. 138-154, Dept. of Mines, P, Q., 1911.

cataclastic structure. In certain instances, however, pressure does not seem to have been active, the foliation apparently having been formed during the slow movement or writhings of the magma while viscous. It may well be that where evidences of pressure are present, the pressure may have been chiefly active during the latest stage in the solidification of the cooling magma.

KEWEENAWAN

Large dykes and a few small stocks of the newer diabases comprise the most recent rocks observed *in situ* within the area. In width, the dykes usually vary from twenty to five or six hundred feet. Their strike ranges from north-north-easterly to a few degrees north of east. Most remarkable is their continuity, or possibly to be more exact, the frequency with which they appear in outcrop at irregular intervals along the direction of their strike. Prior to their injection by these dykes, the other rock-types had been subjected to those influences which have rendered them in part schistose or gneissoid. Effects of contact metamorphism from the diabases are either wanting or extend for only two or three feet from the margins of the dykes.

A dyke of newer diabase crosses the Harricanaw river at the second rapids below the Transcontinental Railway. Quartz-diabase forms the most southerly outcrop on the western shore of Obalski lake. Dr. Robert Harvie, now of the Geological Survey of Canada, who did some prospecting inland from this lake, informs the writer that he found frequent exposures of newer diabase in this vicinity. About a mile below the first portage on the left below Obalski lake, quartz-diabase, with crystals of feldspar up to one-fourth of an inch in length, is exposed upon one of several small islands in the river. This dyke cuts granite, the granite and the margin of the dyke being impregnated with a little pyrite. An inconspicuous outcrop of similar rock was observed on the east side of the Allard river, between seven and eight miles from its mouth, and immediately south of an exposure of a dyke of a porphyrite of striking appearance. Unfortunately the relationship of the syenite porphyry to the diabase could not be determined, but its comparatively fresh appearance and the petrographical similarity which it bears to an occurrence of porphyrite on Tooker's claim, south of Kienawisik lake, which is plainly later than the gold bearing veins of that area, suggest that possibly it should be correlated with the Keweenawan period of igneous activity. Phenocrysts of feldspar up to slightly more than half an inch across are very abundant in this rock.

A very large dyke of quartz-diabase intersects the Matagami series on the point and on the small island adjoining, which mark the eastern entrance of the very large northern bay towards the western end of Matagami lake. Possibly it is a continuation of the same dyke which crosses the southern side of the large island that lies a little more than a mile south-east from the mouth of the Allard river, and, appearing on some of the small islands to the west of this, outcrops in a small bay on the western shore. About three miles within and on the eastern shore of this large northern bay, diabase cuts granite.

On the eastern shore of and about two miles within the long northern arm of Matagami lake leading to the Nottaway river, the point which marks the northern end of the narrows displays a very wide dyke or small stock of quartz-diabase intersecting granite. On the western shore of Olga lake, a little more than a mile south of the narrows, a large dyke of diabase traverses biotite-granite. About three and a half miles south of this narrows another dyke was observed cutting granite. On the eastern side of a sharp point, about four miles south-east of the outlet on Gull lake, a low outcrop displays a dyke of diabase two to three feet wide cutting granite. On the east side of the Bell river, about a mile below Taibi lake, a dyke of olivine-diabase of undetermined width is traversed by a small dyke of mica-lamprophyre and dikelets of aplite.

These occurrences will serve to illustrate and emphasize the widespread manner in which this region was traversed by dykes of diabase during Keweenawan time. In general appearance, in average petrographical character, as well as in the repetition of peculiar local variations dependent upon processes of differentiation, the dykes are similar to those south of the National Transcontinental Railway which have been previously described.(*) Specimens taken from dykes in the vicinity of Matagami lake, may easily be confused with those of Kewagama lake, although the occurrences are separated by a distance of about 100 miles in a straight line. It is also difficult to distinguish specimens from occurrences of these diabases in Quebec from those in Gowganda and other districts in Ontario.

In immediate contact with the intruded rocks, the diabase is black or dark green in colour, and so fine grained that no crystals are discernible to the naked eye, except possibly a few spicule-like crystals of plagioclase. A few inches within the contact, the minute crystals of plagioclase become more and more abundant until from within two to six feet the rock usually becomes quite uniform in appearance, its degree of coarseness of grain depending upon the width of the dyke and the depth to which it has been truncated by profound erosion. Frequently toward their centres, the rock becomes so coarse in grain and devoid of the ophitic texture that it is more appropriately called gabbro.

The majority of the dykes which were observed as belonging to this period of igneous intrusion are of quartz-diabase or quartz-gabbro; others are of olivine-diabase or olivine-gabbro.

In hand specimens of the usual type, plagioclase feldspar, augite and often a little hornblende, biotite and particles of black iron ore can be distinguished by the naked eye. In thin section under the microscope, the quartz-diabase is found to be chiefly composed of labradorite and augite. displaying the characteristic ophitic structure, with variable amounts of quartz which plainly crystallized during the last stages of the solidification of the rock. Invariably the quartz shows a tendency to micrographic intergrowth with the feldspar. In some instances the patterns produced by the contemporaneous crystallization of the last of the feldspar with the quartz are especially intricate. Variable amounts of black iron ore, pyrite, apatite, biotite, hornblende and sphene are present as accessory minerals. Usually these rocks are remarkably fresh, but chlorite, uralitic hornblende, sericite, epidote, zoisite, calcite and leucoxene are common secondary minerals.

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* Report on Min. Oper., Bureau of Mines of P. Q., 1911, pp. 178-182.

Towards the centre of some of the largest dykes, where the diabase becomes more coarsely crystallized and of a gabbroid character, the feldspar becomes reddish and progressively more abundant, giving rise to a red rock which differs in appearance from either diabase or normal gabbro. This red rock is typically developed within the large dyke or small stock of gabbro that is exposed two miles within and on the eastern shore of the long northern arm of Matagami lake, and also on the point marking the eastern entrance to the large northern bay toward the western end of the lake. In mineralogical composition, the red rock is distinguished from the normal diabase by the presence of a larger proportion of feldspar and usually more quartz. At the former locality the feldspar is very much decomposed to epidote and minute flakes of sericite, while the augite is almost completely changed to uralitic hornblende. At the latter locality the feldspar proved to be andesine.

The dyke of olivine-diabase on the east side of the Bell river, about a mile below Taibi lake, is of special interest because it contains an unusually large amount of feldspar for an olivine-bearing rock. The feldspar is bytownite and with the augite displays typical ophitic structure. The particles of black iron ore are more or less surrounded by small flakes of biotite. The olivine is partially altered to fibrous serpentine, chlorite and secondary magnetite. The olivine-diabase is traversed by a dyke of fine grained mica-lamprophyre. In thin section under the microscope, this rock is found to be composed of small phenocrysts of plagioclase feldspar lying in a groundmass composed of a second generation of even smaller lath-like crystals of plagioclase, an abundance of minute flakes of biotite and dust-like particles of black iron ore. Both the lamprophyre and the olivine-diabase are intersected by dikelets of "aplite" or diabase pegmatite. It seems as if the latter is a direct product of differentiation of the lamprophyre. The aplite is a fine grained rock of pink colour within which not a particle of ferromagnesian minerals can be seen by the naked eye. In thin section it is found to be composed chiefly of oligoclase, which is usually turbid, micrographically intergrown with quartz, together with a few small grains of sphene and flakes of biotite. Two small dikelets of similar though more quartzose aplite intersect quartz-diabase on one of the small islets west of the large island near the mouth of the Allard river in Matagami lake. Similar aplitic and "red rock phases of the Keweenawan diabase have been described from Gowganda (1) and other districts in Ontario, and from Fabre township (2) and the vicinity of Kewagama lake (3) in Quebec.

About a mile north of the mouth of the Waswanipi river, on the eastern shore of Gull lake, Mr. Dufresne found a dyke, twenty inches in width and striking N. 48° E. cutting granite containing highly altered inclusions of Keewatin schists. In the hand specimen the rock is holocrystalline and gives a first impression of being composed chiefly of biotite, although crystals of augite are also discernible to the naked eye. In thin section under the microscope, it is found to be composed essentially of biotite, augite and a little plagioclase, with many small grains and crystals of magnetite, a few small garnets, small irregular grains of sphene and pyrite and a little apatite. Augite and biotite form the major portion of the rock, the former usually possessing idiomorphic outlines, and frequently is twinned. The feldspar is almost completely changed to calcite and sericite, the biotite has been partially altered to chlorite, and a small amount of leucoxene probably has been derived from the alteration of sphene. The rock is an augite kersantite. A narrow dyke of similar rock, though more fine grained, traverses an exposure of Keewatin quartz porphyry on the west side of Gull lake, just south of the narrows leading to Middle Gull lake.

It is probable that these dykes were injected during the Keweenawan period of igneous activity. They represent a petrographical type closely allied to diabases in composition. In

(1) "The Origin of the Silver of James Township, Montreal River Mining District", by A. E. Barlow, Journ. Can. Min. Inst., 1908, pp. 264-265. "The Gowganda and Miller Lakes Silver Area", by A. G. Burrows, Ontario Bureau of Mines, 1908, Vol. XVIII., Part II, p. 8.

(2) "Geology of a Portion of Fabre Township", by R. Harvie, Quebec Dept. of Mines, 1911, p. 21.

(3) " Report on the Geology and Mineral Resources of Keekeek and Kewagama Lakes Region", by J. A. Bancroft. Rept. on Min. Oper. in P.Q., 1911, p. 181.

any case, they must be considered among the most recent of Pre-Cambrian rocks within this area.

A very large proportion of the North American Pre-Cambrian shield is now known to have been injected during Keweenawan time by dykes, sheets, laccoliths and small stocks of newer diabases or gabbros. Possibly owing to the prolonged activity of processes of erosion, dykes and small stocks are the most common. In the Lake Superior and Coppermine River districts the extrusive equivalents of these rocks are found. Close resemblances in the petrographical character of average types and the frequent repetition of very similar yet rather extraordinary products of differentiation in widely separated localities have been made use of by many other observers in correlating these rocks with the Keweenawan period of igneous activity. It seems to have been tacitly assumed, though not expressed by other writers, that the Keweenawan intrusions afford an excellent example of a wide petrographical province. It seems probable that the boundaries of this province will be found to be coincident with the area of the Pre-Cambrian shield, an area which embraces rather more than 2,000,000 square miles. Here we have an example of a definite period in geological time during which this great area was traversed by very many fractures and along these lines of weakness, as well as at definite foci, basic magmas of gabbroid types ascended. Quartz- and olivine-diabases are the types of most frequent occurrence. The norite of Sudbury is now considered by many to be of Keweenawan age.

The Keweenawan period of igneous activity was an important metallogenetic epoch. Attention has been attracted to this fact especially by Dr. W. G. Miller (1) of the Ontario Bureau of Mines, and is included by Lindgren (2) under his discussion of the Pre-Cambrian period of ore deposition. The copper deposits of Lake Superior and of the Coppermine river, flowing into the Arctic Ocean about 850 miles eastward along the coast from the mouth of the Mackenzie river, the nickel-copper of Sudbury, and the silver of Cobalt, Gowganda and of

(1) "The Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming", by W. G. Miller, Report Bur. of Mines, Ont., 1905, Part II, pp. 49-61.

(2) "Metallogenetic Epochs" by W. Lindgren, Journ. Can. Min. Inst., p. 104.

the area adjacent to Port Arthur were formed at this time. In a few localities, as on Wahnipitae lake (3) and on Shaft or Mosher's island (4) in Abitibi lake, apparently the diabase has been responsible for the deposition of native gold. Although it does not by any means necessarily follow that the presence of the diabase within this area is a very favourable indication of the possibility of the discovery of deposits of valuable minerals, nevertheless igneous rocks of the Keweenawan period have so frequently been "the ore-bringer" in other localities that prospectors should devote special attention to them wherever they may be encountered on the Pre-Cambrian shield. Where in dykes, these rocks do not seem to have been responsible for important mineralization, but while the dykes persist there is obviously hope that within some area where, because of local structural depression erosion has not been carried to such depths dykes may be found to feed sheets or laccoliths that may be accompanied by important ore deposits.

(?) SILURIAN—NIAGARA LIMESTONE

Boulders of yellowish-gray or buff coloured limestone are strewn in abundance along the lower course of the Allard and Bell rivers, the shores of Matagami, Gull, Olga, and Soskumika lakes, and in places along the Nottaway river. They are most numerous along the Allard river upstream for six miles from its mouth, and on the shores of Matagami, Soskumika, McGill and Laval lakes. These flat boulders, usually less than a foot across and three or four inches thick, occur within the stratified clays. The largest boulder observed was three feet across and one foot and a half in thickness. A few small pieces of bluish limestone are of much less frequent occurrence.

With the removal of the clays by wave action, these fragments of limestone have been assembled upon the shores. Some of them are highly fossiliferous. Small fossil corals, which through weathering have been released from the limestone matrix, are quite plentiful upon some of the long sandy beaches

(3) " Information from Dr. A. E. Barlow.
(4) " Lake Abitibi Area", by M. B. Baker, Bur. of Min., Ont., pp. 268-270.

of these lakes. From these sources the following fossils were collected, and have been determined by Mr. E. Ardley, Assistant Curator of the Peter Redpath Museum, McGill University: *Favosites remistus*, *Halysites escharoides* (?), *Diphyphyllum*, *Cyathaxonia*, *Zaphrentis*, *Streptelasma stricturu*, *Spirafer brachynota*, *Orthis hybrida* (?) and *Rhynconella neglecta*.

Floating ice in the waters of the historical Lake Ojibway must have carried these boulders to their present positions within the stratified clays. Their increased abundance in certain localities and the frequent occurrence of certain fragments containing much arenaceous material, as if they had been derived from basal beds, suggest that not long ago in geological time the Niagara limestone may have occupied a considerable portion of this region, and that outliers of this formation may even now be concealed beneath the clays within some of the more basin-like depressions of erosion within this area.

In places along the Nottaway river, and especially in certain localities on the shores of McGill, Laval and Soskumika lakes, rounded boulders and pebbles of bluish-gray, fine grained quartzite are numerous. No fossils were found in them.

QUATERNARY

By their smooth, striated and grooved surfaces and roches moutonnées forms, the majority of rock outcrops in this region display the results of intense glaciation. These characteristics are preserved best upon exposures of rock from the surface of which the cover of clay has been removed recently by erosion. Striations have almost entirely disappeared from most of the exposures of granite and gneiss. Most continuous and impressive are the heavily glaciated surfaces of Keewatin greenstones along the southern shore of Matagami lake. The length of this lake from east to west occupies a position nearly transverse to the direction of the movement of the ice-sheet which advanced from N.15-20°E. In rising from this depression of erosion which must have existed in pre-glacial times, the ice rode up over the rock surfaces upon the southern shore, imparting to them striated and corrugated surfaces of most striking appearance.

The accompanying sketch map shows the directions of ice movement within this region. Numerous exposures of rock retain more than one set of striæ, older and fainter scratches being crossed at small angles by fresher ones. The directions indicated on the map and the following remarks pertain only to those pronounced inscriptions which were recorded upon the rock floor during the last advance of the ice.

In certain localities, the faithfulness with which the movement of the basal portion of the ice-sheet conformed to the configuration of the floor is surprising. A projecting point or an island close to the shore of a lake have frequently induced a local deviation from the general direction of movement. The average of numerous observations of the directions portrayed by striæ and grooves in the rocks along the southern shore of Mattagami lake shows that the ice in that locality advanced from about N. 15°—20° E. In the large deep bay on this shore, about four miles east of the entrance of the long northern arm extending toward the Nottaway river, the ice turned to within three or four degrees of due south.

In that portion of the area drained by the Nottaway, Allard, Bell and Natagagan rivers, the ice advanced from the well-known Labradorean centre which was situated far to the north-east. Fourteen observations along the Allard river (most of them within ten miles of its mouth) range between S. 70° W. and S. 24° W., while S. 12°—14° W. may be taken as a rough determination of the direction toward which the ice was here moving.

In striking contrast to this eastern portion of the region, along the Harricanaw river, all observations taken indicate that the ice advanced from slightly west of north. This peculiarity is well shown by many exposures on Obalski lake. Whether this is merely a local deviation dependent upon contour of floor, or due to confluence of the ice-sheet from the Labradorean centre with that from the Keewatin, or possibly with that from the Patricia centre (discovered during the past summer by Mr. J. B. Tyrrell), or because of the former presence of a local centre of distribution immediately to the westward of this area, obviously cannot now be stated. No geological exploration has been made to the westward in these latitudes within the Province of Quebec.

No residual soils were observed within the region. Stratified clays and sands usually rest directly upon bed rock surfaces. In a few localities, northward from Soskumika lake and eastward from Matagami lake, the stratified clays may be seen to rest upon boulder clay. By far the major portion of the area between the Transcontinental Railway and northward to a few miles below Soskumika lake, and eastward to a short distance beyond Olga lake, is underlain by stratified clays, while sandy tracts are comparatively few and far between. The stratification of the clays is often accentuated by a slight difference in colour of alternate layers, which seldom exceed more than an inch in thickness. In places they are interstratified with sand or become somewhat sandy. This is especially in the vicinity of Soskumika, Olga and Matagami lakes where, through erosion of clay banks by waves, the particles of sand are accumulated to the formation of sandy beaches resting upon a basement of stratified clays. In a few places about the shores of these lakes clay banks rise to between twenty and thirty feet. Near the base of an exposure of stratified clays about thirty feet high, at the foot of a small cascade on a creek which enters the eastern end of Matagami lake, there is an interstratified layer of gray sand which is slightly more than two feet thick.

In very many localities these clays contain abundant calcareous concretions, most of which are discoidal, while others exhibit very weird and irregular shapes. All of them are flat, some with holes in the centre, others crescentic, etc. In a few instances adjacent concretions have coalesced during growth. The largest observed was seven inches long, three inches wide and about half an inch in thickness. They are especially abundant along the lower courses of the Allard river and the shores of Matagami, Soskumika, Olga, McGill and Laval lakes, where numerous fragments of Niagara limestone are also sporadically distributed in these clays. It seems probable that these limestone boulders contributed much of the calcareous material which solutions deposited along the planes of stratification in the form of these concretions. Although more or less irregularly scattered through the clay, the concretions are usually much more numerous along certain planes than others, their distribution apparently being at least in part dependent upon the relative impermeability of the thin layers upon which they rest.

The origin of the level character of the topography is coincident with that of the heavy blanket of clay and sands. The topography of the Clay Belt of the North differs from that of other portions of the Laurentian plateau or peneplain only in the presence of these stratified clays and sands, which mask all the irregularities of the rocky floor upon which they rest, with the exception of the very few of such prominence that they rise above the remarkably level surface of the cover of silts.

During that very recent chapter in the geology of this region, when Canada and the northern portion of the United States were swathed in a thick mantle of glacial ice, the preglacial rivers flowing into James Bay ceased to exist. When, through amelioration of the climate, the margin of the ice-sheet had receded to a position north of the height of land, a lake came into existence between the height of land and the retreating ice-front. To this englacial lake, Dr. A. P. Coleman, of the Department of Geology in the University of Toronto, has given the name "Lake Ojibway" (1). His graphic description, written in 1909, pertains chiefly to the clay belt as it was then known. At that time, although there was no record of the continuation of the clay belt so far eastward and northward in the province of Quebec as the present report indicates, he surmised its extension toward these directions.

With continued recession of the ice, this lake became progressively larger, discharging its waters through different outlets toward the south, until the rivers could once more flow into the waters of James Bay, when the lake became drained. At that time James Bay was much larger, for when the ice-sheet vanished the land occupied a position which was probably at least 450 feet (2) lower than at the present.

The level surface of the plain of to-day corresponds to the

(1) "Lake Ojibway; Last of the Great Glacial Lakes", by A. P. Coleman Rept. Bur. of Min., Ont., 1909, Vol. XVIII, Part 1, pp. 284-294.
(2) Ibid, p. 293.

bottom of this interesting englacial lake. That portion of the area extending from the height of land, south of the Transcontinental Railway, northward to the outlet of Soskumika, and eastward to include Olga lake is underlain chiefly by stratified clays representing where this extensive shallow lake was deepest.

The stratified clays, deposited from the muddy waters of this lake, were derived undoubtedly both from the working over of boulder clay and from the rock flour which was washed out from beneath the diminishing ice-sheet. Some of the sandy tracts within the clay portion of the area will probably be found to be associated with different levels the shore lines of this lake occupied at different stages; some of them which are coincident with the higher elevations represent the position of shoals or bars in the lake. From Matagami lake northward to Soskumika lake and eastward to Gull lake, some of the local deposits of sand are surely kames, where wash from beneath the ice accumulated so fast that it was imperfectly worked over in the waters of this lake. The stratified sands containing many boulders, surrounding Gull lake (660 feet above sea-level), as well as a terrace to the south of this lake, suggest that during one of the stages of its existence the eastern shore of the lake must have been in that vicinity.

Below Soskumika lake the soil becomes more sandy, and low rocky ridges are more numerous than elsewhere in the region. Here the drift is for the most part stratified, although, locally, stratified sands and gravels containing an abundance of large and small boulders were observed resting upon boulder clay.

Unfortunately, below Iroquois chute (443 feet above sea-level) no marine fossils were observed within the stratified sands. From this chute to the outlet of Kelvin lake resembles a terrace such as would mark a shore line, but circumstances did not permit sufficient study to arrive at a conclusion. On the western side of Kelvin lake, locally, the stratified sands have been cemented by hydrous iron oxide to form a sandstone. (See Plate VII.)

To-day the rivers and streams wind across the bottom of old Lake Ojibway with long stretches of almost dead water alternating with rapids, cascades and occasional shallow lakes.

Post-glacial Sandstone.—West shore of Kelvin lake, Nottaway river.

Looking eastward along the summit of Mt. Laurier, south of Matagami lake.

The most interesting of the recent deposits are the peat bogs, a description of those bordering upon the waterways having been given under "Soil and Climate" in previous pages of this report. The exposed margins of some of these peat bogs display the former presence of several generations of trees. On the eastern side of McGill lake, six feet in thickness of peat display the accumulation of at least three generations of tree growth and the lowest portions of this deposit are not exposed. Resting upon a basement of relatively impermeable clay some of these peat bogs, if studied from a botanical point of view, should reveal many facts concerning the progressive amelioration of the climate since vegetation gained a foothold after the retreat of the ice-sheet.

Results of the action of ice in modifying lake shores during winter and spring may be observed at many points. Upon the northern side of the largest island in Matagami lake and on a small drumlin island south-eastward from the outlet and towards the middle of Gull lake, large boulders have been piled together by this action. From a very general point of view, sandy and pebble beaches seem to be wider on the southern than on the northern shores of Matagami, indicating apparently that the prevailing winds are from the north.

POSSIBILITIES OF THE DISCOVERY OF VALUABLE MINERALS.

Long experience accumulated by those engaged in geology, mining and prospecting in other portions of the Laurentian plateau has proved that, in general, those areas underlain by Keewatin, Huronian and the "newer diabases" are worthy of most careful prospecting. As may be learned from the above description of its geology and from the accompanying map, there are extensive areas of Keewatin rocks within this region.

In the vast area of gneiss and granite lying between Matagami lake and James Bay, a mere possibility remains that valuable minerals may be discovered in the neighbourhood of some of the narrow and widely separated schistose bands. These ribbons and bands were frequently noticed to be somewhat impregnated with pyrite, or traversed by small quartz veins occasionally containing a few specks of pyrite, but never to such an extent as to attract too much attention. While large areas of "promising country" remain untouched, it is advisable for the prospector to avoid such areas as are underlain by granite and gneiss.

Systematic and intelligent prospecting of the areas of other rocks should be attended finally by the discovery of minerals of value; but, unfortunately, over by far the major portion of this region, efficient prospecting will always be a very arduous task. Owing to the heavy and almost universal overburden of stratified clays and sands, outcrops of rock are very widely separated. Inland from the waterways, the country is covered by a heavy blanket of moss, and rock exposures are confined chiefly to the very sparsely distributed low hills and ridges; but, frequently, in making traverses of the bush one will find outcrops of rock when least expecting their presence. Along the rivers and streams, the occurrence of large exposures of rock is restricted almost entirely to the rapids and cascades.

The larger number of the outcrops of rock represent the hardest and most resistant portions of the rocky basement upon which the superficial deposits rest. Although all such exposures of rock should be examined carefully in prospecting, care should be taken that the more lowly outcrops are not passed by, since the latter often are composed of very schistose and softer rock types which are favourable to the deposition of valuable minerals. As a result of glaciation, rock outcrops are usually more numerous and continuous along the southern than the northern shores of lakes; while on projecting points and the majority of the islands, rock is exposed best upon the northern side.

The following statements are extreme examples of the scarcity of rock outcrops. Along the Allard river, for sixty miles northward from "the Harricanaw portage," only twelve small exposures of rock peep out from beneath the heavy cover of clay, and three of these are of granite. For twelve miles up a stream entering the eastern end of Matagami lake from the northeast, only one outcrop of rock occurs. By far the majority of the exposures of rock along the waterways have been located upon the accompanying map. Placing the outcrops, which were examined, thus upon the map serves the double purpose of showing the data from which the geological map was compiled, as well as giving to the prospector information concerning the presence or absence of rock exposures within definite parts of the area. Even this graphic method is somewhat misleading, because the scale of the map demands that a symbol may refer to a single small outcrop or to a group of outcrops. It must be remembered that only those outcrops along the waterways are shown.

In the vicinity of Obalski lake on the Harricanaw river, and in the neighbourhood of portions of Matagami, Olga and Gull lakes, considerable areas of Keewatin rocks are quite easily accessible. The most continuous series of outcrops within the area appear along the southern shore of Matagami lake and to the south of this lake where the rocks of Mt. Laurier are well exposed. With this description in hand, the energetic prospector should not shun other areas where similar rocks outcrop less frequently, but he will enter upon his task with a knowledge of the difficulties attending his work.

During the summer, in connection with our work in mapping, search was made for minerals of economic value. Stringers, lenses and veins of quartz frequently traverse the exposures of Keewatin rocks in all parts of the area. Usually the quartz appears in the form of short stringers or small lenticular bodies parallel to the schistosity. It often contains more or less pyrite and even more frequently a yellowish iron-bearing carbonate, which upon decomposition imparts a rusty appearance to weathered surfaces. Of those quartz veins carrying this carbonate, the best example noticed occurs about two miles within and on the western shore of the largest deep bay on the south side of Matagami lake. Within a zone of schists, 18 feet wide, and striking about N. 80° E, irregular quartz veins parallel to the schistosity are numerous. In addition to many stringers, one vein attains a maximum width of two feet and another of fifteen inches. An assay of a large number of small fragments of this quartz did not yield a trace of gold. Six other assays from quartz veins in other parts of the area show either the absence or only the presence of traces of gold. An assay of pyritiferous quartz from the southern shore of Matagami lake, immediately south of the largest island in the lake and about two miles from the rapids at the mouth of the Bell river, showed the presence of 60 cents per ton of gold. From appearances, one of the best quartz veins noticed within the district is exposed at low water on the southern shore of Matagami lake about four miles east of the mouth of Bell river. Cutting a somewhat schistose intrusive quartz porphyry, it has a width varying from 9 inches to 2 feet 9 inches and is exposed for 55 feet. Although in places it contains considerable pyrite, an assay of some of the best samples collected yielded only a trace of gold. About one hundred yards westward along the shore from this point and near the contact of this intrusive quartz porphyry with chlorite schists, the latter have been heavily impregnated with pyrrhotite for a maximum width of 15 feet. Assays of the pyrrhotite show the absence of gold and copper and the presence of 0.29 per cent of nickel.

Pyrite in the form of disseminated grains, or less frequently in small cubical crystals, is a very common mineral within the Keewatin rocks. Along the lower course of the Allard river on the western and southern shores of Matagami lake and in some exposures on Olga lake, pyrite and pyrrhotite appear within the Keewatin schists in the form of irregular nests or pockets from which small samples of these minerals in an almost pure state may be collected. Five assays of this material from the lower course of the Allard river, the western and southern shores of Matagami lake, and the northern shore of the largest island in Olga lake show the absence of gold. A few specks of copper pyrites were occasionally noticed in the Keewatin schists, and also at the contacts of some of the dykes of the newer diabases.

Owing to quiet rumors from some prospectors that placer gold probably would be found in the sands of Matagami lake and Nottaway river, these sands were panned repeatedly without revealing the presence of a single colour. When the glacial and lacustrine origin of these sands and gravels is considered, it is not to be expected that placer gold in paying quantity will be found within them.

Although somewhat disappointing, sweeping generalizations must not be made from these results. Geological conditions are such that it is yet to be hoped that a continued search will lead to the discovery of some quartz veins which carry gold. Special attention should be devoted to bands of schistose rocks, especially in the vicinity of the contact of intrusive igneous rocks, in the hope of finding bodies of iron or copper sulphides of sufficient size to be of economic value.

DIAMONDS

During the past summer, six or seven men under the direction of Mr. Taberner were prospecting for diamonds in the stratified blue clays and sandy gravels of the vicinity of the mouth of Bell river on Matagami lake. In addition to numerous test borings, shallow pits were sunk on the northern shore of a small bay on the west side of Matagami lake, on the north-eastern shore of one of the more easterly of the small islands near the mouth of the Bell river, and on the east bank of the Bell river just above the first rapids. These pits, none of which reached a greater depth than 18 feet, show that the stratified clays are interbedded with thin layers of sand and fine gravel, while a few boulders are distributed irregularly throughout the deposit. For a distance of between one and two feet below the surface, the clays are brownish or reddish in colour, because of oxidation; below this they display different shades of blue and grey. Towards the bottom of the pit on the island, a fine bluish gravel was encountered, which had been partially consolidated by the deposition of calcareous cement from percolating waters. This was supposed to be "very promising" material.

In the search for diamonds, the method of procedure of this party was simple and laborious, yet thorough. Four screens of different mesh were fitted to frames about 4 feet long, 2 feet wide and six inches high. When piled on top of each other, the uppermost and coarsest screen prevented the passage of pebbles larger than a hickory nut, while the lowest collected those of about half the diameter of a pea. On top of these screens a box-frame was tightly fitted. Clay was shovelled into the box-frame and water was poured upon it until only the clean pebbles remained upon the screens. The pebbles upon each screen were then carefully picked over in the hope that some diamonds might be discovered among them. The pebbles comprised different varieties of Keewatin greenstone, granite, diorite, hornblende, gneiss, quartz and a few of Niagara limestone. The majority of them were rounded, but very many were angular. Occasionally small yet perfect crystals of quartz were found.

During the summer, other parties were engaged in searching for diamonds under somewhat similar conditions to the party at the mouth of the Bell river, but in more remote parts. It is *not* to be anticipated that diamonds will be discovered in these stratified blue clays and sands of the Clay Belt of the North. Unfortunately, in the vicinity of Matagami lake, no rocks occur which are related closely to those bearing diamonds in South Africa. The celebrated residual "blue clays" of the Kimberley district, South Africa, have been derived from the decomposition of very basic igneous rock within the pipes or necks of old volcanoes. The blue clays of this northwestern portion of Quebec have been deposited from the muddy waters of the historical lake Ojibway, which has already been described in this report.

The search for diamonds in this and other portions of the Laurentian plateau has developed from a most reasonable belief among certain geologists that somewhere to the north of the Great Lakes, diamonds must occur within solid rock. This belief is based upon the discovery of emigrant diamonds within the glacial drift in the States of Wisconsin, Michigan, Indiana and Ohio.(*) Prior to the year 1899, seven diamonds ranging in size from less than four to more than twenty-one carats, as well as a number of smaller ones, were found near the margin of "the newer drift," that glacial débris carried southward during the advance of the ice-sheet from the north. Associated with these diamonds are many fragments of rock similar to those which are known to be *in situ* in certain localities to the north of Lakes Huron and Superior.(†)

Although quite convinced that the diamonds did come

* "Emigrant Diamonds in America" by W. H. Hobbs, Pop. Sci. Monthly, Vol. LVI, pp. 73-83.

† Mineral Resources of the United States, U.S.G.S., 1905, pp. 1325-1326.

from that portion of the Laurentian plateau to the north of the Great Lakes, the problem of finding them is closely akin to searching for a needle in a haystack. Yet there are certain guiding principles which may be enunciated. An intelligent solution of the problem involves both a knowledge of the mode of occurrence of diamonds in other parts of the world and a careful study of the directions which different portions of the ice-sheet assumed during its southward advance. With the exception of one or possibly two instances where diamonds have been traced to the conditions under which they were formed in rocks, they have been found within members of that ultrabasic group of plutonic igneous rocks called peridotites. Rocks of this group are dark in colour, being mineralogically distinguished from others by the absence of feldspar, and the presence of olivine usually with other ferromagnesian minerals as biotite, pyroxenes and hornblende. Frequently they are more or less altered, giving rise to certain serpentinous and talcose varieties of rock.

In South Africa the diamonds occur within Post-Triassic volcanic necks or stocks of mica-peridotite breaking through carbonaceous shales and other rock types. For a considerable depth within these stocks the mica-peridotite, or Kimberlite, has been decomposed to bluish and yellowish clays. The diamonds in the "blue ground" of this celebrated locality originally crystallized within this rock while it was solidifying from a molten or liquid state.

At Murfreesboro, Pike county, Arkansas, diamonds of sufficient size to be used for jewels have been found in rock. They occur within a small stock of peridotite which is somewhat decomposed at the surface. Up to 1910, twelve hundred diamonds, weighing 574 carats in all, are reported to have been collected from this locality.(*)

Minute diamonds have been found by Mr. R. A. A. Johnstone, of the Geological Survey of Canada, in chromite occurring within serpentinous peridotites both from Olivine mountain, two miles south of Tulameen river, Yale District, B.C., and from Black lake, Megantic Co., P.Q. (x)

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* Amer. Journal of Science, Vol. XXIV, 1907, pp. 275-276; also Mineral Resources of the United States, U.S.G.S., 1910, p. 858.

x Summary Report, Geol. Survey of Canada, 1911, p. 360.

An exceptional occurrence is that recorded from near Inverell, (*) New South Wales, Australia, where a few small diamonds were found within a hornblende-diabase of Post-Carboniferous age.

Some diamonds have been found within the platinum-bearing placer deposits of the Ural mountains, where there is no doubt that both the platinum and the diamonds have been derived from the hills of peridotite in the immediate vicinity. In Brazil they are found within sandstones and conglomerates. In the celebrated fields of Panna, India, they occur within sandstones and conglomerates which are supposed to be of Pre-Cambrian age. Diamonds have not been formed within sedimentary rocks. Neither in India nor Brazil has the original source of these gems been discovered.

If guided by present knowledge concerning the origin of diamonds, search for the true home of the emigrant diamonds will be restricted to a careful examination of those areas underlain by peridotites. If South Africa be taken as a standard, it may be that conditions are more suitable for their occurrence where peridotites have risen through carbonaceous sedimentary rocks. The possibility also exists that the diamonds within the glacial drift may have come from some Pre-Cambrian sedimentary rocks or sandstone and conglomerate types which in turn derived the diamonds from some mass of peridotite that now may be effectually covered by later Pre-Cambrian sedimentary rocks.

Through elimination, interest in the region from whence the diamonds were transported becomes concentrated to a major degree upon those areas occupied by peridotites and to a minor degree upon those underlain by Pre-Cambrian sandstones and conglomerates. Areas characterized by bed-rock of these types are comparatively few and widely scattered.

The pessimistic possibilities must also be retained in mind that the rocks from which these diamonds were derived may be beneath some of the widespread swamps or muskegs, or beneath

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* (1) "Occurrence of Diamonds in Matrix at Pike and O'Donnell's claim, Oakey Creek, near Inverell, New South Wales", by T. E. David.

Congrès Géologique International, Mexico, Vol. II, 1906, pp. 1201-1210.

the waters of some of the numerous lakes, or they may be buried beneath a heavy mantle of superficial deposits of glacial and lacustrine origin. It is also possible that their presence within the drift may be due to the removal and distribution by the ice-sheet of a pre-glacial alluvial or residual deposit within which diamonds had been concentrated from the decomposition and erosion of a body of peridotite containing comparatively few diamonds. If so, even if the source be discovered, these gems may not be found in sufficient abundance to establish an industry in diamond mining.

To delimit that portion of the region to the north of the Great Lakes from which the diamonds may have come is, according to our present knowledge, somewhat more difficult.(*) By careful observations of the directions of flow of the ice-sheet, it will eventually be possible to assert definitely that particular portion of the region over which the glacial ice moved in its passage to those points where emigrant diamonds have been found. This must be done by systematically recording the directions of the striae which have been inscribed upon bed-rock by glacial erosion. Indirect and important aid may be secured from a study of the manner in which distinctive rock types have been distributed southward from definitely known sources. This may be done by following up boulders in the direction indicated by the glacial striations. In Europe, where much detailed glacial work has been done, it has been found that pebbles and fragments of easily recognizable varieties of rock have been distributed over fan-shaped areas, the width of the fan increasing in the direction toward which the ice was moving, and narrowing toward the apex or source from whence the fragments have been derived. For example, boulders from the vicinity of Christiania in Norway were strewn in this manner over Denmark, Holland, Belgium, western Germany and the eastern part of England. According to this principle, provided the "emigrant" diamonds all came from one locality, the width of the zone within which diamonds could occur in the glacial drift would become narrower

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* "The Occurrence of Diamonds in the Drift of some of the Northern States", by Dr. R. Bell, Journal Can. Min. Inst., Vol. IX, 1906, pp. 124-127.

upon approaching the source or centre from which they have been distributed.

Those people living immediately to the north of the Great Lakes should take an especial interest in the pebbles in the glacial deposits of their respective communities in the hope of discovering diamonds among them. If a discovery were made, this would not give direct assurance that others would be found in the vicinity, but definite proof that the source lies still farther removed in the direction from which the ice advanced.

In Canada the ice moved outward in all directions from two very important centres or gathering grounds, the one far to the north-east in Labrador, and the other in the vicinity of Doobawnt lake in Keewatin. At the recent meeting of the Geological Society of America in New Haven, Mr. J. B. Tyrrell announced the discovery during the past summer of a third centre in the district of Patricia, Ont. At present we do not know enough details with reference to the mutual advance of the ice from these three centres to give boundaries to that portion of the region within which diamonds may be expected to be found.

If gold were discovered in the gravels at the mouth of a large river, prospectors would not rush to the headwaters without a careful examination of the intervening area between the mouth and source. Yet, from analogy, that is what happened during the past summer when men rushed to Labrador upon a search for diamonds. Personally, it seems very, very improbable that the source of the "emigrant diamonds" lies as far to the north-east. Not only the long distance involved, but the movement of the ice from slightly west of north along the Harricanaw river seems to militate to some extent against such an idea.

The factors entering into the problem are at present so complicated that it is not wise to encourage men to make a business of looking for the source of these diamonds. The well-known possibility of their discovery is a fact very readily abused by indiscreet individuals. The above, necessarily more or less indefinite information, has not been given to stimulate prospectors in an attempt to unravel the secret of their source, but rather to inform those who are called upon to live and travel within the region of possible discovery that they may casually keep a watchful eye in the hope that they may solve or contribute toward the solution of a problem that may lead to the discovery of a profitable diamond field in Canada.

APPENDIX.

Plants from the Basins of the Harricanaw and Nottaway Rivers, P.Q., collected by J. Austen Bancroft, July and August, 1912:—

Equisetaceae—

1. Equisetum sylvaticum.—Sterile stems from Kelvin Lake the Nottaway River, July 27th. A common form in the North from Newfoundland to Alaska. Fruiting stems, May-June.
2. E. palustre.—Sterile stems near Allard River, August 16th. Nova Scotia to Alaska. May-June.

Naiadaceae—

3. Potamogeton Richardsonii, *Redb.* Very abundant in the southern half of Lake Soskumika, July 24th. In quiet waters from Quebec to the Mackenzie River and in British Columbia. July-September.

Alismaceae—

4. Sagittaria latifolia, Willd. arrowhead. From McGill Lake, August 15th. Common in water or wet places.

Liliaceae—

5. Maianthemum canadense, *Desf.* Longest portage on Natagagan River, September 1st. In moist woods from Labrador to Manitoba. May-July.

Iridaceae—

6. Iris sp.? Growing in profusion on a sandy bank, Lake Soskumika, July 24th. Specimen not complete, re-

sembled Iris setosa, *Pall.* var. Canadensis, *Foster.* This form is, however, supposed to be confined to sea beaches and headlands.

7. I. vericolar, *L.* A portage on the Natagagan River, Sept. 1st. Common from Newfoundland to Manitoba. Reported by Macoun from James Bay.
8. Sisyrinchium montanum, *Greene.* Blue-eyed grass, Lake Soskumika, July 24th. Gaspé peninsula to the Rocky Mountains, June-July.

Orchidaceae—

9. Habenaria dilatata, (*Pursh*) *Gray.* Rein Orchis, south of Bull Rapids, Nottaway River, July 29th. Meadows woods and bogs, Newfoundland to Alaska. May-August.
10. H. psycodes, (*L.*) Sw. Fringed Orchis. Allard River. July 18th-22nd. First cascade, Nottaway River, July 24th, Matagami Lake, August 8th. Wet places from Newfoundland to British Columbia. July-August.
11. Spiranthes Romanzoffiana. Cham. Ladies' Tresses. Lake Matagami. August 19th. In wet places from Nova Scotia to Alaska. July-August.

Salicaceae—

12. Populus tremuloides, *Michx.* American Aspen. Cascade on Nottaway River. Dry or moist soil, Newfoundland to Hudson Bay and Alaska. March-May.
13. Salix longifolia. *Muhl.* Sand-bar Willow. First cascade on Nottaway River. Along streams and lakes from Quebec to Alberta. April-May.

Polygonaceae—

14. Polygonum amphibium, L. Knotweed. Southern part of Lake Soskumika, July 24th. Aquatic or rooting in the mud, from Quebec to Alaska. July-August.

Ranunculaceae—

15. Actaea rubra, (Ait) Willd. Red baneberry. Below Bull Rapids, Nottaway River, July 26th. Common in the north, extending from Nova Scotia to the Rocky Mountains. April-May.
16. Anemone canadensis, L. Canada anemone. Long rapid, Nottaway River, July 26th. Quebec to Assiniboia. May-August.
17. Thalictrum polyganum, *Muhl.* Tall meadow-rue. Allard River, July 18th-22nd, and the Nottaway River, July 29th. Newfoundland to Ontario. July-September

Fumariaceae—

18. Corydalis aurea. Willd. Golden corydalis. The portage past chute 15, at the entrance of Lake Olga, Aug. 3rd. Both flowers and fruits. Quebec to the Mackenzie River and the Rocky Mountains March-May.

Rosaceae—

19. Amelanchier spicata, C. Koch. Low June berry. Natagagan Portage, September 1st. Banks of streams, Quebec westward about the Great Lakes. May.
20. Crataegus sp.? Hawthorn. A fragment, with one immature fruit, in the character of the stem, leaves and fruit resembled C, uniflora, *Moench.*, which has not been reported as occurring further north than Long Island.
21. Fragaria vesca. L. var. Americana, Porter. Strawberry. Matagami Lake, August 2nd. Common from Newfoundland to the Coast Range of British Columbia. Macoun states that it has not been found north of Lat. 56° on the Peace River.
22. Potentilla fructicosa, L. Shrubby Cinque-foil. Islet at first cascade of the Nottaway River, July 24th, and Lake Soskumika, July 24th. Damp open ground, from Labrador to Alaska. June-September.
23. P. pentandra. *Engelm.* Five-stamened Cinque-foil,

Waswanipi River, August 4th. Found on the prairies. June-September.

24. Rosa nitida, *Willd.* Nottaway River, July 31st. Generally considered a north-eastern form, occurring from Newfoundland to the north-east. June-July.
25. Sibbaldia procumbens, L. Lake Kelvin, July 27th. Throughout Arctic America south to the White Mountains. Summer.
26. Pyrus setchensis (Roem.) Piper. Western Mountain Ash. Leaves and winter buds from Matagami Lake, August 24th. Moist ground. Labrador to Alaska. June-July.
27. Spiraea salicifolia, L. Meadowsweet. Nottaway River, July 29th. Newfoundland to the Rocky Mountains. June-August.

Leguminosae—

28. Lathyrus palustris, L. var. pilosus, *Cham.* Vetchling. Banks of the Nottaway River, 2 miles above Bull Rapids, July 25th. Newfoundland, Eastern Quebec to British Columbia. May-August.
29. Vicia americana, *Muhl.* Vetch. Long Rapid, Nottaway River, July 26th. New Brunswick to British Columbia. May-August.

Geraniaceae—

30. Geranium Bicknellii, *Britton.* Bicknell's Crane's-bill. The portage past Red Chute, Lake Olga, August 3rd. Newfoundland to British Columbia. May-September.
31. Oxalis acetosella, L. Wood sorrel. Gull Lake, south side of river draining the lake, August 3rd. Nova Scotia to Saskatchewan. May-July.

Onagraceae—

32. Oenothera pallida. *Lendl.* White-stemmed Evening primrose. Lake Kelvin, July 27th. Dry plains and prairies extending west to British Columbia. May-

August. The stems of this specimen were more deeply coloured than those of the type form.

33. O. pumila, L. Small sundrops. Nottaway River, July 31st. Common from Quebec to Manitoba. June-August.

Cornaceae—

34. Cornus canadensis. L. Dwarf cornel or bunchberry. Bank of Nottaway River about 2 miles above Bull Rapids, July 25th. Labrador to Alaska, south to Indiana. June-July.

35. C. circinnata, *L'Hér.* Round-leaved cornel or dogwood. Allard River, July 18th-22nd. Quebec to Manitoba. June-July.

36. C. stolonifera. *Michx.* Red osier dogwood. Allard River, July 18th-22nd. Newfoundland to the Mackenzie River. June-August.

Ericaceae—

37. Andromeda polifolia. *L.* Bog rosemary. Natagagan portage, Sept. 1st. Common in Arctic regions, Labrador, Newfoundland. May-July.

38. Kalmia angustifolia, *L.* Sheep laurel, Lambkill. Nottaway River, July 31st. Labrador to Ontario. June-July.

39. Pyrola chlorantha, *Sw.* Wintergreen. Shin leaf. Nine miles from Bull Rapids, Nottaway River, July 31st. Open woods, Labrador to British Columbia. June-July.

40. Vaccinium ovalifolium, *Sm.* Bilberry. Matagami Lake, August 2nd. Labrador to Alaska in low woods and on mountain slopes. South to Quebec and Newfoundland. June-July.

41. V. uliginosum, *L.* Bog Bilberry. First cascade on Nottaway River, August 18th. Arctic America south to the barrens of Washington, New York and Michigan. June-July.

Primulaceae—

42. Trientalis americana, *Pursh.* Star flower. Natagagan River, Sept. 1st. 00 miles below Bull Rapids, Nottaway River, August 2nd. Labrador to Manitoba. May-July.

Gentianaceae—

43. Gentiana Andrenesii. *Griseb.* Closed gentian. Matagami Lake, August 19th. Maine to Manitoba. August-October.

Labiatae—

44. Mentha arvensis. *L.* var. canadensis (L.) *Briquet.* Mild mint. At the mouth of the river flowing from Laval and McGill Lakes to Lake Soskumika, August 16th. New Brunswick to British Columbia. July-October.
45. Scutellaria galericulata, *L.* Skullcap. First cascade, Nottaway River, August 2nd. Newfoundland to British Columbia. June-August.
46. Prunella vulgaris, *L.* Heal-all. Bull Rapids, Nottaway River, July 31st. Atlantic to Pacific. June-September.

Scrophulariaceae—

47. Mimulus ringens, *L.* Monkey-flower. Allard River, July 18th-22nd. New Brunswick to Manitoba. June-September.
48. Veronica scutellata, *L.* Marsh speedwell. Wet places. Newfoundland to British Columbia. May-August

Rubiaceae—

49. Galium triflorum. *Michx.* Sweet-scented bedstraw. Northern shore of East River entering Lake Matagami, August 7th. Newfoundland to British Columbia. June-August.

Caprifoliaceae—

50. Diervilla Lonicera, (*Tourn.*) *Mill.* Bush honeysuckle. South of Bull Rapids, Nottaway River, July 29th. Newfoundland to Manitoba. June-August.
51. Linnaea borealis, *L.* var. americana (*Forbes*) *Rehder.* Twin-flower. Nottaway River, August 2nd. Labrador to British Columbia. June-August.
52. Lonicera caerulea, *L.* var. villosa (*Michx.*) T. & G. Mountain fly honeysuckle. Peat bog on McGill Lake, August 15th. Low woods and bogs, Labrador to Alaska and southward. May-June.
53. Lonicera hirsuta, *Eat.* Hairy honeysuckle. Allard River, July 18th-22nd; islet at first cascade, Nottaway River, July 24th. Damp copses and rocks, Quebec to Manitoba. July.
54. Viburnum pauciflorum, *Raf.* Squashberry. Natagagan portage, Sept. 1st; mouth of river flowing to Soskumika Lake, August 15th. Labrador to Alaska, Newfoundland to Northern British Columbia, Saskatchewan to Slave Lake in Lat. 66°. June-July.

Campanulaceae—

55. Campanula rotundifolia, *L.* Harebell, bluebell. Nottaway River at the cascade, July 27th. Common in north, extending south into the United States. June-September.

Lobeliaceae—

56. Lobelia Kalmii, *L.* Matagami Lake, August 19th. Wet limestone shores and bogs from Newfoundland to Manitoba. July-September.

Compositae—

57. Achillea borealis, *Bongard.* Yarrow milfoil. Lake Soskumika, July 24th. Labrador to Alaska, Newfound-

land, Quebec and southward along the Rocky Mountains. June-August.

58. Anaphalis margaritacea (L.) B. & H. Pearly everlasting. Matagami Lake, August 24th. Common northward. July-August.

59. Aster ptarmicoides, T. & G. Nottaway River, Lake Kelvin, July 27th. Quebec to Saskatchewan. June-September.

60. Erigeron philadelphicus, *L.* Fleabane. 2 miles above Bull Rapids, Nottaway River, July 24th; Long Rapid, Nottaway River, July 26th. Atlantic to Pacific. May-August.

61. Hieracium umbellatum, *L.* Hawkweed. Lake Olga, August 3rd. Lake Superior northward and westward. June-August.

62. Solidago canadensis, *L.* Goldenrod. Mouth of the river flowing from McGill Lake into Lake Soskumika, August 15th. Newfoundland to British Columbia. August-November.

63. Solidago hispida, *Muhl.* Islet at first cascade, Nottaway River, July 24th. Newfoundland to Manitoba. July, early September.

CARRIE M. DERICK.

REPORT ON THE GEOLOGY AND NATURAL RESOURCES OF AN AREA EMBRACING THE HEAD WATERS OF THE HARRICANAW RIVER, NORTHWESTERN QUEBEC.

DEPARTMENT OF GEOLOGY, McGILL UNIVERSITY,

Montreal, May 9th, 1913.

THÉOPHILE C. DENIS, Esq.,

Superintendent of Mines,

Department of Colonization, Mines and Fisheries,

Quebec, P. Q.

SIR :—

I beg to submit the following report on the geology of that portion of northwestern Quebec including the headwaters of the Harricanaw river.

I have the honour to be,

Sir,

Your obedient servant,

J. AUSTEN BANCROFT.

INTRODUCTION.

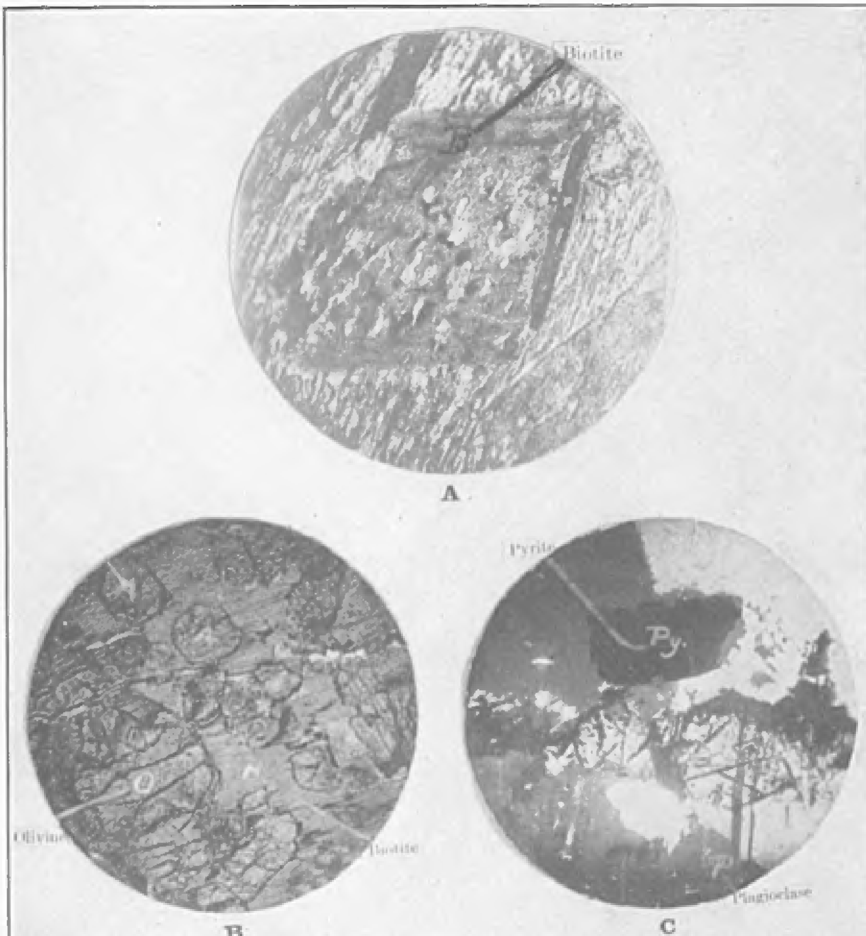
General Statement—

On the eleventh of July, 1911, Messrs. J. J. Sullivan and Hertel Authier discovered gold in a quartz vein on the eastern shore of Kienawisik lake in the projected township of Dubuisson. The discovery did not become known to the public until late in the autumn of the same year, when numerous prospectors were attracted to the neighbourhood of this lake. Many claims were staked in the vicinity of Kienawisik, Blouin and Lemoine lakes.

At the time the first discovery was made, the writer was engaged in making a geological survey of an area including Kewagama, Newagama and Keekeek lakes, the eastern boundary of the area then examined being about fifteen miles due west from Kienawisik lake. From June 1st to July 3rd, during the past summer, field work was resumed to the eastward of the area of the previous season, with the twofold object of examining the discoveries of gold that had been made and of continuing the geological reconnaissance farther eastward to include a much larger area.

Acknowledgments—

In the prosecution of this task, very efficient assistance was rendered by Mr. A. O. Dufresne, a graduate of Laval Polytechnic School, Montreal. He made an independent investigation of the geology of the shores of lakes Piché, Mourier and the major portion of Lemoine lake. In many ways, our work was facilitated by the kindness of Mr. J. H. Valiquette, the Assistant Inspector of Mines of the Province of Quebec, who, having his headquarters at Amos, was supervising the construction of colonization roads at several places along the National Transcontinental Railway westward from Amos in the province of Quebec. The writer is also most grateful to many of those holding mineral claims in this district, and especially to Messrs. J. J. Sullivan, S. G. Smith and M. Benard who, by giving information or willing service as guides, contributed to the success of the work.



A.—Quartz-biotite schist,—from small lake in S.W. corner of Bourlamaque township. --Exhibits remarkable poikilitic structure, a large individual of biotite containing numerous grains of quartz.—Ordinary light.

B.—Peridotite,—end of long narrow peninsula, southern shore of LaMotte lake, just west of mouth of river entering from Kienawisik lake. Exhibits crystals of augite and olivine within a base of biotite.—Ordinary light.

C.—Albite-syenite,—wall rock from "Benard's Vein," Kienawisik lake. Exhibits large crystal of sphene altered to network of rutile crystals.—Polarized light.

Position of the Area—

The major portion of the area lies between latitudes 48° and 48°30′, while longitude 78° lies about ten miles eastward from its western border. It includes the headwaters of the Harricanaw river, which flows northwestward into Hannah bay on the southern shore of James bay.

The crossing of this river by the National Transcontinental Railway during the past year has resulted in the establishment of the little village of Amos at this point. Southward from Amos, the river is navigable for gasoline launches and small steamboats to the head of Mourier lake, a distance of about 62 miles. Within this distance there are some important tributary streams and lakes, all of which are easily accessible to canoemen, and some, in part, to gasoline launches. The area discussed in this report includes the subdivided townships of La Motte, La Corne, a portion of Figuery, the projected townships of Malartic, Varsan, Senneville, Bourlamaque, Dubuisson and portions of Fournière and Sabourin. Rock exposures were examined along all waterways that are navigable for canoes. Traverses through the bush were restricted to the townships of La Corne and La Motte and to those portions of Dubuisson and Varsan where claims were staked.

Previous Work—

In the summer of 1906, Mr. W. J. Wilson (*1) of the Geological Survey of Canada, examined La Motte (or Seals' Home) lake and the Harricanaw river northward to a point five miles below Obalski lake. In the same summer, Mr. J. Obalski (*2), formerly Superintendent of Mines, P. Q., made a hurried examination of some of the main waterways of the district. The topographic map on a scale of 4 miles to the inch, upon which the geology has been recorded, is published by the Department of Lands and Forests, P. Q. Southward from the southern boundaries of La Motte and La Corne townships, it is very deficient in essential detail.

(*1) Geol. Survey of Canada, Memoir No. 4, by W. J. Wilson, pp. 19-20.

(*2) Mining Operations in the Province of Quebec, 1906, pp. 13-18.

GENERAL CHARACTER OF THE DISTRICT.

Topography—

The topography, flora, fauna and geology of this district are very similar to that of the Kewagama lake area, which was described in some detail in the report of the Department of Mines, P. Q., of the past year. The height of land here makes a sudden bend to the south, separating the waters of the Ottawa from those of the Harricanaw. Thus the area described in this report lies to the east and north of the height of land. The greater portion of this area is remarkably flat or gently rolling, and is underlain by stratified clays. La Motte (or Seals' Home) lake during low water has an elevation of about 966 feet above the sea. In so far as could be determined, those portions of the area occupied by stratified clays are always less than 1035 or 1040 feet in elevation; for the most part they are less than 1,000 feet above sea-level.

Protruding from beneath the blanket of clay and sand are low rocky hills and ridges, the highest of which probably do not exceed 250 feet above the surrounding country. Hills of 30 or 40 feet in elevation constitute prominent landmarks. Some of the more striking hills and ridges may be mentioned. The central portion of La Corne township is occupied by a very rugged ridge of granite, partially bare, which extends from north to south, with a maximum width of about three miles and a maximum elevation of probably 250 feet. In the western and northwestern portions of La Motte township, hills of granite are present, while long high sandy ridges trend in a north to south direction. From the summit of one of these sandy ridges a splendid view of Kewagama lake may be obtained. Scattered irregularly through the central and eastern portions of this township are rough hills of peridotite.

Within the southern portion of the area, to the east and west of Lemoine lake in the township of Dubuisson, rocky ridges trend slightly south of east, corresponding to the strike of the schistose rocks of which they are composed. These ridges are of especial prominence within this township eastward from this lake, where through the ravages of fire, bare rock has been exposed over very considerable areas. In the vicinity of Mourier lake the country is broken by rough hills of granite.

In general the country is more poorly drained than much of that in the vicinity of and to the north of the railroad. Immediately along the waterways extensive swamps are of frequent occurrence. Especially dismal are the swamps along the river flowing into Blouin lake from the east. From a point about two miles below the most northerly portage, this stream is bordered almost continuously by more or less open swamps, which are more than a mile in width in certain places, for a distance of eight or nine miles until it bends westward toward Blouin lake. In pleasing contrast is the higher and better land in the vicinity of the rapids and falls along this stream. A very large swamp surrounds the outlet of Atikamek lake, while much of its southern and western shores are margined by a thick accumulation of peat. This constitutes the only important peat-bog observed along the waterways of the district. The stream that enters La Motte lake from the southwest, about two miles southward from the approach to "the height of land portage" leading to Newagama lake, is margined for considerable distances by swamps in which black spruce and tamarack, many of which are dead, are sparsely distributed. Inland from the waterways, black spruce swamps occupy a large percentage of the surface, but many of these will be readily drained with the felling of the bush.

The rivers and streams are very sluggish, while their waters are either of a more or less milky or coffee colour because of the fine mud they carry in suspension, or of a dark appearance because of draining from swamps. A stream flowing into the southern end of Blouin lake possesses the best water observed in the district. It takes its rise from springs of clear cold water rising through solid rock about two miles farther southward. Some of the smaller streams wind in most intricate meanders. Very few streams can be found in which meanders are better developed, although the current is quite swift, than that flowing from Atikamek lake northward to its confluence with a stream from the southwest.

If travel be confined to Harricanaw waters south of the railroad, very few portages will be encountered and all of them are very short. They are restricted to the upper portions of the streams entering Blouin lake, the stream from the southwest debouching into La Motte (or Seals' Home) lake about two miles southward from the portage to Newagama lake, and one short portage on the stream flowing from Piché lake to Lemoine lake. Many of the lakes are large, but they are shallow; especially during low stages of the water, numerous shoals and treacherous rocks are to be guarded against in navigating these muddy waters.

The height of land is most disappointing. If, without previous information, one views the district from the main waterways, it is impossible to delineate its position. For the most part it is so ill-defined that frequently one may recognize its presence only by the flowing of brooks in opposing directions. The "height of land portage", 2½ miles in length, leading from La Motte (or Seals' Home) lake on the Harricanaw river westward to Newagama lake that drains into the Kinojevis river, a large tributary of the upper Ottawa, is low and swampy. The highest point on this portage is 988 feet above sea-level. Here, by a canal with a maximum depth of 25 or 30 feet where the land is highest, a considerable portion of the waters of the Harricanaw river could be diverted into the Kinojevis and thence to the Ottawa river.

Soil and Climate—

Very considerable areas within this and adjacent districts are well suited for agriculture. The clay soil is very similar to that of areas of the same latitude in the province of Ontario that are rapidly developing into small, yet flourishing farming communities. The clays are very tenacious and will require diligent cultivation before they produce the best possible results, but the fact that they are free from stones will make the task very much easier than in many other portions of the Laurentian plateau where farming is being carried on. In the vicinity of the sinuous height of land, the soil is often too sandy to be fertile, as in parts of the western portions of La Motte and Figuery townships, or southward in the vicinity of lakes Mourier and

Atikamek, where sand ridges are numerous and boulders are strewn locally in abundance upon the surface. In other places, as to the north and south of the portage across the height of land from La Motte lake to Newagama lake, the blanket of stratified clays is continuous.

In so far as could be determined, the spring opens about four weeks later than in Montreal, but after the small leaves make their appearance the rapidity of growth is remarkable. The erratic occurrence of frosts during summer months and the presence of large swampy areas are the worst features of the region from the point of view of the agriculturist. Were it not for the presence of widespread low and swampy areas, it does not seem probable that these frosts would occur. In these swamps and muskegs, the heat of the sun penetrates only to very shallow depths, and at night radiation is rapid. The swamps within this area are much more extensive and a less percentage of them can be drained than somewhat farther northward where the drainage is better. With the progressive felling of the bush, drainage and cultivation of the land, the danger to crops from summer frosts will undoubtedly be greatly reduced and finally eliminated. Even to-day heavy frosts may occur on low lands and especially in the vicinity of swampy tracts, when the higher lands and those in the vicinity of the largest lakes are quite free from their effects.

Flora and Fauna—

The principal trees are black spruce, white spruce, jackpine, white pine, balsam or fir, poplar, canoe birch, balm of Gilead and cedar. Of these the black spruce is most abundant. Frequently almost to the exclusion of other trees except the young tamarack, it occupies large swampy areas. Within these swamps, they usually range from four to ten or twelve inches in diameter. Where the ground is better drained, white spruce grows profusely with black spruce, fir, poplar and white birch. The jackpine covers sandy tracts and to some extent lives in the marginal portions of the swamps. It is a beautiful tree, growing tall and straight and free from limbs for many feet upward from the ground. From the point of view of size and number, the best growth of jackpine I have seen in the northern bush occurs in the western portion of La Motte township. On the boundary line between ranges VI and VII, jackpine occupy lots 4 to 13. On the boundary between ranges VIII and IX, they occupy from lots 1 to 13. These trees are tall and straight, and some of them are seventeen or eighteen inches in diameter. A few scattered white pine were observed in the vicinity of Kienawisik and Blouin lakes. Sixty or seventy old specimens of this tree were noticed in the midst of the second growth to the east of Atikamek lake. Inland to the east of the small lake situated at the southwest corner of the projected township of Bourlamaque, there is a grove of white pine.

Poplar frequently possesses a diameter of from 12 to 22 inches. The canoe birch was observed to attain a maximum diameter of 24 inches. The cedar is gnarled and stunted and appears in places along the margins of lakes and streams. The streams are irregularly bordered by a dense, hedge-like growth of alders, willows and red osier dogwood. Alders, Labrador tea and sheep's laurel comprise the most important members of the undergrowth, the first mentioned forming dense thickets in wet places. There is every gradation between the densely forested black spruce swamp and the open muskeg, where the trees are scattered and stunted.

Moose were frequently seen by members of our party. Either specimens or evidences of the existence of the black bear, mink, marten, ermine, otter and muskrat were also observed. With the exception of the muskrat, fur-bearing animals are scarce. Rabbits are numerous. Very few wild ducks were noticed, though they were fairly abundant along the stream flowing into La Motte (Seals' Home) lake, about two miles southward from the portage to Newagama lake. Partridge were not abundant.

Within the waterways, pike, pickerel, whitefish, suckers and chubs exist in large numbers. The Indians informed me that sturgeon are fairly plentiful, at least in Okikeska and La Motte lakes and in the river entering La Motte lake from Kienawisik lake. Mr. Bishop, resident engineer of the National Transcontinental Railway, surprised me with the information that trout exist in the upper portion of Peter Brown creek. Such being the case, it is reasonable to expect that they may be found toward the headwaters of some of the other smaller streams, both within this area and to the north of the railway.

GENERAL GEOLOGY.

The following table of formations displays in a concise manner the geological sequence recorded within the area examined:

1. QUATERNARY.—Glacial and post-glacial clays and sands: chiefly post-glacial stratified lacustrine clays.

Very great unconformity.

2. KEWEENAWAN (?).—Dykes of quartz- and olivine-diabase. Possibly dykes of diorite porphyrite to the south of Kienawisik lake should be correlated with this period of igneous intrusion.

Igneous contact.

3. LAURENTIAN.—Batholiths and stock-like intrusions of granite, syenite and granodiorite with allied dyke rocks.

Igneous contact.

4. PONTIAC GROUP.—Chiefly quartzose-biotite-schists with quartzose-biotite-hornblende and hornblende-schists.

Unconformity (?).

5. KEEWATIN.—Ancient volcanic rocks varying in composition from quartz-porphyry to basalt. Quartz porphyry types seem to preponderate. These rocks are more or less altered to hornblende-, chlorite-, biotite- and sericite-schists. They have been intruded by peridotites, hornblendites, diabase, porphyrite and quartz-porphyry, which are frequently much altered in composition and in part have been rendered schistose.

Keewatin—

The generalized statements, pertaining to Keewatin formation in the report preceding this one within this volume, apply equally well to similar rocks within the area discussed in this report. Within this district the Keewatin formation comprises a complex of igneous rocks of both extrusive and intrusive types. Ancient lava flows, varying in petrographical character from rhyolites to basalts, have been more or less altered to different varieties of schists: chlorite, sericite, actinolite and hornblende schists. These rocks have been invaded by intrusions of peridotites, hornblendites, diabase, diorite, porphyrites and quartz porphyry.

Quartz porphyry, rhyolites and andesites, usually much metamorphosed, are the most important of the volcanic rocks. Lava flows of quartz porphyry at certain points on the southern shore of La Motte lake were observed to be intersected by dykes of a quartz porphyry in which small eyes of quartz are scattered through an extremely compact and chert-like groundmass. Under the microscope this rock is found to be very fresh and to be composed of small phenocrysts of quartz within a microcrystalline groundmass of clear particles of quartz and feldspar, with a few minute grains of black iron ore and pyrite.

The most interesting Keewatin rocks within the area are the peridotites and their serpentinous equivalents. Fine grained serpentine rocks, the relations of which are obscure, occur at a few points on Kienawisik lake and at two of the three outcrops on the river leading from this lake to La Motte lake. On the eastern shore of the latter lake, and especially on the long narrow peninsula just to the west of the mouth of the river from Kienawisik lake, and upon the large island northwestward from this peninsula, they are especially well developed. Upon the other shores and upon some of the islands of this lake, partially talcose or serpentinous peridotites are exposed in numerous localities. In the eastern and central portions of La Motte township, some of the low hills are composed of this interesting group of rocks.

Upon the long peninsula which has been mentioned, the peridotite is fresh and displays great variety in petrographical character. Upon the end of this point, where it is traversed by two small veins of asbestos, the rock is quite coarsely crystalline and displays beautiful lustre-mottling or poikilitic structure. Under the microscope it was found to be composed of olivine, biotite, hornblende and augite, with particles of black iron ore and pyrite. The olivine is quite fresh, though a few individuals are traversed by cracks along which incipient serpentinization has taken place. Crystals of augite, many of which exhibit idiomorphic outline, are distributed through biotite, thus giving rise to the lustre mottling of the hand specimen. (See Plate I., B). Within short distances, the peridotite varies in degree of coarseness of grain and in mineralogical composition. These changes are responsible for the very irregular and deeply pitted surface of the weathered surfaces. In places the rock is chiefly composed of coarsely crystallized biotite; in others it is quite fine grained and is composed of augite, biotite and hornblende with a few grains of sphene, black iron ore and secondary epidote. At certain points upon the island northwestward from the end of this peninsula, the peridotitic type passes gradually into a diorite containing a small amount of plagioclase feldspar.

A small yet prominent hill on the boundary line between ranges VII of La Corne and La Motte townships is related presumably to these peridotites. Very coarsely crystalline, the rock forming this hill is composed of hornblende and biotite with a small amount of black iron ore and apatite. The intrusion of these ultra-basic rock-types does not seem to have taken place very long in advance of the granites of the type which is well developed within the northern and western portions of La Motte township and the central portion of La Corne township.

The Pontiac Group—

During the past summer a better opportunity was afforded to study this group of rocks, which has been designated the "Pontiac Group" by Dr. M. E. Wilson of the Geological Survey of Canada. These rocks were described in my report on the Kewagama lake area as possibly belonging to the Huronian, but in part as possibly Keewatin. Petrographical studies in the laboratory and the field work of the past summer make it plain that the sheared conglomerates, arkoses and the quartzose biotite schists, as well as the iron formation to the south of Newagama lake and on the winter road between Keekeek and Kewagama lakes, represent the most northern and least metamorphosed portions of a belt of sedimentary rocks which are more highly altered as the area to the southward, which is underlain by intrusive granite and granitoid gneiss, is approached. Dr. Wilson informs me that from his investigations in the vicinity of Kekeko lake, which lies west of the Kinojevis river, the schistose rocks of the Pontiac Group pass unconformably beneath the Cobalt Series.

Within the area described in this report, a few exposures of these rocks were encountered along the upper portions of the streams leading to Atikamek lake and the small lakes in the southwestern corner of Bourlamaque township. All of the outcrops of rock along the stream entering the western side of La Motte lake, about two miles southward from the long portage to Newagama lake, belong to this group. The southern and more important branch of this stream is broken by four short rapids, where these rocks are exposed, and takes its rise from two small lakes in Cadillac township which are partially surrounded by low hills composed of the typical quartzose-biotite and quartzose-hornblende-schists of the Pontiac Group, intersected by dykes and small intrusive bodies of granite. In the vicinity of the shores of Lemoine lake, which is elongated in a direction approximately at right angles to the strike of these schistose rocks, and in the neighbourhood of Piché lake, the best opportunities were afforded for a study of their character and relationships. The narrow bay, extending north of west from the northern end of Lemoine lake, and receiving the river (locally called the Thompson river) flowing from Piché lake, marks the northern boundary of these rocks in this vicinity.

Within this area, the Pontiac Group includes quartzose-biotite-, quartzose-biotite-hornblende- and quartzose-hornblende-schists. Occasionally these rocks have a gneissoid rather than a schistose appearance. In some places towards the northern portion of the belt, they are distinctly bedded, more massive beds up to nine or ten inches in thickness alternating with thin slaty bands. In some localities, as on the Thompson river, micaceous slates or phyllites are present. No bands of squeezed conglomerates, such as occur within the upper portion of this series in the area to the eastward, were observed within this district: but the outcrops examined were not so distributed as to preclude their presence.

The strike of this series of rocks varies from about S. 15° to 25° E., while the dip is either vertical or steeply inclined to the north. Dykes and small irregular bodies of granite, granodiorite, diorite and hornblendite intersect the series in many localities. Occasionally, these intrusions cause local deviations in the strike. Especially toward the northern portion of the belt, irregular stringers and lenticular bodies of smoky quartz occupy positions parallel to the schistosity. In manner of occurrence as well as in the dark colour of the quartz, these veins are similar to those traversing the quartzose-biotite schists in the vicinity of Keekeek and Wabaskus lakes to the westward

The most prevalent rock-type of the Pontiac Group is a quartzose-biotite schist, but different bands within the series are very variable in appearance, chiefly because of the relative amounts of biotite and hornblende present. In thin section under the microscope, the specimens of these rocks examined were found to be composed chiefly of quartz, biotite and hornblende with a few small grains of black iron ore and pyrite. Biotite is much more abundant than hornblende, very often being present to the exclusion of the latter. Very frequently, the biotite is characterized by the presence of dark pleochroic spots within it. Some of the bands contain grains of plagioclase and orthoclase. Within any specimen the majority of the grains of quartz (and the feldspar if present) are of about uniform size, forming a mosaic within which the parallel arrangement of the biotite and hornblende imparts the schistose appearance to the rock. Occasionally a few small crystals of tourmaline are present. A specimen of rusty paragneiss from Atikamek lake was found to consist of biotite and rounded grains of quartz with a few small garnets and particles of black iron ore. An interesting specimen of biotite schist from the most northerly of the two small lakes in the southwestern corner of Bourlamaque township was found to be composed of quite large crystals of biotite within a finely foliated matrix of quartz and hornblende with a few minute grains of black iron ore and pyrite. Within the matrix the length of the quartz particles is usually several times that of the width. The crystals of biotite are usually more or less ragged in outline, and including particles of the matrix exhibit a remarkable poikilitic structure. (See Plate I., A).

By far the majority of these rocks exhibit direct evidences of complete recrystallization, the quartz and feldspar grains displaying the characteristic pflaster structure. In certain bands toward the northern portion of the belt, rounded grains of quartz and feldspar have suffered but little from the processes of recrystallization which have given rise to biotite or hornblende. Undoubtedly for the most parts this series of schistose rocks, with a maximum width of outcrop in the southern portion of this area of three miles, are the highly metamorphosed equivalents of sandstones, arkoses and argillaceous rocks. Some of the bands rich in feldspar, or containing so much hornblende that they are appropriately called amphibolites, are of uncertain origin. Possibly they may represent highly altered volcanic tuffs.

At no point were these rocks seen in direct contact with the predominantly volcanic series of the Keewatin. Occupying a position between a large area of intrusive granite and granitoid gneiss to the south and the Keewatin volcanics to the north, and either vertical or dipping steeply to the north and apparently passing beneath the latter would suggest that they are older. Contrary to this apparent evidence. the conglomerate bands within this series of rocks to the eastward of this area were observed to contain pebbles of quartz porphyry, rhyolite, etc., similar to those of the Keewatin volcanics mingled with pebbles of granite, diorite, etc.

A narrower belt of biotite and hornblende schists crosses the Harricanaw river between Okikeska and Figuery lakes, and they also appear on a low hill just to the northeast of La Motte lake. In lithological appearance they resemble the more highly metamorphosed of those types just described. They also occupy positions adjacent to granite, as if through folding they had been brought to the surface from beneath the Keewatin volcanics during the advance of the granitic magma.

The determination of the true stratigraphical position of this great sedimentary series of rocks, as well as the recognition of intrusive bodies of granite of at least two different ages (implied by the presence of granite pebbles within bands of conglomerate in a series invaded by granite) are two problems, the solutions of which may be expected from a detailed study of this or adjacent regions.

Laurentian—

This term is applied to the granites and those rock types which plainly have been evolved from the differentiation of a granitoid magma. The hills of the northern and central parts of La Motte township, and the prominent hills of the central portion of La Corne township, are composed of granite. This type of rock occupies considerable areas in the vicinity of the outlet of Seals' Home lake, and in the neighbourhood of Piché and Mourier lakes. In many other localities, dykes and small irregular bodies of granite and allied rocks intersect all of the other rocks within the area with the exception of a few dykes of diabase and diorite porphyrite.

The prevalent type is a quartzose biotite granite frequently displaying pegmatitic characteristics. In petrographical character it is similar to the granite of Indian Peninsula in Kewagama lake, with which molybdenite and bismuthinite are associated. The granite of La Motte township forms a portion of the great batholith, on the eastern contact of which the molybdenite property of the Height of Land Mining Company at Kewagama river is situated. A description of this, the most common type of granite in the area, is given in the closing pages of this report. In many localities this granite is intersected by pegmatite dykes and quartz veins carrying white mica and occasionally a few flakes of molybdenite. Especially pegmatite-like are the white granite hills to the west of Mourier lake. At no point were these pegmatites observed to be very coarsely crystallized. Upon a small island at the southern end of Lemoine lake, Mr. Dufresne found a crystal of beryl about two inches long and an inch across in pegmatite.

Near the contacts of the batholiths, or where smaller bodies of granitoid rocks intersect either the Keewatin or the Pontiac schists, hornblende frequently becomes an important constituent. Its appearance is accompanied by the development of hornblende-granites, granodiorites, diorites and hornblendites. The granodiorites of the southeastern shore of Okikeska lake, of Sullivan's Claim on the east shore of Kienawisik lake, of the southern end of Pakitanika lake, of some of the first group of rapids on the river leading to Atikamek lake, the diorites appearing in places on the shores and islands of Piché lake, and the hornblendite of the small island near the outlet of Atikamek lake are examples of localities where these types of rock are exposed.

Keweenawan—

A few dykes of the newer diabases were observed within this area. None of those noticed were more than 150 feet in width; and where it was possible to determine their strike, they were found to assume northeasterly to southwesterly directions. In petrographical appearance they are identical with the quartz- and olivine-bearing diabases of the Kewagama lake area, which were described at length in the report of the previous year.* Typical exposures occur on a small island about three-fourths of a mile north of La Motte lake, crossing the southern boundary of lot 45, range VI, of the township of La Motte, and about two hundred yards westward from the discovery post on "Smith's vein," south of Kienawisik lake. Other smaller dykes of diabase were observed upon the claim to the eastward of Smith's, which also are situated upon the low rocky ridge to the south of this lake and east of the narrows extending to Lemoine lake.

This low ridge is also traversed by dykes of an interesting diorite porphyrite which are younger than the quartz veins cut-

* "Report on the Geology and Mineral Resources of Keekeek and Kewagama Lakes Region", by J. A. Bancroft. Mining Operations in P. Q. during 1911, pp. 178-182.

ting the Keewatin. What relation these dykes bear to those of the newer diabases could not be determined, but they receive mention here because, together with the diabases, they represent the youngest rocks within this area. A petrographical description of this porphyrite is included in a description of "Smith's Vein" upon a later page of this report. (See p. 222.)

Quaternary—

In general terms it may be stated that during the last glacial invasion of this area, the ice moved almost exactly from north to south, seldom varying more than eight degrees toward the west or east. A large proportion of the outcrops and especially those of Keewatin greenstones are smoothed and striated, while upon the southern shores of lakes and the northern sides of islands and projecting points, where outcrops are most numerous, the exposures frequently assume the form of roches mou tonnées. Especially typical of this form is a little rocky islet close to the eastern shore of the largest island in Kienawisik lake.

The stratified clays that occupy the major portion of the area are of lacustrine origin. In places, stratification of these tenacious clays is accentuated because of the alternation of reddish and grayish layers, which seldom vary more than from one-third to three-fourths of an inch in thickness. An exposure on the southern shore of La Motte lake displays fifty of these thin layers within a thickness of one foot and a half.

At places within the immediate vicinity of the height of land within this area, sandy ridges and tracts and irregular accumulations of morainic boulders are present. To the east and south of Atikamek lake, an extensive sandy tract is situated, while the islands and long points, especially toward the southern end of this lake, are chiefly composed of boulders. This suggests that here the ice-sheet was transporting more rubbish than it could push or drag across the height of land. Many of the deposits of sand along the height of land are kames modified by the waves on this the shore of englacial Ojibway lake; others are modified eskers. Excellent examples of these types are the high sandy plains and ridges of the western portions of La Motte and Figuery townships.

In the vicinity of the portage, two and a half miles long, across the height of land (988 feet above sea-level), extending from La Motte to Newagama lake, the blanket of stratified clays within this area is continuous with that of the Kewagama lake region which, extending down the Kinojevis and Ottawa rivers, is connected with that of the stratified clays of Lake Temiskaming.

This would seem to leave no doubt that, as suggested by Coleman, when through amelioration of the climate the ice-sheet was receding, at certain places the great englacial lake Algonquin,* during its maximum stages, must have extended across the height of land. When the ice withdrew from the valleys of the Ottawa and St. Lawrence, lake Algonquin was drained. Then Ojibway lake, occupying a position between the height of land and the receding ice-front, became a separate and distinct topographic feature of the late portion of the Pleistocene period. The area of Ojibway lake increased until drainage to the enlarged James bay of that time could be established.

"The development of a rejuvenated drainage system, the streams of which are characterized by long stretches of almost dead water, alternating with occasional rapids and shallow lakes, the modification of lake shores by waves and by the expansion of ice in winter, the development of widespread swamps, muskegs and less frequent peat bogs, the clothing of the surface with trees, shrubs and a heavy blanket of moss, constitute the most important events in the most recent chapter of the geological history of this as well as of that of adjacent districts."†

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* "Lake Ojibway" by A. P. Coleman, Ont. Bur. of Mines, Vol. XVIII. Part I., 1909, pp. 284-294.

Report on Min. Oper. in P. Q. during 1911, p. 183.

† "Report on the Geology and Mineral Resources of Keekeek and Kewagama Lakes Region, by J. A. Bancroft.—Report on Mining Operations in P.Q., 1911, p. 183.

ECONOMIC GEOLOGY

Prospecting—

This area is now easily accessible. The National Transcontinental Railway crosses the Harricanaw river at Amos, 141 miles eastward from Cochrane, Ont., where there are several gasoline launches that may be procured by those desiring to proceed southward in this manner to Kienawisik lake, a distance of thirty-five miles. The exposures of rock along the waterways have been carefully examined, and the more difficult task remains of systematically prospecting the interior. The heavy and widespread overburden of stratified clays, the extensive swamps and the almost universal covering of moss are the discouraging factors that greet the prospector. Comparatively few ridges or hills, where one may be certain of encountering outcrops of rock, may be seen from the waterways; yet, when traversing the bush, one is surprised to find low moss-covered hummocks of bed rock rising within some of those portions of the area where the land is lowest. Considering the discoveries of gold which have been made in the vicinity of Kienawisik lake, diligent prospectors should carefully examine every acre in this vicinity with the well-founded expectation that much better discoveries may be made. During the past summer, numerous prospectors were in the district, but by far the majority of them restricted their endeavours to the rock exposures on the rivers and lakes, soon becoming discouraged by those difficulties with which they were called upon to contend. Until no stone has been left unturned, this area offers more reasonable hopes of reward than those vast expanses of country within which no discoveries have been made. Prospecting should not be concentrated only in the immediate vicinity of Kienawisik and Blouin lakes, but should be extended to adjacent areas, especially to the eastward and westward of Kienawisik and Blouin lakes and of the narrows extending to Lemoine lake. Where schistose, the bands of rock within this portion of the area are striking S. 15° to 25° E.

At the time of our examination of the area, those discoveries of gold that had been made pertained to veins of narrow width and of such character that further expenditure of money was wisely being devoted to a search for veins of greater promise. It is to be expected that thorough prospecting will be attended by such desirable discoveries.

Gold—

During the past summer, interest centred chiefly upon three claims in the vicinity of Kienawisik lake, which were popularly known as "Sullivan's claim," "Smith's vein" and "the Benard vein." Attention was attracted to the Benard vein because of its width, and to the other two because they were the only locations in the area where native gold had been discovered within quartz veins. Since that time the Bureau of Mines in Quebec has been advised by Mr. J. W. Callinan of the discovery of a vein of quartz "four feet in width and carrying gold," upon a claim recorded in his own name and situated on the southern shore of Kienawisik lake upon the middle of the peninsula just west of the narrows leading toward Lemoine lake. Mr. Callinan displayed samples of quartz very rich in native gold which, he stated, had been taken from this vein.

The gold occurs in quartz veins, all of which contain much tourmaline, very little calcite, pyrite and a little chalcopyrite. One of the veins on Sullivan's property also carries a little galena and zinc blende. Benard's vein, as well as some of the veins on Sullivan's claim, are remarkable for the large percentage of visible black tourmaline which is present. In places some of the smaller veins on the latter property are practically pure tourmaline, specks of native gold being found occasionally within this mineral. The greater abundance of tourmaline along what were formerly planes of fracture within the quartz implies that tourmalinization continued long after the crystallization of the major part of the quartz. Within some of the veins on Sullivan's claim, a breccia composed of quartz and small altered fragments of the country rock (granodiorite) possesses a matrix of tourmaline with very little quartz.

In general, the country rock adjacent to the veins has been subjected to more or less intense metasomatic changes. The Keewatin greenstones traversed by Smith's vein are, in places, rich in tourmaline for a foot or more from the vein. The granodiorite on Sullivan's claim is usually more foliated and sheared in the immediate vicinity of the veins. The ferromagnesian minerals (probably both biotite and hornblende) have been completely altered to chlorite, which has apparently been in part replaced by calcite. The feldspar has been much altered to sericite, and in part replaced by calcite. Sphene has been almost completely changed to calcite and leucoxene. Locally, as adjacent to the vein on the hill slightly east of that vein exposed on the shore, a few large cubes of pyrite, up to two inches on the side, have been developed within the sheared granodiorite for a distance of at least two feet from the vein. Two of these cubical crystals of pyrite were assayed, yielding $33.00 per ton in gold.

As to origin, these veins are closely related to pegmatite dykes. In a sense they are intermediate between pegmatite dykes and true fissure veins. They were formed during the final stages of the cooling down of the granite that invaded this region in the form of batholiths, irregular bosses and dykes. That they originally were formed at great depth is evidenced by the geology of the region, which makes clear that they have been exposed by most profound erosion. They represent the result of prolonged exhalations of vapours and highly heated solutions attending the crystallization of the interior portions of the bodies of granite. The granodiorite (a phase of the granite) on Sullivan's property, which is traversed by a remarkable display of small quartz-tourmaline veins, some of which carry gold, contains very much less quartz than exposures of otherwise similar rocks toward the southern end of Blouin lake and in places in the vicinity of the first group of rapids on the river leading from this lake to Atikamek lake. No quartz veins of any importance were observed in those localities where quartz is an abundant constituent within the granodiorite. This suggests that during the solidification of the granodiorite on Sullivan's claim, the crystallization of the quartz was deferred somewhat, thus increasing the acidity of the still uncooled interior portions of the plutonic body of magma. In this sense the quartz veins may represent the siliceous extreme of the cooling magma, which at that time emanated from depth in the form of highly heated solutions and vapours carrying quartz, tourmaline, etc.

Sullivan's Claim—

This claim is situated on the eastern shore of Kienawisik lake, about four miles southward from its outlet. It was here that on July 11th, 1911, Messrs. J. J. Sullivan and Hertel Authier discovered gold within a quartz vein exposed upon the shore of the lake.

Upon this claim a low rocky knoll protrudes from beneath the stratified clays, descending toward the east into a swamp. The granodiorite of which this hill is composed is similar in appearance to that exposed at the southern end of Blouin lake and at the first and third portages en route to Atikamek lake; but less quartz is present in this rock, which is subject to minor variations in texture within a very small area. It usually displays a more or less definite tendency to a gneissoid structure, the crystals of feldspar occasionally appearing as small imperfectly formed augen, as if the rock originally has been porphyritic in part. A typical specimen of the rock when examined in thin section under the microscope was found to consist chiefly of chlorite and plagioclase with small amounts of quartz and orthoclase, disseminated grains of black iron ore and sphene and minute crystals of apatite and zircon. The chlorite has been derived from the alteration of probably both biotite and hornblende. A considerable amount of calcite is present, replacing chiefly some of the feldspar and chlorite. The plagioclase, which proved to be between albite and oligoclase, is altered more or less to minute flakes of sericite. The particles of sphene are partially changed to calcite and leucoxene. Very little quartz is present, occupying the interstices where it is micrographically intergrown with feldspar.

At the time of this examination, the widest vein on the property was that where the first discovery was made. This vein strikes nearly east and west, with a very steep dip toward the north. At the bottom of a shaft, about ten feet deep, which had been sunk so close to the margin of the lake that it is flooded during high water, the dip becomes very nearly vertical. It was on June 21st that the water of the lake had subsided sufficiently to permit an examination of this shaft. The vein has a maximum width of eighteen inches where it appeared from the water at that time. The shaft is about eight feet farther eastward. On the west wall of the shaft the vein is sixteen inches wide; on the east wall, six inches; but at the bottom another stringer of quartz, four inches in width, appears toward the northern face. By stripping, the vein had been exposed for 50 feet eastward from the shore, where it tapers into a crack which is black with tourmaline. Eastward from the shaft, it varies from three to ten inches in width. It is well mineralized with pyrite, a little chalcopyrite, galena and zinc blende, and a few specks of native gold. In places the quartz is dark in colour because of the abundance of tourmaline. An assay of a picked sample, showing no free gold upon its surface, which was taken from the dump, yielded $118.00 per ton in gold. An assay of fragments, representing the complete width of the vein at the bottom and on the western wall of the shaft, yielded $15.80 per ton in gold. A sample, representing the complete width of quartz on the eastern wall of and at the bottom of the shaft, returned $6.20 per ton in gold. A large sample of the country rock immediately adjacent to the vein did not yield a trace of gold.

About 250 feet southward from this vein another quartz vein, striking nearly west to east, had been exposed for a distance of about twenty-five feet, where it displayed a maximum width of ten inches. Irregular in width and tapering to a small stringer at the eastern end of the exposure, this vein contains more tourmaline than the one just described and a few specks of pyrite and chalcopyrite. The marginal portions of the vein are, in places, very nearly pure tourmaline. For a few feet the enclosing granodiorite has been brecciated in small fragments, which are now distributed through a matrix of quartz and tourmaline, the latter mineral predominating. Adjacent to the vein, the granodiorite is much sheared, and up to a distance of three feet from the vein contains a few large cubical crystals of pyrite. One of these crystals was observed to be two inches across the side. Some of them contain a little quartz irregularly disseminated through the pyrite. Two of these crystals, when assayed, returned $33.00 per ton in gold. Eastward about 200 feet and in direct line of strike with this vein, where a low bluff of granodiorite rises, a quartz vein is exposed, starting towards the top of the outcrop as a mere fracture lined with tourmaline and widening to six inches where it passes beneath the overburden. Very rich in tourmaline, a few specks of native gold were found within this vein.

In many other places the granodiorite was observed to be traversed by small veins of similar character, none of which possessed a width greater than ten inches. In most instances it was plain that they were mere stringers appearing and dying out within a few feet or yards.

Mr. Sullivan informs me that toward the southern end of the property he has since found a brecciated vein, which is apparently more important than others yet discovered. He also tells me that the vein exposed upon the shore has been found to appear at intervals along its strike for six hundred feet to the eastward.

Smith's Vein—

So designated because it was discovered by S. G. Smith, this vein is situated on a claim of 135 acres (staked under the name of N. L. Tooker), on the southern side of Kienawisik lake, to the east of the narrows leading to Lemoine lake. A good trail, starting from an open camping place at the bottom of the large bay, extends inland for about twenty chains on clay land to the northern boundary of the claim and thence to the discovery post, which is situated on the northern slope of a low ridge that is visible from the lake.

The vein traverses dark Keewatin greenstones that are partially altered to chlorite schists. Its strike N. 60° W. corresponds with that of the schistose rocks. It dips toward the south in an irregular manner, variations in dip of from 35° to 55° occurring within a few yards. Toward the east it is cut off by a small dyke of porphyrite, two and a half feet wide, which emanates from a larger dyke 35 feet in width striking N. 40° W. A few yards eastward from the vein, this large dyke terminates in an abrupt exposure, but it may be followed toward the northwest for about one hundred yards. Westward from the dyke of porphyrite, the vein extends for 73 feet, when it pinches out. Farther westward along the projected line of strike, the bed rock is obscured by overburden for 72 feet, while beyond this a barren quartz vein, with a maximum width of eight inches, extends for 30 feet.

The following remarks pertain to that portion of the quartz vein extending for 73 feet N. 60° W. from the porphyrite dyke. In width it is very irregular, varying from three to fourteen inches. Except where rusty from the weathering of sulphides of iron and copper, the quartz is milky-white and is often somewhat sugary in appearance. Irregularly distributed within the quartz are numerous grains of pyrite, a little chalcopyrite, a few specks of native gold, small needles of black tourmaline and very small amounts of calcite and epidote. For 35 feet eastward from the discovery post, which is situated 45 feet from the porphyrite dyke, the vein is better mineralized than elsewhere. Westward from this post, it is generally barren in appearance. A few specks of native gold were found within the best mineralized portion of the vein, and Smith exhibited a large fragment taken from the top of the vein within which the display of gold was spectacular. Near the surface, some of the chalcopyrite has been altered to azurite and malachite.

Very small needles of tourmaline, either isolated or in radiating aggregates, are irregularly disseminated through the quartz and were observed within the Keewatin greenstones up to a distance of slightly more than a foot from the vein. Within this vein the needles of tourmaline or, very much less frequently, a little pale yellowish-green epidote, are more abundant in narrow seams, within the quartz, that may correspond to the position of cracks within the quartz during the latter stages of the formation of the vein. Within the quartz, a few small cavities are present, into which small crystals of quartz protrude.

In addition to stripping, a few blasts had been discharged along the eastern portion of the vein. A comprehensive sample, composed of small fragments taken across the vein at intervals of every two feet, yielded twenty cents per ton in gold. Samples similarly taken along the best mineralized portion of the vein yielded $1.20 per ton in gold. The last result was disappointing, for it is certain that samples may be selected from here which will return a high assay for gold.

The diorite porphyrite of the dyke which cuts off this vein is characterized by the presence of well-formed crystals of feldspar up to one-fourth of an inch across, which with small irregular crystals of hornblende are abundantly disseminated through a fine-grained groundmass. The feldspar crystals display beautiful zonal structures upon weathered surfaces. Under the microscope, the rock is found to consist of these phenocrysts of plagioclase and hornblende scattered through a groundmass of minute clear particles of feldspar, with a very small amount of quartz and a few small crystals of apatite. Calcite, epidote and chlorite, in small quantities, are present as secondary minerals.

Benard's Vein—

On the eastern shore of Kienawisik lake, about two miles southward from the outlet, a large vein of quartz is partially exposed. More exactly, it is situated on the eastern side of a small point which marks the entrance from the north to the large bay opposite the northern portion of the largest island on the lake. It is popularly known by the prospectors as "Benard's Vein." Appearing from beneath a heavy bank of stratified clays, the outcrop is so low that it is covered during a period of high water. At the time of our visit, the southern wall of the vein was exposed and 19 feet in width of quartz. In so far as could be determined, the vein is vertical, striking S. 80° E. A trench had been dug which, so the writer was informed by Mr. S. G. Smith, proved that the vein has a width of 54 feet. Unfortunately, during high water the waves had filled up this excavation.

The rock which forms the southern wall of this vein is massive, light gray, white or reddish, fresh in appearance and possesses a texture similar to that of a medium grained granite. To the naked eye this rock is composed of feldspar, containing a very large percentage of small but usually perfect cubical crystals of pyrite. In thin section under the microscope, it is found to be essentially a pure albite rock, and hence is appropriately called a syenite. A very small amount of quartz, numerous little prismatic crystals of rutile, small crystals of pyrite in the form of cubes, some tiny crystals of zircon and apatite are present as accessory minerals. Some calcite and a few minute flakes of sericite occupy the position of secondary minerals. The albite displays beautiful twinning according to albite, pericline and Carlsbad laws and, although quite fresh, contains an abundance of very minute inclusions of sericite and rutile and others too small to be determined.

The rutile assumes the form of minute prisms, which occur separately or gathered together in sagenite webs. They are very closely congregated within diamond-shaped outlines, which have the exact forms that sphene habitually exhibits in sections. So frequent are these outlines that it is certain they were occupied formerly by crystals of sphene, the contents of which became partially absorbed or re-arranged so that rutile developed prior to or contemporaneous with the crystallization of the feldspar. (See Plate I., C). They are now included within individuals of plagioclase, the twinning planes of which are continuous across those spaces within these outlines that are not occupied by the rutile. This would seem to show that the partial absorption of the sphene and the development of rutile took place prior to the crystallization of the plagioclase. Very little quartz is present, this mineral occupying a few of the interstitial spaces where it is micrographically intergrown with the feldspar. The quartz contains many liquid inclusions in extremely minute cavities. Within a large number of these inclusions, minute bubbles of gas are present.

The abundant small cubical crystals of pyrite within this rock are exceptionally brassy or yellowish in appearance. An assay of a fragment of the white fresh rock with a uniform sprinkling of pyrite revealed the presence of $1.40 per ton in gold. Plainly, the pyrite is auriferous.

The quartz in the vein is penetrated by myriads of visible needles of black tourmaline. Ordinarily milky-white in colour, the quartz is frequently dark because of the abundance of tourmaline. The largest needles of tourmaline observed were one-sixteenth of an inch across and three or four inches in length. They penetrate the quartz in every direction, often in radiating groups, or are so numerous and irregularly distributed that occasionally they form closely matted aggregates. Minute prismatic crystals of tourmaline also line small cracks within the quartz, indicating that the crystallization of the tourmaline continued after as well as during the crystallization of the quartz.

Some of the quartz contains a small amount of an iron-bearing carbonate of a faint yellowish colour. Very sparsely and irregularly distributed are disseminated grains of pyrite, while very rarely a few specks of chalcopyrite are present.

In thin section under the microscope, the quartz is found to contain abundant minute liquid inclusions frequently containing bubbles of gas. Strain shadows and cataclastic structure displayed may imply that the quartz was subjected to subsequent pressure, or probably these characteristics were imposed by the original great pressure under which this vein was formed.

A sample of the vein, containing all of its component minerals and especially rich in pyrite, yielded a mere trace of gold. This result, when compared with that of the assay of the wall rock, arouses the suspicion that the sulphides in the latter may be a primary constituent.

About 50 or 60 feet southward from this vein on the end of the point is another exposure of the albite-syenite, eight feet in width, traversed by a large number of small quartz veins, their total width being about four feet. S. G. Smith informed me that at low water they may be seen to come together, forming a vein eight feet wide. In every respect they are similar to the larger vein that has been described in detail.

L. J. Martin's Claim—

Some stripping had been done upon this claim of 200 acres which is situated a little more than a mile south of Blouin lake. A few irregular veins of quartz have been exposed, some of which carry a little iron-bearing carbonate, a little pyrite and a few specks of chalcopyrite. Near the southeastern corner of the claim an irregular quartz vein, with a maximum width of 15 inches and at one point breaking up into a series of small stringers for a distance of five feet, has been followed for 45 feet. An assay of the most promising quartz within this vein showed the absence of gold.

Near the northwestern corner of the claim a vertical vein, striking N. 70° W. and traversing Keewatin schists, has a maximum width of 18 inches. In reality, as is the case with the majority of veins within this area, this vein is a series of small lenticular bodies of quartz connected by quartz stringers. A sample of the best appearing quartz from this vein yielded forty cents per ton in gold.

Claims on Lake Lemoine—

On the narrows extending toward Lemoine lake, about two miles south of Kienawisik lake, one encounters the northern boundary of that band of metamorphosed sedimentary rocks, the Pontiac schists, which, during the previous summer, were traced from the Kinojevis river below Routhier lake and eastward toward the iron range south of Newagama lake. Here the series consists of very quartzose biotite schists, occupying a vertical position with a general strike of S. 20° to 25° E. No bands of conglomerate, such as characterize this series to the westward, were observed to be present within this area, but since the outcrops studied were not continuous across the series, such bands may be present.

These schists are traversed by stringers and small lenticular bodies of dark bluish or smoky quartz, which trend in a direction parallel to the strike. In tracing them along the strike, they usually terminate within a few feet or yards, others frequently appearing along their projected line of strike. In some localities zones of the schists of irregular width are characterized by the presence of a large number of parallel veins of this type. In habit and in the colour of the quartz, they are the same as those which recently attracted considerable attention in the vicinity of Keekeek lake to the westward, where it was found that veins of type are as irregular with depth as along the strike. Undoubtedly, these quartz veins were formed at the time when these sedimentary rocks were rendered schistose.

Along this band of rocks within this area, a considerable number of claims have been staked for gold. A description will be given of a few claims of this type upon which work was in progress at the time of our examination of this area.

J. Leclaire's Claim—

The long narrow arm of Lemoine lake extending to the north-westward and forming part of the route to Piché lake marks the northern boundary of the quartzose biotite schists. About a mile within this narrow bay and about thirty chains inland from the southern shore, Leclaire's claim is situated. Here, though much metamorphosed, these rocks display a distinctly sedimentary appearance, being arranged in bands, usually from two to four inches wide, separated by thin laminae. Where stripping work was being performed, a lens of smoky quartz, four feet in length and with a maximum width of three feet, had been exposed. This eye-like mass of quartz tapered off, on one end only, into a small stringer which terminated within a foot from the lens. Numerous other small parallel stringers of similar quartz traverse the schists at this locality. Other portions of this claim, where similar work had been done, were visited. The largest individual vein of quartz observed was about two feet wide for a distance of twelve feet, rapidly becoming narrower at either end and finally pinching out. The marginal portions of the quartz veins frequently contain a little biotite. Within the quartz a small amount of iron-bearing carbonate is frequently present which, upon weathering, leaves small rusty cavities in the quartz. In the schists adjacent to the veins, as well as within the quartz, small specks of pyrite are occasionally present. An assay of a fragment of the quartz containing a little iron-bearing carbonate and a few specks of pyrite did not yield a trace of gold. Panning for gold at a point where it was claimed "a few colours had been found" was equally unsuccessful.

Authier's Claim—

This claim is situated on the eastern shore and at the northern end of Lemoine lake, immediately south of the narrow arm on the west side of the lake which receives a river from Piché lake. Here a large exposure of these metamorphosed sedimentary rocks rises quite steeply from the shore and is traversed by a large number of veins of the dark smoky quartz. Within this exposure the parallel lenticular veins and stringers of dark smoky quartz are more numerous and some of the lenses larger than was elsewhere observed among the veins of this type. Some of the irregular lenses of quartz have a width of slightly more than three feet, but along the strike all of them diminish in width and pinch out, while at intervals farther along veins of similar character make their appearance. Much stripping and some blasting has been done here; sufficient to demonstrate that the veins are as irregular with depth as they are along the strike. In places, the quartz contains a little iron-bearing carbonate, but one must search diligently to find specks of pyrite. An assay of the best specimens of the quartz that could be collected did not yield a trace of gold. Panning of the debris on the surface revealed the presence of as high as eight "colours" to the pan, but it was peculiar that the distribution of "colours" was restricted to that debris which had been disturbed during the progress of prospecting operations.

Mr. Authier informed me that on the western shore of this lake and almost directly opposite to his claim, similar quartz veins contain a little galena. He displayed some nice specimens of the characteristic smoky quartz containing disseminated galena, but stated that at the time the exposure from which they were taken was covered by the high water of the lake.

Asbestos—

About three-fourths of a mile due north of the entrance of the waters from Lemoine lake into Kienawisik lake, a small island is situated which is composed of altered peridotite. At a point on the western shore and near the southern end of this island, two or three gash veins of stiff-fibred asbestos traverse the serpentinized peridotite.

On the western band of the river joining Kienawisik and La

Motte lakes, about two miles and a half from its mouth, serpentine is intersected by a few minute veinlets of similar asbestos.

The long narrow peninsula on the southern shore of La Motte lake, immediately west of the mouth of the river entering from Kienawisik lake, is composed of peridotite and pyroxenite rock types that have been described briefly upon a preceding page of this report. Upon the end of the peninsula, quite coarsely crystallized peridotite is traversed by two gash veins of silky slip-fibre asbestos, one of which is only two to three feet in length and the other passes into the water. The maximum width of these veins is about an inch. The peridotite is here remarkably fresh, except immediately adjacent to these veins, where it is altered partially to serpentine. Minute veinlets of the width of a knife blade to one-sixteenth of an inch in width extend from the vein for a few inches into the walls.

None of these occurrences are of economic value, but the fact that serpentinous rocks are present within this area and that they carry a little asbestos should be an incentive to those engaged in prospecting this region to examine these rocks somewhat closely in the hope that valuable deposits of asbestos may be found. Diamonds, platinum and chromite are known to be associated with rocks of the peridotite family in some parts of the world. No evidences of the presence of these minerals were observed within this area.

Molybdenite—

The same granite as that which is associated with the deposits of molybdenite and bismuthinite in the vicinity of Kewagama lake and Kewagama river to the westward appears within many portions of this area. It occupies the most western and the northern portions of the township of La Motte, forms the rugged hills in the central portion of La Corne township, outcrops upon a small island near the outlet of Okikeska lake and upon some of the small islands near the central portion of La Motte (or Seals' Home) lake. It is probably the same phase of the granite that displays such striking pegmatitic tendencies in the vicinity of Mourier lake.

It may be well to repeat a portion of the description of the typical granite with which the molybdenite occurs, that was given in my report of the preceding year. This granite "is usually light grey or white in colour, occasionally assuming a slightly reddish hue." In the hand specimens much quartz, feldspar, biotite and muscovite are discernible, either one of the micas sometimes occurring to the exclusion of the other. Frequently, small reddish garnets, seldom larger than the head of a pin, are more or less abundantly scattered among the other constituents. In some cases, the normal granite passes gradually into coarse grained pegmatite on the one hand and fine grained aplite on the other. In rare cases, in the neighbourhood of its contacts, the granite displays a faint gneissoid structure, or a tendency towards a porphyritic structure in which the phenocrysts are feldspar.

A careful examination of this granite in one locality will lead to its easy recognition in other places. This fact is of importance to the prospector, because of the frequency with which molybdenite occurs within quartz veins and aplitic dikelets that traverse this granite in very many localities. The quartz in the veins is usually of a faint rose tint and frequently is accompanied by a pale greenish-white mica. Where it is possible to do so, the contacts of the intrusive bodies of granite of this type should be carefully examined in the hope that valuable deposits of molybdenite may be discovered. Mr. C. H. Richmond, of the Height of Land Mining Company on Kewagama river, informed me that near the contact of the granite with biotite-schist in the western portion of La Motte township, he found a large boulder of granite traversed by a quartz vein, from which he collected very large crystals of molybdenite. He was unsuccessful in his attempt to locate the source of this boulder. Both the areas of granite in the western and northwestern portions of La Motte and the central part of La Corne townships are traversed by veins of quartz which are identical with those of the Kewagama lake region.

In miniature, the small islet near the outlet of Okikeska lake displays the same geological relations as those of Indian peninsula in Kewagama lake. It is composed of biotite-muscovite granite, faintly gneissoid as in certain localities near the contact between the granite and schists. Though small, the exposure is traversed by numerous rose tinted quartz veins, containing a little white mica. Upon the southern shore, the largest vein is 16 inches wide; while another, 4 inches in width, was observed to contain a few flakes of molybdenite. At another point the granite is aplitic and a few specks of molybdenite were found within it. On the northern side of the island an irregular vein of similar quartz with a maximum width of 4 feet, which extends into the water of the lake, contains a little molybdenite.

On the southern shore of Okikeska lake, in the bottom of the first little bay to the eastward of where the Harricanaw river enters, Keewatin greenstone is cut by a dikelet of aplite, about two inches wide, which, occupying an approximately horizontal position, contains numerous small flakes of molybdenite.

A little island, near the central portion of La Motte (or Seals' Home) lake and northwestward from the large dumb-bell shaped island, is composed of this granite intersected by numerous quartz veins of similar character, within one of which a few small flakes of molybdenite were found.

On the west side of Kienawisik river, about half a mile from its mouth, there is a low knoll of biotite-hornblende schists rising to 20 or 25 feet near the river. Upon the surface of this knoll is a large boulder of biotite-schist traversed by a vein of rose quartz containing numerous flakes of molybdenite. Undoubtedly it has been glacially transported from the vicinity of some contact of this granite with the schist.

None of the above-described occurrences of molybdenite are of economic importance; yet they serve to emphasize the widespread occurrence of this mineral within this region in close association with a definite phase of the granites traversed by definite types of quartz veins of pegmatitic origin.

Sweezy's Claim, St. Maurice Syndicate, Indian Peninsula, Kewagama Lake—

Receiving information that a group of men, under the direction of Mr. R. O. Sweezy, were working upon the molybdenite claims of the St. Maurice Syndicate on the northern portion of Indian peninsula in Kewagama lake, these claims were visited and a morning we devoted chiefly to an examination of the work which had been performed since my examination of these properties in the previous summer.

The following quotations are taken from the report* of the previous year:—

"These claims are situated on the northern slopes of Burnt mountain, on the western side of this peninsula, where a wide-spread area of granite (of the type above described) is traversed by a remarkable display of these quartz veins. From a few inches to 12 feet in width, these veins strike in a general north-westerly direction and the majority of them dip steeply toward the northeast. The contact between the granite and Keewatin schists crosses the northeastern corner of the Sweezy claim, and thence, in an irregular curve, convex toward the north across the Huestis claim."

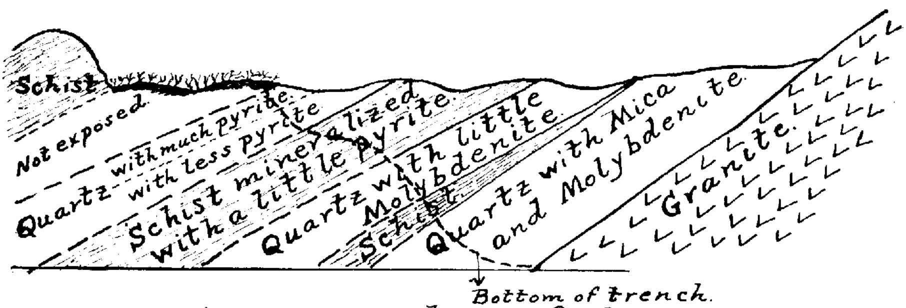
"The vast majority of the veins displayed upon these claims are barren: some contain a few flakes, others rich streaks and pockets of molybdenite, and occasionally a little bismuthinite. In the surface of a large number of veins, a few blasts have been discharged, which in general reveal no characteristics different from those which may be gathered from tracing the veins along the strike. In following them, molybdenite may suddenly appear as irregularly disseminated flakes, being more abundant where mica is present. Those veins within one hundred yards from the contact with the schists are usually better mineralized than those farther removed. The veins on top of the mountain seldom contain these minerals. Of the deposits here known at the present time, the best are upon the Sweezy claim.

"A few yards from the eastern boundary of this claim, at a point about 350 yards north of S. G. Smith's post No. 4, an outcrop of schists striking N. 64° W. and dipping about 30° toward the northeast is situated about ten yards from the margin of the exposed granite. The intervening space, within which

*For a more complete description of the manner in which the molybdenite and bismuthinite occur within this region, the reader is referred to "Report on the Geology and Mineral Resources of Keekeek and Kewagama Lakes Region, Mining Operations in P. Q.", 1911, pp. 186-201.

the contact lies, is covered with soil and bracken, with the exception of an outcrop of almost massive pyrite with a little quartz that occupies a space about three feet square...... The exposure of granite is faced by quartz carrying much muscovite and small amounts of feldspar, pyrite and molybdenite."

It was at this point that most of the recent work had been done prior to my visit on June 25th. A trench had been dug to a maximum depth of fifteen feet, extending from the exposure of pyrite to the granite. The following rough section displays the relations exposed by this trench:—



Scale 1 inch = 15 feet

Adjacent to the granite is a body of quartz, eight feet in width, which is comparatively rich in molybdenite. By the pressure to which the quartz has been subjected, shearing planes have developed parallel to the periphery of the batholith. White mica appears along these planes as streaks within the quartz, some of which have a width of several inches. The molybdenite is associated chiefly with the mica. Along some of these planes, the molybdenite has been smeared out like paste during the minor adjustments that have taken place consequent to the pressure. Mr. R. O. Sweezy informed me that an assay of an average sample collected from this mass of quartz within the trench by Dr. T. L. Walker of the University of Toronto, yielded 6.4 per cent of molybdenite. It is the best showing of molybdenite upon the property, yet if it be followed along the contact by trenching it will be found to be a body of quartz of very variable width in which the molybdenite values are very irregularly distributed.

In passing outward from the granite in the trench, this body of quartz is separated by a narrow band of schist, with a maximum width of two feet, from a quartz vein four feet in width, within which the flakes of molybdenite are widely scattered. There then follows a band of schist about five feet in width, containing disseminated grains of pyrite. Beyond this is a vein or mass of quartz containing much pyrite and a few minute flakes of molybdenite.

At a point on this claim, approximately 300 yards and 400 feet from its eastern and northern boundaries respectively, a body of quartz, of which twenty-two feet in width of outcrop was exposed by stripping, is on its northern side, in contact with Keewatin schists dipping 15° to 20° toward the north, and to the south passes beneath a heavy overburden of black soil and boulders. The nearest exposure of granite lies about forty yards to the southward. Upon the southern side of this mass of quartz, five feet in width of outcrop contains a high percentage of pyrite. In part, this portion is solid pyrite of granular character. The size of this deposit has not as yet been determined.

In last year's report the following statement was made :—"Of the other veins upon these claims, the most promising seemed to be the one on the Sweezy claim, near to its northern boundary, where during the latter part of August and the beginning of September, a group of men were engaged in sinking a shaft. The vein of quartz was about four feet wide, but the values in molybdenite were more or less concentrated along a zone ranging up to eight inches wide." This shaft had been sunk to a depth of twenty feet. The vein is dipping steeply toward the south and the eight inch zone on the footwall containing molybdenite proved to be irregular, having a maximum width of fifteen inches. A small amount of molybdenite is very irregularly disseminated through the quartz along the hanging wall.

Other development work in progress pertained to proving the continuity of some of the large quartz veins that traverse the granite. Work continued until the beginning of September, and since that time Mr. Sweezy has written :—"One of these veins was traced for 2,000 feet without a break, while indications leave no doubt as to its length being at least 2,600 feet. Several veins have been traced for 500 feet in length."*

With depth the molybdenite content of these veins may be expected to be as irregular as they are within a foot of the present surface, where erosion has truncated them at very different depths. There is usually a tendency for the molybdenite to be concentrated with the mica near the walls of the veins. Mica is absent from many of the veins, and in the remainder is very irregularly distributed. The same is true of the molybdenite. In tracing a vein, if molybdenite is present it will appear as irregularly disseminated flakes, frequently concentrated near the borders of the vein for a certain distance, only to be followed by a distance, usually very much greater, within which no molybdenite is present. Those veins near the contact of the granite batholith contain more molybdenite than others.

* Can. Min. Journal, Mar. 15th, 1913, pp. 190-191.

ALPHABETICAL INDEX