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REPORT OF
THE BUREAU OF MINES
1902

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To His Honor the Honorable Sir Oliver Mowat, G.C.M.G.,

Lieutenant-Governor of the Province of Ontario.

Sir :

I have the honor to transmit herewith, for presentation to the Legislative Assembly, the Eleventh Report of the Bureau of Mines.

I have the honor to be, Sir,

Your obedient servant,

E. J. DAVIS,

Commissioner of Crown Lands.

Department of Crown Lands,
Toronto, 4th March, 1902.

To the Honorable E. J. Davis,
Commissioner of Crown Lands :
Sir,—

I beg to hand you herewith, to be presented to His Honor the Lieutenant-Governor, the Eleventh Report of the Bureau of Mines.

The Reports of the Bureau, though presented annually and dealing in the main with the work of the year immediately preceding that of publication, are not confined to the events of the twelve months, but aim to chronicle the progress of the mining industry in the Province up to the actual time of issue. This will explain the references in the present Report to dates subsequent to the close of 1901. The statistics of mineral production, however, are for the calendar year ; but those relating to metalliferous products for the first quarter of 1902, having been collected while the Report was in press, are also given below.

In the language of the Act of the Legislature creating the Bureau of Mines (54 Victoria, chapter 8) the Bureau was established "to aid in promoting the mining interests of the Province," and its resources have been steadily directed towards the furtherance of the object for which it was designed. No formal plan of operations was outlined for the Bureau by the Legislature, which left means and methods to the discretion of the head of the Department and of the Bureau for the time being ; but the effort has been to make the work of the Bureau as practical and as useful for economic ends as possible.

Doubtless the Bureau's principal function is the collection and publication of information which will be of service to those actually engaged in the business of mining as prospectors, miners or mine owners, as well as to promoters and capitalists looking for opportunities of interesting and investing money in the development of the Province's mineral resources. Such information embraces a very wide range of subjects, but at its foundation lies a knowledge of the geology and mineralogy of the Province, without which any attempt to exploit and develop the mineral wealth of the country would be mere groping in the dark. This knowledge can only be obtained at first hand by actual work in the field, and as a matter of fact there is much of the geology of the Province which is yet unknown or known only in the most general way. The Geological Survey of Canada has the whole of the Dominion under its care, and though probably a fair share of attention has been devoted to Ontario, there are yet extensive districts in the Province whose rock formations have not been studied even in the most superficial manner. The surveying expeditions sent into northern Ontario in 1900 by the Government of the Province made us somewhat more familiar with the outcropping rocks north of the Canadian Pacific Railway, but from the nature of things the expeditions returned with much more information respecting the timber and agricultural capabilities of the soil than of the geology of the region, or of the existence of valuable minerals. Indeed, in the limited time at the disposal of the parties it was not to be expected that search for mineral deposits could be made.

Nevertheless, the labors of the Geological Survey and the Bureau of Mines have resulted in accumulating a considerable body of useful knowledge respecting the geological phenomena of the more readily accessible portions of the Province, and in various districts the way has been cleared for more detailed examination and the tracing out of mineral-bearing formations or known mineral belts. A number of such districts have been visited and explored by competent geologists on behalf of the Bureau ; characteristic occurrences of ore have been studied and described ; geological and mineralogical conditions favorable to the existence of ore bodies have been carefully noted ; geologically colored maps of mineral regions have been prepared and published, and much other information acquired of a kind likely to aid the prospector in his search for mineral veins or deposits or in other ways calculated to be of use to the mining industry, especially in its early stages. The results of these labors have been given to the public from year to year in the Reports of the Bureau; for which there has been a steady and active demand, not only in Ontario, but throughout the whole of Canada, from Great Britain, and from the United States and other foreign countries. These Reports, too, have given the yearly statistics of the mineral output of the Province, by means of which the development of the industry or of any branch of it can be traced. For several years past, figures showing the quarterly output of the metalliferous mines and works of the Province have also, in accordance with the Mines Act, been collected and given to the public.

The field of the Bureau's operations is very far from being exhausted ; on the contrary, opportunities to extend its work increase and multiply with the general development of the Province. The opening up of new or northern Ontario is a question deeply occupying the public mind, and the settling upon the waste lands of the Crown of a hardy and productive population is a prime necessity if Ontario is to keep in step with the progress of the continent or maintain her pre-eminence among the confederated Provinces of the Dominion. That there is great mineral wealth in the northern and western portions of newer Ontario can no longer be doubted, and upon its utilization in the near future must to some extent depend the speedy development of those districts, especially where the land is not well adapted for agriculture.

But it is not in newer Ontario only that there is scope for the best energies of the Bureau. The palæozoic rocks of the southwestern peninsula differ greatly from the Huronian formations of the north and northwest portions of the Province in the character of the economic minerals which they contain ; but the petroleum and gas wells, the salt and gypsum beds, the limestone and sandstone quarries afforded by the Silurian and Devonian formations of settled Ontario, as well as the beds of marl and clay, the banks of sand and gravel, and the peat bogs overlying them, are not less important and useful in their way than are the iron, copper, nickel, gold and silver found in the older rocks of the east, north and west. More or less data with regard to the non-metallic deposits of the palæozoic formations exists in the Reports of the Geological Survey, of the Bureau itself and elsewhere, but it is fragmentary and scattered through many volumes and hence is difficult of access to the ordinary inquirer. There is need for an overhauling of the information already on record as well as of fresh investigations in the field, the amount of original work done since the days of Logan, Murray and Hunt, now about forty years ago, having been but small.

Take for example, the clay deposits of older Ontario, leaving out of sight for the moment altogether the clays of newer Ontario, which are important, but little known. As the raw material for common, pressed and paving brick, for drain tiles and sewer pipe, for terra cotta and pottery, as an ingredient in the manufacture of Portland cement, and for many other uses, clay is an article of prime utility. In Ontario it is abundant in a variety of forms and in several geological formations. There are the Saugeen and Erie clays described by Logan, as well as countless other areas and pockets in the drift of great aggregate extent, and in addition there are the indurated shales of the Hudson River, Medina and other formations, some of which as in the neighborhood of Toronto, at Milton and elsewhere, are now being used for making pressed brick and terra cotta of a high grade of excellence. These shale deposits are of great thickness and constitute reserves which can be drawn upon for ages to come in the manufacture of structural materials. But notwithstanding the undoubtedly rich resources which the Province possesses in the matter of clay, there is a lack of systematic or classified information bearing upon the origin of the deposits, their composition or their utilization for economic purposes. The collection of data of this kind has been made a feature by the authorities of several of the States of the Union, to the decided advantage of industries using clay as raw material.

Similarly, there is need for particular information respecting the limestones of the Province. In limestone, as in clay, Ontario is singularly rich, there being few districts of any extent in the older portions of the Province where outcrops of limestone are not found. It is everywhere burned for lime, and where of suitable quality is extensively quarried for building and construction purposes or in the manufacture of rock cement, but new uses for limestone are being found, as for instance in making calcium carbide, in the refining of beet sugar, in the manufacture of sulphite wood pulp, and in other ways. These various uses require limestone of appropriate composition, certain constituents being necessary in some cases and detrimental in others. To locate and describe the available deposits of limestone in Ontario, to determine the purposes for which they are severally adapted, and to ascertain something of their commercial value as the bases of actual industries, is work which will involve much geological and chemical investigation, yet it is work which if properly performed will be of material benefit in the industrial development of the Province.

Again, the cement industry is one which is expanding with more than ordinary rapidity. Cement is being used for a variety of purposes to which not long ago no one thought of applying it, and in the construction of street foundations, granolithic pavements, etc., there is a large and increasing demand. Notwithstanding the abundance of the raw materials from which Portland cement is made. and the increased production in Ontario during the past two or three years, much foreign cement is being imported into the country, particularly from the United States, and there seems no good reason why the great bulk of the product consumed in Ontario should not be of home manufacture. It would probably conduce to this end if a careful examination of the marl beds of the Province were made, typical deposits analyzed and all useful information brought together as to processes of manufacture, uses for product, etc.

It is unnecessary to further recapitulate the advantages which a careful and intelligent examination of the mineral resources of older Ontario might be expected to yield to the public interest. The need for such work is great, and it is only because the resources at the Bureau's command in men and money have been limited, and because the necessity of exploring the iron, copper, nickel and gold regions of the Province seemed to be still more urgent, that more of it has not been done. To effectually carry out such an examination will require time, money and skill, but in the opinion of the undersigned the importance of the objects aimed at will amply justify any reasonable outlay.

Many inquiries were received at the Bureau during the past year respecting minerals of various kinds, both from parties desirous of purchasing supplies of such minerals or lands containing them, and from owners of deposits or lands wishing to effect sales. These inquiries covered a long list. As might be expected from the activity in the iron and steel trade, iron ore lands have been specially in demand, and numerous applications were received, especially from the United States, for particulars as to developed or partially developed iron ore deposits. Nickel ore and matte, and nickel and copper lands have also been inquired for by many correspondents; gold and silver locations to a smaller extent, while deposits of iron and copper pyrites, mica, felspar, baryta, talc, asbestos, gypsum, zinc ore, marl (for cement), graphite, corundum, limestone, granite, lepidolite, molybdenite, platinum, manganese and peat have been the subject of correspondence with a varying number of persons. Wherever possible the Bureau has put purchaser and seller in touch with each other, leaving them to make their own bargain.

The position of Inspector of Mines for Eastern Ontario held by Prof. Courtenay DeKalb of the Kingston School of Mining, was rendered vacant by Prof. DeKalb's resignation in August, 1901. It seemed advisable to place the inspection of mines in both eastern and western Ontario in the hands of one official with headquarters at Toronto, and an appointment to the vacant position was delayed until such an arrangement could be brought about.* Meantime Mr. W. E. H. Carter, Secretary of the Bureau, has efficiently performed the work of mine inspection, and his report is submitted herewith.

Prof. A. P. Coleman has as usual carried on geological explorations on behalf of the Bureau during the season for field work. Last year he was engaged on the Iron Ranges of Northwestern Ontario, and his report thereon is printed herewith. Dr. Coleman devoted a good deal of attention to the geology and mineralogy of the Helen mine and neighborhood, it being considered that a somewhat minute investigation of this deposit, which is the most important body of iron ore yet uncovered in the Province, would tend to throw light upon the probability of similar bodies occurring elsewhere. In this work he had the advantage of the co-operation of Prof.

*On 1st May, 1902, Mr. Willet G. Miller, professor of geology and petrography in the School of Mining, Kingston, was appointed Provincial Geologist and Inspector of Mines. His duties will include the work of geological exploration in old and new Ontario as well as inspection of the working mines. Prof. Miller has for some years already been connected with the Bureau in the capacity of geologist during the summer months, and has a wide acquaintance with the economic geology of the Province, particularly of the eastern and northeastern portions.

A. B. Willmott, formerly of McMaster University, Toronto, and also of the Bureau of Mines, but now Superintendent of Mineral Explorations for the Clergue interests at Sault Ste. Marie; and the report on the geology of the Michipicoton Iron Region and accompanying map is the joint work of these two gentlemen.

In addition, Prof. Coleman contributes a study of the Syenites of Port Coldwell, a highly interesting class of rocks, some of which are likely to prove of value for structural and decorative purposes; as well as notes on the Sturgeon Lake and other gold districts of western Ontario, the limestones of Port Colborne and neighborhood used in making natural rock cement, and the pleistocene geology of the regions in which he was engaged last year.

The important metallurgical and mineral industries established at Sault Ste. Marie by the Clergue companies are fully described by Prof. A. B. Willmott.

The season for field work last year was spent by Prof. Miller partly in an examination of the Eastern Ontario Gold Belt, and partly in pursuing the investigation of the mineral resources of Nipissing district between lake Temiscaming and the Height of Land begun by him in 1900. The results of his work in both these areas are given in the present volume accompanied by geologically colored maps.

Mr. J. Walter Wells, who is in charge of the Provincial Assay Office, Belleville, reports on the work of the office for the year, and has also written a paper on Arsenic in Ontario, containing much information on the mispickel deposits of the Province and the industry growing up for the production of white arsenic therefrom which promises to be one of importance.

Summer mining classes for the benefit of prospectors, miners and others were carried on under the Bureau's auspices by Dr. W. L. Goodwin, Director of the School of Mining, Kingston, and Mr. M. B. Weekes of the School of Practical Science, Toronto. Dr. Goodwin's report on the season's work will be read with interest.

The exhibit ot Ontario minerals at the Pan-American Exposition held at Buffalo, N.Y., last year, is described by Mr. Frank N. Speller, superintendent of the exhibit; and Rev. Thomas Nattress of Amherstburg supplies a brief description of the Corniferous rocks as exposed in the quarries of Anderdon township, Essex county. Mr. Nattress' example is worthy of imitation by other geologists throughout the Province, who by working out in detail the geology of the localities in which they live, might materially widen the existing store of information regarding the rock formations of the Province.

It was intended to publish in this volume an account of the Peat Industry of the Province, giving with some particularity the results hitherto achieved in utilizing peat for fuel purposes, as compressed peat and in the form of gas, but the retirement of Prof. DeKalb, in whose hands the matter was placed, from the Bureau's service, has delayed publication of the report.

The output of the metalliferous mines and works of the Province during the first three months of 1902 is given in the following table, together with the figures for the corresponding period of 1901 for the sake of comparison.

Substance.		1902 First 3 months.	1901 First 3 months.
Gold :			
Ore treated	tons.	18,238	10,174
Gold product	ounces.	4,485	3,150
Value of gold	$	77,068	54,520
Silver :			
Silver product	ounces.	35,000	20,077
Value	$	17,000	12,046
Nickel-Copper :			
Ore raised	tons.	99,990	72,036
Ore smelted	"	61,049	36,706
Nickel in matte product	"	1,485	903
Copper " "	"	1,280	840
Value of Nickel	$	546,356	190,858
Value of Copper	"	191,170	75,625
Copper :			
Ore raised	tons.	4,640	
Concentrates produced	"	120	
Value of concentrates	$	6,000	
Iron :			
Ore raised	tons.	5,207	36,503
Value	$	8,753	44,106
Ontario ores smelted	tons.	21,991	21,083
Foreign "	"	32,869	27,580
Mill cinder, etc., smelted	"	5,149	3,486
Pig iron product	"	28,459	28,694
Value pig iron	$	397,838	438,659
Arsenic :			
Product	lb.	350,000	236,054
Value	$	10,500	8,262

The aggregate value of the production for the first quarter of 1902 was $1,254,685 as against $824,076 for the first quarter of 1901—an increase of $430,609 or 52 per cent.

The table shows the following gains as compared with the same period last year : gold, $22,548 ; silver, $4,954 ; nickel, $355,498 ; copper, $121,545 ; arsenic, $2,238 : and the following decreases : iron ore, $35,353 ; pig iron, $40,821.

The increase in quantity and value of nickel and copper is notable, part of the gain in value being due to the larger output and part to the fact that the mattes of the Sudbury district are now brought to a much greater richness in metallic contents than formerly.

The decrease in the output of iron ore is more apparent than real, and is explained mainly by the fact that navigation on Lake Superior had not opened on 31st March and consequently none of the product of the Helen mine had been moved.

The quantity of pig iron produced was almost exactly the same in both periods, but the value this year is somewhat less. About 52 per cent. of the ore smelted was from Ontario mines, as compared with 43 per cent. in 1901.

I have the honor to be, Sir,

Your obedient servant,

THOS. W. GIBSON,

Director.

Office of the Bureau of Mines,

Toronto, 2nd May, 1902.

ELEVENTH REPORT OF THE BUREAU OF MINES.

By Thos. W. Gibson, Director.

STATISTICS FOR 1901.

Farming and lumbering have for long been regarded as the characteristic industries of Ontario, and those upon which her reputation and place among the confederated Provinces in great degree depend. In late years has been added manufacturing ; and it is now apparent that mining has claims to be considered an industry of first-rate importance, worthy to rank with those already named. In value of yearly output the minerals and mineral products of Ontario are but little behind the produce of the forest, and there seems every probability that the gap will speedily be still further lessened.

Progress of the Industry.

The year 1901 was productive of substantial progress in many branches of the mineral industry, especially in those concerned with iron, copper and nickel, the three most important products of the metalliferous mines of Ontario. Up to the present time a very large proportion of the mineral output of the Province has consisted of non-metallic substances, including building and structural materials such as stone, brick, lime, etc. The aggregate value of this non-metalliferous output is growing from year to year, but much more rapid progress is being made in the production of metals, as will be apparent from the tables of production given below. The present ratio of development if maintained will soon place the value of metallic minerals annually produced in the Province in excess of that of the non-metallic products. The following figures will illustrate this point :

Year.	Total production of minerals.	Metallic output.		Non-Metallic output.	
		Value	Per cent.	Value	Per cent.
	$	$		$	
1898	7,235.877	1,689,002	23	5,546,875	77
1899	8,416,673	2,055,492	24	6,361,081	76
1900	9,298,624	2,565,286	28	6,733,338	72
1901	11,831,086	5,016,734	42	6,814,352	58

Thus, while the total production in 1901 as compared with that for 1898 showed an increase in value of $4,595,209, or 63 per cent., the metallic products increased by $3,327,732 or 191 per cent., and the proportion of metallic output to the entire value which in 1898 was 23 per cent., rose in 1900 to 28 per cent., and in 1901 to 42 per cent. As compared with 1900 the gain in the production of metals is about 100 per cent.

Of the metalliferous output in 1901, copper contributed 11 per cent., nickel 37 and pig iron 33, a total of 81 per cent. The yield of gold was 5 per cent. of the metallic product, silver 1.6 per cent., iron ore 3.4 per cent , and steel 6 per cent.

Grouping iron ore, pig iron and steel together, and making no deduction for the ore smelted into pig iron, or the pig iron converted into steel, these three products account for about 44 per cent. of the metallic output, or about 19 per cent. of the gross mineral production for the year. In 1896 the first iron ore was raised and the first pig iron made for many years, so that within five years the iron industry—that industry of prime importance—has made good progress.

In the mining of nickel and copper, too, the advance has been marked. The output of both metals in 1901 was the largest yet reached, and owing to the more extended manipulation to which the nickel-copper mattes of the Sudbury district are now subjected previous to exportation, the product had a much larger value than ever before. Some of the mines on the north shore of Lake Huron, where the ore carries copper only as distinguished from the pyrrhotite of eastern Algoma and western Nipissing which contains both copper and nickel, are in a condition promising speedy production on a considerable scale. Indeed, one of them, the Rock Lake mine, where an extensive plant has been installed, has begun the shipment of concentrates to Michigan since the beginning of 1902. There is some prospect of a smelter being erected in the district for treating the product of this and other properties also likely to become producers ere long.

As the business of mining is carried on almost exclusively by means of joint stock companies, the formation of which under the provisions of the laws of Ontario is neither difficult nor expensive, the number of such companies organized in the Province, and of foreign corporations licensed to do business in Ontario, is to some extent an indication of the interest taken by the general public in mining affairs. That this interest has been well sustained in comparison with 1900 is shown by the table given below from which it will be seen that 47 companies were incorporated under Ontario laws with a nominal capital of $27,716,000, and that 13 companies of foreign origin took out licenses to sell stock and hold real estate in the Province, with a capital of $12,250,000; the total number of companies being 60, and the aggregate nominal capital $39,966,000. In 1900 the number of companies was 57, and the total capital $42,403,999.

JOINT STOCK COMPANIES AND MINING.

But while the formation and introduction of joint stock companies is some evidence of attention being paid to mining by the general public, it is by no means a safe guide to the volume of work actually going on in the mineral industry, or even the amount of capital actually being invested in mines and used in carrying on mining operations. It must be said that the interest manifested by the non-mining public in the mining business is chiefly of a speculative character and has its origin in the hope of quickly making large returns on small investments. Many of the companies formed on the basis of undeveloped mining properties never emerge from the chrysalis state; the formal notice in the *Ontario Gazette* announcing the fact of their coming into existence being the first and last occasion on which their names are mentioned in public. Others advance a stage further and offer their stock for sale, but the rage for mining shares has for the time being passed away, repeated disappointments having brought home the truth that the road to sudden wealth seldom lies through the purchase of stock in a million dollar company the value of whose lands is entirely unknown, even though the stock may be sold at the bargain-day rates of 10 or 15 cents per dollar share.

It is a somewhat remarkable fact that metalliferous minin in this Province is almost wholly carried on by companies whose share capital is in the hands of people living in Great Britain or the United States. In nickel and copper this is true without exception, in gold it is all but true, and so also in iron. There is no objection whatever to English and American capital finding employment in our mining industry; on the contrary, capital is the industry's crying need, and is made heartily welcome from whatever source it comes, neither sentiment nor the laws of the country discriminating between funds of home and funds of foreign origin. But in this, the formative stage of the business, it is matter for regret that the people of Ontario invest so little money in legitimate mining enterprises in their own Province, and are allowing the control of what promises to be one of the most important factors in the country's development to pass into the hands of others.

Following is the table of companies referred to:—

JOINT STOCK MINING COMPANIES ORGANIZED IN 1901.

Name of Company.	Head Office.	Date.	Capital.
London and Canadian Mining and Development Company, Limited	Brantford	21 March, 1901	$10,000
Manxman Gold Mining Company, Limited	S. S. Marie	20 June, 1901	1,500,000
Osawabik Mining Company, Limited	S. S. Marie	29 November, 1901	2,500,000
Peat Development Syndicate, Limited	Toronto	5 December, 1901.	40,000
Peat Industries, Limited	Toronto	16 October, 1901	500,000
Redeemer Mining and Milling Company, Limited	Windsor	29 November, 1901	500,000
Rob Roy Mines, Limited	London	9 October, 1901	120,000
The Argentine Peat Syndicate, Limited	Guelph	14 February, 1901.	60,000
" Beaver Oil and Gas Company, Limited	Brantford	26 July, 1901	250,000
" British Canadian Gold Fields of Ontario, Limited	Toronto	29 April, 1901	100,000
" Brockville Mining Company, Limited	Brockville	4 January, 1901	40,000
" Canada Consolidated Mineral Company, Limited	Ottawa	24 April, 1901	500,000
" Canadian Oil Refining Company, Limited	Petrolea	7 August, 1901	100,000
" Canboro Natural Gas Company, Limited	Canboro	23 August, 1901	12,000
" Cartier Mining Company, Limited	Toronto	23 August, 1901	100,000
" Champion Gold Mining Company of Ontario, Limited	Rat Portage	28 February, 1901.	1,000,000
" Consolidated Mines Company of Lake Superior, Limited	Port Arthur	23 August, 1901	1,000,000
" Czarina Gold Mines Company of Ontario, Limited.	Fort William	28 August, 1901	40,000
" Desbarats Mining Company, Limited	Desbarats	23 March, 1901	500,000
" Dominion Portland Cement Company of Wiarton, Limited	Wiarton	9 March, 1901	250,000
" Durham Natural Gas and Oil Company, Limited	Durham	20 December, 1901	10,000
" Golden Star Mining Company, Limited	Toronto	16 January, 1901	1,500,000
" Gopher Mining Company, Limited	Fort Frances	23 August, 1901	1,000,000
" Grace Mining Company, Limited	Ridgeway	4 September, 1901	1,000,000
" Grey and Bruce Oil and Gas Company, Limited	Hepworth	20 February, 1901.	100,000
" Honor Bright Gold Mining Company of Ontario, Limited	Berlin	17 April, 1901	1,000,000
" Imperial Corundum Company, Limited	Toronto	13 March, 1901	1,000,000
" International Mica and Mining Company of Ottawa, Limited	Ottawa	10 April, 1901	15,000
" J. G. Gibson Marble and Granite Company, Limited	Toronto	11 May, 1901	40,000
" Kent Oil and Gas Company, Limited	Dresden	7 August, 1901	50,000
" Laurentian Stone Company, Limited	Ottawa	10 January, 1901	40,000
" Log Cabin Gold and Copper Company, Limited	Toronto	23 October, 1901	3,000,000
" Longford Quarry Company, Limited	Longford Mills	12 September, 1901	50,000
" Massey Station Mining Company, Limited	Copper Cliff	29 April, 1901	300,000
" Michigan-Ohio Gold Mining Company of Ontario, Limited	Windsor	22 August, 1901	1,000,000
" Ontario and California Oil Company, Limited	Toronto	7 August, 1901	1,000,000
" Ontario Portland Cement Company, Limited	Brantford	11 July, 1901	450,000
" Ottawa Mica Mining Company, Limited	Ottawa	12 April, 1901	100,000
" Rush Bay Golden Horn Mining Company, Limited.	Rat Portage	18 March, 1901	250,000
" Sakoose Gold Mining Company, Limited	Ottawa	9 March, 1901	300,000
" Standard Mining Company of Algoma, Limited.	S. S. Marie	2 October, 1901	40,000
" Superior Copper Company, Limited	S. S. Marie	6 September, 1901.	1,500,000
" Taylor Copper Mines Company, Limited	S. S. Marie	13 June, 1901	2,400,000
" Tilsonburg Oil and Gas Developing Company, Limited	St. Thomas	9 October, 1901	99,000
" Toronto Portland Cement Company, Limited	Dresden	13 November, 1901	300,000
" Twentieth Century Mining Company, Limited	Toronto	23 August, 1901	2,000,000
" Westport Mining and Developing Company, Limited	Westport	13 March, 1901	50,000
			$27,716,000
LICENSED MINING COMPANIES.			
Black Eagle Gold Mining Company, Limited	London, Eng.	6 September, 1901	500,000
Consolidated White Bear Mining Company, Limited	Toronto	29 November, 1901	300,000
Gold Mountain Mining Company	Buffalo, N.Y.	13 June, 1901	500,000
The Algoma Queen Mining Company	Pierre, South Dakota	7 November, 1901	300,000
" The Crow's Nest Pass Coal Company, Limited	Toronto	9 March, 1901	2,000,000
" Deer Trail Consolidated Mining Company, Limited	Toronto	7 February, 1901.	3,000,000
" Echo Lake Mining Company	Saginaw, Mich.	5 December, 1901.	500,000
" Hamilton Steel and Iron Company, Limited	Hamilton	28 December, 1900.	2,000,000
" Homestake Gold Mining Company of Ontario, Limited.	St. Paul, Minn.	13 June, 1901	1,250,000
" Ontario Graphite Company, Limited	Ottawa	11 January, 1901	200,000
" Ontario Mining Company	Cleveland, Ohio.	22 May, 1901	500,000
United States Gold Mining Company	Augusta, Maine.	20 December, 1901.	1,000,000
Westerfield Mining Investment Company, Limited	Phœnix, Arizona	23 October, 1901	200,000
			$12,250,000

Mining Lands Sold and Leased.

The total area of Crown domain granted last year under the provisions of the Mines Act was 40,001 acres, which realized $53,276.52, as compared with 59,099 acres and $97,166.69 in 1900. There were issued 187 leases covering 28,699 acres, for which $28,411.52 was received as first year's rental, while the sales, which numbered 111, were for 11,302 acres, and brought $24,865.00, an average of $2.20 per acre. The rentals received on account of lands leased previous to 1901 were $13,222.99, while the fees for miner's licenses in the Michipicoton Mining Division and for prospector's licenses available in the unsurveyed territory were $4,405.00; making the total receipts from mining lands $70,904.51, as against $108,952.51 in 1900.

MINING LANDS SOLD.

District	Number.	Acres.	Amount.
			$ c.
Rainy River	75	6,463	13,911 06
Thunder Bay	16	1.354	3,008 00
Algoma	12	2,175	4,449 29
Elsewhere	8	1,310	3,496 65
	111	11,302	24,865 00

MINING LANDS LEASED.

District	Number.	Acres.	Amount.
Rainy River	49	4,074	4,074 38
Thunder Bay	53	8,131	8,181 50
Algoma	71	13,892	13,873 89
Elsewhere	14	2,602	2,331 75
	187	28,699	28,411 52

Production of Minerals.

The output of minerals and mineral products reported to the Bureau for 1901, together with the number of workmen and wages paid was as follows:

SUMMARY OF MINERAL PRODUCTION IN 1901.

Product.		Quantity.	Value.	Employees.	Wages.
METALLIC.			$		$
Gold	oz.	14,293	244,443	585	287,409
Silver	"	151,400	84,830	65	29,500
Copper	lb.	9,074,000	589,080	2,284	1,045,889
Nickel	"	8,882,000	1,859,970		
Iron ore	tons.	273,538	174,428	360	231,039
Pig iron	"	116,370	1,701,703	580	274,554
Steel	"	14,471	347,280		
Zinc ore	"	1,500	15,000	10	6,287
Total metallic		....	5,016 734	3,884	1,874,678
NON-METALLIC.					
Actinolite	tons.	521	3,126	5	782
Arsenic	lb.	1,389,056	41,677	(a)	(a)
Tile, drain	no.	21,592,000	231,374	3,318	752,184
Brick, common	"	259,265,000	1,530,460		
" paving	"	3,689,000	37,000	40	20,000
" pressed and terra cotta	"	12,846,000	104,394	172	45,816
Building stone, rubble, etc.		....	850,000	1,800	600,000
Carbide of calcium	tons.	2,771	168,792	83	40,788
Cement, natural rock	bbl.	138,628	107,625	89	35,460
" Portland	"	350,660	563,255	460	190,536

SUMMARY OF MINERAL PRODUCTION IN 1901.—*Continued.*

Product.		Quantity.	Value.	Employees.	Wages.
NON-METALLIC.			$		$
Corundum	lb.	1,068,000	53,115	68	30,406
Felspar	tons.	5,100	6,375	25	6,750
Graphite	"	1,000	20,000	40	7,200
Gypsum	"	1,554	13,400	9	6,652
Iron pyrites	"	7,000	17,500	16	3,000
Lime	bush.	4,100,000	550,000	775	210,000
Mica	lb.	854,000	39,780	83	6,280
Natural gas		....	342,183	129	59,140
Pottery		....	193,950	213	81,720
Petroleum	Imp. gal.	21,433,500			
Illuminating oil	"	9,463,262			
Lubricating oil	"	764,861			
Benzine and naphtha	"	1,075,999	1,467,940 (*b*)	351	161,042
Gas and fuel oils and tar	"	2,652,987			
Paraffin wax and candles	lb.	3,489,492			
Salt	tons.	60,327	323,058	189	67,024
Sewer pipe		....	147,948	81	33.096
Talc	tons.	400	1,400	5	600
Total NON-METALLIC		....	6,814,352	7,951	2,358,476
Add METALLIC		....	5,016,734	3,884	1,874,678
Total		....	11,831,086	11,835	4,233,154

(*a*) Included in gold. (*b*) Value of refined product and crude used as such.

The development of the mineral industry which has been going on for some time is brought out by the following comparative table, giving the values of the mineral products during the last four years.

TABLE SHOWING MINERAL PRODUCTION IN 1898, 1899, 1900 AND 1901.

Product.	1898.	1899.	1900.	1901.
METALLIC.	$	$	$	$
Gold	275,078	424,568	297,861	244,443
Silver	51,960	65,575	96,367	84,830
Copper	268,080	176,237	319,681	589,080
Nickel	514,220	526,104	756,626	1,859,970
Iron Ore	48,875	30,951	111,805	174,428
Pig Iron	530,789	808,157	936,066	1,701,703
Steel	....	....	46,380	347,280
Zinc Ore	....	24,000	500	15,000
Total METALLIC	1,689,002	2,055,592	2,565,286	5.016,734
NON-METALLIC.				
Actinolite	....	....	....	3,176
Arsenic	....	4,842	22.725	41,677
Brick, common	914,000	1,313,750	1,379,590	1,530,460
" paving	....	42,550	26,950	37,000
" pressed and terra cotta	100,344	105,000	114,419	104,394
Building stone, rubble, etc	750.000	667,532	650,342	850,000
Carbide of calcium	55,976	74,680	60,300	168,792
Cement, natural rock	74,222	117,039	99,994	107,625
" Portland	302,096	444,227	598,021	563,255
Corundum	....	....	6,000	53,115
Felspar	....	....	5,000	6.375
Graphite	6,000	16,179	27,030	20,000
Gypsum	4.000	16,512	18,050	13 400
Iron pyrites	....	....	....	17.500
Lime	308,000	535,000	544,000	550,000
Mica	7,500	38,000	91,750	39,780
Natural gas	301.600	440.904	392,823	342.183
Pottery	155 000	101.000	157,449	193,950
Petroleum products	1,970,534	1,747,352	1,869.045	1,467,940
Salt	278.886	317.412	324,477	323 058
Sewer pipe	93,717	138,356	130.635	147,948
Talc	....	500	5.000	1,400
Tile, drain	225,000	240,246	2[illegible]9,738	231,374
Total NON-METALLIC	5,546.875	6,361,081	6,733,338	6,814.352
Add METALLIC	1,689,002	2,055,592	2,565,286	5,016,734
Total production	7,235,877	8,416,673	9,298,624	11,831,086

Compared with 1900 the total value of the minerals produced in 1901 exhibited an increase of $2,532,462 or 27 per cent. Nearly all the gain was in the metallic products, principally in nickel, copper, pig iron and steel. There was also a considerable advance in iron ore, though the increase in quantity is more marked than in value, and a gain in zinc ore, the production of which however, is still on a small scale. On the other hand, the precious metals both show a decrease, the yield of gold being valued at $53,418 less, and of silver at $11,537 less than in 1900.

The non-metallic minerals show an increase in value over the output for 1900 of $81,014. There are decided gains in brick, stone, carbide of calcium, corundum and arsenic, and moderate increases in pottery, sewer pipe and drain tile. Lime and salt remain nearly stationary, while cement, graphite, gypsum, mica, and talc show small decreases. The chief falling off is in petroleum and natural gas, the causes of which are dealt with below.

The variety of minerials produced in Ontario is very great, and the list is still growing. Two products find a place in the statistics for 1901, which have heretofore been unenumerated, viz., actinolite and iron pyrites, though both of these substances have in previous years been raised in small quantities.

Gold and Silver.

The output of the gold mines of the Province for 1901 was 14,293 ounces of bullion worth $244,443, a decrease of 4,474 ounces and $53,418 as compared with 1900. Nine mines were producing gold as against 18 the previous year. The course of the gold mining industry for the last five years is shown by the following figures:

Schedule.	1897	1898	1899	1900	1901
Mines worked........... .....number.	9	17	15	18	11
Men above ground................ "	222	296	307	412	305
Men under ground .. .. "	216	284	356	338	288
Ore treated........................tons	27,589	57,895	59,615	46,618	54,336
Gold product.......... .. .. oz.	11.412	16,261	27,594	18,767	14,293
Gold value .... $	150,244	275,078	424,568	297,861	244,443
Wages paid for labor............... "	217,766	290,919	324,024	350,694	287,409

The results so far attained in mining for gold in Ontario have not been commensurate with the expectations which were entertained some years ago, when the discovery of gold over very extensive tracts in the northwestern portion of the Province gave rise to unbounded hopes. Many of the conditions are favorable ; the auriferous material is mostly free-milling quartz amenable to the ordinary processes of stamping and amalgamation with chlorination or cyanidation for concentrates ; there is abundance of water, plenty of wood and no scarcity of labor. Many of the veins are of good size, some of unusual magnitude, and there are no royalties or other undue burdens to be borne by the industry. As yet there has been but little deep gold mining in Ontario, and workings up to the present time scarcely afford sufficient grounds for generalization. In a few of the mines irregularities have developed below ground in the course and location of the payable ore chutes as well as in the veins themselves, and the conclusion has been reached that the gold ores of north and west Ontario are in the main low grade, and cannot be expected to yield large profits unless economically worked on a considerable scale. Low grade propositions, however, are not necessarily undesirable, and where other conditions are propitious are indeed by many preferred to rich "specimen" mines.

Other causes not connected with the character of the ore bodies have contributed to the unsatisfactory results as yet achieved. Shafts have been opened on locations which did not warrant the expenditure of a dollar upon them ; promising properties have been ruined by unskilful operations above or below ground ; and in too many cases the capital of investors has been lavished upon stamp mills, buildings and machinery before the presence of payable ore in sufficient quantity was proven. The last-mentioned mistake has been a very common one, and idle and rotting mills now stand in various parts of the gold fields testifying to the folly alike of those who furnished and of those who expended the money thus wasted. The effect of mismanagement of this sort is to discredit the district, and to make the introduction of fresh capital and the inauguration of new schemes more difficult.

Another drag on the efforts of operators in the Seine river region, namely, the cost of transporting supplies and material to their mines, which was so great as to be almost prohibitory, has been obviated by the construction of the Ontario and Rainy River, or as it is now called, the Canadian Northern Railway. This line runs through the mineral belt from Port Arthur to Fort Frances, and is already having a beneficial effect in enabling freights to be moved at greatly reduced rates. Testimony to the advantages wrought by the building of this line is borne by Mr. Alan Sullivan. M. E., manager of the Anglo-Canadian Gold Estates Limited, whose letter is quoted below. These advantages will be shared alike by the iron mines and the gold mines of the region served by this railway, and are already bearing fruit in quickening the development of both these branches of the mining industry in that part of the Province.

Notwithstanding what has been said there is good reason to be hopeful of the future of gold mining in Ontario. Experience will garner wisdom from the mistakes no less than from the successes of the past, and skilled and careful management backed by sufficient capital will yet be richly rewarded by the result of operations on some of the easily worked quartz veins or the big dikes and fahlbands characteristic of the western parts of the Province.

In eastern Ontario the Belmont mine owned by the Cordova Exploration Company, and the Deloro mines which are the property of the Canadian Goldfields Limited, have been steadily at work throughout the year. Though situated within fourteen miles of each other, the former partly in the county of Hastings and partly in the county of Peterborough, and the latter wholly in the county of Hastings, these two mines are quite distinct in the character of their ores. The Belmont veins are of free-milling quartz, and the 30-stamp mill and amalgamation plant is supplemented by cyanidation, while at Deloro the ore is mixed quartz and mispickel, from which both the gold and arsenic contents are recovered, the former by amalgamation and leaching with bromo-cyanide solutions, and the latter by a process of sublimation. This mine is unique of its kind in America, if not in the world, and the problem of reducing the rebellious nature of the ores so as to permit of extracting the gold as well as the arsenic is one which engaged the attention and absorbed the funds of a succession of owners for over thirty years before a profitable solution was found. The Atlas Arsenic Company, whose property immediately adjoins that of the Canadian Goldfields, crushed a few hundred tons of ore during the early part of the year ; and the old Cook stamp mill near Deloro after having been idle for many years, was once more put in operation to work over the dump at the mine from which a small quantity of gold was recovered.

The mines in western Ontario active during the year were the Sakoose, situated on Mining Location H.W. 416, near Dyment station on the Canadian Pacific Railway, the Sultana, Mikado, and Black Eagle (formerly Regina) on Lake of the Woods, the Golden Star in Lower Seine region, the Sturgeon Lake on the body of water of that name about 70 miles north of Ignace station, C.P.R., the Elizabeth on timber berth No. 41, the Big Master on lake Manitou, and the Grace, near lake Wawa, in Michipicoton Mining Division, the property of the Algoma Commercial Company, Limited. The stamp mills at the Golden Star and Sturgeon Lake mines ran for a short time only, and the Elizabeth, Big Master and Grace mines have not yet reached the producing stage. At the first-mentioned mine a determined effort was put forward by the company to locate further bodies of payable ore by diamond drilling, the pay chutes having been worked out by the predecessors of the present management. It is understood that good results were reached, but unfortunately available funds became exhausted and a stoppage of operations was necessary. The old Regina mine, next in order to the Sultana among the pioneers of the Lake of the Woods district, passed into the control of the re-organized company called the Black Eagle Gold Mining Company, Limited, which during the latter part of 1901 substituted a new 30-stamp mill of the gravity pattern for the old Tremaine mill formerly in use, and began crushing ore about the 1st of January, 1902. Mr. Frank Peterson is the manager.

THE ANGLO-CANADIAN GOLD ESTATES, LIMITED.

As mentioned in the Report of the Bureau for last year, a license of occupation was granted on 17th October 1900 to the Anglo-Canadian Gold Estates, Limited, conferring the exclusive right of exploring for mineral certain areas of land in the District of Rainy River. The conditions of the license required the expenditure of $35,000 in exploring and mining operations during the year 1900, $40,000 in 1901 and $45,000 in 1902, one-quarter of the area being surrendered at the end of 1900, a second quarter at the end of 1901, and the remainder at the end of 1902. The areas licensed to the company were within the region believed to be gold-bearing. Two years' work on the part of the company, involving an expenditure of over $76,000, have resulted in locating two gold mines on the licensed areas, the principal one being what is known as the Elizabeth mine, situated on timber berth No. 61. The following report on the company's operations during 1901 has been furnished by the manager, Mr. Alan Sullivan :

I beg to submit a short statement covering the operations of the Anglo-Canadian Gold Estates, Limited, for the year 1901. The above work is represented by the development of the Elizabeth mine and a certain amount of prospecting upon the area held by your licensees, also some prospecting in the new district of Sturgeon lake north of the Canadian Pacific Railway.

The development at the Elizabeth mine to date (13th March, 1902) is at two shafts, numbers 1 and 2, distant from each other 450 feet. Shaft No. 1, of which the depth is 110 feet and from which two levels, north and south, 110 feet have been driven, has proved up a fair body of low-grade ore which can be treated at a profit. Work in this shaft was discontinued so that all efforts might be concentrated on shaft No. 2, which has now attained a depth of 240 feet. Three levels are being driven from a depth of 65, 135 and 235 feet respectively. Before this plan of development was put into operation, the deposit was thoroughly tested by the company's diamond drill with most satisfactory results. The deepest bore hole intersected the vein at 210 feet from the surface, giving a width of ore of five feet, with highly payable values. The sinking and drifting since that time have fully borne out the evidence given by the diamond drill. In this shaft there are at present in sight about 8,000 tons of ore which should yield a net profit of about $50,000, and within three months from date about a year and a half's supply of ore will be blocked out for a 20-stamp mill which the company proposes to erect this summer.

The surface works include large and commodious camps for the accommodation of about 40 men, general and assay offices manager's house, boiler, compressor and hoist houses, heavy timber head-gear and large blacksmith shop at mouth of shaft. Plant consists of two boilers, aggregating about 50 horse-power, one half of a duplex 6-drill Rand air compressor, double cylinder hoisting engine, a Bullock diamond drill with a capacity of about 800 feet, necessary power for the same, and all other appliances incidental to the prosecution of the work. The average number of employees is about 30, and the average monthly expenditure from $3,000 to $3,500.

The company's prospectors, during their explorations in the Sturgeon lake district in the spring of 1901, discovered what we have since proved to be a very valuable quartz lode. Surface work has stripped the lode for about 1,000 feet, in which the pay chute, so far as proven at present, is about four feet wide and of an average value of about $20 per ton. The geological conditions governing its existence are most favorable and the company believes that with due development it will make a mine no less valuable than the Elizabeth. Various test pits have been sunk all along its length to a depth of 25 feet, and in every case the result has been all that could be expected.

Another property owned by the company lies about two miles from that just described, and immediately adjoins the St. Anthony Reef owned by the Jack Lake Mining Company. To this property as yet we have not been able to turn any attention, as our time has been fully occupied elsewhere. It is proposed to thoroughly test this property with the company's diamond drill.

While the year 1901 has seen a good many failures recorded in the mining industry throughout western Ontario, the work done by those who have gone in for steady and legitimate development has proved beyond a shadow of doubt that the country offers every inducement to those who are willing to engage in mining as a business and not a speculation, and so far as this company is concerned we have no reason to regret the undertaking which we have entered into with your government. The construction of the Canadian Northern Railway has simplified matters to such an extent that freight from the mine to Port Arthur, which last year cost us $70 a ton now costs about $7. Regular communication has been established with the outside world, and many properties which were heretofore practically inaccessible so far as mining is concerned now offer every reasonable inducement to the investor.

On 31st December 1900 the Anglo-Canadian Gold Estates surrendered to the Crown blocks 1 and 2 described in their license, and on 31st December 1901, block 3. These three parcels contained in all about 58 square miles, leaving under license blocks 4 and 5 with an aggregate area of about 59 square miles. The terms of the agreement require the company to explore these two blocks during the year 1902 at an expense of $45,000, but application has been made for an extension of one year to permit of the areas being thoroughly examined at additional expense. The total amount of the company's expenditures for purposes of the license, up to 31st December 1901, according to sworn returns made to the Department was $76,777.60, classified under the following headings : wages $35,819.20, salaries $4,848, board $8,498.43, plant $9,723.10, buildings $3,057.64; general expenses $7,030.99, stores $1,985.28, explosives $1,285.80, diamond drill $2,037.41, camp outfit $1,283.25, realty $1,208.50. Of these sums, $36,267.87 was spent in 1900 and $40.509.73 in 1901, the amounts specified in the license of occupation being $35,000 and $40,000 respectively.

The extension of the company's operations to the Sturgeon lake district, which their license does not include, is evidence of the wisdom of the agreement under which the company became interested in Ontario, and proof that English capital once introduced and achieving satisfactory results is ready to enlarge its scope upon meeting with fair encouragement.

GOLD IN PLACER DEPOSITS.

Fine gold was discovered in 1896 in gravel along the banks and in the valley of the Vermilion river, and an examination of the deposits was made in the spring of the following year by Mr. Arthur H. Gracey, whose report was published in the annual volume of the Bureau of Mines for 1897. Mr. Gracey found the auriferous gravel widely disseminated in the basins both of the Vermilion and Wahnapitae rivers and also on the banks of lake Onaping, but the gold was mostly in fine colors and the average value of the gravel low, not more than a few cents per cubic yard Richer deposits were found carrying as much as 50 cents or $1 per cubic yard, but on the whole the beds appeared to be too low in gold contents to admit of profitable working, at any rate by hand, and ordinary hydraulic methods were precluded, a sufficient head of water not being obtainable on the rivers. A closer investigation was made of these placer gravels by Dr. Coleman, whose account was printed in the Bureau's Report for 1900, and who found them to extend much farther north than the area examined by Mr. Gracey. More or less work had been done by prospectors during the intervening years, and it was therefore possible for Dr. Coleman to form some opinion as to the value of the field as a whole. The conclusion at which he arrived was that the gold being very fine and apparently nowhere concentrated in deposits which could be worked by hand, the scope for profitable operations was limited. It would probably be found, Dr. Coleman thought, that only the gravels from Meteor lake, on the height of land, southwest to "Dawson City" on the Vermilion were deserving of attention, the beds over this stretch extending along the river for 40 miles and having a breadth of a mile and sometimes of two or three miles. He agreed with the suggestion made by Mr. Gracey and others that the most promising method of treating the gravels was by dredging, for which the conditions were eminently suitable, provided the gold contents proved to be sufficient. As to the origin of the gold, Dr. Coleman regarded the quartz veins or stringers in the Huronian rocks to the northeast and north as the most probable source, and deemed it likely that the auriferous gravels had been brought a considerable distance, probably by glacial action.[1]

During the past year Mr. Robert H. Ahn of Toronto has been experimenting with these gravels with the view of recovering the gold by a combined amalgamation and cyaniding process. A small plant was erected on the banks in Hanmer township, which according to Mr. Ahn's statements has proven the practicability of his method. The gravel is first screened down to about one-fourteenth of the original bulk, this residue containing all the gold obtainable without crushing. The remainder of the treatment is thus described by Mr. Ahn :

The fine pulp, or the one-fourteenth, is pumped into tanks of special filtering construction, which are situated at a central treating station located on shore. From these tanks the pulp is drawn in a fairly dry state, and charged into an amalgamating barrel in which there is a large, heavy, copper-covered roller, lying loose in the bottom of the barrel ; as the barrel revolves the roller revolves also, rolling the ore under itself, and thus subjecting the pulp to amalgamation under pressure, care being taken that only enough mercury be added to take up the amount of gold in the pulp.

As the ore is fed into the barrels which, by the way, are so constructed as to allow of a continuous feed and discharge, it is further moistened by a charge of cyanide solution which not only assists in amalgamating the coarser particles of gold, but at once attacks the finer portions of gold, and owing to the agitation and splash which takes place inside the barrel the cyanide is greatly assisted in its work by the absorption of the necessary amount of oxygen.

As the pulp leaves the amalgamating barrel it is received into a launder and conveyed to concentrating tables, where all the black sand and rusty gold that may have escaped from the barrel is separated from the main portion of the pulp. The black sand is conveyed to separate tanks where it undergoes a further cyanide treatment, by which means all the values are extracted The pulp is conveyed to receiving tanks constructed on the same principle as the first receiving tank. Here the cyanide solution is filtered off, and if it is rich enough in gold it is passed through the precipitation or collecting boxes, which may be of any approved construction or method.[2]

Deposits of gold-bearing gravel, apparently somewhat similar in character to those of the Vermilion river, were discovered last year on a large body of water known as Savant lake, north or northeast of Sturgeon lake where gold exists in quartz veins and in dikes, and about 120 miles north of Ignace station on the Canadian Pacific railway. Ignace is about 150 miles west of Port Arthur. The gravel beds are described by Mr. Alan Sullivan, C.E., who made a hasty examination of them in the summer of 1901, as extending over at least a length of six miles and a breadth of one mile, the average value of the gravel within this area, as shown by numerous pannings from the surface, being about 8 or 10 cents per cubic yard. A number of islands which run in a range down the middle of the lake are entirely of gravel and vary in height from 25 to 100 feet. Mr. Sullivan states that he did not reach bed rock in any place, and therefore cannot say whether there is any concentration of value at that point. The gold is not light and flaky, but in small rounded particles, and large boulders are conspicuously absent. It is possible some further investigations may be made of this region during the present year.

The yield of silver in 1901 was 151,400 ounces, valued at $84,830, as compared with 160,612 ounces in 1900 worth $96,367. Following is a table giving particulars respecting the silver mining industry of the Province during the past four years :

[1] Rep. Bur. 1900, p. 159. [2] R. H. Ahn in Engineering and Mining Journal, New York, March 1, 1902, p. 319.

Schedule.	1898.	1899.	1900.	1901.
Ore raised .. ..tons	6,600	8,000	12,500	11,000
Ore stamped .. .. "	5,600	8,000	8,000	7,560
Bullion product .... oz.	86,600	105,467	160,612	151,400
Value of bullion..... .... $	51,960	65,575	96,367	84,830
Wages paid for labor.................. .... "	28,430	29,000	24,000	29,500
Average workmen above ground... ....number	32	23	20	30
Average workmen below ground............. "	27	17	30	35

The principal source of the silver produced in the Province during the period covered by the foregoing table has been the West End Silver Mountain mine, situated west of Port Arthur. A number of other silver properties in the same region which closed down when the heavy slump in the price of silver occurred a number of years ago have remained unworked. There is a prospect of some of these again coming into activity, an amalgamation having taken place by which the Badger, Porcupine, Keystone, and East and West End Silver Mountain mines passed into the control of a newly organized company called the Consolidated Mines Company of Lake Superior, Limited. The names of the officers of the company are as follows : C. W. Stone, Warren, Pennsylvania, president ; M. A. Myers, Warren, Secretary ; A. M. Wiley, Port Arthur, Ont., treasurer ; Herbert Shear, Port Arthur, general manager. The new owners are operating the West End mine in full force as well as the Porcupine, and hope to open up the East End, Keystone and possibly the Badger in a short time.

Nickel and Copper.

Nickel mining occupies the chief place in the list of mineral industries for 1901, the output of nickel exceeding in value that of any other single product, though closely followed by pig iron. The production for the year amounted to 8,882,000 pounds, or 4,441 tons, valued in the matte at $1,859,970, an increase in quantity of 25 per cent., and in value of 145 per cent., as compared with 1900, when the yield was 3,540 tons valued at $756,626. The output in 1901 reached the highest point yet recorded.

It will be observed that the advance in value in comparison with the previous year was much greater in proportion than the advance in production. The reason for this will be made plain by the following explanation. About the middle of the year 1901 the Ontario Smelting Works erected by Col. R. M. Thompson at Copper Cliff for the purpose of re-treating the low-grade mattes made in the furnaces of the Canadian Copper Company, began operations, the effect of the retreatment being to raise the metallic contents of the matte from say 30 up to about 70 per cent. Additional labor and expense having thus been expended upon the mattes, and the metals contained in them having been brought so much nearer the point of actual refinement and separation, it follows that the contents were worth more per pound in the high-grade than in the low-grade condition. It has been the practice of the Bureau to compute the value of the Sudbury nickel-copper mattes at their selling price at the place of production, and not at the price of the refined metals, consequently the relative as well as the absolute value of the nickel and copper contained in the mattes produced in 1901, was considerably higher than in 1900, when only the low-grade product was made. The average price at which the nickel contents of matte were appraised in 1900 was 10.7 cents per pound, while in 1901 it was 20.9 cents. Only about one-half the product of the Canadian Copper Company's smelters was treated at the Ontario Smelting works last year, consequently the total increase in value of the nickel is not so great as it would have been had the whole of the product been re-handled.

It is not uncommon for the metals contained in raw or partly treated ores to be valued for statistical purposes at their full selling price in a refined condition. This method is adopted for instance, by the Geological Survey of Canada, and by the mining departments of one or more of the Provinces, and were it applied to the nickel and copper of the mattes produced in the Sudbury region, the values would have been given as $4,440,000 and $1,450,000, instead of $1,859,970 and $589,080 respectively. The apparent value of the mineral output of the Province would have been increased by upwards of $3,440,000, but the gain would have been in seeming only, not in reality. So long as the product of the mines is exported in an unfinished condition, so long ought it in strictness to be set down for what it really is worth, namely the price at which it would be sold at the place of production. There are advantages, too, in adhering to an established basis of valuation, a departure from which would make it difficult to compare the figures of one year with those of another.

The following table gives the principal features of the nickel-copper industry for the last five years, and clearly shows the substantial growth made during that time :

PROGRESS OF NICKEL-COPPER MINING 1897-1901.

Schedule.		1897.	1898.	1899.	1900.	1901.
Ore raised	tons	93,155	123,920	203,118	216,695	326,945
Ore smelted	"	96,093	121,924	171,230	211,960	270,380
Ordinary matte produced	"	13,706	21,101	19,109	23,336	29,588
High-grade matte produced	"	328	....	106	112	15,546
Nickel contents	"	1,999	2,783¾	2,872	3,540	4,441
Copper contents	"	2,750	4,186¾	2,834	3,364	4,197
Value of nickel	$	359,651	514,220	526,104	756,626	1,859,970
Value of copper	"	200,067	268,080	176,236	319,681	589,080
Wages paid	"	253,226	315,501	443,879	728,946	1,045,889
Men employed	No.	535	637	839	1,444	2,284

During the ten years beginning with 1892 and ending with 1901, according to the returns made to the Bureau of Mines by the producing companies, there have been raised from the nickel-copper and copper mines of Ontario a total of 1,306,722 tons of ore. Of this quantity 1,245,422 tons have been smelted into matte containing 52,411,000 pounds or 26,606 tons of metallic nickel, and 56,140,500 pounds or 28,070 tons of metallic copper. Computed at the selling prices of the refined metals in the New York market, the nickel was worth $20,500,000, and the copper $7,000,000, a total of $27,500,000, or an average annual output of $2,750,000. The production has been on a growing ratio, and the yield and value during the latter part of the 10-year period were much greater than in the earlier part. For instance, in 1892 there were 72,349 tons of ore raised, and matte containing 2,082 tons nickel and 1,936 tons copper produced ; while in 1901 the ore raised amounted to 326,945 tons, and the matte turned out by the furnaces contained 4,441 tons nickel and 4,537 tons copper. In 1892 the mines employed 690 men and paid out $339,821 in wages. In 1901 the number of workmen was 2,284 and the amount paid out in wages $1,045,889. The matte produced in 1892 was valued at $823,037, while in 1901 the product was worth $2,449,050. As stated, the foregoing figures include the copper produced by the non-nickeliferous copper mines of the north shore of lake Huron and elsewhere in the Province, but so far the output from this source has not been large. The prospects are, however, for a considerable increase from the purely copper mines at a not distant date.

The price of nickel remained steady throughout the year, being quoted at about 50 cents per pound in New York. The producing companies in the Sudbury district have been prosecuting their operations vigorously. These comprise the Canadian Copper Company at Copper Cliff, the Mond Nickel Company at Victoria Mines, and the Lake Superior Power Company. Matte is not yet being turned out by the last-named company, but the Gertrude and Elsie mines have been opened up and are yielding considerable ore, part of which is being roasted on the former property, where smelting works are also being erected. Picked ore from the Gertrude containing little or no copper is taken to the company's reduction works at Sault Ste. Marie for treatment. At Victoria Mines the Mond Nickel Company's plant began turning out matte during the year by the Bessemer process. The product is a high-grade article carrying about 80 per cent. metallic contents in equal proportions of nickel and copper, the iron in the ore being almost entirely eliminated. The matte is sent to Great Britain, where it is refined near Swansea, Wales, by Dr. Mond's own process.[3] The smelting establishment at Victoria Mines is well-equipped and modern in its appointments, and the offices and other buildings connected with the business are tasteful and substantial. Less than two years ago the site of the village was a swamp, but it now shows a number of comfortable houses with electric lights and other adjuncts of civilization.

The bulk of the nickel and copper is produced by the Canadian Copper Company, whose mines and works have now been operated for a period of about fifteen years. A feature of this company's business in 1901 was the opening of an immense deposit of nickeliferous pyrrhotite and copper pyrites on lot 10 in the first concession of the township of Snider, called the Creighton mine. This remained one of the company's many undeveloped properties until the construction of the Manitoulin and North Shore Railway from Sudbury rendered it accessible. The body of ore, which is exposed on the surface in very considerable dimensions, was sunk upon, and so far the work has been carried on as an open cut, shipments to the smelters at Copper Cliff averaging perhaps 500 or 600 tons a day. The ore is said to run higher in both nickel and copper than the average of the district.

A distinct advance in the treatment of the company's ores was made during the year by the commencement of operations at the Ontario Smelting Works, a plant established at Copper Cliff by Col. R. M. Thompson, president of the Orford Copper Company, with the object of re-treating the low-grade mattes produced at the Copper Cliff smelters and raising their metallic contents from 30 to about 70 per cent. This is effected by crushing, grinding, calcining and re-smelting the matte, thus getting rid of a great deal of the rock-matter, iron and sulphur, and producing an article so much nearer the point of actual refinement and separation of the metals.

THE NICKEL COMBINATION.

Since the beginning of the present year (1902) there have been many rumors of an impending sale of the Canadian Copper Company's mines to other American capitalists, and a recent publication[4] contains what appears to be an authentic account of the consummation of the transaction. What appears to have taken place is a consolidation of the Canadian Copper Company and Orford Copper Company, always hitherto closely allied, and the transfer of the properties and stock of these companies and of some other less highly developed Ontario concerns, together with certain nickel interests in New Caledonia and refining works in the United States, to a new company called the International Nickel Company, formed under the laws of the State of New Jersey with $12,000,000 common and $12,000,000 preferred stock, and $10,000,000 worth of bonds. Of this amount, $9,000,000 common and $9,000,000 preferred stock is to be issued to acquire the properties taken over. The Anglo-American Iron Company, which owns iron lands, mostly undeveloped, in the County of Hastings, and the Vermilion Mining Company, whose nickel property in the Sudbury district was looked upon as valuable in the early days of mining there but on which nothing has been done for many years, are non-active Ontario concerns acquired by the new corporation. The companies holding nickel lands in New Caledonia

3 Dr. Mond's works have a capacity of about 1,000 tons refined nickel per annum, but provision is made for increasing the output. The copper is recovered as sulphate of copper. Refining operations on a commercial scale began about 1st April 1902.

4 Engineering and Mining Journal, New York, April 5, 1902, p. 474.

are the Nickel Corporation, Limited, and the Societé Miniere Caledonienne, neither of which, so far as is known, has yet contributed much to the supply of nickel. The refining works owned by Mr. Joseph Wharton in Camden, N. J., are also taken over.

Actively interested in bringing the transaction to a close are said to have been Mr. Chas. M. Schwab, of the United States Steel Corporation, Col. R. M. Thompson of the Orford Copper Company, and Col. J. R. De La Mar. The officers of the International Nickel Company are, president, Ambrose Monnell, formerly assistant to the president of the Carnegie Steel Company ; chairman of the board, Col. R. M. Thompson ; general counsel, Max Pam, of the United States Steel Corporation ; treasurer, Stephen H. P. Bell ; secretary, Joseph Claudet. Other directors are E. C. Converse, of the U. S. Steel Corporation, Joseph Wharton, of Philadelphia, Dr. Leslie D. Ward, A. W. Maconochie, J. R. De La Mar, and Millard Hunsiker, of London.

The other great producer of nickel, Societé le Nickel, with its extensive properties in New Caledonia and its reduction works in France, which now divides with the Canadian Copper Company the duty of providing the world with this metal, is not included in the combination ; but it is stated that a full understanding has been arrived at between the new company and le Nickel as regards prices, production, and division of markets. Also outside the consolidation are the Mond Nickel Company, whose mines and works at Victoria Mines have been referred to, the Lake Superior Power Company, with mines in Creighton township, smelters under way at the same place, and reduction works at Sault Ste. Marie. There are also the Nickel Copper Company, whose works at Hamilton to operate the Frasch process of refining have not yet been put into operation ; the Dominion Mineral Company, and H. H. Vivian and Company, both of whom own lands and idle smelters in the Sudbury region ; the Great Lakes Company, and other companies, firms and individuals.

The combination by no means controls all the nickel ore in the district, and there is plenty of room for independent companies. Locally, it is believed that not more than one-fourth of the known deposits have passed into the possession of the new company.

The formation of the new corporation and the transfer to it of the properties at Sudbury have been accompanied by a partial cessation of work at the mines and smelting plants. This has given rise to apprehension in some quarters that the consolidation will have a prejudicial effect upon the development of the nickel industry in this Province. It is of course too soon to say what the result will prove to be, but the stoppage of work is not likely to be more than temporary, and there is little or no doubt that the new company with the ample capital at its command will operate the mines quite as vigorously as its predecessor in ownership.

A PROMISING COPPER DISTRICT.

West of the nickel region generally spoken of as the Sudbury district, which includes parts of the western side of Nipissing district and the eastern side of Algoma, lies a tract of Huronian rocks characterized in many places by deposits of copper sulphides. A typical example is that at Bruce mines, which upwards of forty years ago yielded large quantities of ore containing probably more than $3,000,000 worth of copper. Another vein of a similar nature has been opened up and is now being worked at Rock Lake, some twelve miles north of Bruce Mines, where a 200-ton concentrator began work about the beginning of the present year. A railway has been built to the mine from Bruce Mines on the Canadian Pacific Railway, which will be extended to deep water on lake Huron, so as to afford shipping facilities. At present the concentrates produced at the Rock Lake mine are being sent to Dollar Bay, Michigan, where they are smelted into copper, but a project is on foot for establishing a smelter either at Rock Lake itself or some other convenient point in the district at which the product from all the mines in the neighborhood could be reduced.

Other bodies of copper ore occur at the McMillan location in Aberdeen township, not far from the Rock Lake mine, at the Stobie mine near Desbarats station on the C. P. R., in the townships of Montgomery, Gould, Morin, Haughton, Gladstone, Plummer, Salter, Victoria, in timber berth No 153 and elsewhere over a district stretching from Massey station on the east to the east shore of Lake Superior on the west, and there is little doubt that if the region were better supplied with railway facilities, further exploration would take place which would bring many more deposits to light. It is well within the range of possibility, even probability, that this portion of Ontario will yet take important rank as a copper field. Other minerals occur, such as gold at the Ophir mine in Galbraith township once regarded as of promise, but not now being worked, and iron, of which there are prospects near lake Huron and indications along the upper stretches of the Mississaga river and elsewhere. There is a tract of country lying west of the tiers of townships accessible from Sudbury and vicinity, south of the main line and north of the Sault Ste Marie branch of the Canadian Pacific Railway, whose timber, minerals and agricultural resources are little known. There is reason to believe that extensive white pine forests exist in that region, all the more valuable because tributary to the north shore of lake Huron. Most of the rivers, too, are marked by good water powers.

Of purely copper ores, mainly derived from the north shore district just spoken of, some 6,800 tons were raised during 1901, having an estimated value of $47,180. The number of workmen employed in the mines and to operate the plants was 432, to whom wages amounting to $142,964 were paid. These statistics are included in those for nickel and copper. Practically none of these mines were in the producing stage during the year, which fact partly explains the size of the wage bill as compared with the value of the output. The Bruce Copper Mines were in operation about four months in 1901, but are now idle. The concentrating plant ran a short time and produeed over a hundred tons of concentrates, which were shipped to New York.

Iron Ore, Pig Iron and Steel.

The production of iron ore in 1901 was more than three times that for the previous year, 273,538 tons being raised and shipped as against 90,302 tons in 1900. The value of the ore was returned as $174,428, as compared with $111,805 for the preceding twelve months. Eight mines in eastern Ontario produced about one-twentieth of the whole, but by far the larger proportion of the ore was the product of the Helen mine in the Michipicoton Mining Division, which was worked steadily during the year. The shipments from the Helen were to the following points: Midland, Ont., 11,574 tons; Hamilton, Ont., 66,330 tons; Ashtabula, Ohio, 98,213 tons; Buffalo, N.Y., 65,612 tons; Cleveland, Ohio, 17,026 tons; total, 258,755 tons.

Of the ore mined 13,783 tons were magnetite and 259,755 tons hematite. The working force of miners which in 1900 was 439, was returned last year as 360. Wages paid rose from $107,583 to $231,039. The latter amount is considerably greater than the value of the ore produced, and an explanation of this is to be sought in the amount of preliminary work necessary in opening up a large mine like the Helen which does not immediately result in uncovering ore, and also in the fact that only the ore actually shipped is returned as produced, the remainder though raised to the surface being stored in stock piles awaiting the opening of navigation. Improvements have been made in the methods of operating the Helen mine, and an increased output is looked for during the current year.

The iron mines of eastern Ontario appear to be somewhat handicapped by the smallness of the scale on which they are worked and their irregular operations, and by the long land haul necessary to get their product to the smelting plants. The duty of 40 cents per ton on ore imported into the United States prevents the possibility of doing business with furnaces in Pennsylvania. If a furnace for making coke iron were established at some convenient point, say at a port on lake Ontario, the lighter freight rates which would result would be of material advantage to the mines of Hastings county and along the Kingston and Pembroke Railway. There is also the difficulty that in some of the ore bodies sulphur is developed in objectionable proportions as depth is attained, which unfits the ore for use in making charcoal iron. Consequently, the blast furnace at Deseronto, in which charcoal is the fuel employed, has up to the present time preferred to bring in Lake Superior ores of known and uniform quality not open to objections of this kind. Careful cobbing of ores at the mine might do much to eliminate sulphur, and even roasting might be resorted to in the case of rich magnetic ores without obliterating the margin of profit, in view of the usefulness of magnetite in making mixtures of ore for furnace charges.

In the township of Grattan, Renfrew county, the Canada Iron Furnace Company are opening up what gives promise of proving a large deposit of first-class magnetic ore. They have tested it with satisfactory results in their furnace at Radnor Forges, Quebec, and if their expectations are fulfilled in the matter of supply, they will use the ore to mix with that from the Helen mine at their Midland plant.

The unprecedented demand prevailing for iron and steel in the United States and the enormous drafts which are in consequence being made on the known sources of ore supply in that country[5] are very greatly stimulating the search for workable ore bodies in this Province. This is true especially of that portion of Ontario lying west of Port Arthur and contiguous to the international boundary, now traversed from east to west by the Canadian Northern (formerly the Ontario and Rainy River) Railway, the district adjoining lake Nepigon on the east and west, the Michipicoton Mining Division, and other sections tributary to lake Superior. A very large extent of iron "ranges" has been located in these and other districts of the Province, and in many parts of such ranges explorations are being vigorously conducted in the hope of finding deposits of ore of commercial size and quality. A good deal of prospecting was done last year by the Lake Superior Power Company and others in the region lying east of lake Nepigon as far inland as Long lake, and some of the more promising indications were tried by the diamond drill. The banded magnetite and jasper which outcrops on the surface has so far not proven to be underlaid with bodies of good ore, but the points at which it has been properly or sufficiently tested are few in number.

The investigations carried on for the Bureau of Mines by Prof. Miller in the northern part of Nipissing district last year and the year previous, and by Prof. Coleman in Western Ontario for several years past show conclusively that if surface indications and geological conditions are any guide, the discovery of important bodies of iron ores on the Ontario side of the line may be confidently looked for. The geological equivalents of the famous Mesabi and Vermilion iron-bearing series of Minnesota are undoubtedly found in Ontario, the former in the Animikie series of Thunder Bay extending from Gunflint lake eastward beyond Port Arthur, and the latter on Hunter's Island. The Michipicoton rocks are also considered by Van Hise parallel to those of the Vermilion district. At the same time, experience with the iron mines of the south shore of lake Superior leads to the belief that much careful exploration, probably to a large extent with the diamond drill, will be

[5] Prof. Van Hise, in his recent work on The Iron Ore Deposits of Lake Superior (Washington, 1901), emphasizes the fallacy of supposing that there is an inexhaustible supply of first-class ore in that region, and prophesies that material much lower in metallic contents than any now in demand, will yet come extensively into use. He says (p. 420): "The exhaustibility of high-grade iron ores in the Lake Superior region cannot be too strongly insisted upon, for belief to the contrary almost invariably results in lack of foresight and waste on the part of the operators. . . . The total product of the Lake Superior region since mining began in 1850 to 1900, inclusive, is 171,418,984 long tons. The amount mined in the decade between 1891 and 1900, inclusive, is 114,017,546 long tons, or 66.5 per cent., or nearly seven-tenths of the total amount mined. The product for the year 1900 surpasses that of any previous year and is one-ninth of the aggregate of this and all preceding years. It is certain that the product of the current decade will far surpass that of the last decade. The mining men should seriously consider how many decades' supply such as that of 1891 to 1900 of high-grade material is in sight, or even discoverable, on the United States side of the boundary. If this amount be placed at 1,000,000,000 long tons, mining at the rate of 20,000,000 tons per year would exhaust the supply in the first half of the twentieth century, or in about the same length of time that mining has been carried on in the Lake Superior region. The exhaustion within a few decades of the high-grade ores of the Lake Superior region *now discovered* is little short of a certainty. It is therefore plain that the material in which the percentage of iron is below the present market demand and which must be handled in connection with present operations should be stock piled, and that the mines be developed and exploited with the expectation in a comparatively short time of mining material running between 50 and 60 per cent. metallic iron, and within a comparatively few decades of material running between 40 and 50 per cent. metallic iron."

required to locate the ore bodies, and that the process may be both tedious and expensive.[6]

Diamond drilling was carried on on the Atik okan and Mattawin ranges last year, but without much definite result, except that considerable ore was found on the latter, too low in iron to be of present value. On the shores of Steep Rock lake float hematite of excellent quality found in the drift has led to the active taking up of mining locations, and work on some of these is being done to test their value. Several drills, including the larger one owned by the government, are now at work, and definite information may be looked for this year. An account of what is being done there will be found in the report of Mr. W. E. H. Carter, who visited the region in March, 1902.

The pig iron product of the blast furnaces of Ontario in 1901 was 116,370 tons valued at $1,701,703, an advance in quantity of 53,984 tons and in value of $765,637 as compared with 1900. The average per ton at which the pig iron was valued at the furnace in 1900 was $15.00; in 1901 it was $14.62.

The large increase last year was mainly due to the fact that there were three furnaces making iron during the year as against two in 1900, the Canada Iron Furnace Company's plant at Midland, of which a description was given in the last report, having been blown in about the end of 1900.

To produce the above-mentioned quantity of pig iron there were smelted 194,510 tons of ore, of which 109,109 tons were from Ontario mines, and 85,401 tons imported from the United States. Native ores thus constituted about 57 per cent. of the total quantity used, as compared with 23 per cent. in 1900, a decided gain in the utilization of the domestic product. As in 1900, the bulk of the home ore originated in the Helen mine. The smelting plants at Hamilton, Midland and Deseronto all carried on a steady campaign throughout the year.

The steelmaking department of the Hamilton Steel and Iron Company's plant produces an excellent quality of open-hearth steel; and in April, 1902, the Lake Superior Power Company's steel mill at Sault Ste. Marie began operations, converting pig iron, mainly from the Midland furnace, into Bessemer steel. The product of the Sault Ste. Marie plant will be ingots. rails, beams, channels and other structural shapes, and the annual capacity will be 200,000 gross tons of ingots and 180,000 tons of finished products. A description of the plant and methods of operation was given in the Bureau's report for last year.[7]

A plant for the manufacture of steel is now being constructed at Collingwood by the Cramp Steel Company, Limited, whose head office is 608 Temple Building, Toronto. Both the Bessemer and open-hearth processes will be employed, and the product will be steel rails, beams, plates, bar iron, rods, etc. The mill will have an estimated annual capacity of 200,000 gross tons.

The company also proposes to erect two furnaces for making coke iron with a daily capacity of 250 tons each.

The steel product of Ontario in 1901 was 14,471 tons valued at $347,280, as compared with 2,819 tons worth $46,380 in 1900.

The following table gives particulars showing the growth and development of the iron and steel-making industry in Ontario since pig iron again began to be made in 1896 after an interruption of many years:

[6] Discussing the possible iron ore resources of Western Ontario, Van Hise says in the work already quoted (The Iron Ore Deposits of Lake Superior), p. 411: "With one possible qualification, so far as one can see there is no known geological cause why iron ores should not extensively exist on the Canadian side of Lake Superior. This qualification is due to glacial erosion. . . . . It cannot be doubted that the glacial erosion was more vigorous north of Lake Superior than to the south. In so far as the glacial erosion was more vigorous, just to that extent more iron ore was lost north than south of the lake, and the conditions are to that extent less favorable for the existence of numerous large ore deposits. . . . . While, therefore, it may be possible that on account of glacial erosion the product of high-grade ore in Canada may be less than in the districts of similar size and geological position on the United States side of the boundary, it cannot be doubted that in the future important quantities of iron ore will be exploited in the Canadian Lake Superior region. Doubtless also this exploitation would have begun many years ago were it not for the duty which ores mined in Canada must pay when entering the United States."

[7] Rep. Bur. 1900, p. 63.

PRODUCTION OF PIG IRON FROM 1896 TO 1901.

Schedule.	1896.	1897.	1898.	1899.	1900.	1901.
Ore smelted .... tons.	51,138	37,492	77,023	110,036	100,692	194,510
Scale and mill cinder .. .. "	5,883	5,350	8,614	10,004	13,092	12,676
Limestone for flux .... "	8,657	9,473	13,799	25,301	24,927	51,452
Coke for fuel . ... "	30,348	27,810	50,407	74,403	59,345	113,119
Charcoal for fuel .... bush.	... .	....	... ...	.. ..	955,437	915.789
Pig iron product .... tons.	28,302	24,011	48,253	64,749	62,386	116,370
Steel product .... "	....	....	....	....	2,819	14,471
Value pig iron ....$	353,780	288,128	530,789	808,157	936,066	1,701,703
Value steel........................"	....	....	....	... .	46,380	347,280
Wages for labor ...."	47,000	40,000	61,476	79,869	97,915	274,554
Workmen employed ....number	125	130	130	200	419	580

Note. Statistics of charcoal used not collected previous to 1900.

Under the provisions of the Mines Act (R. S. O. 1897, cap. 36) a fund of $125,000 was created called the Iron Mining Fund, out of which a bounty is paid by the Government of Ontario on iron ore raised or mined and smelted in the Province at the rate of $1 per ton of the metallic product of the ore. An important restriction limits the annual payments to $25,000, consequently when the pig iron smelted from Ontario ores exceeds 25.000 tons in any one year, there is a *pro rata* reduction of the bounty. The bounty year ends 31st October, and last year was the first occasion on which the maximum amount of the bounty was called for there having been smelted during the twelve months ending 31st October 1901, 97,689 tons of ore raised from Ontario mines, the product of which was 55,214 tons of pig iron. The rate of bounty was accordingly reduced from $1 to $0.472 per ton. The companies and individuals to whom payments were made were as follows :

PAYMENTS OUT OF THE IRON MINING FUND FOR 1901.

Name.	Ore smelted.	Pig iron product.	Bounty.
	tons.	tons.	$ c.
Hamilton Steel and Iron Company	38,172	22,070	9,993 00
Canada Iron Furnace Company, Limited	56,000	31,159	14,108 46
H. C. Farnum, L'Amable Station..........................	1,477	764	345 93
Stephen Wellington, Madoc	142	78	35 35
Leopold Meyer, Ottawa	1,337	805	364 24
T. C Gordon, Ottawa	420	264	119 39
Sewmillee Iron Mining Company, Belleville	141	74	33 63
Totals............	97,689	55,214	25,000 00

The Iron Mining Fund, if not sooner exhausted, will expire 1st January 1906. The total paid out of the $125,000 appropriated up to the present time is $59,741.01 as per the following table :

Year.	Tons pig iron made.	Bounty paid.
		$
1896	4,000.00	4,000 00
1897	2,603.95	2,603 95
1898	8,647.19	8,647 19
1899	12,752.07	12,752 07
1900	6,737.80	6,737 80
1901	55,214.00	25,000 00
Totals..	89,955.01	59,741 01

Special provision is made in the Mines Act for payment of bounty out of the Fund on pig iron made by furnaces using charcoal or peat as fuel, such bounty to be at the rate of $1 per ton on the product of Ontario ores and 50 cents per ton on the product of ores not mined within the Province, provided that the proportion of Ontario ore shall not in any case fall below 20 per cent. No claim has so far been made under these clauses of the Act, as the only charcoal furnace in the Province uses imported ore almost exclusively, and so far no pig iron has been made in Ontario by the use of peat as fuel.

Zinc Ore.

Production of zinc ore was confined last year to the Zenith mine on the north shore of lake Superior. The quantity returned to the Bureau as raised during 1901 was 1,500 tons worth $15,000. The deposit was discovered many years ago, but remained dormant until 1899.

Actinolite, Graphite, Mica and Talc.

The townships of Hungerford, Elzevir and Grimsthorpe in the county of Hastings as well as Kaladar in the county of Frontenac are characterized by a band of serpentine or magnesite carrying bodies of actinolite or fibrous amphibole, which though not so highly prized as the silky asbestos of commerce which can be spun and woven, is nevertheless useful for various purposes involving resistance to the effects of fire. Near the village of Actinolite close to the boundary between Elzevir and Hungerford a deposit of this mineral has been worked for many years. A mill for grinding it is owned and operated by Mr. Joseph James, the product, which is fire-proof, being used in the manufacture of roofing material, also for side-walks and the foundations of buildings. Last year the output of the mill was 521 tons valued at $3,126.

Graphite is by no means an uncommon mineral in eastern Ontario, and deposits are known to exist along the Rideau canal and elsewhere. The only one at present being worked is the Black Donald mine on Whitefish lake in the township of Brougham, Renfrew county, the property of the Ontario Graphite Company of Ottawa. There is a large body of ore occurring between walls of limestone and extending under the waters of the lake. Some massive blocks, the largest of them 25 by 40 by 30 inches, were displayed in the Ontario mineral exhibit at the Pan-American Exposition at Buffalo, and elicited general admiration for their size and purity of material. Formerly, the crude graphite was shipped to the United States, but the company have now built at the mine a factory for treating and refining the ore which has a capacity of ten tons of finished product per day. Power for operating the machinery is brought from the Madawaska river, some two miles distant, where a water privilege has been developed and an electric power house constructed. The current is conveyed by a pole-and-wire line to the mine. This is the second instance last year in which the aid of neighboring water powers has been invoked for mining purposes, the other being at Deer lake, Peterborough county, whence power is now being taken for use at the Belmont gold mine at Cordova.

The output of graphite for the year was 1,000 tons valued at $20,000.

The high prices and active demand for mica which prevailed during the early part of 1900 were followed by a lowering of values and lessened activity during the remainder of that year and 1901, though there was a slight improvement towards the close of the latter year.

Part of the mica mined in Ontario as well as Quebec is extracted from the ground by farmers who employ their spare time in mining on their own places. Such operations are necessarily irregular and are confined to shallow pits or pockets, which are abandoned when exhausted of mica, or when working ceases to be profitable owing to low prices, lack of hoisting machinery or other causes. Production from this source can be increased or diminished with little trouble, and the output is regulated largely by market prices. When these are good, more attention is paid to getting out mica ; when demand slackens and prices go down, interest in the business declines, and production is curtailed by the simple process of the farmers and their sons devoting their time to more profitable or pressing work.

In last year's Report [8] allusion was made to the fact that the demand for mica in Great Britain was almost wholly supplied by the output of the mines of Bengal and Madras [9] and to the possibility of finding an outlet there for part of the Canadian product. Efforts were made by the Geological Survey of Canada and in other ways to introduce mica from this country into England. That these efforts have been successful is shown by the trade returns for the year ending 30th June 1901, which state that out of a total export of 979,258 pounds of mica from Canada valued at $149,588, 211,833 pounds, worth $26,959, went to Great Britain, nearly the whole of the remainder being exported to the United States. For the previous year the exports to Great Britain amounted to 14,429 pounds only, worth $1,765. Part of the credit for opening up this important market is apparently attributable to the advertisement which Canadian minerals received at the Glasgow Exhibition. A firm in Ottawa writes to the Bureau under date of 5th November 1901 : "Shortly after the Glasgow Exhibition opened, we had several inquiries for mica which led to sales. We now have our agents in London, and sales through them are increasing monthly. We have just made a contract to supply an English firm with $30,000 worth of mica."

The yield of mica in Ontario last year is reported as 427 tons, worth $37,219. Sydenham and Ottawa are the headquarters of the mica trade. There are works at these places and also at Kingston and Perth where the "books" or blocks of mica are split and "thumb-trimmed" for the American market. Most of the product is of the phlogopite or "amber" variety, and is exported to the United States for use chiefly in the manufacture of electrical apparatus, in which it acts as an insulator of the current. A very large proportion of the mineral taken from the ground is waste, owing to its being shattered, crumpled, or stained with iron, or consisting of pieces too small to cut into saleable sizes. This "scrap" mica finds a number of uses, being manufactured into coverings for boilers and steam pipes, also in making lubricants, wall paper, etc. There is a mill at Gananoque for grinding scrap.

Talc was mined in Ontario last year to the extent of 400 tons, having a value of $1,400. In 1900 the yield was 1,000 tons worth $5,000. The mine in the township of Huntingdon, Hastings county, which was productive in 1900, was not worked last year on account of disputes between the owner and the person operating it, but a quantity of mineral on the dump was shipped away. Last year's output was from a mine near Gananoque.

Arsenic.

The main source of arsenic in this Province is the mispickel of the county of Hastings, bodies of which are also found in the county of Frontenac and in the district of Nipissing east of lake Temagami.[10] The fact that in many cases the ore contains gold in payable proportions as well as arsenic gives the industry a double chance, though the refractory character of the ore defied for years all attempts to extract the gold at a profit, and many hundreds of thousands

[8] Rep. Bur. 1900, p. 135.

[9] The yield of mica from the mines of Bengal and Madras in 1900 was 916 gross tons. The value is estimated at 885,669 rupees, say $287,500, or about 14 cents per pound. It was the product of 131 "mines," employing 6,047 male and 3,470 female workers, or 9,517 persons in all. (Report on Inspection of Mines in India, 1900, Calcutta, 1901, p. 11 ; Mines and Quarries (Great Britain) 1900, London, 1902, Part IV., p. 332). From these figures, which show an output of about seven tons per mine and 215 pounds of mica for each person employed, it is clear that the mica deposits of India are worked spasmodically and on a small scale. Indeed, mica wherever found is characteristically "pocketty" in its manner of occurrence. Irregularity of operations and small workings are likewise features of mica mining in North and South Carolina and other parts of the United States.

[10] Mr. John Ferguson, vice-president and formerly manager of the Dominion Mineral Company, states that during the time he had charge of the company's operations, there was extracted from the Worthington mine in the Sudbury district 500 tons of arsenical pyrites carrying 28 per cent. nickel and 18 per cent. arsenic, which was sent to Swansea, Wales, for treatment. This would represent 140 tons of nickel and 90 tons of arsenic.

of dollars were expended in the efforts to find a suitable process. The adoption of bromo-cyanogen solutions for leaching the ores, however, solved the problem, and for some years the Canadian Goldfields Limited have been recovering both the gold and the arsenic at their Deloro works. An extended account of the arsenic resources of the Province and the uses for the mineral will be found in the paper by Mr. J. Walter Wells in this volume.

The production of arsenic rose from 303 tons worth $22,725 in 1900 to 695 tons having a value of $41,677, in 1901. It goes mainly to the United States where it is used in making Paris green and other insecticides, in the manufacture of glass and in other ways. The suggestion has been made that crude arsenic applied directly to the ground in agricultural operations would be valuable as a destroyer of objectionable insect life, and experiments by Mr. W. H. Stevens near Detroit some years ago seem to favor this opinion. It is probable that further tests to determine the usefulness of arsenic when employed in this way will be made during the present season at the Ontario Agricultural College, Guelph. If it be found to have the merits claimed for it when used in this way, a very large and important field will be opened for the employment of arsenic.

The difficulty of procuring capital to further the development of the arsenic industry in the Hastings district has led a number of those interested in mispickel properties and mining generally in that neighborhood to agitate for a government bounty on the production of arsenic. The aid asked for is $15 per ton, $5 to be paid by the government of Ontario and $10 by the government of the Dominion, the bounty period to be for seven years, and the rate per ton to decrease by one-third at the end of three years and by another third at the end of five years. It is stated that capitalists stand ready to embark in the business on a large scale if the application for a bounty is granted. Those concerned in the matter are confident that Ontario can easily supply the whole of the arsenic required on the continent of America, supplanting Germany and Great Britain entirely in the market of the United States, where little or no arsenic is produced.

Clay Products and Building Materials.

Clay products and building materials when grouped together take first rank in value of output among the non-metallic substances, and in the aggregate represent a very large amount both of labor and of value. It would be easy indeed to under-estimate the importance which the production of these articles plays in the economy of the Province. The raw materials of which they are made, mostly clay and limestone, are of little money value, and by far the greater part of the sum total which the finished products represent is contributed by labor. There are few parts of the earth's surface more abundantly supplied with limestone than the settled portions of Ontario ; and where outcroppings are wanting there is often a profusion of limestone boulders, the gathering and removal of which at once clear the ground and furnish material for the lime kiln. Similarly, pockets of clay suitable for brickmaking are plentiful, to say nothing of the Hudson River, Medina and other shales which require systematic quarrying to get at.

The rural brickyard and lime kiln afford useful and remunerative employment for many farmers and farmer's sons, and help in no small degree to furnish the work for want of a sufficient supply of which, now that felling the forests and cradling the harvests are things of the past, the agricultural districts of Ontario are annually losing so many of their young men to the cities of this country and the States and the new lands of the west.

Building materials, especially brick and stone, are expensive in transportation and hence cannot ordinarily be carried with economy very far. It is all the more fortunate, therefore, that in few parts of the Province are bricks, stone and lime difficult to procure or high in price.

The effect which this has upon the housing of farmers and the people generally is most beneficial, for it brings substantial and comfortable buildings within the reach of almost every one. Part of the lime and brick output is the product of large kilns and yards, particularly where situated within easy reach of a city market, but a large part also is turned out by the numerous small establishments whose owners in making returns to the Bureau frequently find it difficult to give exact particulars of the amounts paid out in wages, seeing that they do the work themselves or by members of their family. This is not so true of building stone, much of which is used in railway and other heavy construction work, and is of necessity produced systematically from quarries of considerable size.

Classifying building stone, common brick, pressed brick, terra cotta and lime as distinctively materials for use in erecting buildings, the inference to be drawn from the statistics of 1901 is that building operations have been going on pretty briskly, a deduction borne out at any rate by city dwellers throughout Ontario. For the last three years, the output of these four classes of material has been in value as follows :

PRODUCTION OF STONE, LIME AND BRICK, 1899–1901.

Material.	1899.	1900.	1901.
	$	$	$
Building stone, rubble, etc.	667,532	650,342	850,000
Lime	535,000	544,000	550,000
Common brick	1,313,750	1,379,590	1,530,460
Pressed brick and terra cotta	105,000	114,419	104,394
Totals	2,621,282	2,688,351	3,034,854

The average value of lime according to the figures returned to the Bureau was 13.4 cents per bushel as compared with 13.9 cents in 1900 and 12.3 cents in 1899 ; the price of bricks, on the other hand, again showed an increase, being $5.90 per thousand in 1901 as against $5.73 in 1900 and $5.61 in 1899.

The remaining clay products, namely, drain tile, paving brick, sewer pipe and pottery, were each turned out to greater value in 1901 than in 1900, the total increase amounting to $85,500. The following table gives a comparative statement for the last three years :

PRODUCTION OF OTHER CLAY PRODUCTS 1899 to 1901.

Material.	1899.	1900.	1901.
	$	$	$
Drain tile	240,246	209,738	231,374
Paving brick	42,550	26,950	37,000
Sewer pipe	138,356	130,635	147,948
Pottery	101,000	157,449	193,950
Totals	522,152	524,772	610,272

CEMENT.

Cement is also classed among materials of construction, but its use is by no means confined to buildings in the ordinary sense of the term. The employment of cement has of late years been extending in a multitude of directions, and it has been found capable of satisfactorily replacing not only clay products and stone, but also wood and iron for many purposes. In almost every variety of public works, such as canals, dams, breakwaters, piers, bridges, conduits, etc., cement plays a highly important part, and in the composition of buildings it is no longer restricted to foundations or floors, but finds much favor with architects especially in large modern steel and iron structures as a substance for embedding beams and girders to give additional strength, prevent oxidation and guard against the destructive effects of warping in case of fire. In the construction of highly specialized edifices such as grain storehouses, the durability and imperviousness to moisture of cement walls renders it very useful. The lead in using cement for storehouses has been taken by builders in some of the countries of continental Europe, but recently a huge elevator was put up for the late P. H. Peavey at Duluth, Minn., capable of holding 6,200,000 bushels of grain, on the "concrete and wire mesh system with steel tie rods as an additional strengthening," absolutely no wood whatever being used in the building.[11] The grain is stored in 50 bins or tanks, of which 30 are circular, the others occupying the interspaces between the circles. In one-half of the building the concrete walls, which vary from eight to twelve inches in thickness and are 104 feet high, are strengthened by 1½ by ⅜-inch flat bands placed horizontally and spaced eight inches apart. In the other half these straps are supplemented by a system of steel wire built into the concrete as a steel mesh. The concrete used was ordinary Portland of a leading brand, mixed in the usual way and by machinery. The structure is considered fire-proof, and no insurance is carried upon it. For roofing tiles, sewer pipes, culverts, for decorative and art purposes, for the manufacture of hollow building blocks to take the place of brick or stone, for the foundation of bank barns, and for a hundred other uses, cement is rapidly winning its way. One of the most noticeable methods of its employment is in the cement or "granolithic" sidewalks which are becoming so common in the cities, towns and villages of Ontario. In nothing is the march of improvement showing itself more in the smaller places of the Province than in the increased care which is being taken of the streets and sidewalks, and within the last three or four years many thousands of dollars have been spent in laying down permanent walks and pavements of which the leading material was cement.

A natural consequence of the increased use of cement has been a very marked stimulus to its manufacture. It is doubtful whether any other staple industry in the United States, not even excepting that of iron and steel in which there has been phenomenal growth, can show a record of equal expansion. In 1890 the production of cement in that country was 335,500 barrels, in 1899 it was 5,652,266 barrels and in 1900, 8,482,020 barrels. To supply the demand in the last-named year there were also imported into the States, mainly from Germany, Belgium and England 2,836,683 barrels, a quantity equal to the entire native production in 1897. From 1890 to 1900 the average rate of increase from year to year in the manufacture of cement in the United States was 40 per cent., and the output of 1901 will show no diminution in the ratio of growth. The chief centres of cement manufacture on the other side are Pennsylvania and New Jersey, which together contributed about five-sevenths of the aggregate production in 1900, but rapid strides are being made by Illinois and Michigan. In the latter State, indeed, there has been a veritable cement "boom." Nine factories were operated and five more were under construction in 1900, while an almost countless number were being projected. Marl is abundant everywhere and nearly every lake and marsh in the State are underlain by it.

The conditions in Ontario are not unlike those in Michigan. The raw materials of cement,—shell marl and clay,—are found on every side, though of course only those deposits conveniently situated with reference to transportation facilities can at present be made use of. With plenty of marl and clay, and with a prosperous and energetic community to afford a home market for the product, it would be surprising indeed if the cement industry had not established itself in

[11] The Iron Age, New York, 3 April, 1902, p. 13.

this Province. The first Portland cement in commercial quantities was produced in 1891, and since that time the business has grown in the manner shown in the following table, which includes also the production of natural rock cement, an article prior in the field.

PRODUCTION OF CEMENT IN ONTARIO.

Year.	Natural rock.		Portland.		Total.	
	Bbls.	Value.	Bbls.	Value.	Bbls.	Value.
		$		$		$
1891	46,178	39,419	2,033	5 082	48,211	44,501
1892	54,155	38,580	20,247	47,417	74,402	85,997
1893	74,353	63,567	31,924	63,848	106,277	127,415
1894	55,323	48,774	30,580	61,060	85,903	109,834
1895	55,219	45,145	58,699	114,332	113,918	159,477
1896	60,705	44,100	77,760	138,230	138,465	182,330
1897	84,670	76,123	96,825	170,302	181,495	246,425
1898	91,528	74,222	153,348	302,096	244,876	376,318
1899	139,487	117,039	222,550	444,227	362,037	561,266
1900	125,428	99,994	306,726	598,021	432,154	698,015
1901	138,628	107,625	350,660	563,255	489,288	670,880

In the Portland cement plants the number of workmen employed in 1901 was 460 and the amount of wages paid for labor $190,536 ; in the natural rock cement plants 89 men were employed and $35,460 paid out for wages ; in all, 549 workmen and $225,996 paid for wages.

An industry which in eleven years shows such a record of growth gives unmistakeable proof of being native to the soil, and the outlook is for still further advancement in the immediate future. In 1901 four factories making Portland and four natural rock cement reported their output. The former were the Canadian Portland Cement Company, Limited, whose works are situated at Strathcona and Marlbank, the Hanover Portland Cement Company, Limited, of Hanover, and the Owen Sound Portland Cement Company, whose factory is at Shallow Lake in the county of Grey. The Imperial Cement Company of Owen Sound, formerly the Georgian Bay Portland Cement Company, did not operate during the year, but expected to begin work again about 1st March 1902.

The producers of natural rock cement were the Toronto Lime Company, Limited, Limehouse ; Isaac Usher, Queenston ; F. W. Schwendiman, Rymal Station ; and Estate of John Battle, Thorold.

The Lakefield Portland Cement Company completed their works in the village of Lakefield, county of Peterborough, about the end of last year and began manufacturing on 2nd January 1902. Their marl supply is obtained from a deposit at Buckley's lake about two miles distant from the factory, and is transported direct to the mixer in the company's own cars and over their own railroad. Electric energy generated from a water power at Young's Point, five miles away, operates the plant which is of the most modern type. In February 1902 the company were producing at the rate of 300 or 400 barrels a day, their brand being known as the "Monarch," described as first-class in color and quality.

At the town of Durham in the county of Grey the National Portland Cement Company, Limited, has under construction a large plant to utilize the marl beds of Wilder's lake and elsewhere in the neighborhood. Marl occurs very abundantly in the town and vicinity. A switch has been laid from the Grand Trunk Railway to the factory, and also from the latter to Wilder's lake for the purpose of bringing the marl from that place. As the elevation of the lake is some 200 feet above the site of the factory, the transportation of the marl will be easily and cheaply accomplished. The buildings are extensive and substantial, being composed themselves largely of cement, and will be equipped with up-to-date machinery modelled on a recent Michigan plant. Electric power developed at falls on the Rocky Saugeen river will be used. The capital stock of the company is $1,000,000 divided into 10,000 shares of $100 each. The officers are; president, W. F. Cowham, Jackson, Mich.; secretary, P. W. Stanhope, Toronto; treasurer, Gilbert McKechnie, Durham.

At Owen Sound, the plant of the Grey and Bruce Portland Cement company is now in operation, and that of the Sun Cement company is approaching completion.

The increase in production of cement in Ontario in 1901 as compared with 1900 was, as shown above, 43,934 barrels of Portland and 13,200 barrels of natural rock cement. Prices however were materially lower, falling from $1.95 per barrel at the works in 1900 to $1.60 in 1901. Natural rock cement lost much less in value, the average in 1901 being 77 cents per barrel, as against 79 cents in 1900. The consequence of the fall in price was that while the production was considerably greater in 1901 than in the previous year, the value of the output was $27,135 less.

CEMENT IN THE UNITED STATES.

Competition with cements imported from the United States is complained of by some of the manufacturers, who state also that this had the effect of curtailing last year's output of the native article. The immense strides which the industry has made on the other side of the line have probably, in a measure at least, overtaken the demand and produced a surplus for which a market is now being sought in foreign countries. Trade statistics, do not bear out the impression that the Canadian market is fully supplied by home-made cement; indeed, they show conclusively that such is not the case. For instance, while the imports of cement into Canada for the twelve months ending 30th June, 1900, amounted to 1,312,170 cwt., worth $520,593, exclusive of duty, $151,075, for the 12 months ending 30th June, 1901, they rose to 1,614,666 cwt., worth $675,768, or adding $183,198 duty, to $858,966. The countries from which the imports were made were:

Great Britain	$230,584
United States	228,845
Belgium	142,936
France	2,787
Germany	70,170
Other countries	446
Total	$675,768

During the preceding twelve months the United States exported to Canada 55,569 barrels only, so that a very considerable increase took place in the importations from that country. Subsequent statistics show that supplies of cement are now coming into Canada from the United States at a highly accelerated rate. For the seven months ending 31st January 1902 the total import of cement amounted to $610,041, of which the United States furnished no less than $501,014, thus leaving Great Britain, Germany and Belgium far in the rear. So long as the requirements of Canada are not met by the products of her own factories, so long is there a possibility of increased sales for Canadian makers, and the reduction in price, while far from being an agreeable feature, may in the natural order of things be expected to lead to greater consumption. It will be the part of wisdom for those interested in or proposing to become interested in the manufacture of cement in Ontario to study well the conditions which prevail at home and abroad, with the view of avoiding over-production and its consequent demoralization of markets and values. In a recent official review of the cement industry of the United States, Mr. Spencer

B. Newberry, after referring to the remarkable expansion of cement making in that country during the past few years utters the following warning:

"It is to be feared, however, that factories are being established and extended with little consideration of the probable future condition of the market. For ten years each year has witnessed an increased consumption of Portland cement almost exactly equal to the increased output of our factories. It is hardly to be expected that this advance in demand can continue as in the past, at constantly increasing speed. The least check in the extension of the applications of cement, or a year in which the amount used is only equal to that of the previous year, will bring about a sudden and immense over-production, with great disaster to the smaller and less favorably situated manufacturers. Whether this will take place next year or the year following can only be conjectured; it is certain, however, that the day of keen competition among American producers is not far distant."[12]

When the day arrives of which Mr. Newberry speaks, not the last to feel the effects will be the manufacturers of our own Province, whose market is close to the great cement plants of the United States, and who may have to meet prices on a lower plane than any they have yet seen. But there is no reason why with the advantages of modern plants, cheapness of raw material and lighter freights in their favor, not to mention a tariff duty of 12½ cents per 100 pounds, the skilled business men who own and manage the cement works of Ontario should not find themselves as well equipped for a period of over-production and reduced profits, should such a period come, as their competitors in the United States.

CEMENT ROCK AT PORT COLBORNE.

Dr. A. P. Coleman furnishes the following notes respecting the occurrence of limestone suitable for the manufacture of water lime or natural rock cement on the lake Erie shore of Welland county:

The success of the natural rock cement works near Buffalo naturally calls attention to the fact that rocks of the same age and character cross the Niagara river and occur in Ontario. In order to investigate this matter a short examination was made of the formations about Port Colborne.

The excavations for the Welland canal, which passes through Port Colborne, furnish excellent specimens of the rock which can be studied with little trouble. The Corniferous rocks heaped along the sides of the canal are largely limestones with chert and numerous corals and other fossils, but as one goes north some portions have a more shaly character suggesting water lime, as just north of the Humberstone bridge, at the north end of lot 28 in the second concession of the township of Humberstone. The rock from the canal at this point, which is gray, fine-grained, and has a somewhat conchoidal fracture, contains neither chert nor fossils, and on analysis proves to have a composition suitable for cement. It belongs evidently to a bed below the Corniferous. The analysis made by Mr. A. H. A. Robinson of the Chemical Department, School of Practical Science, Toronto, gives the following results:

No. 1.	
Ca CO_3	44.68
Mg CO_3	36.27
Silica, Clay and Insoluble Silicates	16.14
Fe_2O_3 and Al_2O_3	2.46
Total	99.55

No. 2.	
Si O_2	12.32
$Fe_2 O_3$ $Al_2 O_3$	4.94
Ca O	25.02
Mg O	16.80
CO_2	39.13
Moisture	0.06
Total	98.27

In the first analysis the ingredients are reckoned as carbonates, in the second as oxides.

For the sake of comparison analyses of the rock from which the famous Rosendale cement is made are given below:

	Layer No. 9.	No. 13.	No. 17.
Ca CO_3	43.30	28.48	40.00
Mg CO_3	26.04	32.86	39.04
Silica, etc	18.52	26.00	11.10
$Al_2 O_3$	2.18	4.64	2 52
$Fe_2 O_3$	1.86	1.18	0.22
Alkalies	4.24	4.72	4.06

[12] United States Geological Survey; Twenty-first Annual Report, 1899-1900, pp. 398, 399.

It will be seen that the composition of the Port Colborne waterlime does not differ greatly from the Rosendale rock.

As it was thought that the same horizon might be found on higher ground, more favorably placed for quarrying, a visit was made to an outcrop on lot 7 in the second concession of Wainfleet township, to the west of Port Colborne. Here dark, somewhat bituminous limestone and also a lighter variety rise as a low escarpment a few feet above a swampy area to the south. The material appears to be too pure a limestone to serve for natural rock cement, and probably the waterlime must be looked for in the swampy tract to the south.

According to Mr. J. C. McRae, who was good enough to serve as guide to the region, the Corniferous limestone near Port Colborne is not more than 25 or 30 feet thick, the waterlime lying beneath it and, as one may see in Wainfleet township, a thin sandstone, probably Oriskany, overlies it. The latter rock is a coarse-textured, pale gray stone, only a few inches or a foot thick where we saw it, fitting into all the fissures of the limestone below, as if the lower rock had been weathered before the sands were deposited.

The Corniferous furnishes excellent material for lime burning and Messrs. Reeb and Sons have five large lime kilns some distance west of Port Colborne, near the shore of lake Erie. The limestone in their quarry is 10 to 15 feet deep, and the stone is unusually pure, containing, it is said, only a trace of magnesia. It is shipped to Hamilton as flux for the iron smelter and also to the carbide works. A large amount of lime is burnt in the kilns by a continuous process, natural gas being used as fuel, and the kilns at night are picturesque places.

Port Colborne is lighted with natural gas, which burns with a dull reddish flame, having only a low illuminating power. With incandescent mantles, however, an excellent light is furnished by the gas, which is a powerful fuel, but poor in the hydro-carbons burning with a bright flame. The generally level country rising but little above lake Erie is relieved from monotony by a row of tree-covered sand dunes along the shore of the lake, providing a picturesque summer resort.

A small collection of Corniferous fossils was made from the field boulders of the region and the rock dump along the canal. the commonest species being corals, some parts of the rock apparently having been practically a coral reef in the Devonian seas.

Mr. B. E. Walker of Toronto has been good enough to determine these as follows:[13]

1. *Favosites basaltica*, (*Goldfuss.*)	1. This variety was *Favosites epidermata*, (*Rominger.*)
2. " " "	2. This variety was *Favosites tuberosa*, (*Rominger.*)
3. " *hemispherica*, (*Milne-Edwards and Haime.*)	3. *Favosites Emmonsii*, (*Rominger.*)
4. *Favosites turbinata*, (*Billings.*)	
5. *Michelinia convexa*, (*d'Orbigny.*)	
6. *Diphyphyllum Simcoense*, (*Billings.*)	
7. *Blothrophyllum decorticatum*, (*Billings.*)	
8. *Streptilasma prolificum*, (*Billings.*)	8. *Zaphrentis prolifica*, (*Billings.*)
9. *Cystiphyllum visiculosum*, (*Goldfuss.*)	9. This variety was *Cystiphyllum Americanum*, (*Milne-Edwards and Haime.*)
10. *Cyathophyllum Halli*, (*Milne-Edwards and Haime.*)	10. *Heliophyyllum Halli*, (*Milne-Edwards and Haime.*)
11. *Cyathophyllum exiguum*, (*Billings.*)	11. *Heliophyllum exiguum*, (*Billings.*)
12. *Zaphrentes gigantea*, (*Lasueur.*)	
13. *Acrophyllum Oneidäense*, (*Billings.*)	*Clisiophyllum Oneidäense*, (*Billings.*)
14. *Syringopora perelegans*, (*Billings.*)	
15. " *Maclurei*, (*Billings.*)	
There is also a brachiopod :	
16. *Orthis* (*Rhipidomella*) *Livia*, (*Billings.*)	

The other fossils have been examined by Dr. W. A. Parks, who finds among them the following species :

Strophodonta demissa.
Strophodonta ampela. (?)
Leptæna rhomboidalis.
Amphigenia elongata.
Atrypa reticularis.
Strophodonta sp. (cast only.)
Spirifera sp.

13. Note by B. E. W.—The names in the left column are according to Lambe's revision. His revision may not in all cases be accepted, and the names in use until his revision are given in the right column.

Platyostoma, probably *linearis.*
Conocardium sp.
Enomphalus rotundus? (This may be a large *Platyostoma*, as only a cast is to be seen).
Fenestella, two species (impressions only).
Callopora, probably *macropora.*
Orthoceras sp.
Large crinoid column.
Dalmanella sp.
Fragment of a plate of fish (probably).

Calcium Carbide.

The discovery by Thomas L. Willson about ten years ago that powdered lime and coke dust fused in the intense heat of the electric furnace unite to form calcium carbide which when placed in contact with water at once decomposes with evolution of acetylene gas that burns with a brilliant flame, laid the foundation of a great industry, and brought the boon of first-class artificial light within reach of millions of people the conditions of whose life preclude the enjoyment of electric light or even ordinary illuminating gas. There are two carbide factories in operation now in the Province, one at Merritton and the other at Ottawa, the necessary power being obtained from the locks on the Welland canal and the Chaudiere falls of the Ottawa river respectively. The combined production of the two plants for 1901 was 2.771 tons worth $168,792, as compared with 1,005 tons valued at $60,300, which was the quantity made in 1900. The average value of the product was $61 per ton as against $60 in 1900, the number of workmen employed 83 as against 32, and the amount of wages paid $40,788 as against $15,898. At both seats of manufacture limestone of good quality is abundant, and cheap water power available.

The figures subjoined illustrate the progress of this industry in Ontario :

PRODUCTION OF CALCIUM CARBIDE 1897-1901.

Schedule.	1897	1898	1899	1900	1901
Carbide produced .... tons.	574	1,040	1,064	1,005	2,771
Value of product .... $	34,440	55,976	74,680	60,300	168,792
Workmen employed .... No..	30	35	48	32	83
Wages paid .... $	12,544	16,398	23,828	72,584	40,788

A recent British consular report [14] notes that up to the middle of 1900 about 10,000 horse-power with a capital of about £350,000 were devoted in Germany to the production of carbide of calcium, and that German capital had gone largely abroad for the same purpose. About the time mentioned there was a grave crisis caused by over-production in the carbide industry and prices since 1898 had declined about one-half. Acetylene gas lighting meanwhile had made rapid strides; over 420,000 jets were then installed, and about 36 small towns exclusively lighted by the new illuminant. A signal success was the adoption of the acetylene oil-gas system of lighting railway carriages by the Prussian and German State railways. It is said that for the whole of Europe the production of calcium carbide in 1900 was 60,000 tons. [15]

Salt, Gypsum and Iron Pyrites.

The production of salt in 1901 from the great beds which underlie the east shore of lake Huron and the waterways which conduct the waters of that lake into lake Erie was somewhat less in quantity, but nearly the same in value as in 1900, the yield for 1901 being 60,327 tons

[14] Diplomatic and Consular Reports No. 561, Miscellaneous Series, July 1901, p 72.
[15] Le Mois Scientifique et Industrial, 25 Janvier 1902, p 384.

valued at $323,058, which was 6,261 tons but only $1,419 less than the product of the previous year. Nine works were in operation as compared with ten in 1900, and wages paid to 189 workmen were $67,024 as against $72, 584 to 243 employees in 1900. Several plants are standing idle.

The gypsum industry shows little animation. One factory only is at work, that of the Alabastine Company of Paris, Limited, which transforms crude gypsum, mined in the neighborhood of Caledonia, into finished products such as calcined plaster and alabastine. The company manufactures a cement wall plaster, under the name of Paristone, which is claimed to be much superior to ordinary lime mortar in that it makes a harder wall and one that will not crack, and is specially adapted for internal plastering in winter, as it sets in an hour or so and is not affected by frost. Paristone is calcined gypsum treated with an animal retarder, then ground a second time. It is sold for $7.50 per ton at the factory in car lots, and its use is said to be little, if at all, more expensive than that of lime mortar. The employment of similar wall plasters in the United States has led to a great development of the gypsum industry in that country during the last few years, where experience has shown that they impart to the walls of office and other buildings a hardness and durability unknown in walls made of ordinary lime plaster. A factory for mixing calcium gypsum, sand and wood fibre has been established at Toronto. The product is called "wood fibre," and is used in building operations.

Iron pyrites to the extent of 7,000 tons, valued at $17,500, was raised in 1901. Most of the product came from a mine near Bannockburn, in the county of Hastings. It was exported to the United States for use in the manufacture of sulphuric acid.

Deposits of iron pyrites are known to exist in Darling township, on the north shore of Lake Superior, west of Port Arthur and elsewhere. Little has been done to develop them, however, and none of them except the deposit above mentioned were producers last year.

Corundum and Felspar.

A brief account was given in the Bureau's Report for last year of the agreement entered into between the government and the Canada Corundum Company, under which the latter undertook the development of some of the corundum deposits of north Hastings and west Renfrew.

The company has now been carrying on operations for upwards of two years, and has made substantial progress, notwithstanding the fact that many difficulties of treatment arising from novel conditions and untried material have had to be met and overcome. Mining, or more properly speaking quarrying, operations have been begun on the side of a "mountain" at the company's Craig mine in the township of Raglan, and the corundum-bearing rock is treated in a mill of which a description is elsewhere given. In the process the corundum is crushed, separated from the accompanying impurities—mainly felspar and magnetite—and graded according to the size of the grains from No. 12 to No. 200. The principal difficulty in treating the ore has been to make the concentration of the corundum sufficiently perfect, in other words to get rid of the impurities. This has now been achieved, and 98 per cent. purity is claimed for the product. The output of the mill is sold in Canada, the United States and Europe, and wheels manufactured from Craig mine corundum in Hamilton, Ont., and in the United States are said by those using them to be very satisfactory and to give excellent results, much superior for most purposes to wheels made of emery or any artificial abrasive.

A good deal of the value of a corundum or emery wheel depends upon the nature of the "bond" used in holding or cementing the grains together. The best results are obtained by the use of a bond which wears away as rapidly as the cutting points in the wheel became dulled or rounded, thus constantly exposing fresh edges for cutting or abrading. The principal varieties of wheels are known as "vitrified," "chemical," and "cement," these names having reference to the kind of bond used and the processes by which the wheels are made. Mr. Joseph Hyde Pratt thus describes the method of manufacturing these several kinds of wheels.

"*The vitrified wheel.* In the manufacture of this wheel more care is necessary in the selection of the corundum, for in the vitrification of the bond, if there are any foreign minerals present containing water, they are apt to cause the wheel to burst, and any that fuse easily will reduce or destroy altogether its abrasive efficiency. The corundum grains are mixed thoroughly in a paste of prepared clay and other fluxes, enough being added to make it of the right consistency, and it is then poured into paper moulds and set aside in a drying room until hard enough to be readily handled. When they are sufficiently dry they are subjected to a dressing or trimming process and shaped to approximate dimensions on a potter's wheel or shaving machine, and are then further dried. The excess of mechanical water having been driven off, they are then ready for the kilns. The kilns are cone-shaped, and the inside measurements vary from 12 to 20 feet in height and 10 to 18 feet in diameter. When the kiln is filled, the entrance is closed and sealed and the fires are started. The temperature is allowed to rise but slowly until all the water of mechanical mixture and of crystallization in the foreign materials is driven off, when the temperature is raised to about 3,000° F. or to a white heat. This heating process requires several days. The clay and other fluxes fuse and form a porcelain setting for each grain or fragment of corundum, which makes a strong bond. The kilns are allowed to cool slowly, a number of days being required for this. The kiln is then opened and the wheels are brought to a lathe, called the "truing machine," where they are turned to the exact dimensions desired, the hole is bushed to the exact size, and the wheel is then trued and balanced ready for shipping.

The chemical wheel. In the manufacture of this wheel, which is made by the silicate process, silicate of soda is used as the binding material. The silicate is thoroughly mixed with the emery or corundum and with some drying material and tamped into moulds. It is then subjected to an "oven" heat for twenty-four hours, after which it is removed and finished according to the method described above for the vitrified wheels after their removal from the kilns. Wheels over 2,000 pounds in weight have been made by this process.

The cement wheel. In making the cement wheel, shellac, rubber, linseed oil and other substances are used as the binding material. This makes a soft wheel that is well adapted for roll and surface grinding when made with shellac, and for saw gummers and thin wheels when made with oils."[16]

Corundum is said to require a different bond from emery, and some disappointments at first experienced with wheels made from the Ontario article were traceable to the unsuitableness of the binding material used. This trouble, it is stated, has been got rid of, and a satisfactory bond provided. The purity and first-rate cutting qualities of the Canadian corundum are rapidly bringing it into favor with the largest users in this country and the United States.

The output of grain corundum in Ontario for 1901 was 534 tons, worth $53,115 at the mine. The number of men employed was 68, and $30,406 was paid out as wages for labor.

PRODUCTION OF CORUNDUM ELSEWHERE.

Production of corundum in the United States during 1900 was confined to one mine, the Corundum Hill, situated on Cullasagee creek, near Franklin, Macon county, North Carolina. The quantity produced was 4,305 tons valued at $102,715, and the imports of emery amounted to 661,482 pounds of grains worth $26,520, and 11,392 long tons ore or rock valued at $202,980. In addition $10,006 worth of mannfactured goods were imported, making a total importation of corundum and emery of $239,506.

Corundum and emery are not specified by name in the British trade returns, but it is learned from Mr. A. C. Wood, Principal of the Statistical Office, Custom House, London, that the importations of emery into Great Britain during the calendar year 1901 amounted to 12,208 gross tons valued at £56,181. In addition, 93 gross tons of corundum were imported, worth £2,161. The emery came entirely from Greece and Asiatic Turkey, the corundum from Madras and Bengal.[17]

[16] Bulletin of the United States Geological Survey No. 180. The Occurrence and Distribution of Corundum in the United States, 1901, pp. 77, 78.

[17] The production of corundum in India in 1900 is given in the Report on the Inspection of Mines for that year as 69½ tons, all of which was raised from the mines of Madras.

These figures enable us to form an approximate estimate of the quantity and value of the corundum and emery required annually to supply the wants of the United States and Great Britain. Adding the production and imports of the former country to the imports of the latter, a total is obtained of about 31,000 short tons worth about $630,000. No discrimination being made between corundum and emery in giving the output of the mines in the United States, it is not possible to say how much of this was one and how much was the other. Assuming that the rest of the world will afford a market for somewhat less than the combined requirements of these, the two foremost manufacturing nations, the conclusion is reached that about a million dollars worth of corundum and emery are consumed yearly in the aggregate. Other abrasives known to commerce compete to some extent with corundum and emery, such as garnet, carborundum, etc. The manufacture of the latter, which is a silicide of carbon, made by fusing silica and carbon in the electric arc, has grown rapidly since it began about 1893. It is made at Niagara Falls, N.Y., and in 1900 the production was 2,401,000 pounds.

Felspar amounting to 5,100 tons and having a value of $6,375 was produced in 1901 from a mine or quarry in the township of Bedford, Frontenac county, owned by the Kingston Feldspar Company. The product is a microcline containing 12 or 14 per cent. of potash, and is of a highly satisfactory quality for pottery-making purposes. It is exported to Trenton, N.J. The deposit is large and easily worked. The percentage of potash present in this mineral has suggested the possibility of utilizing it as a raw material from which to obtain one or other of the salts of potash so valuable for use as fertilizers. The huge blocks of felspar exhibited by the company at the Pan-American Exposition were much admired.

Petroleum and Petroleum Products.

There was again a decline in the quantity of crude petroleum from the oil fields of Ontario as compared with the preceding year. The yield was 21,433,500 Imperial gallons, against 23,381,783 in 1900 and 23,615,967 in 1899. There is little doubt that a slow process of diminution is going on in the area at present productive, and a falling off must be looked for from year to year, unless counteracted, as in the main it so far has been, by an extension of the oil-bearing territory. The oil-fields of Ontario are probably unique in the world in respect of the large number of producing wells and the smallness of the individual yield. There are not less than 10.000 wells now giving oil, the average product of which is less than a quarter of a barrel per day. The very fact that the individual output of the wells is so small, and that production has been going on in this manner for so many years, is an indication that the yield may be expected to continue at a similar, or slowly reducing rate, for a long time to come, rather than a sign that any sudden exhaustion of the field is to be apprehended.

Following are the figures of petroleum products for the last three years :—

PRODUCTION OF PETROLEUM AND PRODUCTS 1899–1901.

Product.	1899	1900	1901
	$	$	$
Illuminating oil	1,059,485	1,076,242	798,149
Lubricating oil	189,294	232,805	78,975
Benzine and naphtha	148,963	174,346	122,781
Gas and fuel oils and tar	213,544	200,934	139,753
Paraffin wax and candles	136,066	184,718	165,882
Crude used for fuel and gas-making	......	... ...	162,400
Totals	1,747,352	1,869,045	1,467,940

Until recently practically all the crude oil raised was refined, but improvements in methods of retorting have led to a considerable use of crude in gas-making, for which it is now by some preferred on equal terms to gas oil. In 1901 a considerable quantity, estimated to be about 3,500,000 gallons, was deflected from the refineries and used in making gas or for fuel. The effect of this was to reduce the quantity and value of illuminating oil and the various other products of refinement, and to assist the smaller yield in lowering the gross value of petroleum and petroleum products, as compared with 1900

Mr. Charles Jenkins, president of the Petrolea Crude Oil and Tanking Company, Limited, who has had long experience in the Ontario oil fields and is thoroughly informed on all movements of the industry, states that from a variety of causes a demand from gas and fuel men came straight on the crude last year, and more shipments of crude oil as such were made in 1901 for these purposes than ever before. This quantity from his actual knowledge was not less than 100,000 barrels. Speaking of developments in the oil trade, Mr. Jenkins says that decided changes have been made in the commercial grading of crude oil as well as in the processes of refining since the great refining consolidation took place in 1898. More rigid conditions are now applied to the estimation of extraneous matter such as water and decomposed rock, etc., held in frost-pumped crude than was possible where a number of competing buyers were after it all the time, and this in turn has led to a larger percentage of oil products being taken out of a specific quantity of crude than formerly. Then, the varieties of crude oil produced in the United States brought about a development of uses for light production, and fractional distillation was carried to a point not commercially practicable then in Canada. The uses spread, however, and the demand for gasolines and benzines increased very largely here. Our refiners then had been adapting themselves to the altering conditions, but the change was at once made up to date when the one refinery absorbed all the others. The gain in the lighter products and burning oils is offset by the decline in gas oils and tar, but there is a positive gain beyond that. The refining process as carried on in this Province now is said to take 98 per cent. out of the crude ; formerly to obtain as much as 94 per cent. was looked upon as good work. The difference is won by complete condensing power, and the fractional distillation possible by steam.

In Mr. Jenkins' opinion the natural time for oil statistics to be taken is 30th June, which is the end of the oil year. Circumstances are apt to cause differences from year to year in figures collected as of 31st December. A cold snap, for instance, will keep back from delivery 30,000 to 50,000 barrels at any time, and stocks at the wells have to be reckoned on before an accurate account of production can be given. It must be admitted, however, that the aggregate yield of crude oil is falling off, but in a perfectly natural way. All the world over, when a field is once thoroughly defined and worked, the percentage of yield begins to decline. In Ontario no additions were made in the working territory in 1901, and it may be estimated under these circumstances that there is an average yearly decline of about five per cent. Several times during 1901 it seemed likely that a clear addition would be made to the producing territory, but the reports of new strikes were not confirmed. Mr. Jenkins says : "They will come yet. When I came here, it was in this vicinity alone that oil was pumped. Since then it spread out through a large part of Enniskillen and well up in the townships of Sarnia and Plympton. Oil Springs was revived, Bothwell revived, Dawn, Euphemia and Dutton discovered, and one of these days we will have another, for as it has been, so it shall be."

A feature of the industry last year was the revival of the business of refining at Petrolea. One result of the consolidation of the oil interests in the hands of the Imperial Oil Company four years ago was the closing of the refineries in Petrolea and the opening of an establishment at Sarnia at which all the refining has since been done. It has been found that the economic methods necessary in selling petroleum products call for special plant equipments at suitable distributing points, with power to handle every product freely in bulk, which must be controlled by the refining interests. Some of the so-called independent concerns in the United States had developed a trading system in Canada, and Canadian products being called for a refinery had to be erected. An up-to-date plant has therefore been put up at Petrolea on the site of one which was operated years ago. The owners are the Canadian Oil Refining Company, whose headquarters are at Hamilton. All the products will be manufactured that modern science has shown can be taken out of crude petroleum.

The price of crude oil varied somewhat during the year. It opened at $1.60 per barrel and fell off to $1.40 owing to the great Texas field coming in, but the oil there being as yet suitable for fuel purposes only, the market gradually recovered until it touched $1.66. It then declined to $1 61, at which it closed the year.

Small quantities of American crude are brought in, but there is no general importation of crude from the United States to be manufactured here. A great many varieties of crude are produced on the other side, and some of them without any distilling are suitable for compounding with other substances for lubricating oils, the kinds and varieties of which are legion. The making of lubricants is a special business, and each manufacturer or power-user has his own ideas and wants, which must be catered to. It is mainly for such purposes that crude oil finds its way into Ontario from south of the line.

Natural Gas.

There was $50,640 worth less of natural gas produced in Ontario in 1901 than in 1900, the figures of production being $392,823 and $342,183 respectively. In 1899 the yield was valued at $440 904, so that in two years the falling off has been over $100,000, or nearly one-quarter of the output in 1899. The wells producing gas number 158, and 368 miles of pipe were needed to distribute the gas. Sixteen producing and 14 non-producing wells were bored during the year. The number of employees which in 1900 was 161 fell to 129 in 1901, while wages paid for labor rose from $43,636 to $59,140.

The receipts from taxation of natural gas companies under the Supplementary Revenue Act (62 (2) Vic., cap. 8) were as follows :

F. P. Byrne, successor to Interior Construction and Improvement Company	$1,882 49
Provincial Natural Gas and Fuel Company of Ontario, Limited	2,382 02
United Gas and Oil Company of Canada, Limited	4,262 73
Total	$8,527 24

The principal cause of the diminution in the yield of natural gas was no doubt the action taken by the government of the Province in putting an end to the export of gas from the Essex county field to Detroit. It was mentioned in last year's Report that evidences were not wanting of a serious falling off in the supply of gas, and that apprehensions were entertained by the people of Essex that if the export were allowed to go on, there would soon be none left for home use. The government was therefore urged to annul the license of occupation by authority of which the pipe lines for conveying the gas across the Detroit river were laid in the bed of that stream, as power was reserved to it in the instrument to do. Petitions were received from the corporations of the city of Windsor, the towns of Sandwich, Kingsville, Leamington and Essex, the township of Gosfield South, and many inhabitants of the county of Essex, praying that the export of gas might be stopped. In order to arrive at the facts the government directed Mr. Charles Stiff, C.E. to investigate the conditions surrounding the production and distribution of natural gas in Ontario, including the Welland as well as the Essex field, in the meantime serving notice upon the parties interested that it was proposed to cancel the license of occupation. Mr. Stiff visited the localities and his report addressed to Hon. J. M. Gibson, Attorney-General, dated 7th August, 1901, is printed herewith, as giving a clear and business-like view of the situation :

THE GAS REGIONS OF ONTARIO.

SIR,—In accordance with your request I have investigated the condition of the natural gas production and distribution, and now submit report upon the existing state of affairs :—

The Essex Field.

The natural gas fields are in the southern part of the county and are confined to a strip of land about seven miles in length and two miles in width adjoining lake Erie in the townships of Gosfield and Mersea.

The operations are under the control of three corporations, viz : The United Gas and Oil Company of Ontario, the town of Kingsville and the town of Leamington.

The first named company, organized under an Ontario charter, acquired the rights of their various predecessors and have a capital of $500,000 and a bonded indebtedness (6 per cent.) of $1,000,000. Their earnings for the year ended 31st May 1901 were :

From Canadian business	$ 116,032 88	
" Detroit "	137,334 12	
		$ 253,367 00

The operating expenses for the same period were :—

Salaries and wages	$ 46,291 38	
Lease rentals	10,995 86	
Taxes	9,641 80	
Various	12,464 24	
	79,393 28	
Add interest on bonds	60.000 00	
New wells and plant	35,895 99	
		175,289 27
Available for depreciation and dividends		$ 78,077 73

The output for the year was :

Exported to Detroit	1,373,341,200 cubic feet.
Supplied consumers in Essex	865,983,000 " "
Total	2,239,324,200 " "

As regards the export to Detroit, the gas is used mainly for domestic purposes (heating and cooking). None is used for manufacturing purposes, but it is also used to some extent for mixing with artificial gas for illuminating, the quantity so used being approximately ten per cent. of the total consumption of artificial gas and estimated at 90,000,000 cubic feet per annum or about six and a half per cent. of the total exported.

Of the consumption in Essex there were, in

Windsor	1,929	consumers	using	446,261,000	cubic feet.
Walkerville	329	"	"	291,096,000	" "
Sandwich	76	"	"	17,358,000	" "
Essex	126	"	"	31,773,000	" "
Kingsville	10	"	"	64,118 000	" "
Leamington	53	"	"	9,659,000	" "
Ruthven	32	"	"	5,718,000	" "
Total				865,983,000	

A considerable portion of this consumption is for manufacturing establishments as fuel for boilers, but the main portion is for domestic purposes (heating and cooking).

This company has 73 employees, and there are 462 lessors who receive $50 per annum for each well in operation, free fuel, and 25 cents per acre for the right to exploit.

The gas is conveyed to Detroit by three main pipes from the gas fields, the total length of pipe being 94 miles.

The number of wells drilled by the company is 95, of which 52 are producing gas ; 21 were abandoned ; 22 were dry holes and there are now five being drilled.

In considering what effect the stoppage of exportation would have upon the consumers and upon this Company I broached the subject to the manager, Dr. King, and the secretary of the company, Mr. Kennedy, and I gather from their remarks that the courts will be appealed to to prevent such stoppage. No doubt your Government has considered this phase of the question, and I introduce it now with the object of pointing out that if such stoppage does take place there is no reason to suppose that the company would cease operations, the earnings from Canadian business being 46 per cent of the total earnings and capable of being increased. I consider that the expenses might be materially reduced, and while I do not think there would be sufficient after allowing for depreciation of plant to pay a reasonable return on the capital stock and bonded indebtedness of $1,500,000, yet I am satisfied that there would be sufficient to produce a reasonable return for the money expended on the enterprise.

This company has now obtained the services of the manager of the company which operates in Welland, Mr. Coste, with a view of improving the supply, and he tells me that of the wells producing gas, 52 in number, three-fourths are loaded with salt water and are not producing gas in great quantities in consequence. He considers that if they were pumped out and kept free a large quantity of gas is still to be obtained. He says, too, there has been great extravagance and waste of gas, the field lines being in bad shape and numerous leaks existing in the main pipes which convey the gas to Detroit, of which I had ample proof while driving along the road on the side of which they are located. I mention this for the purpose of showing that the gas company are taking steps to improve the supply, and as already stated they are now drilling five new wells.

The town of Kingsville own their own plant and wells, purchased at an expenditure of $50,000, and supply 500 consumers at very moderate rates for domestic purposes—heating and cooking. The revenue derived after paying working expenses has covered the outlay, but it has not been devoted to this purpose. and the fear of failure of supply and consequent loss of revenue therefrom is looked upon with alarm, for it would leave them with a debt incurred for the purchase of the plant and cost of wells without anything to represent it, would cause considerable loss to consumers who would have to revert to the old system of heating and also pay increased cost of fuel which is now supplied by the town at very low rates, viz., $1.25 per month per stove ; $15.00 per annum for furnaces for large residences ; $10.50 per annum for stove and office heaters. In addition to this low cost the use of gas has proved such a great convenience that its disuse would be much felt.

This town induced several manufacturing establishments to locate there under a promise of free fuel so long as there was a surplus above what was required for domestic use, but as there is now no such surplus these establishments have to obtain fuel from other sources and the fear of losing these establishments is also a source of anxiety to the townspeople. Hence the desire, which is almost unanimous, for a stoppage of the exportation, which they hope will prolong their supply and the benefits which they have derived from it. It is convenient at this point to refer to one of these manufacturing establishments, the Glass Company, who are now supplied with gas by the United Gas and Oil Company at the very moderate charge of 5 cents per 1,000 cubic feet, and whose consumption at the present time is at the rate of 50,000,000 cubic feet per annum, which equals about four per cent. of the quantity exported to Detroit.

I presume that the Kingsville people, in common with others in Essex, thought that they had an unlimited supply of gas and have not been as careful of it as they would otherwise have been, for undoubtedly there has been great waste. At one time the streets were lighted with this gas and kept lighted day and night, a large flambeau was allowed to burn day and night for two years on one of the public buildings, and at the present time the system of charging the lump sum per stove instead of by meter consumption must be productive of waste.

The town of Leamington also own their own plant and wells, but have not invested as much money as Kingsville, the total amount being $25,000. The revenue after paying working expenses during the last three years has been sufficient to clear this off, but as at Kingsville it has been applied to other purposes. There are 700 consumers and the same conditions exist as at Kingsville. Factories have been supplied at nominal rates and domestic consumers at low fixed sums, no meters being used, and the feeling is unanimous that the exportation should be stopped with the expectation that the benefits they have derived from this gas supply will be prolonged.

The complaints of scarcity of supply during last winter were well founded, and the fear of a repetition of the scarcity has induced many persons to provide against it by supplying themselves with other means of heating. As an illustration of this the public schools in Windsor had to be dismissed on several occasions last winter in consequence of inadequate heat and the school board has decided to order coal to provide against a recurrence during the coming winter.

During my visits to Essex I saw a number of the manufacturers who use natural gas, interviewed a number of the domestic consumers, also several of the farmers on whose lands the wells are, saw the mayor and leading citizens of Windsor, Walkerville, Kingsville, Leamington, and also the Ontario and Dominion members of parliament, and I think I am safe in saying that the feeling in favor of stopping the exportation is almost unanimous. Nevertheless it must be borne in mind that the views are those of interested parties—I may say selfish views—and in dealing with this question you will no doubt not overlook the claims of those who have invested large sums of money in developing this enterprise, and by whose means the residents of Essex have received cheap fuel and comfort. (The land owners on whose farms the wells are located in addition to being paid for the privilege of using their land, get their gas free.)

To cut off a considerable part of the revenue of this company by stopping exportation altogether is of course a serious matter, but may be justified by the exigency of the situation. Certainly the people on this side of the river are justified in protesting against their supply becoming deficient by reason of the too considerable export which has been going on.

A petition was sent to the Ontario Government dated 6th March, 1901, by the town of Windsor asking that the export of natural gas be stopped. A copy of the petition I enclose, and would call your attention to a paragraph in it which I have marked in which the following words are used :—

"Should interpose its authority and restrain gas companies from piping gas out of the Province *except any excess remaining after local necessity be met.*"

The paragraph coincides with what I consider would be an equitable settlement of the question.

The Gas Company might be allowed to export any excess after local requirements have been met providing the depletion of the field be not thereby unduly accelerated, and the license might be renewed and continued under conditions which will protect the Province, in this respect being of course a matter of arrangement.

The Welland Field.

The gas fields in this county extend over a larger area than the Essex field.

The Provincial Natural Gas and Fuel Company of Ontario is the only company exporting gas. This company's capital is now $240,000, having been reduced from time to time in pursuance of a wise policy of providing for the ultimate giving out of the gas. The city of Buffalo is supplied mainly from the Pennsylvania fields, and the Welland fields are used as an auxiliary supply during the winter months.

The quantity exported in 1900 was 563,957,000 cubic feet, and the quantity supplied consumers in Canada 51,164,000 cubic feet. The company supply 432 consumers in Welland, viz., in Bridgeburg, Fort Erie, Sherkston and Stevensville. The gas is used for lighting as well as heating, also as fuel for boilers.

The Company has sunk 145 wells, of which 63 are non-productive. The gas is conveyed across the Niagara river in one 8-inch and four 6-inch pipes.

There are 127 lessors who receive various amounts, generally $50 per well per annum and free gas, also 25 cents per acre for the privilege of sinking wells on other fields.

The Mutual Natural Gas Company of Port Colborne (capital $20,000) and the Producers' Oil, Gas and Mining Company of Welland (capital $30,000), both under one management at Port Colborne, own 25 producing and 4 non-producing wells, supply Port Colborne, Welland and Humberstone with gas for heating and lighting purposes and occupy land from 50 lessors who receive varying rentals and free gas.

The firm of R. & J. W. Greenwood also own wells and supply 90 consumers in the town of Port Colborne to a limited extent, another company supplying the village of Ridgeway and still another the village of Stonebridge.

Messrs. Carroll Bros. of Sherkston have 20 wells, the product from which is used by themselves for fuel in lime-making.

From inquiries I have made there are no complaints of shortage of supply in the county on the part of the local consumers and all agree in commending its economy and convenience. As an illustration of its cheapness, one of the consumers tells me that his entire bill for heating and lighting one room for one month amounted to 70 cents.

In my opinion whatever conclusion is come to as to stopping the exportation in Essex there is nothing to warrant stopping it in Welland; indeed it would be a great hardship to the farmers who receive rentals for the use of their fields and free gas, as the limited number of local con-consumers would hardly warrant the Provincial Gas and Fuel Company continuing to carry on their business.

An Order-in-Council was passed 26th October 1901 revoking the license of occupation by virtue of which the gas from the Essex field was being exported. The companies interested in the export of gas, the Interior Construction and Improvement Company and the United Gas and Oil Company, contested the Government's right to bring the business to an end, and the dispute found its way into the courts, but was finally decided on 10th December 1901 in favor of the Government. None of the product of the Essex natural gas field is therefore now being sent across the Detroit river.

Gas was struck by the Grey and Bruce Oil and Gas Company Limited, at Hepworth, in the township of Amabel, Bruce county. Mr. E. P. Rowe, secretary-treasurer of the company, supplies the following logs of wells, and other particulars :

	No. 2 ft.	No. 3. ft.	No. 4. ft.
Drift	8	28	16
Top lime, Niagara and Clinton	200	225	200
Green shale, Niagara and Clinton	9	7	9
Red rock, Medina	60	60	60
Slate (blue shale)	40	40	40
Lime	40	40	40
Slate	25	25	25
Red rock	85	85	85
Slate	70	70	70
Red rock	20	20	20
Slate, soft	468	467	467
Top of black shale, Utica	1,025	1,067	1,032
Top of Trenton	1,050	1,092	1,057
Gas	1,409	1,505 (dry hole)	1,421

No. 3 well was dry. Gas was found in the Trenton in each case at a distance from the top of that formation of about 350 feet. The wells have a uniform pressure of about 425 lb. to the square inch, and the indications are for a large supply, the pressure having diminished very little after more than one year's use. The product is utilized for light, heat and power in the village of Hepworth, and it is intended to convey it as soon as possible to Shallow Lake and Owen Sound for similar purposes. A fifth well was being put down in February last.

Borings for oil or gas were made by a syndicate called the Port Hope Oil and Gas Fund on what is known as the "mill concession," at the corner of Cavan and Barrett streets, Port Hope, concerning which Mr. P. H. Passy, secretary of the Fund, has furnished particulars. At 596 feet the drill struck what was thought by the driller to be granite, but which was more probably Potsdam sandstone. A pocket of gas was encountered at about 100 feet and a greater flow at about 20 feet from the bottom of the hole, which gave a pressure of about 100 lb. to the inch. Water was struck at 30 feet from the surface, but was cased off, and the remainder of the hole was dry. A second well was put down some distance away, and several small shows of gas were obtained, but no oil. Salt water was struck at a depth of 574 feet when the drill was in all likelihood again in the Potsdam.

Molybdenite.

There has been considerable inquiry for molybdenite for the last year or two, and the mineral is known to exist in various parts of the Province, principally in the eastern counties, though no actual mining of it has yet been done. The principal use to which molybdenite is put is the manufacture of special alloys of steel, the formulæ for which are guarded as trade secrets. From the inquiries which have reached the Bureau there is reason to believe that a considerable quantity of this mineral could be disposed of at high prices.

Mr. S. Dillon Mills, M.E., of Toronto, recently examined some deposits of molybdenite in the districts of Haliburton, and read an interesting paper dealing therewith and with the mineral in general before the Canadian Institute, of which he has been kind enough to supply the following abstract :

"This ore is a bi-sulphide with the following composition : Molybdenum, 59.6 per cent.; sulphur, 40.4 per cent.; the specific gravity being 4.45 ; crystalline system hexagonal. It occurs mostly in the form of plates of different sizes and thickness, varying from mere scales up to plates 10 inches or more in diameter and up to an inch in thickness. It is easily distinguished from graphite, which in some respects it resembles, by its slightly lighter color and streak, its greater softness and its extreme tenacity, some specimens being almost malleable.

It is foliated like some graphite, but may also be distinguished from the latter by the peculiar steely-blue tinge noticable in freshly split folia. The best way to observe this is to open the folia without entirely separating them; on looking between them the blue is very apparent, being probably intensified by reflection. The specific gravity also, as above given, is nearly double that of graphite, viz.: 2.25. The distinction between the two minerals was first pointed out by Scheele, who first separated the metallic base molybdenum in the year 1778.

Molybdenum also occurs as a molybdate of lead commonly known as wulfenite, the composition of which is molybdic trioxide, 34.25 per cent.: lead protoxide, 64.42 per cent.; equal to about 22.5 per cent. molybdenum; and as molybdic ochres, containing the molybdic trioxide in a condition of greater or less purity. When pure the trioxide contains 65.7 per cent. molybdenum. There are a few other minerals containing molybdenum, but of minor importance.

MOLYBDENUM AND ITS USES.

The uses of molybdenum may be briefly stated as follows: Besides its well known use in chemistry as ammonium molybdate for detection and estimation of phosphorus in various compounds, it was used many years ago as the basis of a beautiful blue pigment. It was also found out about the year 1851 that it could be used in the dyeing of silks and cottons, and was proposed as a substitute for indigo by a German chemist about that time. It appears to have been better suited for silk than cotton, giving a more brilliant and permanent color with the former. I am, however, inclined to think that of late years its use in this respect has been superseded by the aniline dyes, as no mention of its use is now to be found in the most recent publications on the subject, though at one time the preparation of these dyes from wulfenite ore formed a very extensive industry in the city of Prague.

The interest now excited in ores of molybdenum arises from its recent application to the production of a peculiar high-grade steel, a matter which like many others, has been rendered possible by recent advances in electro-metallurgy, with the result that molybdenite has emerged from its position of comparative obscurity as a rare mineralogical specimen and become an article of considerable commercial value, the present price being about $1.25 per lb.

The output of ferro-molybdenum for the United States for the year 1899 was 30,000 lb., and for 1900 over 32,000 lb. of 50 per cent. molybdenum, the market value of which in December 1901 was $1.25 per lb. while that of commercial metallic molybdenum was $1.82 per lb. (This quality consists of molybdenum 96 per cent., carbon 4 per cent.)

Pure molybdenum is a silver-white metal harder than silver, but more brittle; specific gravity about 9.01; very infusible, being according to Debray infusible at the highest temperature obtainable in a wind furnace. It oxidizes to the tri-oxide $Mo\,O_3$ only when heated in air to a temperature of 600° centigrade; it decomposes water at a red heat, is insoluble in hydrofluoric acid, also in dilute sulphuric and hydrochloric acids; it can be hammered, welded, and polished like iron. The pure metal when cold is not hard enough to scratch glass, but if heated for some time to 1500° centigrade in contact with carbon, it absorbs a little and on cooling becomes hard enough to scratch glass or quartz.[18] Some years ago it was thought that molybdenum was used at the Krupp works in Germany for the manufacture of a steel alloy for armor plates, along with tungsten and some other of the rarer metals, and in 1895 experiments were made at the Creusot works in France with the result that armor plate steel of excellent quality was obtained with 2 to 3 per cent. molybdenum, and the same amount of chromium, the metals being added to the charge in the converter in the form of ferro-molybdenum, and ferrochromium.

For some time prior to this tungsten had been used as an alloy for steel for the production of a very hard and tough metal for tools and other articles; and Prof. Von Leepin of St. Petersburg, was led to suggest the use of molybdenum for the same purpose owing to its resemblance in many respects to tungsten. He succeeded in 1896 in having some experiments made at the Pubilov iron works, the results of which were published first in the Russian Mining Journal in 1897, and copied by many other scientific publications throughout the world. A very complete series of tests appears to have been made, care being taken to have both tungstic and molybdic steel made as nearly as possible under the same conditions. The properties of the two steels are said to have been very similar, but the molybdenum steel appears to have stood forging and hardening better than the tungsten, which is always liable to split lengthwise in tempering. The tungstic steel was harder than the molybdic when tempered in oil, but when tempered in water, the molybdic steel was the stronger, showed better temper, did not split in working and did not break cold as easily as the tungstic steel. Both steels were made in Siemens furnaces, cast into ingots and rolled to rods of suitable size for testing.

[18] NOTE BY S. D. M.—In view of the above qualities it looks as if molybdenum might yet reach a very extended use in many ways, as for instance in an alloy which would do away with the brittle quality and so render it available as a substitute for silver in tableware, etc.
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Since that date no original information on the subject seems to have been published. The various items printed in different journals recently appear to be merely copies or abstracts of the above quoted statements. It is however evident from the market quotations before mentioned that its use in this direction is increasing, and of course when the use of an alloy like molybdenum steel becomes a matter of business, manufacturers are not anxious to publish accounts of results obtained perhaps by costly experiments.

The mineral molybdenite appears to be the most common ore of molybdenum in Canada In Sir William Logan's Geology of Canada we find (pp. 503 and 755) a number of localities where it occurs in small quantities, and since then it has been found in many places in the Laurentian and older Huronian formations.

DEPOSITS IN HALIBURTON.

During the fall of last year I was employed by The Land and Immigration Company, Limited, of Haliburton, to do some further exploratory work, and to report on the prospects in that part of their land which is in the two southern ranges of Harcourt township, especially near lake Farquhar, where operations in search of a copper vein conducted by their engineer, the late F. Straith-Miller, had resulted in the discovery of some scattered molybdenite. I found the rocks in the immediate neighborhood of the molybdenite show to be chiefly gneiss, with some intrusive granite, patches of pyroxenite, and at a little distance some crystalline limestone and diorites of a very peculiar character with large phenocrysts of hornblende. The pyroxenite was in two separate irregular masses, one near the south of the lake forming a bold bluff flanked by gneiss and pretty well exposed over its entire area. The other to the southeast, being smaller and in lower ground, was mostly covered by alluvium ; this patch showed no appearance of either copper or molybdenite. The work was therefore confined to the other mass where both had been found in small quantities.

The exposure here was somewhat lenticular in shape, about 300 yards in length, by 80 yards in width from east to west, with two deep notches or bays on the west side, in one of which was a patch of intrusive granite. The longest diameter of the pyroxene ran about north and south and along this line approximately were three highly mineralized gossan patches. In the southern one a pit of about 12 feet in depth had been sunk without any result. beyond finding some pyrrhotite (magnetic pyrites), and apparently a few pieces of molybdenite; the next patch did not look encouraging, and was left untouched ; and in the northern patch, a rock cut had been commenced, and a shaft put down about 15 feet, which after cleaning out and examining I decided to abandon, and to start work on the rock cut for the present. The cut had been begun on the eastern slope of the bluff. and running in a north-easterly direction had been carried in about 25 feet. Some stripping had been done on top along the proposed line about nine feet in width by one to two feet in depth. The depth of the cut at 25 feet in was about 17 feet, being at this point about 25 feet below the summit of the bluff, which was the objective point.

The rock was very seamy, and as it afterwards proved, full of vugs or open seams and pockets, rendering blasting very uncertain and requiring great care in the placing of shots. The first few shots opened out a large vug on the south side and a seam of iron pyrites (the ordinary non-magnetic FeS_2) with a little molybdenite leading into a pyrites pocket containing over a ton of pyrites free from molybdenite. We then crossed another open vug running all across the cut, then struck another seam of pyrites, next came about five feet of somewhat more solid rock, and then a vein of pyrrhotite with some molybdenite We exposed in this way five narrow veins of pyrrhotite carrying more or less molybdenite and traces of chalcopyrite. Of these veins two were connected by a cross vein about seven inches in width, the contents of which showed nearly one-half molybdenite, the balance being pyrrhotite and chalcopyrite. The molybdenite was in fair sized crystals, one to two inches diameter. This was near the north wall of the cut, and towards the south wall another thinner vein of similar character was found running diagonally between the same two main veins or stringers, showing good indications of our approach to a body of ore beneath. The upper shallow stripping showed also some seven or eight other stringers from one to four or five inches in width carrying molybdenite in places

The weather owing to the lateness of the date was now becoming too severe for tenting in this exposed situation, so it was decided to stop work at this stage, as enough had been done to show the probability of molybdenum in quantity, and it was not advisable to expose the ore till arrangements had been made for taking proper care of it.

The veins or stringers above mentioned varied as stated from one to five or more inches in thickness and ran with a fairly steady course about : 0 degrees east of north, thus crossing the cut nearly at right angles, and several of them could be traced on the bare surface of the bluff for some distance each side of the cut and down the exposed, almost vertical, face to the north. They were separated by two to five or six feet of the pyroxenite rock, the latter varying much in composition in places and containing occasional detached masses of gneiss greatly altered, which appeared to have been carried up by the intrusive pyroxenite.

The chief points of interest about this development are the following :

The occurrence of two distinct sets of stringers each forming with its cross veins a sort of independent "stockwerk," one containing magnetic pyrites with chalcopyrite, the other ordinary pyrites and marcasite; the two occurring in pyroxenite but separated from each other by a five to six feet rib of very hard rock differing somewhat from the pyroxenite, lighter in color, variable apparently in composition, but very hard to drill.

The empty or partially empty "vugs" which are confined to the ordinary pyrites side of this rib. This separation may not be permanent; the magnetic pyrites may change as the veins go down.

The peculiar twisted and contorted condition of the molybdenite plates, which have the appearance of having been first formed, and then twisted and folded by some subsequent action during the consolidation of the pyrrhotite and pyrite.

The freedom from molybdenite of the pyroxenite enclosing the veins; the ore being in the seams and stringers though sometimes partially embedded in the walls as if forced into them while they were in a softened state. Yet the form of the seams shows that the pyroxenite had been completely solidified before the deposition of the vein matter. This may form an interesting subject for further study. We know but little about vein formation yet.

The peculiarly intrusive character of this mass of pyroxenite rising perpendicularly through the surrounding gneiss, accompanied apparently by an intrusive mass of granite in which one solitary crystal of molybdenite was found. So far I have not found any molybdenite in the gneiss.

Pyroxenite is considered to be an alteration product from an impure limestone, and in the mass to the southeast of this where there appears to be neither molybdenite nor pyrrhotite it is in contact with mica schist, and mica passing into crystalline limestone containing graphite in small quantities, but no molybdenite.

Following are some of the minerals found in the seams and vugs associated with the molybdenite and pyrrhotite; quartz, felspar, scapolite, spodumene, hornblende, tremolite, augite, sphene, calcite, arsenic, sulphur, mica, pyrites, marcasite, chalcopyrite, bornite, molybdite.

There are many interesting geological features connected with this district which space will not permit me to dwell on as they have no direct bearing on the subject. The question of recent changes of level causing drainage of lakes etc., is especially deserving of attention. From many points of view this section recommends itself as worthy of the attention of the students of geology and mineralogy.

MINING ACCIDENTS.

The list of mining accidents occuring year by year continues to be longer than it ought to be in view of the number of working miners in the Province. There were 29 accidents reported, causing injuries to 39 men, of whom 8 were slightly and 18 seriously hurt while 13 were killed.

The progress of the mining industry is creating a larger demand for efficient labor in the mines, and during the past year employers of all kinds have found it more difficult than usual to obtain a sufficient supply of the right kind, or indeed any kind, of men. One consequence has been the diversion into mining pursuits of numbers of inexperienced laborers, and it is too plain that some of these have paid forfeit of life or limb while acquiring a knowledge of the business. The miner's calling cannot in the nature of things be dissociated from danger, but experience and care will reduce the risk to a minimum; and when a body of skilled workmen grows up in our mines, not only will there be increased output at reduced cost, but mining casualties will fall to a level below which they can hardly be expected to go.

It seems probable that the considerable proportion of foreigners employed in the mines, with their imperfect understanding of the English language and their inability to read, may also have had the effect of increasing the number of accidents.

At the M'Gown Copper Mine.

An accident occurred at this mine in November 1900 though it was not reported to the Bureau until after the beginning of 1901. On the 23rd of that month two miners named F. E. Leushner and John Kitts, while engaged in timbering shaft No. 3 of the McGown copper mine, owned by the Parry Sound Copper Mining Company, Limited, were precipitated to the bottom of the shaft through the collapse of the scaffold upon which they were standing. The shaft was about 39 feet deep, and the scaffold was about 18 feet from the top ; hence the men fell about 21 feet, or more properly speaking about 18 feet into three feet of water at the bottom of the shaft.

Kitts sustained slight injuries about the mouth and face, for which he was treated at the mine. Leushner spent two weeks in the hospital at Parry Sound, having been more or less bruised about the arms and body, but both were soon able to be about again.

At the Canadian Copper Company's Mines.

In the west roast yard at Copper Cliff on 28th January Patrick Lantin, aged 35 and married, while at work on pile No. 35 was caught by sliding ore which overwhelmed him. The ore was removed with all possible haste, but when the body was extricated Lantin was found to be dead.

Coroner McMurchy, of North Bay, held an inquest, at which the following verdict was rendered by the jury : " Patrick Lantin came to his death in consequence of a body of ore falling on him, and we are of opinion that this accident was largely due to the neglect of the foreman in charge."

At the Assizes held in North Bay an action was brought by Lantin's estate against Mr. McKinnon, the contractor, in whose employ deceased was, and judgment was entered for some $500 in favor of the estate.

On Saturday 9th March about 2.30 o'clock, Louis Carboneau, a drill runner and scaler at the Stobie nickel mine, was engaged in scaling the walls of the mine about 60 or 70 feet from the floor. He was mounted on a ladder, or rather on the uppermost of three ladders fastened end to end, the lowest section of which broke and precipitated Carboneau to the floor. It is stated that the ladders are made with exceptional care and are closely examined by the men before using them. The section which gave way was heavily built and had been in use only two or three times. Carboneau, whose injuries were very severe, was removed to Dr. Struthers' hospital, Sudbury, where he died at 8.30 p.m., 10th March. Coroner McMurchy was notified of the death and visited the spot. In his opinion an inquest was desirable, but owing to some delay or misunderstanding, or possibly because Corbonéau's relations did not wish an investigation to be held, the body had been removed to Quebec for burial before the coroner's arrival.

A labourer named Pietro Domenizucci lost his life at Copper Cliff on 20th March in the following manner : On account of very heavy falls of snow the snow plough was in use clearing the Canadian Copper Company's main line of railway to the C.P.R. track. The deceased was on the plough holding the lever along with foreman John Guthrie and James Fera, a laborer. The plough jumped the track and was turned end for end, but not capsized. The accident was so sudden and the storm raging at the time was so blinding that no one either on the engine or the plough saw just what happened to Domenizucci, but it is presumed he jumped out thinking to save himself, and was caught by the plough while it was in the act of swinging round. At any rate he was found under the blade at one end of the plough pressed down into the snow and was dead when taken out. The plough is said to have been running at a rate of about 6 or 8 miles an hour. Coroner McMurchy was notified, but after making inquiry into the circumstances decided that an inquest was unnecessary.

Frederick Carter, about 17 years of age, was employed as a skip tender in the twelfth level of the Copper Cliff mine. On the morning of 26th March when the shift quit work, he gathered up the drill steel to be taken to the surface and put it in the skip, in which the men had also deposited their dinner pails before starting for the ladders to ascend to the surface. Before the skip was ready to go up all the men had left but Carter. The next that was seen of him was on the arrival of the men at the surface. When they went to the skip to get their dinner pails they found him lying unconscious in the skip and across his neck lay one of the shaft rollers,—

wooden blocks about 15 inches long and 7 inches in diameter on which the hoisting cable runs. In some way the action of the rope had dislodged this roller and it fell down the shaft and into the skip, striking Carter on the head. The roller was dislodged between the first and second levels, about 75 feet below the surface. Carter's skull was fractured and after being attended by the company's physicians, Doctors Coleman and Arthurs, he was removed to Grace hospital, Toronto, the company sending him to Sudbury by their engine and van so that he might get the first train to that place. An operation was performed at the hospital and Carter was discharged on 2nd May.

Carter was well aware that riding in the skips was strictly against orders, as he had previously been found indulging in the practice, and was warned by the foreman that a repetition of the offence would lead to his discharge. It is stated that the shaft rollers had been examined two days before the accident and had been found in good condition.

A Finlander named Matti Tasko, working on the roast heaps of the Copper Cliff yard on 4th April was injured by an unexpected explosion under the following circumstances : Having charged two holes with dynamite he exploded one without any untoward results. Under the impression that he had lit one of the fuses only, he returned followed by the foreman to touch off the other. As Tasko bent over the hole the charge suddenly exploded, filling his eyes with fine dirt and making a small wound about half an inch long above the left eye, also bruising him slightly on the chest. The doctor was in attendance shortly after the accident and after giving him appropriate treatment had him removed to the hospital. The only explanation offered of the occurrence is that Tasko must have lit the fuses for both charges in the first instance and believed himself to have failed in one. The ore was entirely cold.

About 12 o'clock of 16th June an employee of the Canadian Copper Company named Delores Allard whose place was in the quartz-crushing department of the Bessemer plant, left his post, and accompanied by M. Labelle, who belonged to the tuyere floor of the same plant, and John Beaulieu, off duty, went to the elevator used for hoisting material to the cupola. The man in charge of the elevator was absent filling his buggy with coke, and Labelle undertook to set it in motion for the purpose of giving all three a trip to the upper floor. The hoist had risen some four or five feet only when Beaulieu shouted to stop, and it was seen that Allard had been caught between the elevator and the overhead cross beam of the entrance to the hoist. He was at once extricated, but was so severely injured both externally and internally that he died about four o'clock in the afternoon.

The men had no business to be on the hoist, and in doing as they did, were admittedly moved by curiosity only. The hoistman had instructions not to allow any one to use the hoist to go to the upper flats, as there were two flights of stairs for the purpose.

Inspector DeKalb, who was in the neighborhood at the time, was instructed to make an investigation into the occurrance. He did so, and took the evidence of Peter Stoddart, foreman of the Bessemer plant, George Fagan, the hoistman, M. Labelle, and T. N. Kilpatrick, superintendent of the smelters. It appeared from the testimony that notwithstanding Fagan had received orders from the superintendent through the foreman not to allow any one to ride on the hoist he "saw no harm in letting them go up." Though in this instance he was absent at the time, and did not witness the accident, yet the discretion which he exercised in interpreting his orders may have contributed to the fatal result. Labelle had taken Beaulieu up in the hoist before the same day. These men admitted they were out of place on the hoist, but there is some contradiction in their statements as to whether or not they were ignorant of the rule forbidding them to use it. There was a "No admittance" notice at the entrance of the Bessemer plant, but no notices were posted forbidding unauthorized persons riding on the hoists. If aware of the orders not to trespass on the elevator the men chose to disregard them, and Allard paid the penalty with his life. He was 23 years of age and unmarried.

A brakeman in the company's employ named Louis Menard fell from the top of a box car forming part of a train which was being shunted in Copper Cliff yard on 14th September. The train was stopped and he was picked up between the engine and the car, his leg broken in two places and so badly that it was found necessary to amputate it. From Menard's own statement it appears he was walking on the top of the car and did not realize that he was so near the end. The train is said to have been moving slowly, not faster than three miles an hour.

A premature or unexpected explosion of dynamite in the roast yard at Copper Cliff on 21st September caused the death of Ernest Roy, a blaster working for Mr. McKinnon, the contractor. Roy was assisting to break up roasted ore in a heap which had been ignited on 30th April and which, according to the evidence, was cool enough to be handled with comfort and safety though "not so cool as earth." He had placed four sticks of dynamite in a hole drilled in the ore the previous day, and was tamping the powder with a broomstick when the charge exploded, throwing Roy into the air and wounding him very seriously, especially in the head. He was at once removed to the hospital at Sudbury, but died five days after the accident. Blasting in hot ore is forbidden by the Mines Act, and in order to ascertain the facts it was requested that an inquest should be held. Accordingly Dr. R. B. Struthers, coroner, conducted an investigation, from which it appeared that Roy having put in the dynamite, inserted the cap, and was tamping the charge when the explosion occurred. The inference is that he had struck the cap with his stick. The evidence went to show that the hole had been drilled the day before and was cold, and that the ore was not warm enough to be a source of danger. The jury returned the following verdict: "Ernest Roy came to his death from injuries received from a premature explosion of dynamite in roast yard No. 1, at Copper Cliff, and we believe that the said premature explosion was caused by said Roy not taking proper precautions while charging hole."

On 3rd October the roast yard at Copper Cliff was the scene of another accident, due to careless or improper handling of explosives. A workman named Joseph Levesque, employed by contractor McKinnon, had his right hand completely torn away and his fore-arm mangled for some inches, besides receiving other injuries in the face and neck, by meddling with dynamite when not called upon to do so. He was not employed as a blaster, but had in his hand a stick of dynamite with fuse and detonator attached. He lit the fuse and was about to insert the charge in a hole when the dynamite exploded in his grasp, greviously injuring him as above described.

At the new mine, called the Creighton, which the Canadian Copper Company is opening up, a miner named Patrick Cullen working on the night shift, was killed on 28th November. A loaded skip was being hoisted from the first level and left the rail about half way to the dump, discharging part of its contents on the stair at the end of the rock house on which Cullen was standing. He was struck in the head by a piece of ore from the skip, inflicting a scalp wound and fracturing the skull. The unfortunate man was removed to the Sudbury hospital, but died on Sunday following.

An inquest was held by Coroner Struthers at which evidence was adduced tending to show that Frank Audette, the skip-tender, who had begun work only two nights before the accident, was either incompetent or careless in the performance of his duties, in not seeing that the skip wheels and track were free from pieces of ore likely to give trouble or throw the skip off the track, and also in failing to give the signal to stop when the accident was imminent. As it was, the engineer in charge of the hoist stopped the car at once when he felt the jerk on the rope caused by the car leaving the track, but by that time the mischief had been done. Audette was a mere youth and new to the position.

The coroner's jury distributed the blame for the accident among Audette, for his negligence, the foreman Michael Thompson, for employing him as skip-tender, and the company, for not having the rock house stair more fully protected from falling ore. The verdict was as follows :—"We find that Patrick Cullen came to his death from being hit by falling ore from a skip which had jumped the track at Creighton mine on the evening of November 28th, 1901, and we find that bell-man Audette was negligent of his duties, that the foreman exercised poor judgment in selecting Audette for this work, and the Canadian Copper Company negligent in having an outside stair to rock house exposed to falling ore from skip track." One juryman dissented from this finding and signed a minority verdict.

The company do not admit any remissness on their part, contending that the stairway is not a place where ore is liable to drop, and that the fact of its being uncovered would not be of any moment had the accident not happened to the skip at this particular place. If, they say, they undertook to put a roof over every place on their plant where it is possible for an accident to occur, there would be no end of their roof building. As to Audette, they consider him a man of enough intelligence, but like many another, in the face of an accident he did not act quickly.

A lad, thirteen years old, named Joseph Poulin, employed as a rock-picker in the rock house of the Creighton mine, was killed on 3rd December, as the result of his own boyish recklessness and disregard of danger. It was his work, with other boys, to stand beside the vibrating table which receives the ore from the screens and pick out the rock as the ore passes down the table. The boys are in charge of the rock-house oiler, and investigation shows that in the temporary absence of the oiler Poulin began to play, getting up on the table and dancing, and finally crossing over into a compartment of the rock house, into which the lads had strict orders not to go. To get into it he had to climb over a large 14-inch beam, the top of which is about three feet above the platform on which the boys stand when at work. The shaft projects into this compartment, and while here Poulin's coat was caught by the revolving shaft, and he was drawn round with it, his arm and back being broken. Coroner Struthers went to the mine, and having satisfied himself that the lad's death was due to his own foolishness and not to any defect in the machinery, did not deem it necessary to hold a formal inquest.

At the M'Nally Mine.

On 19th March H. W. McNally, proprietor with his brother Mr. Bernard McNally, of the McNally mine, about seven miles from Westport, was killed by a plank which fell upon him from the mouth of the shaft. Mr. McNally and A. E. Stevens were at the bottom of the opening, which was some 25 feet deep, when a workman named William Waffle slipped on the plank, which was loose, and caused it to fall into the shaft, striking Mr. McNally on the head with fatal results. Stevens was injured in the hand, but not seriously. Inspector DeKalb was instructed to ascertain the facts, but as he found no one was blamed and the occurrence was regarded as purely accidental, he did not hold any formal inquiry.

At the Belmont Gold Mine.

Mr. D. G. Kerr, manager of the Cordova Exploration Company, Limited, reported on 10th May that on that day an accident had occurred in the east stope of the second level in No. 3 shaft, Belmont gold mine, whereby George Forbes, helper, was severely injured in the hands, and Fred Lee, machine miner, very slightly hurt. Mr. Kerr's report was to the effect that through the men's own carelessness they had started a block hole within an inch of a hole that had already been fired and which must have had some dynamite left in it—enough to crack a piece of rock in four places and tear the drill out of Forbes' hands, laying them both open. The injured man, after being attended to by the Company's physicians, was sent to St. Joseph's hospital, Peterborough, where it was found necessary to amputate both his hands.

Inspector De Kalb investigated the circumstances and reported at some length. He states that the accident occurred during the block-holing by drilling into a "dummy," or unexploded portion of an old charge. The block-holing was being done by hand, Forbes holding the drill, and Lee striking. When the explosion occurred it injured Forbes' hands severely, and also Lee's eyes temporarily, but the latter soon recovered and lost almost no time in consequence.

According to Lee the block was a large one, about four feet long, and several feet wide and thick. It had been shot down a day or two before. It was impossible to say by whom it was shot down, but it must have been either by Lee or his opposite partner, (i. e. machine man or night-shift for same work-place) viz : Benj. Van Norman. The day foreman, Mose Fisher, had set Lee and Forbes at this task about ten minutes before the accident. It was Lee's practice to inspect blocks before drilling them ; therefore he thinks the "dummy" hole must have been on the other side of the block, else he and Forbes would have seen it. The block broke into four pieces by the accidental shot, the "trace" of the dummy hole and of the new hole appearing on one of the pieces.

Questioned further, Lee said that all blasting in stopes was done by fuse and the shots were counted. If the count failed to tally with the shots set, a careful inspection was always made. He had had no such case for a long time. The steel used is dressed to an inch and a half bit, and $1\frac{1}{4}$-inch dynamite employed. The loading stick is $1\frac{1}{4}$-inch diameter also. It seems that all possible precautions are taken. F. F. Rowe, underground superintendent, says that it is the duty of the miners to inspect blocks before block-holing. It is the duty of both miners and foremen to inspect miss-fires.

Inspector DeKalb stated he could not find that negligence had been responsible for the accident, and that it would be manifestly impossible to require that large blocks be turned over to look for "dummies." In his opinion it was a case of unforeseen accident in the discharge of duty.

At The Sakoose Gold Mine.

On the night shift, Friday 23rd August, one of the miners at the Sakoose gold mine named Andy Yeomans while coming up the ladder-way from the sub-level to the first level, was struck with the descending bucket and knocked down to the sub-level where he was partially caught by another miner. He was taken to the hospital at Rat Portage, but his injuries did not prove to be very severe, as he was able to leave in about two weeks' time.

At the McMillan Copper Location.

A casualty having the remarkable and distressing result of simultaneously depriving four men of their eyesight occurred on 15th November on what is known as the McMillan location, the south half of lot 6 in the second concession of the township of Aberdeen, Algoma District. Four miners named John Nicholson, John Ferguson, George McLeod and Murdock McLeod, were working on the surface putting in a cross-cut. Nicholson, who is said to be an experienced miner, loaded a hole with dynamite and adjusted the cap and fuse. Seeing that he had omitted a small piece of dynamite he put it in the hole, and pushed it down with his loading stick. At once the cap exploded, and the whole charge went off without having been tamped. The other three men were near the blast when it exploded, and all four were injured in the face and eyes. Dr. F. Parker who was in attendance on the wounded miners expressed the belief that Nicholson, Ferguson, and George McLeod would as a result of their injuries be permanently blind, and that Murdock McLeod had just fair chances of saving the sight of one of his eyes, the other being destroyed. The only other injury of account sustained by any of the men was a fractured jaw which fell to the lot of Murdock McLeod.

At the Stobie Mine.

Recklessness and disregard of orders led to the death of John Alfred Rintoul at the Stobie copper mine near Desbarats on 10th December. Rintoul was a machine drill-man's helper, and along with another miner jumped into a bucket loaded with ore and water as it was starting for the surface with the object of obtaining a ride up. The bucket was destined for the landing about eighteen feet above the collar of the shaft. As the bucket passed the collar both men jumped off without stopping the bucket, and Rintoul missed his footing and fell backwards into the shaft, being dashed to the bottom a distance of 160 feet and instantly killed. The company's manager, Mr. J. Bristol Johnson, states that very positive orders were given and posted up forbidding men to ride in the bucket and that the hoist-man had even orders not to obey the signal to "hoist slow" unless he understood timber or machinery was being raised. Consequently comparatively few infractions of the rule took place, and only when it was thought the mine captain was not about. Rintoul himself was well aware of the danger of riding in the bucket, and knew the practice was forbidden, but apparently the temptation to take a short cut to the surface was too great to be resisted. Dr. Gibson of Sault Ste. Marie, coroner, was notified of the occurrence, but after visiting the mine and making enquiries, deemed an inquest unnecessary, it being evident that the fatality was due to Rintoul's own foolhardiness.

At the Gold Moose Mine.

On 18th December a blast had been set off at the Gold Moose mine, and Peter Peterson went down to muck out the ore. It was thought that all the charges had exploded but in one of the holes a small quantity of dynamite had been left and Peterson's pick or shovel coming in contact with it, an explosion followed which damaged his eyesight. A month or six weeks later Peterson was reported to be nearly better, and about ready to resume work.

Accidents at the Helen Mine.

The Helen iron mine, Michipicoton, was worked for part of last season by Messrs. Powell and Mitchell, and for the remainder of the season by Messrs. Foley Bros., on behalf of the owners, the Lake Superior Power Company. Several accidents occurred, in which three men were killed, and a number injured.

The first accident was reported 30th April. The powder-man was springing a hole, but the hole not being large enough the cap and fuse were withdrawn and thrown to one side. The fuse burned down until it came to the cap which exploded, and the shock of the explosion set off a bag of dynamite containing twenty sticks, lying beside the powder man. The cap was fifteen feet away from the dynamite which exploded. Eight men in all were hurt, four of whom reported for work next morning. The other four remained in the hospital for several days, but in ten days or so all were out again save one, Thomas Shea, who was being treated for deafness. The names of the other three who went to the hospital were Tony Moran, Thomas Cleary and Walter Brice. The suggestion was made that perhaps the dynamite had been exposed to the heat of the sun and so rendered more sensitive, but the contractors were of the opinion that this was not likely, it having come from the magazine only a short time before the accident.

An unlooked for explosion of dynamite on 20th May resulted in serious injuries to two Finlanders, named Jesta Bakka and Jacob Lauray, who were in the employ of Victor Turnquist, a sub-contractor. The men, who are said to be experienced miners, had been drilling some holes about three feet deep in order to extend a trench, and after they had finished procured dynamite from Turnquist with which they loaded two of the holes. They were loading the third when the charge exploded, mangling Bakka's right arm so badly that it had to be amputated at once below the elbow joint, and injuring his eyes, especially the left one. Lauray had three fingers of the right hand broken, one of which had to be taken off, both arms badly torn, and his eyesight permanently destroyed. The men say they were using a stick to tamp the dynamite with, but Turnquist states that they were employing a piece of gas pipe with a stick in the end of it. There was no cap within 150 feet, and the inference is that the use of the gas pipe caused the explosion. There were only three sticks of dynamite in the hole, and the charges in the other two did not explode. Some six sticks of powder about four feet away also remained intact. Bakka was about 30 years old, and unmarried; Lauray about the same age, with a wife in Finland. They spoke and understood English imperfectly.

James Ryan, powder monkey, was blown to pieces 14th November under the following circumstances: He was engaged in thawing dynamite in a small building kept for that purpose, in which only one box of dynamite was supposed to be kept, but where as a matter of fact there were several boxes of the explosive at that time. Ryan was at this powder house early in the morning, and left it about 9.30 a.m. for breakfast. A few minutes after his return an explosion occurred, the cause of which, Ryan being alone at the time, is unknown. The shock of the explosion was very great, but the storage magazine was not involved. Dr. Gibson, coroner, Sault St. Marie, was advised, but did not think the facts warranted an inquest.

On 14th October the cable operating the aerial tramway at the Helen mine broke, the end falling to the ground and striking two miners who were mucking on the ground beneath. One of these men, Anthony Budischie, aged 20 years, was badly hurt, his skull being fractured at the base and his right arm broken in two places. The other, Charles Chelas, received some bruises across the back, and was cut about the face. Both were removed to the hospital at the mine and given every attention, but Budischie succumbed to his injuries on the 27th. He was a native of Austria. Chelas, who was a Greek, left the hospital cured on the 26th.

The cable had only a few days before the accident occurred shown signs of wear; no strands were gone, but the wires composing the strands were broken in places. Measurements had been taken for a new cable, though the old one was considered good for some time to come. The signal man is said to have given warning when the cable parted, but the men below stood looking at him and did not heed the warning.

A Finlander named Jacob Lawrila, aged about 40, had the toes of his left foot crushed on 19th October by a lump of iron ore rolling down some ten feet and landing on his foot. The second toe required to be amputated. He was discharged from the mine hospital on 27th November.

Andea Speziale, Italian, while walking on the railway track 16th November was hurt under the following circumstances: A locomotive engaged in switching cars to the incline got beyond the control of the engineer and struck a cable being raised, dragging it along the track. The cable struck Speziale on the left leg and broke it. On 31st December he was reported as able to walk about and recovering rapidly.

John Wilkie of Rat Portage, about 24 years of age, was injured on 20th November. In getting out of the way of rolling rock he stopped a piece of ore which turned over and jammed his right leg, fracturing it. He made a good recovery.

Stripping ore of its covering of soil is not usually attended with much risk, yet Phelas St. John, who was engaged in this work on 2nd December, suffered a double fracture of his right leg, apparently through his own carelessness or absence of mind. A boulder weighing about 1,000 pounds was imbedded in the earth about six feet above the level at which St. John was working. He went up to pry it down with a bar when it began to roll, and instead of stepping back he stepped in front of the stone with the above result.

While returning to work after dinner, 3rd December, and when about 20 feet from the dining hall, John Berthiaume, laborer, was struck in the face by a small piece of flying ore, the result of a blast at the mine. The blow destroyed his right eye and inflicted other severe injuries.

The same day, Tony Vendome, Italian, was mucking ore, when a block of ore about 500 pounds in weight slowly shifted its position some ten feet. Instead of getting out of the way, as he might easily have done, Vendome is reported as having deliberately allowed the block to roll upon his foot, probably not realizing until too late that it would reach him. The result was a compound fracture of the leg.

Manly W. Card was a powder man, and part of his business was to load holes drilled during the night so that they might be blasted in the morning. On 19th December he had charged some holes with dynamite and after connecting the fuse, he sent his helper, Joseph Bernier, to tell the electrician to start the dynamo and come down to the pit with the lead wires so that he might fire the shot before 6 o'clock a.m. The electrician brought the wires, and strung them from the pit to the switch. Card connected them with the charge, the other end being connected with the switch by the electrician. Instead of coming out Card and Bernier remained in the pit after adjusting the wires and after the whistle blew. In the explosion which followed Card, who was evidently very close, was instantly killed. Bernier escaping unhurt.

At the Massey Station Copper Mine.

At the Massey Station copper mine on 11th November, a miner named Antoine Mousseau fell out of a bucket while ascending the shaft and was instantly killed. He was mucking on the second level, and at noon instead of coming up by the ladder he and two others got into the bucket to ride up. About 40 feet up the shaft the bucket left the skids, and Mousseau either jumped or fell out, striking on the platform at the second level and then tumbling down the hole through which the bucket passes. When reached he was dead.

Of the other two men both got out of the bucket ; one slid down the skids to the first level, and the other climbed a ladder to safety. Both of them as well as the deceased were quite aware that it was against the rules to ride in the bucket, and the superintendent of the mine, Joseph Errington, fifteen minutes before the accident had warned Mousseau against breaking the rule. Notices were also posted threatening with discharge any miner who should indulge in the practice.

Dr. R. H. Flaherty, coroner, Massey Station, conducted an inquest. The jury returned the following verdict. "The deceased Antoine Mousseau came to his death by accidently falling out of the bucket while ascending the shaft on the 13th day of November, 1901. We also find that the deceased alone was responsible for his own death as he was disobeying the rules of the Company by riding in the bucket."

At the Victoria Nickel Mines.

Three accidents occurred to workmen in the employ of the Mond Nickel Company, Limited, during the year, two of them at the mine and one at the smelting works.

On 31st August Albert Match was loading cars on the west stope, second level, working on a contract basis. He was cautioned by the foreman to keep away from the pile of ore until the drill man on duty above had finished cleaning out preparatory to starting the drill. Match however resumed work before being notified that it was safe to do so, and a rock rolled down from above and fractured his leg.

James Tate, a laborer at the smelter, was unloading roasted ore from the dump car, 31st October, when the car becoming overbalanced capsized and threw him beneath it. His shoulder blade was injured, and he was otherwise more or less bruised.

While removing loose rock from the wall in the east stope of the second level, 15th November, W. Sgoblom was injured by a premature explosion, losing two fingers of his right hand.

TABLE OF MINING ACCIDENTS IN 1901.

No.	Date.	Mine.	Name of person injured.	Result of injury. Slight.	Serious.	Fatal.	Above ground.	Below ground.	Nature of injury.	Cause of Accident.
1	November 23, 1900	McGown	F. E. Leushner	1				1	Bruised	Collapse of scaffold in shaft.
			John Kitts	1				1		
2	January 28	Copper Cliff	Patrick Lantin			1	1		Killed	Struck by ore falling from roast heap.
3	March 9	"	Louis Carboneau			1		1	Killed	Collapse of scaling ladder.
4	" 20	"	Pietro Domenizucci			1	1		Killed	Struck by snow plough.
5	" 26	"	Frederick Carter		1			1	Skull fractured	Struck by dislodged roller while ascending in skip.
6	April 4	"	Matti Tasko	1			1		Bruised in face	Unexpected explosion of dynamite.
7	June 16	"	Delores Allard			1	1		Killed	Crushed in elevator.
8	September 14	"	Louis Menard		1		1		Broken leg	Fell from top of railway car.
9	" 21	"	Ernest Roy			1	1		Died in five days	Premature explosion of dynamite.
10	October 3	"	Joseph Leveque		1		1		Hand torn off	" " "
11	November 28	Creighton	Patrick Cullen			1	1		Killed	Struck by ore falling from skip.
12	December 3	"	Joseph Poulin			1	1		Killed	Caught by revolving shaft.
13	March 19	McNally	H. W. McNally			1		1	Killed	Struck by plank falling into shaft.
14	May 10	Belmont	George Forbes		1			1	Both hands mangled	Drilled into a hole containing dynamite.
			Fred Lee	1				1	Eyesight temporarily affect'd.	
15	August 23	Sakoose	Andy Yeomans	1				1	Bruised	Knocked down shaft.
16	November 15	McMillan	John Nicholson		1		1		Permanently blinded	Premature explosion of dynamite.
			John Ferguson		1		1		" "	
			George McLeod		1		1		" "	
			Murdock McLeod		1		1		Eyesight badly affected	
17	December 10	Stobie	John Alfred Rintoul			1		1	Killed	Fell down shaft.
18	" 18	Gold Moose	Peter Peterson	1				1	Eyes injured	Struck dynamite while mucking ore.
19	April 30	Helen	Thomas Shea		1			1	Bruised; hearing affected	Unexpected explosion of dynamite.
			Tony Moran		1			1	Bruised	
			Thomas Clary		1			1	"	
			Walter Brice		1			1	"	
20	May 20	"	Jesta Bakka		1		1		Arm lacerated; eyesight inj'd	" " "
			Jacob Lawray		1		1		Arms torn; eyesight destryed	
21	October 14	"	Anthony Budischie			1	1		Died in 13 days	Struck by falling cable.
			Charles Chelas		1		1		Bruised	
22	" 19	"	Jacob Lawrila		1			1	Foot crushed	Struck by falling ore.
23	November 14	"	James Ryan			1	1		Killed	Unexpected explosion of dynamite.
24	" 16	"	Andea Speziale		1		1		Leg broken.	Struck by cable.
25	" 20	"	John Wilkie		1			1	" "	Struck by rolling rock.
26	December 2	"	Phelas St. John		1		1		" "	Struck by rolling boulder.
27	" 3	"	John Berthiaume		1		1		Bruised; right eye destroyed.	Struck by flying ore.
28	" 3	"	Tony Vendome		1			1	Leg broken	Struck by rolling ore.
29	" 19	"	Manly W. Card			1		1	Killed	Explosion of dynamite.
30	November 11	Massey Station	Antoine Mousseau			1		1	"	Fell out of bucket ascending shaft.
31	August 31	Victoria	Albert Match		1			1	Leg broken	Struck by rolling ore.
32	October 31	"	James Tate		1		1		Shoulder injured	Capsizing of ore-car.
33	November 15	"	W. Sgoblom		1			1	Right hand injured	Premature explosion.
				6	24	13	22	21	Total number of casualties, 43.	

WORK WITH THE DIAMOND DRILLS.

The two diamond drills owned by the Government were in use during the whole of the year. Both machines were made by the Sullivan Machinery Company of Chicago, the larger of the two having a boring capacity of 1,200 or 1,500 feet, and the smaller a capacity of 500 feet. The drills are of "C" and "S" size respectively, the diameter of the core taken out by the former being one inch and an eighth, and of the latter fifteen-sixteenths of an inch. Under the regulations governing the use of the drills, 35 per cent. of the actual cost of operations is borne by the Bureau of Mines.

The "C" Drill.

In January, 1900, the "C" drill was procured by the Mattawin Iron Company to explore mining locations W 217 to 222 and the west half of 223 on the Mattawin iron range west of Port Arthur. It remained at work there until July, 1901, during which time four holes were put down as follows: No. 1, 623 feet; No. 2, 1,000 feet; No. 3, 502 feet; No. 4, 684 feet; total depth bored, 2,809 feet. The whole cost of the borings was $11,587.39, or $4.12 per foot; the net cost (after deducting the Government's share, 35 per cent.), $2.67 per foot. In the gross cost is included $3,883.56 for 72.59 karats diamonds at $53.50 per karat, equal to $1.38 per foot. The drilling was done mainly on what is known as Hill No. 8, on location W 218, and disclosed, especially in holes numbers 1 and 2, a good deal of iron ore, somewhat low in metallic contents. The rocks penetrated are described in the drill manager's reports as diorite, quartzite, granite, slate, jasper, etc. Considerable banded jasper and ore was met with, and owing to the hardness of the formations, progress was slow.

On concluding work for the Mattawin Iron Company, the "C" drill was engaged by Messrs. Mackenzie, Mann & Co., and placed on mining location 138 E, situated on the Atik-okan iron range. One hole only was put down on this property, the depth being 606 feet. Drilling was equally difficult on this location, the prevailing rocks reported by the manager being hornblende schist, quartzite, actinolite schist, etc. At various depths iron ore was encountered, but too sulphurous to be of value. The total cost was $2,801.61, or $4.62 per foot, and the net cost $1,977.05, or $3.26 per foot. Wear and tear of diamonds amounted to $1,076.66, or $1.77 per foot. The work was finished here 30th November, 1901, and early in 1902 the drill was placed at the service of Mr. J. M. Clark, K.C., of Toronto, who ordered it to Steep Rock lake to be used on mining locations 857 to 873 X, owned by American capitalists. Hematite of excellent quality has been found in the drift in the neighborhood of this lake, and hopes are entertained of locating workable bodies of ore by means of the drill.

The "S" Drill.

The "S" drill when purchased in 1900 was sent to a lead and zinc property on lot 7 in the eleventh concession of Lake township, in the county of Hastings, called the Katherine mine, owned by the British and Colonial Mining and Development Company, Limited, where one hole having a depth of 266 feet was put down on the vein. Nothing of value having been disclosed by the boring the company transferred the drill to the township of Gloucester, in the county of Carleton, where, on lot 8 in the fifth concession, indications of petroleum had been observed. One hole was bored on this lot and one some miles away, the depths being 469 and 460 feet respectively. In both holes gas was struck in considerable volume at 413 feet and 130 feet respectively in what was believed to be Utica shale, but no oil was obtained. In all, 1,195 feet were bored for this company at a gross cost of $1,417.46; net, $921.33. The total cost per foot was $1.18, of which 38 cents was for diamonds, the net cost per foot being 77 cents.

At the beginning of April 1901 the "S" drill went on to lots 22 and 23 in the twelfth concession of Brunel township, district of Muskoka, where Mr. George Paget and others had located a deposit of pyrrhotite carrying a percentage of nickel. Five holes were drilled having the following depths, 112, 25, 28, 120 and 55 feet respectively ; total depth 340 feet. Copper, nickel and iron pyrites were reported by the drill manager as occurring in all the holes except number 4. The total cost was $514.12, or $1.51 per foot ; the net cost $334.18, or 98 cents per foot. Wear and tear of diamonds accounted for $106.09, or 31 cents per foot.

From Brunel township the drill was forwarded to the Golden Star mine near Mine Centre in the district of Rainy River. The Canadian company which took over this property from an American concern had found the payable ore pretty well worked out from the upper levels, and were anxious to learn whether values could be found in depth or in other portions of the vein. Eight holes in all, aggregating 1,001 feet were sunk, the shortest being 44 feet in length, and the longest 260 feet. Most of the holes gave negative results, the most important being number 5, put down 519 feet north of the shaft, in which at a depth of 118 feet nine feet of quartz was passed through diagonally, the width of the vein at this point being four feet three inches. Drilling at the Golden Star was hard work, the rocks being principally diorite and quartzite, with gravel seams in places which gave a good deal of trouble. The gross cost was $1926.02 or $1.92 per foot, loss of diamonds amounting to 56 cents per foot. The net cost to the company was $1251.90 or $1.25 per foot.

Coming east in September 1901 the drill was set to work on an iron ore prospect situated on lots 17 in the ninth and tenth concessions of Grattan township, county of Renfrew, in which the Canada Iron Furnace Company were interested. Two hundred and eighty feet of drilling in one hole was done here, and the prospects of finding ore in quantity not being deemed encouraging, work was not further prosecuted. The gross cost was $870.87, equal to $3.11 per foot ; the net cost $566.08, or $2.02 per foot. The loss of diamonds amounted to $117.75, or 42 cents per foot. After going through 12 feet of surface drift, the drill pierced 56 feet of gneiss, from which point to the depth of 90 feet there was iron vein-matter mixed with hornblende ; from 90 to 123 feet the formation was gneiss, and from 123 to 280 feet it was hornblende and granite mixed with a little iron and biotite in places.

From about 25th November till Christmas the drill was employed by the Milton Pressed Brick Company, Limited, to test their clay deposits on lot 1 in the first concession of the township of Esquesing, Halton county. One hole was put down, the depth of which was 460 feet. The manager's report states that from the surface to the depth of 364 feet the drill passed through "clay shale" suitable for brickmaking, from which point to the bottom of the hole the drill was in "slate shale." These shales furnished easy drilling, 20 and 25 feet being made in the 10-hour shift without difficulty. As a consequence the cost was low, the whole work amounting to $330.83, or 72 cents per foot, while the net cost to the company was only 47 cents per foot. The wear of diamonds was a mere trifle, only $1.35 for the entire depth bored.

R. A. Pyne, M.D., of Toronto, next employed the drill to explore a graphite property near Oliver's Ferry on the Rideau canal, situated on lot 21 in the sixth concession of North Elmsley in the county of Lanark. Here mining for graphite was carried on many years ago, a mill having been erected for treating the mineral in 1872, which remained in operation for some time.[19] Diamond drilling had also been done on the deposit, but it was desired to make further explorations. Four holes were put down having a depth respectively of 130, 140, 64 and 100 feet, a total of 434 feet. The borings showed the presence of a large quantity of graphite of good quality, together with bodies of mixed ore. The manager's record states that in No. 1 prospect there was found 32 feet of graphite, the remainder of the hole being in altered granite.

19 See description of mill and process by J. Robb, Rep. Bur. 1896, pp. 35, 36.

In No. 2 prospect there was limestone and altered granite the full depth of the hole. No. 3 prospect showed two feet of altered granite mixed with graphite, the remainder of the hole being in limestone. There was 30 feet of rich ore in No. 4 prospect, the rest being lean ore. The total cost of the drilling was $502.09, or $1.15 per foot; the net cost $323.40, or 74 cents per foot. The wear of diamonds amounted to 16 cents per foot of drilling.

Summary of Boring Operations.

The several operations carried on by the drills may be summed up as follows:

Firm or Company.	Kind of mineral.	Total depth drilled.	Total cost.	Total cost per foot.	Net cost.	Net cost per foot.	Cost of diamonds per foot.	Drill.
		ft.	$	$	$	$	$	
Mattawin Iron Co	Iron ore	2,809	11,587 39	4 12	7,526 06	2 67	1 38	"C"
Mackenzie, Mann & Co	Iron ore	606	2,801 61	4 62	1,977 05	3 26	1 77	"C"
British and Colonial Mining & Developing Co	(1) Lead & zinc; (2) oil	1,195	1,417 46	1 18	921 33	77	38	"S"
George Paget *et al*	Copper-nickel.	340	514 12	1 51	334 18	98	31	"S"
Golden Star Mining Co	Gold ore	1,001	1,926 02	1 92	1,251 90	1 25	56	"S"
Canada Iron Furnace Co	Iron ore	280	870 87	3 11	566 08	2 02	42	"S"
Milton Pressed Brick Co	Shale	460	330 83	72	215 05	47	....	"S"
R. A. Pyne	Graphite	434	502 09	1 17	323 40	76	16	"S"
Total		7,125	19,950 39	......	13,115 05	.....	....	
Average		....	....	2 80	....	1 84	88	

Mr. E. K. Roche is mechanical superintendent of the "C" drill, and Mr. Oscar R. Smith of the "S" drill.

SUMMER MINING SCHOOLS.

BY W. L. GOODWIN.

I have the honor to submit the following report on the Summer Mining Classes conducted by Mr. M. B. Weekes, B.A.Sc., and myself during the year 1901.

Itinerary for the Season.

Leaving Kingston 28th May, I was joined at the Central Ontario Junction by Mr. Weekes, and on the following day we opened the class at Deloro. This class was continued until 7th June, the last two days being employed by Mr. Weekes to complete the work, while I drove to the Cordova Mines in Belmont township (about fifteen miles from Deloro) to open a class on 6th June. Mr. Weekes joined me on the 8th, and the class was closed on the evening of the 13th. We drove immediately to Marmora and took the Central Ontario Railway train next morning for Bancroft arriving at noon. Here we collected enough sodalite for the remaining classes, and next day, 15th June, drove thirty-two miles to the Canada Corundum Company's mine near Combermere.

About half way (20 miles from Bancroft) we stopped for dinner at Armstrong's Mills, where we were hospitably entertained by the Armstrongs. Their corundum property was at that date still in the market.

The Craig corundum mine was reached at 5 p.m. and the class opened on Monday, 17th June, at 7 p.m. We closed this class on Friday, 21st June, and started for Copper Cliff at 5 a.m. on Saturday 22nd, driving three miles to take the steamer *Hudson* to Barry's Bay on the Canada Atlantic Railway.

Sunday was spent in Renfrew and we arrived in Sudbury at noon on Monday, 24th June. We drove to Copper Cliff and opened a class there on Tuesday, 25th. This class was closed Wednesday, 3rd July.

The Canada Copper Company having kindly forwarded our baggage, we proceeded by track bicycle the same evening eight miles along the line of the Manitoulin and North Shore Railway to the Creighton mine, where a class was carried on for five days, closing on Tuesday, 9th July.

Baggage having been transferred by cart, sent for the purpose by Capt. Travers of the Gertrude mine, we walked two miles west along the line of the Manitoulin and North Shore Railway to the Gertrude mine, where a class was opened on 10th July and continued until the 15th.

Captain Travers having sent our baggage on by cart, we walked six miles to Naughton station on the Canadian Pacific Railway Company and took train for Sudbury. Here Mr. Weekes remained while I went to Toronto on business which occupied me three days.

On my return we proceeded to Victoria Mines, twenty-two miles from Sudbury on the Sault Ste. Marie branch of the C.P.R., reaching the smelter on the afternoon of Saturday, 20th July. We walked 2½ miles to the mining camp, sending baggage by cart. The class was opened on Monday 22nd July. It was advertised for the preceding Saturday, but owing to miscarriage of part of the luggage we were unable to begin. The class at this mine was closed on Friday, 26th July.

Saturday was spent in Sudbury and Copper Cliff assembling the luggage. The midnight train for Rat Portage was taken, and we arrived there Monday morning 29th July. Mr. T. R. Deacon, resident director of the Mikado mine, had made arrangements for us to go to the mine (forty miles distant) by the steamer *Clipper*, so that we were able to continue the journey after an hour or two in Rat Portage. The class was opened that evening (Monday 29th July) and closed on Thursday evening 1st August.

On Friday we returned to Rat Portage, and on 3rd August we took the Imperial Limited to Fort William, but found the C. P. R. steamer so crowded that we were unable to get berths

We left Fort William by the C. P. R. steamer *Manitooa* on Tuesday 6th August, and arrived in Sault Ste. Marie at midnight on Wednesday 7th August, too late to catch the boat for Michipicoton Harbor. As the next boat connecting with the train for Helen mine did not leave until Saturday evening, we were obliged to spend the intervening days in Sault Ste. Marie. The time was employed in visiting the works of the Lake Superior Power Company and associated companies. Michipicoton Harbor was reached on 11th August by steamer Minnie M. The Algoma Central Railway provided transportation to the Helen mine, twelve miles north, where a class was begun on Monday 12th August, and carried on for four days. Mr. Weekes left for Toronto on Thursday 15th August, and I remained until Friday to complete the work. As the steamer did not leave Michipicoton Harbor for Sault Ste. Marie until Sunday, I had a day to spare to visit the Grace mine, reached by a five-mile drive from the Mission, at the mouth of the Michipicoton river. A sail boat carries the mail from the Harbor to the Mission, four miles east.

I reached Sault Ste. Marie in the morning and spent the day in further inspection of the great works being carried on there. The afternoon and evening were pleasantly spent with Mr. E.V. Clergue and party on his steam launch, from which fine views of the canals, bridges, steel works, dredges, etc., were obtained. I reached Kingston on 21st August by S.S. Athabasca to Owen Sound, and C.P.R. to Toronto and Kingston, having been absent twelve weeks. Nine places were visited and classes held for fifty-three days, with an aggregate attendance of 347 men. About 14,000 mineral specimens were distributed. The total distance covered was about 2,920 miles.

The work of this summer being confined to the mining camps, it was necessary to hold the classses in the evenings. As it is difficult to study minerals by artificial light, the classes were called together as soon as possible after tea, and carried on as long as daylight lasted. Some work wasdone by lamplight and electric light. Wherever circumstances permitted, another class was held for the night shift. In some camps the most suitable hour was found to be 7.30 a.m. In other camps, the hour selected was 4 p.m. or 3.30 p.m. It was found however that very few men working on the night shift could be tempted to do anything during the day. The sleep during the hot summer days is not very refreshing, and in many cases is cut short by various disturbing causes.

The instruction given was essentially of the same character as in former summers, with the exception that very little time was found for the short talks on the principles of geology and vein formation which were formerly given. Stress was laid upon the minerals characteristic of the place in which the class was being held, and specimens collected on the spot were used as much as possible. In this way an interesting local color was given to the work.

Canadian Goldfields, Deloro.

At Deloro are situated the mines of The Canadian Goldfields Limited, and The Atlas Arsenic Company (W. A. Hungerford, manager). The former is producing gold and white arsenic from a mispickel ore. The manager, Mr. P. Kirkegaard, received us pleasantly and gave us during our whole stay the hospitality of a well-conducted mining camp. The company has built a public hall, tastefully designed by the manager. In this the class was held under the most comfortable circumstances. This hall is used for divine worship and for various public meetings. The officials of the company recognize that they owe to the men under them something more than the mere wages earned. The class was held at 7 p.m. for about two hours each evening. The men who attended were mostly mechanics and miners, and the majority came with great regularity. Thirty-seven joined the class. The daily average was twenty-five. Books on elementary mineralogy were provided for consultation, and were used by a number of the students The significance and value of the minerals identified were explained in short addresses at the close of each session, or sometimes as each mineral was identified. Special attention was paid to mispickel ore and the products obtained from it. The treatment of this ore is being carried on at Deloro with close attention to economy of labor and material. The best quality of white arsenic is being produced in the arsenic works. While at Deloro we collected and prepared enough mispickel specimens for the other places to be visited during the summer. Our stock of magnetite was also replenished from a deposit about a mile south of the arsenic works, where it was found mixed with pyrrhotite and a little chalcopyrite.

The Belmont Gold Mine, Cordova.

This property belonging to the Cordova Exploration Company is in Belmont township, and consists of ten quartz veins roughly parallel and fed by numerous off-shoots. The ore is free milling, thirty stamps being in use. The concentrates are treated by the cyanide process. There are seven shafts and numerous levels. The pay roll showed 184 men. Arrangements are being made to bring compressed air by a pipe-line from the falls at Deer lake about two miles distant. About 800 horse power will be made available in this way. The ore from the various shafts is run to the mill by a system of horse trams, a horse drawing three or four cars. Buildings and mines are lighted by electricity. Accompanied by the manager, Mr. D. G Kerr, I spent parts of two days underground, and was pleased to see the large bodies of ore blocked out ready for stoping,—enough to keep the stamps busy for several years. But development work is being pushed forward, by sinking, drifting, and opening up new prospects on the property. All this is in marked contrast with the unscientific way in which so many of our gold properties have been exploited. Mr. Kerr entered with enthusiasm into the plans for carrying on the class. We had the pleasure too of spending a very pleasant week in his house, and of accompanying him on a number of occasions to inspect new prospects being opened up. Thirty-two men attended the classes at 7 p.m. and 4 p.m. The average daily attendance was about twenty. At the Ledyard Mine near by, we collected samples of specular ore and pyrite for use in the classes. At Cordova Mines the calcite contains enough ferrous carbonate to cause it to become rusted in appearance when exposed to the weather. This was also noticed at Deloro, and at the Ledyard mine. At No. 7, Cordova Mines, galena is being found in small quantities, along with the more commonly occurring iron and copper pyrite.

The Cordova camp is an example of what business-like but sympathetic management can do in giving tone to a body of men. As at Deloro, the management takes other aspects of the men's life into consideration besides the day's work. Comfortable houses, a foot-ball campus, a church, a clubhouse and a school house are among the things already provided or planned for.

The Craig Corundum Mine.

This is the property of the Canada Corundum Company, and is situated a short distance from the Madawaska river, about eight miles from the village of Combermere. Barry's Bay on the Canada Atlantic is the nearest railway station, with which the steamer Hudson makes connections. Supplies are brought in and the corundum shipped by this route. The line of the Bancroft and Irondale Railway surveyed this summer passes close to the mine. In the absence of Mr. Bartlett, the manager, we were received by Mr. Reginald Instant, engineer in charge, and were put up comfortably in the company's offices. It was found impossible to get a room large enough for the attendance here. Although the mine employees numbered only fifty men, forty attended the classes, which were held at 7 p.m. and 7.30 a.m. The average attendance was about twenty-five, which overflowed from the small kitchen (the only place available for the class) to the steps outside. Many of the French employees were unable to read English,and could not use the printed instructions for the determination of minerals. To these the specimens were given, and a *viva voce* description was found to answer all purposes.

Here, as in other places, some of the men inquired for names of books suitable for carrying on their studies.

Corundum concentrates are being produced here of high grade and excellent quality at the rate of about one and a half tons a day. The plant is small and will doubtless be extended or replaced as circumstances warrant. The appearance of the quarry is good, there being no signs of decrease in the percentage of corundum. New benches are being uncovered at lower levels.

Canadian Copper Company, Copper Cliff.

This place presents peculiar difficulties in the way of work of the kind undertaken by us. The men are largely Finns, Swedes, and other foreigners with little or no knowledge of English. The fifteen hundred employees are scattered over a wide area, they do a great deal of overtime work, and there is very little chance of getting even a small body of them together with a common interest outside of their daily labor. This condition is being improved by the organization of lacrosse and other sports, and by the Gorringe Club, the idea for which was, I am informed, supplied by Mrs. McArthur, wife of the manager. In the clubhouse the members meet to read, play games, dance, and amuse themselves in any laudable way. Here we found convenient quarters for our classes, held at 7 p.m. and 4 p.m. The total attendance was forty, with a daily average of about twenty.

The work at Copper Cliff is being pushed on with great energy, and extensions are so rapid that it is hard to get men enough to carry them on. A week spent at Copper Cliff in the company of Manager McArthur, Assistant Manager Turner, Captain Lawson, and Master Mechanic Campbell, convinces one of the great and growing importance of this the oldest of our nickel-copper industries, which now includes not only the works of the Canadian Copper Company, but the refining works of the Orford Company, where the matte of the former works is refined. Copper Cliff with its churches, schools, hospital and club may now be considered a mining town.

The Creighton Mine.

Here we were welcomed by Mr. Norman Campbell, the engineer representing the Canadian Copper Company, owners. There are about 150 men employed developing the mine, building a rock house, laying tracks etc. Many of the men are Italians and other foreigners with little or no knowledge of English. The classes were held in the dining camp, where tables and seats were fitted up, the day shift attending at 7 p.m. and the night shift at 4 p.m. The total attendance was thirty-six, and the average daily attendance twenty-six.

The ore body here promises well. Exploration by shafts, drifts and test pits show it to be of great extent. Considerable quantities of pentlandite were noticed mixed with the pyrrhotite. Preparations were being made to ship ore by the Manitoulin and North Shore Railway to Copper Cliff. A three-way switch permits of the loading of three cars at once from the ore bins. The rock house is a good example of such structures. Houses for the miners are being rapidly put up, and there is every indication here of a permanent addition to the mining camps of Ontario.

This opportunity is taken of thanking the officials of the Canadian Copper Company at Copper Cliff and Creighton mine for many kindnesses, including transportation of luggage to Sudbury and a very pleasant ride on one of the company's engines.

Lake Superior Power Company; Gertrude Mine.

The Gertrude mine is the property of the Lake Superior Power Company of Sault Ste. Marie, and is a deposit of pyrrhotite with an unusually low proportion of copper pyrite. The ore is thought to be suitable for the manufacture of ferro-nickel by the process now being elaborated at Sault Ste. Marie. The mine is connected with Sudbury by the Manitoulin and North Shore

Summer mining class, Canadian Goldfields, Limited, Deloro.

Falls on York branch, near Bronson station, Central Ontario railway.
Photo by G. W. L. English, New York

Grace gold mine from north, showing shaft and power houses.

Forest fire north of Helen mine, 1901.

railway, which was being ballasted at the time of our visits. Freight was being carried from Sudbury to the Creighton and Gertrude mine and ore was being sent to Sault Ste. Marie.

About fifty men (mostly English speaking) are employed. The sleeping camp just being finished is a large frame building lathed and plastered inside. It contains sleeping rooms to be partitioned off into rooms for two beds each, a wash room, bath room, and a large, airy and well-lighted recreation room. In the latter the classes were held at 7 p.m. and 4 p.m. The attendance was good—a total of forty-two and a daily average of about thirty. Thanks are due the Lake Superior Power Company and their representative, Capt. Thos. Travers, for the hospitality of the camp and for transportation of luggage.

The rocks in the neighborhood of the Gertrude and Creighton mines are strongly impregnated with sulphides which weather readily. Green vitriol effloresces from the sides of test pits, and standing water in these and other cavities is a more or less strong solution of it. Frogs and beetles die quickly when immersed in it. In one pit water beetles were observed swimming in an underground rivulet where it discharged its waters As soon as they by chance came in contact with the green vitriol solution, they wavered, turned, and swam back into the mouth of the rivulet. Many had failed to do this and were floating dead in the poisonous liquid. From a test made with water from a pit at the Gertrude I judged that it contained between half a pound and a pound of green vitriol to the gallon. Evidently this solution, of which there is at present an abundant supply, could be used as a disinfectant, deodoriser for drains etc.

Mond Nickel Company ; Victoria Mines.

At Victoria Mines Dr. Ludwig Mond is smelting the ore of a group of mines about three miles from the "Soo" branch of the Canadian Pacific Railway. The smelter, at which about 170 men are employed, is on the railway line twenty-two miles from Sudbury. The ore is conveyed from the mines to the roast beds near the smelter by an aerial tramway, which carries 300 tons a day. We were shown through the smelter by Mr. Hiram Hixon, the manager, and then directed to the mines where the class was to be held. Notices had been previously posted through the kindness of Mr. Hixon. There are about 130 men employed at the mines, the majority being French. There is a well managed dining camp, but many of the men board in private houses. A considerable proportion of the French and some of the English employees live at the mines with their families. A school house is to be found here, which is also used as a recreation room and a place for religious and other meetings. The classes were held in this building at 7 p.m. and 4 p.m. The attendance was not good, considering the number of men in the camp—a total of about thirty, with an average of about fifteen.

Both development and mining work are being pushed on vigorously under the superintendence of Captain Hixon (brother of the manager). At his suggestion we visited the mine from which ore is being shipped at present. The shaft is down 300 feet, large quantities of ore are stoped out ready for hoisting, and drifting is being continued so as to keep development well ahead of present needs. The ore now being taken out is so pure that is found necessary to use thirty tons of rock a day to mix with it for flux. About one quarter of a mile west of this shaft is a prospecting shaft from which good ore has been taken. About two miles farther west are extensive surface works in pyrite and pyrrhotite, the latter being apparently rather scattered. Near this is the quartz vein from which is obtained the quartz used in lining parts of the furnaces.

Mikado Gold Mine.

Through the kindness of Mr. T. R. Deacon, the local director, and of Mr. N. MacMillan, mine manager, we made our way comfortably to the Mikado Mine, and carried on the work of the classes under the most favorable circumstances. The classes were held at 7 p.m. and 4 p.m.

in the dining camp, and were attended by forty men, with an average daily attendance of about twenty-eight. The men here are mostly English, but several Swedes and French attended the classes. On Thursday evening, 1st August, a lecture on explosives was given at the close of the class work. Both the manager and mine captain Mackenzie speak in the warmest terms of the capability and thrift of the fine body of men gathered here. A large proportion are married and have their families with them at the camp. Rows of comfortable log houses have been built for their accommodation. About 50 men are employed.

On Tuesday, July 30th, I visited the mine accompanied by the manager and the mine captain. The shaft is down 1000 feet on the incline. Good pay ore has been struck again after a considerable amount of work in lean ore. As usual, the strike of good ore has been accompanied by the appearance of bismuthinite.

Development at Sault Ste. Marie.

While waiting here for the boat to Michipicoton some time was spent in inspecting the works of the Lake Superior Power Company and associated companies. Mr. Rhodin, the manager of the Canadian Electro Chemical Works, conducted us through these works, in which caustic soda and bleaching powder are being manufactured by an electrical process, common salt being the raw material. As both the salt and the limestone (used in making lime for the bleach) are obtained in Ontario, this is an Ontario industry from the start. A saturated solution of salt is decomposed by the electric current in such a way that the sodium is deposited in a layer of mercury, while the chlorine is carried away by tubes to chambers where it is absorbed by slaked lime and thus forms chloride of lime or bleaching powder. By an ingenious device the sodium amalgam is brought into contact with fresh water which is decomposed by the sodium with the production of caustic soda and hydrogen. The solution of the former is constantly being drawn off and boiled down until it solidifies on cooling. The product is a very fine-looking crystalline caustic soda. The mechanical arrangements for carrying the gas and solutions are so perfect that the whole process can be conducted by two men. The factory seemed deserted, although the work was going on uninterruptedly. This is one of the first applications of our water powers to electro-chemical industries, which are advancing at such a rapid rate in all those countries of Europe in which water powers are available.

Another interesting development here is in the metallurgical department under the superintendency of Mr. Sjösted, who with his foreman Mr. W. Goodwin, showed us the apparatus for manufacturing ferro-nickel and sulphur dioxide from pyrrhotite. The ground ore is roasted in a specially devised furnace in which water gas is used to supply heat. A sweet roast is obtained, the sulphur being reduced to not more than 0.3 per cent., and probably a great deal less. As this ore contains no phosphorus, the result is a Bessemer iron ore containing a high percentage of nickel. It is now mixed with a small percentage of lime and briquetted, ready for the blast furnace. The briquettes are turned out rapidly, the whole process from start to finish being a mechanical one, necessitating a minimum of handling.

The water gas is manufactured in a Dellwik furnace, the first to be erected on the continent. This method of making gas is only about three years old, and is just beginning to make its way in Europe, where it was devised. The improvement consists of an improved method of introducing the air blast during the period of heating. This is economical in two ways. In the first place it shortens the time required for heating the coke to the temperature at which it decomposes steam with the production of hydrogen and carbon monoxide. In the second place, the carbon is burned mostly to carbon dioxide, thus giving a larger amount of heat from the same amount of coke than by the older process, in which the greater part of the carbon is burned to carbon monoxide. Thus time and coke are saved. The cost of manufacture is so greatly reduced by this improvement that water gas can now be manufactured as a cheap fuel.

The sulphur dioxide formed during the roasting of the pyrrhotite is dissolved in water, so as to separate it from the gases with which it is mixed, as it comes from the furnace. The dissolution is effected by passing the gases up a tall tower in which they come into contact with a large surface of water. The sulphurous acid is then heated so as to drive off the sulphur dioxide, which is dried and condensed to a liquid by pressure. It is then in a condition suitable for transportation or for use in various chemical manufactures, *e.g.*, the manufacture of sulphuric acid by the Clemens Winkler process. Part of it will be used in the manufacture of bi-sulphite for the bi-sulphite pulp mill now nearing completion.

About three-quarters of a mile west of the metallurgical works are the steel works, the construction of which was going on rapidly. The new power canal (40,000 h.p.) is being built in this vicinity. This, added to the 25,000 horse-power of the canal now in use, will supply power enough for the development of a great industrial city.

Through the kindness of Messrs. F. H. and E. V. Clergue every facility was given for an inspection of the works.

The Helen Iron Mine.

This is reached by the steamer *Minnie M.*, which makes three trips a week from Sault Ste. Marie to Michipicoton Harbor, where is situated the loading pier at which the steamships of the Lake Superior Power Company's fleet receive their cargoes (about 2,500 tons each) of iron ore From this point a ride of twelve miles on the Algoma Central Railway brought us to the Helen mine. Here we were made comfortable by Mr. Hamilton Lindsay, the engineer in charge for the company, and Mr. E. O. Little, manager for the contractors, Messrs. Foley Bros , of St. Paul, Minn. (formerly of Almonte, Ont.). The classes were held in the dining camp at 6 45 p m. and 3.45 p.m. The attendance was so large as to overcrowd the only room available. A number of men were unable to find places To these sets of specimens were given with such instructions for their identification as were feasible. The total attendance was about fifty, with a daily average of about thirty-five. There were many inquiries about books for continuing the study of minerals and rocks. The mine employs about 400 men.

The ore at the Helen Mine is a mixture of hematite and limonite with smaller quantities of göthite, turgite and siderite. It is being taken out by open mining on three benches The ore is blasted out partly by dynamite and partly by very large charges of black powder (from 70 to 100 kegs have been used at a blast) prepared for by 'springing' twenty foot holes by repeated small charges of dynamite at the bottom. Enough ore is loosened up by one great blast to keep the steam shovel going for weeks. By this the ore is loaded directly into ore-cars for transportation to crusher No. 2. In parts not accessible to the steam shovel, the ore is carried by a trolley hoist and by an incline hoist to No. 1 crusher. From the crushers it passes into ore bins, whence it is loaded into steel ore cars for transportation to Michipicoton Harbor. It is worth noting that the Algoma Central Railway, over which the ore is taken, has a first class road bed, on which are laid the best of 85 lb. steel rails. It is somewhat of a surprise on landing on this north shore, 130 miles from the nearest town, to find a comfortable railway carriage in which one is carried inland as smoothly as over the more travelled roads. About 180,000 tons of ore had already been shipped. The present rate of shipment is about 2,500 tons a day. The ore is all taken out under contract by Messrs. Foley Bros., who are also contractors for building the Algoma Central Railway.

The camp arrangements are excellent. The most inveterate grumbler could hardly find fault with the results of the combined efforts of the obliging dining camp steward and chef, and their small army of assistants. Good sleeping quarters, recreation rooms, abundant water supply, and a hospital with resident physician—these are things to be thankful for in the wilderness.

Grace Gold Mine.

There was time for a flying visit only to this mine, owned by the Algoma Commercial Company, and reached by sail boat from Michipicoton Harbor to "The Mission" at the mouth of Michipicoton River. Here I was met by Mr. P. N. Nissen, manager. A drive of five miles over a good road brought us to the mine. The vein is quartz, mineralized with iron and copper pyrites, mispickel, and a little pyrrhotite. The values extend into the schist which lies between the vein matter and the walls. The strike is northwest and the dip is nearly vertical. Samples taken in shaft No. 1, from the walls of the north drift (100 ft. level) were submitted to Mr. A. G. Burrows, of the School of Mining, for examination, who reports as follows:—Sample 1 from hanging walls contains biotite, hornblende, and quartz making up the mass of the specimen, with ilmenite muscovite, calcite and orthoclase. Sample 2 from the foot wall contains quartz in large quantity, both finely and coarsely fractured; biotite in abundance; calcite and pyrite fairly abundant, and orthoclase. The ore assays well. A sample lot of 60 tons has been run through the Keewatin Reduction Works. The results shows the ore to be free milling and to carry a high value in gold.

The mine employs forty men, all engaged in development work, building, woodcutting, etc. The management is excellent; and we notice with delight the absence of the stamp mill, which has so often ornamented gold prospects of Ontario while being developed. Sinking, drifting and stoping are being carried forward, and the milling stage of development will be reached in due time.

Notes and Observations.

These classes have now been carried on for six years, the character of the work being varied more or less from year to year. The identification of mineral specimens has however always formed the ground work of the instruction. Familiarity with minerals is the first step towards an intelligent understanding of rocks, vein matter, ore bodies and their origin and transformations, and in fact of all the material to be observed and worked in prospecting, development and mining. The summer mining classes have thus in some degree made up for the lack of instruction in mineralogy and geology in our public schools and high schools. This summer's work has carried us from the extreme east to the extreme west of the Province, and the majority of the important mining camps have been visited. I have been impressed with the fact that Ontario has now a large mining population—a considerable number of men who have cast in their lot with the mineral industries of the Province, both as managers, foremen, etc., and as miners and workmen of other trades. The business requires men of intelligence, courage, and tenacity of purpose, and ability to endure discomfort and hardship with only that minimum of grumbling which is a man's privilege. Our mines are now pretty well supplied with men of this spirit. Drunkenness, dirt, and incompetency are excluded from the best camps. By careful weeding and generous cultivation, many managers have succeeded in getting around them a good class of men, and they find no difficulty in keeping them.

The older mines, such as Deloro and Copper Cliff, have provided means of education and recreation, and such comforts of civilized life as are attainable. This broad view of the responsibilities of companies and managers is the rule, with few exceptions, in Ontario mining camps. In the newer camps, recreation halls, schools and hospitals are being built so soon as circumstances warrant.

The education of the children in our mining camps is a subject requiring serious consideration. In most cases these communities are so different from both the ordinary country school district and the incorporated town or village, that regulations under which things work quite smoothly in the latter may be difficult of application in the former. In the mining camp, the only tax-payer may be the company, and it would be difficult to organize the camp into a school district in the ordinary way. Companies are usually willing to go to considerable expense to build school houses, and pay the teachers ; but it seems hardly just that they should bear the burden alone. Any system of taxation would be difficult to apply, on account of the fact that the majority of the wage-earners are unmarried men, or men whose families are being educated at homes in other places. Then, too, there is a large floating population, mostly men of foreign birth and language, whom it would be practically impossible to tax. As to trustees, it is obvious that the companies themselves are the best trustees. Schools are likely to be better managed by them than by elected boards. These circumstances make the mining camp a special case for which, it would seem, there should be special provision made.

In one camp visited there were over 100 children and no school. I am able to state from my own observation that there are large numbers of *young* men and boys in Ontario who cannot read or write. If children are allowed to grow up in our mining camps without schools, the number of these unfortunates is likely to be increased. Mining is a comparatively new industry in Ontario, and may be expected to give rise to many problems, industrial, political and educational. The problem of schools for the children is one which has already emerged.

In conclusion, I have to thank the Canadian Pacific, Grand Trunk, Central Ontario, Canada Atlantic and Algoma Central Railways for free transportation of excess luggage.

MICHIPICOTON MINING DIVISION.

BY D. G. BOYD, INSPECTOR.

I beg herewith to present the fifth annual report on the Michipicoton Mining Division. The office at Michipocoton River was opened on 23rd May, and continued open until 1st November.

During this period 137 miner's licenses were issued, and 120 mining claims registered. The total number of licenses issued during the year was 187, 50 being issued from Toronto. The claims registered numbered 164, of which 44 were registered at Toronto while the office at Michipicoton River was closed.

The amount of money forwarded to the Treasury Department from the office at Michipicoton was $2,541, and the amount received at Toronto $2,824.50, making a total of $5,365.50. Of this amount $1,870 was received for miner's licenses, $1,505 fees for additional mining claims, $470 for transfers of claims, and the balance, $1,520.50, was paid in on account of patent fees by licensees who had fulfilled the conditions required and desired to obtain patents for their claims.

Compared with the figures for 1900, there is a decrease in the number of licenses issued of 84, in the number of claims registered of 288, and in the total receipts of $1,300. These decreases are to be accounted for by the withdrawal from sale or lease for one year of a large part of territory comprised in the Division (with the exception of land within a radius of ten miles of Michipicoton Harbour and the land situate west of Dog River) by an Order-in-Council dated 29th April, on account of the land grant to the Algoma Central Railway Company. This Order-in-Council left so small a portion of the Division open for exploration, that very few new prospectors entered the District.

Helen Iron Mine.

This mine was inspected 23rd October. The changes since the date of the last inspection were very striking. The large amount of ore which had been removed had given the ore body a new appearance, and the pumping out of Boyer lake had lowered the water 25 feet. The pumping was done by a 14 inch centrifugal pump. The mine has been in operation since the last report, the ore which was taken out during the winter months being stocked.

A double-tracked skipway has been erected from the ore body to the crusher, and the skips which were of 3½ tons capacity were operated by a Webster, Camp and Lane double-drum hoist, geared to a 75-h.p. engine, the diameter of the drums being 4 feet. The drilling was being done by air, a 12-drill Ingersoll-Sargent air compressor having been installed. Situated about one mile from the mine towards the Harbor a second crushing plant has been put up, consisting of a No. 8 Gates crusher, driven by a 125-h.p. engine, the steam for which is supplied by a 125-h.p. water-tube boiler.

No work was being done underground at the time of inspection, although some had been done during the winter months. The tunnel mentioned in the former report had been driven an additional 28 feet in an easterly direction, the north branch 28 feet, and the south branch 56 feet, the work being in ore. Close to the mouth of the tunnel a shaft was sunk 5 feet by 8 feet in cross section, 100 feet deep, with drifts at the bottom, one running in a northeasterly direction 24 feet, and one in a southwesterly direction 165 feet. The ore was being mined principally in two places, one being the cable pit, whence the ore was conveyed to the crusher by the cableway and skipway. In order to hasten the output and handle the ore more economically a locomotive crane with a 70-foot boom was used to remove loaded skips to a hopper where the ore was dumped, fed into skips and hoisted to the crusher.

At the other place the ore was blasted from a face of the ore body 120 feet high, loaded by a 65-ton Bucyrus steam shovel into dump cars and hauled by locomotives to No. 2 crusher. The average output for 24 hours was 2,000 tons. The total amount of ore shipped from the Harbor during the season to the first of November was 209,065 tons. Of this amount 142,130 tons were shipped to Lake Erie ports, while 66,935 went to Canadian ports (Midland and Hamilton).

Messrs. Powell and Mitchell had the contract for mining until the 13th of June, when Messrs. Foley Bros. took charge of the operations, and put in Mr. E. A. Little as superintendent. Mr. Hamilton Lindsay C. E. was engineer representing the Lake Superior Power Company.

The number of men employed was 500, of whom 450 were miners.

The Frances Mine.

The Frances property is situated on Paint Lake and is being developed by The Algoma Commercial Company. I inspected it on 21st June. At that time a shaft had been sunk seven feet by nine feet in cross section, 95 feet deep. A large area had been explored by stripping and test pitting. The indications of iron were very strong, but no large body of ore had been discovered up to that time. The machinery on the property was a Sullivan E diamond drill, the steam for which is supplied by a 15-h.p. upright boiler ; one Cooper single-drum, double engine, 6-inch special hoist, one Cooper 20-h.p. locomotive boiler, and one No. 5 Cameron pump. The hoisting was done in a special ½-ton automatic dumping Cooper steel bucket. A mast and boom were used for a hoisting frame.

Since the time of inspection I have been informed by Mr. W. R. Seelye, the superintendent who took charge on 1st June, that a drift was run in a northerly direction from the bottom of the shaft 130 feet at right angles to the formation, and one 20 feet in a southerly direction. A chamber was excavated at the bottom of the shaft for the diamond drill, and the shaft sunk three feet deeper.

Work will be continued all winter, diamond drilling, test pitting and tapping the contact. The number of men employed is 30.

The principal buildings are an eating and cook camp, sleep camp, warehouse, engine-house, office and stables.

The Josephine Mine.

The Josephine is situated about 24 miles from the Harbour. The Algoma Central Railway has been graded to this property, the junction with the Helen mine branch being at the west end of Moon or Talbot lake.

Capt. Williams was in charge of the work, consisting of diamond drilling, the results of which I did not learn.

Ely Iron Claims.

On the claims of the iron range situated west of Iron lake, a gang of 20 men under the superintendence of Mr. Robert Murray have been engaged in prospecting work.

At the date of my inspection, 20th June, the work done was as follows : the "Ralph" drift, 6 feet by 8 feet, had been run 206 feet in a northeasterly direction ; 75 feet from the entrance of the drift a shaft was sunk, 6 feet by 6 feet by 9 feet deep. The "McCue" drift, 6 feet by 8 feet in size had been run 128 feet in a northwesterly direction. The "Ralph" shaft which is 12 feet by 8 feet in section, was sunk to a depth of 26 feet on the contact between the iron formation and greenstone. The "McCue" shaft, 6 feet by 6 feet in section, was sunk to a depth of 10 feet in the iron formation. About 150 feet above the "Ralph" drift, a drift was run 40 feet easterly.

The above drifts were made in the iron formation, which consists of alternate bands of chert and iron ore. A large area was stripped and test-pitted. At the time of my visit no large body of ore had been discovered.

Since my last report work on this property has been carried on steadily by the Algoma Commercial Company. Mr. P. N. Nissen is superintendent, and Joseph Hicks (late of the

GRACE GOLD MINE.

Mikado mine) captain. It was inspected on 12th October, and at that time the following machinery had been installed: a Webster Camp and Lane, double-cylinder, friction drum-hoist, cylinders 8½ inches by 12 inches, diameter of drum 44 inches; an Ingersoll-Sargent straight line class A, four-drill air compressor; a six-inch Knowles vertical bucket plunger pump; a Jenckes special six-inch hoisting engine; two locomotive boilers, one 45-h.p., and the other 35-h.p.

Shaft No. 1 was sunk to a depth of 180 feet, being 4½ feet by 9 feet in cross section inside the timbers. At 100 feet a level was made and drifts run, "A" drift in a southeasterly direction, a distance of 68 feet, and "B" in a northwesterly direction, a distance of 98 feet. A sump was made at the 100-foot level with a capacity of 500 gallons, the drainage being pumped to the surface by the Knowles pump. The hoisting is done in an automatic lock-steel skip with a capacity of 1,500 pounds, with a ¾-inch steel wire cable, elevated by the large hoist. The skipway is provided with an extension leg, thus allowing the rock to be hoisted from the bottom while sinking is being carried on. A temporary head frame 14 feet high was used with a 22-inch sheave wheel.

Shaft No. 2 was sunk to a depth of 60 feet. In this shaft the rock was hoisted in a bucket by the Jenckes hoist. It is the intention of the superintendent to use this shaft for ventilation purposes, and ultimately to connect with the main shaft by B drift.

The principal buildings consist of boiler room, 14 feet by 42 feet, hoist and compressor room, 14 feet by 32 feet, both under the same roof and covered with corrugated sheet iron; blacksmith shop 14 feet by 16 feet, dining-room 40 feet by 20 feet with kitchen attached, sleep camp 20 feet by 24 feet, two stories high with annex 16 feet by 18 feet, office and superintendent's residence.

An average of 24 men were employed, of whom 12 were miners.

Mining operations were greatly retarded by a fire which occurred during the early part of spring, when the shaft and engine house was burned and the machinery destroyed. Considerable time was lost before they could be replaced.

THE ZAGLOBA GOLD CLAIM.

Work was recommenced on this claim and continued until 25th May, when the mine was closed down.

Machinery was installed consisting of a 27-h.p. upright Jenckes boiler, a Jenckes duplex hoist, cylinders 6 inches by 8 inches, a No. 5 Cameron pump, a steam drill, and a 15-inch ventilating fan.

When I visited the property on 10th June the shaft had filled up with water to the first level. Mr. T. H. Murray, who was in charge, informed me that the shaft was sunk a further distance of 27 feet, making a total depth of 155 feet. At 145 feet a level was made, and drifts were run, one in a westerly direction a distance of 70 feet, and one easterly 23 feet.

The Waterloo County Mining Syndicate, who are developing the property, are also interested in the Michipicoton Falls water power. The work has closed down until the water power is developed.

On a bay off Dog lake about 6 miles southwest of Missanabie a gang of eight men under Ross S. Craddock have been engaged in prospecting some gold claims for the Algoma Commercial Company.

The work was chiefly test-pitting and stripping. Eighteen pits had been sunk ranging from five feet to 18 feet deep. The vein which has a course of north-northwest and south-southeast had been traced by these means a distance of about 1,300 feet.

At the time of my visit on 26th September a shaft was being sunk, which was 6 feet by 8 feet and 26 feet deep.

On claim No. 1276, owned by C. E. Martin of Titusville Pa., situated about one mile south of Wawa lake, a shaft was sunk 7 feet by 9 feet, 19 feet deep. The vein is a wide one, the sides of the shaft showing all quartz. Mr. W. A. Stowell was in charge. Date of inspection 12th October.

On claim "Peru" No. 336, owned by Robert Rush of Echo Bay, two men were working all season. During this time the shaft was sunk to a depth of 20 feet, and a drift 7 feet by 8 feet was run a distance of 24 feet.

The Manxman Gold Mining Company started a gang at work on a group of claims situated four miles east of the Mission. Work will be carried on all winter.

Other claims were visited, but the work done was not of sufficient importance to be noted here.

Appended is a list of licensees, place of residence, number of license, and number of claims (if any) registered during the year. Where not otherwise indicated the licensees are residents of Ontario. Claims marked with an asterisk (*) are in dispute.

Name.	Residence.	No. of License.	Claims.
Abell, J.	Toronto	1040	
Andre, G	Michipicoton River	1073	
Armstrong, H	Michipicoton River	1149	
Armstrong, W. J	Guelph	1174	1201.
Bacon, B. T	Chicago, Ill	1092	
Bain, W	Toronto	1016	
Barton, F	Michipicoton Harbor	1025	1221, 1226.
Barton, S	S. S. Marie	1128	
Bauldy, W. J.	Wawa	993	1199.
Beebe, W. D	Pleasantville, Pa	1053	1256.
Blackinton, A. B	Michipicoton River	1126	1187, 1314.
Bole, B. P	Cleveland, Ohio	1093	
Boyer, B	S. S. Marie	1121	
Bradford, F. E	Michipicoton Harbor	1000	1217.
Brotherton, G. H	Port Arthur	1082	1212.
Brown, A. F	Michipicoton River	1140	1312.
Brown, Jane	Michipicoton River	1103	
Buckley, H	S. S. Marie	1169	1161, 1166, 1167, 1168, 1195.
Burgess, D	Michipicoton River	1003	
Butterfield, G. S	S. S. Marie	1044	1284.
Charlebois, F	Wawa	995	*1206.
Chitty, A. H	S. S. Marie	1153	1216, 1248, 1268.
Clark, E. D	Guelph	1151	
Clergue, B. J	S. S. Marie	1109	
Clergue, E V	S. S. Marie	1062	1169, 1170, 1171, 1172, 1173, 1174, 1175, 1176, 1177, 1178, 1179, 1180, 1181, 1182, 1183, 1214, 1225.
Clergue, F. H.	S. S. Marie	1066	
Clergue, Gertrude	Bangor, Maine	1163	
Clergue, Helen	Bangor, Maine	1161	
Clergue, J. H	Bangor, Maine	1110	1264.
Cochrane, R. B	S. S. Marie	1060	
Conmeyer, N	Wawa	984	
Culbert, D. S	Wawa	1033	1254.
Davidson, J.	Ottawa	1116	1253.
Davis, J	Wawa	989	*1320.
DeHass, N. G.	Marquette, Mich	1013	
Dickson, J. L	Michipicoton Harbor	1101	
Dion, J. J. T	Wawa	1052	1246.
Douglas, J. W	S. S. Marie	1099	1299.
Downey, L	Michipicoton Harbor	1006	
Downey, M	Wawa	1125	1304.
Doyle, J. P	Wawa	1011	1186, 1198.
Doyle, Kate	Wawa	999	1258.
Dycie, J. G.	Michipicoton River	1020	*1274.
Dycie, Margie	Michipicoton River	982	

Name.	Residence.	No. of License.	Claims.
Dunn, Mrs. M	S. S. Marie	1122	1301, 1302.
Edey, M. C	Ottawa	1112	1232.
Edey, R. W	Michipicoton Harbor	1113	1231, 1234.
Ely, A. C	Chicago, Ill	1047	
Everett, W	S. S. Marie, Mich	1107	1294.
Evans, R. B	Michipicoton Harbor	1080	1266, 1309.
Fay, J	Marquette, Mich	1018	
Fleming, S. E	S. S. Marie	1136	
Francis, G. F	Pakenham	1118	
Gemmell, L. J	Perth	1058	1255.
Georgi, J	Michipicoton River	1102	1227, 1275.
Gibson, A	S. S. Marie	1057	1243, 1244, 1245.
Godon, A	Missanabie	1035	*1210.
Godon, Elise	Ste. Anne Pirade	1097	*1207.
Godon, J	Missanabie	1037	*1209.
Godon, N	Missanabie	1036	*1208.
Godon, T	Missanabie	1084	*1204.
Goodwin, W. B	Michipicoton Harbor	1081	1190.
Gray, A. N	Woodstock	1138	
Grover, M. B	Wawa	1026	1222, 1263.
Guelph Mg. & Dev. Co., Ltd.	Guelph	1173	
Hall, W	S. S. Marie	1063	
Hamilton, H. C	S. S. Marie	1165	1291, 1310.
Hamlin, F	Chicago, Ill	1147	1290.
Hamwell, A. N	S. S. Marie	1155	1251, 1269.
Harrison, Grace	New York, N.Y	1162	
Harrison, W. L	New York, N.Y	1148	
Holbrook, H. B	Wawa	1132	*1318, *1321.
Holbrook, L. J	Watford	1133	*1317, *1319.
Hoyt, J. H	Cleveland, Ohio	1012	
Hunt, J	Michipicoton River	1123	1296.
Husson, W	Guelph	1152	1200.
Irving, jr., T. C	Toronto	1145	1261, 1311.
Johnes, E. R	New York, N.Y	1042	
Johnston, E. J	S. S. Marie, Mich	1108	1293.
Keenan, C	Michipicoton River	1130	1316.
Keusie, O	Berlin	1008	1160.
Kimball, W	Michipicoton River	1050	1260.
Kitchener, B	Michipicoton River	1100	
Kreismann, R. D	Michipicoton River	1119	1306.
Labelle, J	Michipicoton River	1022	
Lacombe, A	Wawa	1124	1300.
Laird, W. H	New York, N.Y	1009	
Lauzon, A	S. S. Marie	1005	
Lawlor, J. A	Michipicoton River	1076	
Leffoniere, L	Missanabie	1027	1273.
Legge, C. H	Gananoque	1170	1237.
Legge, J	Gananoque	1141	1238, 1313.
Lemieux, M	Wawa	1072	1253.
Lewis, F	Michipicoton River	1104	1307.
Lewis, F. S	Philadelphia, Pa	1164	
Lewis, W. H	Detour, Mich	1054	
Madge, P	Thames Road	997	
Manxman Mg. Co., Ltd	S. S. Marie	1077	1229, 1240, 1241, 1322.
Martin, C. E	Titusville, Pa	1086	1276.
May, E	Michipicoton River	1021	1228.
May, Jane	Michipicoton River	1056	1297.
Merrick, W. C	Cleveland, Ohio	1095	
Michael, Ada L	S. S. Marie	1045	
Michipicoton Dev. Co	Michipicoton River	1007	
Monsarrat, N. S	Cleveland, Ohio	1094	
Morrison, E	Michipicoton Harbor	1038	
Morrisseau, A. J	Nepigon	1023	
Murray, W. P	Cleveland, Ohio	1089	
McCue, W	Duluth, Minn	1074	
McDougall, J	S. S. Marie, Mich	1106	1295.
McDougall, L	White River	1167	
McDougall, W. H.	White River	1068	
McGillivray, W	Ottawa	1113	1230. 1236.
McKay, A. A	S. S. Marie	1010	

Name.	Residence.	No. of License.	Claims.
McKeehan, H. H	Cleveland, Ohio	1075	
McLean, A	Wawa	998	
McLean, J. R	S. S. Marie	1085	
McMillan, E	Michipicoton River	1059	
McNeil, E. W	Toronto	1017	
McRae, P. J	Detour, Mich	1055	
Nelson, J. D	Michipicoton Harbor	1001	1188, 1220.
Nissen, P. N	Michipicoton Harbor	1024	
Parks, Emily H	St. Catharines	983	1193.
Parks, G. F	S. S. Marie	990	1191, 1283.
Peck, A. L	Lowell, Mich	1144	
Perry, F. L	Bridgeport, Conn	1004	
Perry, R. I	Bridgeport, Conn	1120	1165.
Pettit, R	S. S. Marie	1117	
Pinze, A	Riviere Ouelle, Que	1088	
Pinze, J	Missanabie	1030	
Pokorney, L. G	Huntsville	1071	
Pol, B	Bangor, Maine	1146	1247, 1271.
Pol, J	Bangor, Maine	1160	
Pononish, A	White River	988	
Premier Gold Co., Limited	St. Thomas	1131	1202, 1203.
Preneveau, G	Missanabie	1029	*1211.
Quarters, N	Marquette, Mich	1015	
Ralph, M	Duluth, Minn	1048	
Rankin, E	Marquette, Mich	1019	
Reed, G	Michipicoton River	1139	1239, 1305, 1323.
Rogers, G. H	Ottawa	1115	
Roth, F	Cleveland, Ohio	1150	
Rothschild, H. J. M	Wawa	1078	1259.
Rush, R	Echo Bay	996	
Sage, M	Michipicoton Harbor	1031	
Schafer, E. J	Michipicoton River	1142	1303.
Seaver, J	S. S. Marie	1046	
Secord, J. L	Brantford	1049	
Seneca Gold Mg. Co., Ltd	Welland	1061	
Seymour, W. L.	Chicago, Ill	1091	
Sheppard, A. A	S. S. Marie	1168	1164, 1166, 1167, 1168.
Shipley, H. F	Michipicoton Harbor	1079	1213, 1265, 1308.
Simpson, N	S. S. Marie	1166	1298.
Sjostedt, E A	S. S. Marie	1064	1189.
Smith, R. H	Michipicoton Harbor	1039	
Spencer, D	Brantford	1137	
Stone, R	S. S. Marie	1157	1286.
Stribling, F. W	S. S. Marie	1028	1196, 1282.
Struthers, W	S. S. Marie	1002	1219, 1224, 1249, 1267, 1288.
Sutherland, J. G	S. S. Marie	1154	1252, 1270.
Talbot, H. E	Dayton, Ohio	1111	
Taylor, G. H	Michipicoton Harbor	1098	
Taylor. H. H	S. S. Marie, Mich	1105	1292.
Teare, J. H	S. S. Marie	1067	
Thibault, N	Wawa	1051	1242.
Thompson, C	Michipicoton River	1129	1315.
Thompson, R	S. S. Marie	1158	1287.
Tobin, jr., J	Marquette, Mich	1014	
Todd, J. A	Titusville, Pa.	1087	1278, 1279, 1280, 1281.
Touchette, J	Missanabie	994	*1205.
Trembley, J	Michipicoton Harbor	1135	
Van Evera, J. R	Marquette, Mich	1096	
Vansickle, W. B	Lynden	1043	
Wall, A	Saginaw, Mich	1083	
Warren, S	S. S. Marie	1156	1250, 1272, 1289.
Ward, Venia A	Pleasantville, Pa	1034	
Ward, W	Pleasantville, Pa	1041	1277.
Wheeler, C. P	Chicago, Ill	1090	
Whiteoak, W	Wawa	1143	
Wilde. J. A	S. S. Marie	1065	
Wilmott, A. B	S. S. Marie	1032	1223.
Woodward, W	Michipicoton Harbor	1127	
Worthington, C. P	S. S. Marie	1159	1215, 1218, 1285.
Younkin, F	Jackson, Mich	1134	

PROVINCIAL ASSAY OFFICE.

BY J. WALTER WELLS, B.SC

This office was opened in July 1898 by the Bureau of Mines with the view of encouraging prospecting and exploratory development of mineral lands in Ontario. It offers to prospectors and owners of mineral lands an opportunity of securing reliable assays, analyses and other tests of ore samples at a nominal cost, the fees charged being on a scale large enough only to prevent abuse of the privileges. That prospectors and mining men appreciate the usefulness of a public testing laboratory may be judged from the following yearly records of determinations made at the Assay Office :

	1898 (6 mos.)	1899.	1900.	1901.
Assays and analyses........................	406	1,651	2,215	2,949
Identifications, qualitative examinations, etc..	45	304	187	487

The office is located in Belleville under agreement with the city council, by which the latter undertakes to provide suitable quarters. It occupies two flats at No. 24 Victoria Avenue, the ground floor being divided into (1) office, (2) sample room for storing pulp and rough ore samples, (3) crushing and store-room, containing crushing machinery, supplies, etc The second flat is divided into (1) analytical room, (2) assay room, (3) balance room. An outhouse is used for storing gasoline underground. There is at present no extra space and two more rooms could be utilized to advantage.

Functions of the Office.

The work of the office during 1901 included the following services performed directly for the Bureau of Mines :

1. Issuing laboratory reports (assays and analyses, etc.) of samples sent in by Government geologists and survey parties exploring the unsurveyed portions of northern and western Ontario. These reports are published in the annual report of the Bureau of Mines when of sufficient interest to the general public. Many samples are received through the head office sent in by private parties and reports are sent and charged to the Bureau of Mines.

2. Issuing check analyses of iron ores raised and smelted in Ontario, on which it is proposed to claim the bounty provided by the Iron Mining Fund.

3. Doing general laboratory work for a report by the Bureau of Mines on the peat industry in Ontario, including tests of various raw and briquetted peats for fuel purposes.

4. A report on the Arsenic Industry, with special reference to the deposits of arsenical pyrites in eastern Ontario as a future source of supply. This report is included in the present volume.

5. Collecting ore samples from eastern Ontario for the Government exhibit at the Pan American Exposition held in Buffalo, N.Y., during 1901.

The following services have been performed during the year for prospectors and parties engaged in mining or developing ore bodies in Ontario :

1. Issuing laboratory reports consisting of assays, analyses, qualitative examinations identifications or reports as to probable commercial value of minerals. These reports are charged for at actual cost according to a scale of fees approved by the Director of the Bureau of Mines, and are entirely the property of parties ordering the tests and paying the fees. While this is a public laboratory, custom work is done for private parties, and such reports cannot be issued other than to the parties ordering them on payment of the prescribed charges. Pulp of samples sent in by private parties is held for reference by the sender only or subject to his written order. The same rule holds good in the case of laboratory reports.

2. Acting as an information agency and answering as far as possible inquiries from owners of mineral lands as to market prices, uses and purchasers of minerals and raw ores. On

thousand six hundred and twenty-two letters were sent out, many of which were in response to requests for such information. Inquiries from dealers, investors and manufacturers using raw ores for information regarding minerals found in Ontario are published in the monthly office bulletin.

3. Making check determinations, and also doing umpire work in case of disputes as to correct values contained in samples. In most cases the differences were found to be due to different methods of sampling, rather than to errors on the part of the assayer or chemist whose report was disputed.

4. Issuing free of charge a monthly official bulletin containing monthly laboratory report, inquiries of general interest and notes on minerals coming into demand. This bulletin is sent to any person interested in mining in Ontario, and is reproduced in whole or part by newspapers in Ontario and mining journals in Canada, the United States and Great Britain. The following minerals which have recently come into more important commercial use have been described in the monthly bulletins, and information given regarding uses, market, etc.

(*a*) Iron pyrites, which is distributed throughout the iron regions of Ontario and is rising in commercial value owing to its more extensive use in the manufacture of sulphuric acid, sulphites employed in bleaching wood-pulp and paper, and the various salts in which sulphur is a constituent.

(*b*) Molybdenite or sulphide of molybdenum, which is coming into vogue as an alloy with steel, as well as in making various commercial chemicals.

(*c*) Platinum, which is going up in value on account of increased consumption in many lines.

(*d*) Monazite sand, containing the rare earths such as zirconium, cerium, thorium, etc., several of which are used in the manufacture of the Auer and Welsbach mantles employed in incandescent gas lighting.

This method of keeping the prospectors in touch with various changes in metallurgy and uses of minerals is appreciated. Many inquiries have been answered and samples of minerals coming into use were sent to prospectors in response to requests for full information.

5. Samples of commercial economic minerals have been distributed to *bona fide* prospectors and interested parties who were in doubt as to the characteristics of certain ores and wished samples for comparison. Eighty-four such samples were distributed throughout Ontario in answer to this demand during the year.

Laboratory Determinations for the Year.

The following tabular statement shows the laboratory determinations in detail made during the year, each being checked off by a duplicate (to avoid errors) before issuing certificates.

ASSAYS.

Determination.	For the Bureau.	For the public.	Total.
Gold (fire assay)	34	370	404
Gold (amalgamation assay)	6	1	7
Silver (fire assay)	22	239	261
Copper	15	111	126
Nickel	10	36	46
Platinum	4	5	9
Zinc	1	4	5
Manganese	7	6	13
Tin	0	0	0
Cobalt	2	3	5
Lead	7	3	10
Totals	108	778	886

ANALYSES

Determination.	For the Bureau.	For the public.	Total.
Silica	20	30	50
Sulphur	161	52	213
Phosphorus	37	17	54
Titanium	30	20	50
Metallic iron	61	90	151
Moisture	312	11	323
Volatile combustible	202	4	206
Fixed carbon	147	11	158
Ash	148	5	153
Alumina	4	16	20
Ferric oxide	3	9	12
Arsenic	6	3	9
Lime	9	16	25
Magnesia	4	14	18
Alkalies	2	1	3
Miscellaneous	562	56	618
Totals	1,708	355	2,063

Total number of samples received for assay, etc	1050
Total assays	886
" analytical determinations	2063
" identifications and qualitative examinations	487
Total laboratory determinations	3486

A comparison with the results of the laboratory work for 1901 with 1900 shows a falling off in gold, silver, copper and nickel, and an increase in iron ores, in prospecting for which there is now much activity, particularly in northwestern Ontario.

Limestones are receiving considerable attention due to the starting of the beet-sugar industry in this Province. Marls and clays are also in demand for making Portland cement, and the laboratory report for 1902 will doubtless show considerable increase in this line.

Laboratory Methods Employed.

The laboratory is equipped for the following determinations :—

Gold and Silver : by fire assay, and by bottle amalgamation to test the free-milling quality of gold ores.

Copper : by electrolytic and cyanide titration methods, the latter on pure copper ores only.

Nickel : by electrolytic and cyanide titration methods.

Lead : by fire assay for rich ores and molybdate titration for lean ores.

Manganese : by standard methods as employed by iron smelters.

Metallic iron : by bichromate and permanganate methods using stannous chloride as reductor.

Sulphur : by weighing as barium sulphate for iron ores. By Gladding's method for sulphur in pyrite and pyrrhotite.

Phosphorus : by precipitating with ammonium molybdate, weighing directly, or titrating with potassium permanganate, with metallic zinc as reductor ; also by Handy's method.

Titanium : weighing as dioxide.

Lime : titration with potassium permanganate for limestones and marls ; weighing as oxide in rock-analyses.

All other determinations by standard methods. All determinations except those requiring an impalpable powder are done on 100-mesh pulp at ordinary temperatures without being previously dried unless stated otherwise in the certificate. Raw ore carrying water to such an extent as to prevent grinding is dried at 110°, and report is made both on the basis of dried ore and on the ore in natural state as received.

A standard sample of pulped iron ore analyzed in this laboratory was sent to six different chemists during the year, and the results for metallic iron as reported show that all practically obtained the same results, though the methods used were not uniform.

Standard samples of iron ore and marl have been prepared for analysis, and a portion of each sample for analysis together with a copy of complete analysis as made in this laboratory will be sent free of charge to any Canadian chemist on condition that the results as obtained by each chemist will be reported to this office.

Two laboratory assistants are employed. Messrs. W. B. Jameson and A. G. Burrows, students from Kingston School of Mines acted as first assistant for separate portions of the year. Both are at present finishing their course of studies.

Laboratory fees amounting to $130.40 for identifications, etc., and $992.75 for assays, etc., total $1,123.15, were collected during the year and remitted to head office. While the charges are nominal, no report can be issued till they are paid. No charges are made for identifications and qualitative examinations on samples brought to the office by parties desiring such reports.

Shipping bags and mailing envelopes addressed to the Assay office are supplied free of charge to prospectors and parties wishing assays.

MINING LAND AGENCIES.

At three convenient points in the mining districts of Ontario, where a great deal of the land is still the property of the Crown, namely, at Sudbury, Massey Station and Rat Portage, agencies are maintained by the Department of Crown Lands for the purpose of facilitating the transaction of business between the Department and persons interested in mining, particularly those who wish to take up Crown mineral lands. The agents at these points are furnished with district and township maps, with books of record containing practically a transcript of the entries in the Department at Toronto affecting the title of individual lots, with reports of the Bureau of Mines, blank forms of all kinds, etc. Prospectors and others are free to examine these maps and records, and no charge is made for the agent's services, except the small fee customary when affidavits are taken. A prospector who wishes to look for mineral in any region included in one of these agencies can ascertain before setting out what lands in the locality have been taken up, and if he makes a discovery can have his application for the land at once sent on by the agent to the Department at Toronto.

Following are reports by the agents at the above-named places concerning the working of their respective offices during the year 1901 :

Rat Portage Agency.

Mr. L. C. Charlesworth, the Mining Lands Agent at Rat Portage, writes under date of 24th February, 1902 : I beg to submit the following short account of the work done at the Mining Lands Agency here during the past year, with a little information also as to the mining work being done in this vicinity.

There was not a great deal of activity in taking up mining lands in the region around Lake of the Woods during 1901, and although a considerable number of applications were dealt with here, many of them were for agricultural lands. A number of maps were distributed both to prospectors for mineral and to those seeking farm lands, and information was furnished to many inquirers. The amount of money forwarded to the Department during the year was $2,175.26.

The early part of the year showed less mining work going on in the vicinity of Lake of the Woods than for some time previously, but during the summer the Regina mine was reopened under the management of Mr. Frank Peterson. This mine is now known as the Black Eagle. Active work has been going on there ever since, and a fine new mill of 30 stamps has been erected, which is running night and day. The result of the first twenty-two days' run was brought into Rat Portage recently and was, I am informed, in value somewhere about $6,000. I am also informed from a reliable source that there is now two years' ore blocked out and that they are rapidly progressing with further development.

The Sultana mine has also been continuously working, and Mr. Wm. M. Strong, the manager, gives the following figures showing the development work done during the past year :

No. 4 level south was connected with the south air shaft, distant 800 feet south of shaft No. 1. The Crown Reef ore body has produced a limited amount of ore between No. 2 level and the surface, but at the depth of No. 4 level 246 feet below the surface, the ore body was found to be represented by quartz stringers carrying little or no values, therefore work in the south workings has been abandoned.

The main ore body in the north workings had been displaced by faulting between the sixth and seventh levels. For the purpose of re-locating the displaced ore body No. 7 level was driven northeasterly 328 feet. From this heading diamond drill bore holes were driven northeasterly cutting about 12 feet of quartz and mixed ore at a distance of 266 feet from the drift heading.

The present development work consists in driving No. 7 level to intersect the quartz discovered by the diamond drill.

Ontario mineral exhibit, Pan-American Exposition; general view.

Ontario mineral exhibit, Pan-American Exposition ; nickel and arsenic.

Ontario mineral exhibit, Pan-American Exposition ; corundum and copper ore.

The Mikado mine too has been continuously working, the results of the monthly mill runs appearing in the form of gold bricks periodically in the windows of the Imperial Bank here. The development done is given by Mr. Macmillan, the manager, as follows:

During the year ending 31st December a total of 1710 feet of development has been done, namely 601 feet of sinking, 1048 feet of drifting, and 61 feet of upraising. The average cost of this work has been reduced by about 40 per cent. on previous years. The expenses in the milling department have been reduced over 40 cents per ton, while the cost of treating our tailings by cyanide is less than $1.00 per ton treated. Our improved treatment in the latter department has increased the extraction from 5 to 10 per cent. over previous years.

The entire development carried out this year has been on the vein, four new levels having been opened up, all of which follow the ore chute. The values are more patchy and of lower grade than was met with in the upper levels, but since the month of August last sufficient improvement has taken place to enable us to cover our total expenses and even show a small profit.

During diamond drilling operations which were carried on last October, at a point 1700 feet south of the main shaft a large vein was tapped traversing the country east and west and dipping towards the north. This vein showed six feet of quartz and 14 feet of vein matter at a vertical depth of 135 feet, and we purpose striking it at a depth of 600 feet by producing the ninth level in No. 1 vein.

The number of men employed is 49, being a reduction of 19 on the previous year.

Prospects for mining work in this vicinity appear to be brighter than last year, the properties already working apparently intending to continue and it being very probable that some others will be developed.

During the year a map of Lake of the Woods was prepared for publication and forwarded to the Department of Crown Lands. A map of the country east of the lake has also been in course of preparation here for some time, but as there is at present very little prospecting being done there I have not completed it, and am merely adding fresh information to it when the same can be obtained.

Massey Station Agency.

The agent at Massey Station, Mr. D. M. Brodie, who also represents the Department of Crown Lands at that place, writes as follows with reference to the workings of his Agency for 1901:

Applications for mining lands for the past year have averaged well with other years. Undoubtedly the shortness of the prospecting season limits their number. During the year seventeen applications were made covering an acreage of 2,600 acres of land in the townships of Victoria, Shedden, Salter, May and Berth 138.

The last named township not being in the market and being unsurveyed, applicants were so informed; the fact being that it is under timber license, and that there would be danger of fire were mining operations allowed thereon.

Development has been steadily going on. Outsiders from the United States have been interested, and considerable work has been done by them in proving claims.

The principal and leading mine is in the township of Salter, and is owned by the Massey Station Mining Company. It is now beyond the prospecting stage, a shaft having been sunk to a depth of 230 feet, with three levels and still striking ore as good as on the surface. A fair estimate of the amount of ore taken out would be about 3,000 tons averaging about $3\frac{1}{2}$ per cent. copper. Over 1,000 tons of this has been shipped to the Orford Copper Company's plant at Copper Cliff, where I understand it is used in the concentration process of that company and provides an excellent flux in connection with the nickel matte.

A railroad from the company's mine to the village of Massey Station is now under construction which will connect with the Canadian Pacific Railway's line here, being about three and a quarter miles in length.

An appropriation having been made by the Dominion Government to dredge and make navigable the Spanish river so that the larger lake vessels could navigate it with safety, I understand that it is the intention of the Massey Station Mining Company to extend the spur line to the river, and thus have access to the great lakes for the shipment of their product as well as for procuring their supplies of coke and coal. The making navigable of this river should be of untold benefit to others engaged in mining operations in this vicinity by giving them cheap means of transportation.

The sum of $213.18 has been forwarded to the department through this agency for applications and renewals of leases.

On 27th March a large shipment was forwarded from the agency to the Pan-American Exhibition at Buffalo embracing samples of copper, galena and talc.

The Massey Station Mining Company also forwarded at their own expense a large sample of the product of their mine when requested to do so, and altogether the specimens sent from this agency received more than favorable comment, the ores from township 137 being especially rich in copper.

Many letters have been received by me from various parties throughout the Dominion and the United States, who had seen the samples on exhibition at Buffalo, requesting information regarding the prospects of mining in this district, which have been answered to the best of my ability.

Sudbury Agency.

Mr. T. J. Ryan, Crown Lands Agent at Sudbury, furnishes the following report:

I beg to submit the following short report of business transacted at Sudbury Mining Agency for the year 1901. There was a marked increase in the amount of mining work over 1900. I have charge of 29 townships in my Agency. Inquirers find the Land Roll of great convenience to them. Prospectors and others make good use of the office, consulting maps, books of record, mining laws, regulations, etc. Reports of the Bureau of Mines, maps, blank forms of affidavits, applications etc., are furnished free to those requiring them.

The Bureau's report printed in 1901 has been greatly in demand; and the supply was twice exhausted. The new mining map of the "Sudbury Nickel District" has been a great help to the work, and its free distribution by the department has been greatly appreciated by people interested in mining.

The Provincial Assay Office located at Belleville is of much advantage to prospectors, who can obtain at this agency envelopes free for the purpose of mailing ores for assays and analysis.

The mining industry of the district for the year has been very prosperous and the general outlook is bright. The distinguished Mr. Edison, the great electrical inventor of Orange, New Jersey, paid the district a personal visit and as a result is securing nickel properties for supplying his immense laboratories and works. His attention was directed to the Sudbury district by the splendid mineral exhibit made by the Bureau of Mines at the Pan-American Exposition in Buffalo. Dr. Pauli of Germany has also paid the district a visit through means of the Exhibit.

Great interest is taken in the test work being done by William McVittie and others in the Onaping coal fields district, also in Mr. R. H. Ahn's work in the placer gold district on the Vermilion river.

During the year about 15,420 acres of mining lands were duly applied for through this office and affidavits and papers filed in the department. The sum of $2,195 was paid through this office for discoverers on account of the lands. In addition to this many others received information from the land books here, made affidavits and deposited the same personally, and paid in the money direct to the Department.

ONTARIO AT THE PAN-AMERICAN.

BY FRANK N. SPELLER.

At no time has a large international exposition been situated so conveniently for the people of this Province as was the Pan-American Exposition at Buffalo, N.Y., which was held from 1st May to 1st November, 1901. The buildings outlined at night with their myriads of incandescent lights were plainly to be seen from the Canadian side of the Niagara river. Hence in making an exhibit of the mineral resources of this country by placing plain eye-evidence of its existence before men of capital and experience looking for profitable investments and before the great American market in general, and at the same time in giving a considerable portion of the people of Ontario an opportunity for the first time to see on an adequate scale what our mineral wealth really means. how it compares with other portions of the continents of North and South America, and what is being done to exploit and open up these possessions, a double purpose was served.

The attendance of Canadians, as was expected, proved to be proportionately large, and on the whole the visitors from home were not the least interested in our exhibits. On the contrary, the questions asked often demonstrated the force of the admission made by an Ontario editorial writer on his return that "sometimes we have to go away from home to learn about ourselves."

The accompanying photographs illustrate prominent features of the exhibit, of which a brief account is given herewith.

The work of enlisting the co-operation of the mining community of the Province was begun only about the end of 1900, thus allowing little more than four months for the work of collection and installation at a most unfavorable season as regards properties not working during the winter.

Scope of the Exhibit.

The collection was designed to be representative of the economic ores and minerals of the Province, showing truly the average quality as nearly as possible. Contributors were especially requested to send large blocks as samples, all freight expenses being borne by the Bureau of Mines. Circular letters were despatched to all likely to be interested in the undertaking. The effect of these was but small, and it was found necessary to visit the important mining sections personally and explain the purpose and scope of the exhibition to mine owners and others in order to arouse a more general interest. Every means possible was employed to accomplish the object in view and to be in readiness for the opening day.

Finally, a very generous response was made and with the aid of the principal mining companies, local boards of trade, and public-spirited individuals in many sections of the Province, the organization of a collection was soon well under way. The result was an exhibit representing every section of Ontario and with few exceptions all the important mines. Individual samples varied in weight from a few pounds to five tons, and aggregated approximately 100 tons in weight—nearly double the quantity of material assembled for the Ontario Mineral Exhibit at the World's Fair, Chicago, in 1893.

One principle kept steadily in mind in assembling the exhibit was to procure samples of ore and mineral as far as possible from working properties, or at all events of average composition and richness, rather than picked specimens, more attractive perhaps to the sight-seer but not properly representative of the body of ore or mineral from which they were taken. It was thought that well informed visitors would prefer such a collection, calculated to convey a correct impression of the nature and value of the mineral deposits of the Province, to one made up of rich and handsome samples whose very richness would tend to cast doubt upon their representative capacity.

Hardly less important than the character of the samples comprised in such a collection is their size. First-class hand specimens may be obtained from almost any deposit of mineral, whatever its grade or value ; but where it is desired to show the real nature of a vein or lode the only convincing proof– so far as such proof can be given by samples at all—is the production of specimens large enough to be unmistakably characteristic of the whole. The adoption of this principle greatly increased the difficulties of collecting the exhibit, but in the eyes of practical men much enhanced its value. Wherever practicable, large, even bulky specimens were obtained, especially from mines actually being worked, so that not only might the quality of the mineral worked be clearly shown, but that it might also be made apparent that the properties from which these massive specimens were taken had arrived at a stage of development demanding the use of suitable mining equipment and appliances. Further, there is no doubt that the mind is impressed through the eye, and the sight of a large mass of workable ore insensibly conveys the impression that the lode or deposit from which it is taken is of corresponding size as well as quality. The foregoing remarks explain the presence in the collection of many large blocks of the ores of copper, copper-nickel, iron, gold, zinc, etc., as well as of corundum, graphite felspar and other minerals.

Little effort was put forth to make the exhibit scientifically complete, hence some varieties of crystals and probably a few minerals not of much commercial importance were wanting, the aim being to emphasize the practical rather than the purely mineralogical aspects of the exhibit.

Installing the Specimens.

The space assigned to Ontario in the Mines building, while not as large as required for the amount of material available for display was well situated, being on the main line of travel through the building, and cut diagonally by one of the principal aisles, the limits of which we were kindly permitted to disregard in the scheme of installation adopted. The location was such as to render it difficult for the visitor to enter or leave the Mines building without passing through the Ontario section, and it frequently happened daily that the number of visitors taxed the space to its utmost capacity while in other sections of the building, more commodious, there were comparatively few.

A female figure representing Canada, by Mr. J. Lisney Banks of Toronto, was placed on a ten-foot column in the centre of the above aisle, forming an appropriate connecting link between the two main portions of the exhibit and a key to the symmetrical arrangement of the several divisions of exhibits on either side.

With the exhibits of the State of New York on one side and the Standard Oil Company on the other, both enclosed in massive ornamental constructions, it became necessary for Ontario to carry out the general design in harmony. For this reason, and to distinguish the boundaries of the space, the main aisle was spanned with arches at either end. These and other ornamented parts of the enclosure were of the same design and finish.

On the north side facing another aisle a massive arched doorway of pressed brick and terra cotta designed and erected by the Milton Pressed Brick Company, of Milton, Ont., was placed, being worked in as a portion of the general scheme of enclosure. This latter piece of work had a frontage of 19 feet 6 inches and was about 13 feet high over all. The excellent material employed made a very creditable showing which was much commented upon.

On one wall was hung a large map of Ontario, 18 by 22 feet, geologically colored and with the names of the most important minerals found in the various sections clearly printed thereon. It contained in readable type notes on the Province, its laws, resources and statistics of production, population, schools, etc. This map was visible from almost any point in the building and formed a prominent feature of the exhibit. The artistic manner in which the work was executed by Elliott & Sons of Toronto, was very creditable to that firm.

Among the useful features of the installation should also be mentioned the map of Ontario, prepared by the Lake Superior Power Company of Sault Ste. Marie, Ont. The canvas was 10 by 15 feet in size and was enclosed in a heavy oak frame. The object was to show the timber and mineral resources of Northern Ontario and the various railroad and steamboat connections at Sault Ste. Marie now existing and projected for the near future, the transportation routes being marked by red incandescent lights, and the whole forming a striking spectacle even in day-time

Some fifty-five photographs, a number of which were enlarged, were framed and hung where possible. These with a few moose and deer heads and a plentiful supply of Canadian ensigns and Ontario arms were used as seemed best in the way of general decoration.

Fortunately, additional space was secured for Ontario exhibits on the front verandah of the Mines building, and at either side of the front and north entrances. These supplementary sections were prominently marked, and visitors were directed to the main exhibit inside.

Practically all our material was in place by 15th May and the Mines building was officially opened 18th May, two days before the formal opening and dedication of the Exposition, and considerably in advance of all other departments.

Due attention was given to the exhibit by the principal mining periodicals of Canada and the United States including in some cases considerable detail. It may be useful to mention a few of these before touching briefly upon the more prominent and important features of the display. Illustrated articles by the correspondent of the Engineering and Mining Journal appeared in the numbers of 22nd June, 24th August and 19th October. The September number of Mines and Minerals, Mining and Metallurgy of 1st June and 15th September, and the Canadian Mining Review all contained fairly full descriptions by special correspondents who visited the Ontario exhibit for that purpose.

Samples were classified in sections according to the kind of ore. These sections were sometimes subdivided into the districts represented. The limitations of space prevented any hard and fast rule in this matter.

The system of labelling was somewhat unique and was favorably remarked upon. Cards were printed with the name of the ore and spaces for the name of the locality and other details. A colored border distinguished the various sections from one another, the characteristic "metal color" being used where possible, i.e., gold-bronze bordered cards for samples in the gold ores section, a silver border for the silver ores, etc.

Metalliferous Ores and Products.

The Gold ores were arranged in pyramidal shape, the ores from the various districts being grouped together. On top of this pile, large blocks from the Sultana, Mikado, Regina, and Belmont mines were conspicuous. Case specimens were also shown illustrating peculiar variations in these ores and showing also the rarer free gold samples. Those from the Sturgeon Lake region, north of the C.P.R. were particularly handsome.

Among the arsenical gold ores the exhibit made by the Canadian Goldfields Limited deserves special mention, on account of its unique character. A handsome case was provided in which were to be seen all varieties of the ore and country rock, and samples illustrating the process of winning the arsenic and gold. The company's plant at Deloro, Ont. was shown by a number of enlarged framed photographs. A neat pamphlet prepared by Mr. P. Kirkegaard, manager of the works, describing the exhibit and the process of treating these ores was distributed to those interested. The Canadian Goldfields being the only company manufacturing arsenic on a commercial scale in America, the display attracted no little attention and did credit to eastern Ontario and to the enterprising concern which it represented.

In the same section large quantities of arsenical ores from the Atlas Arsenic Company, Joseph James of Actinolite and others were shown.

Under the head of Silver Ores a large number of samples from the Port Arthur district represented that section. These samples were for the most part from the collection of Mr. F. N. Gibbs of Port Arthur and were widely representative in variety and locality. About three hundred pounds of ore from the West End Silver Mountain mine sent by Wiley & Co. of Port Arthur attracted much attention by its richness.

The Copper Ores included the well-known varieties from the north shores of Lake Huron, Algoma, Parry Sound and other districts.

Blocks of ore from the Rock Lake mine, Bruce Mines, Stobie mine near Desbarats, Massey mine near Massey Station C.P.R. and the Paton claim on Whiskey Lake, Algoma, varied in weight from 2000 to 8000 pounds each. One of the Rock Lake blocks taken transversely with the vein measured seven feet by three feet on one side. These ores were placed in the supplementary section on the front porch and judging by the number of inquiring visitors attracted to the office in the main section thereby, there can be no doubt as to the practical value ot such samples.

On entering the main exhibit the visitor could hardly fail to notice the massive collection of ores, mattes and metallic products representing the Nickel mining interests of the Province. The Canadian Copper Company, the Mond Nickel Company, the Great Lakes Copper Company, the Nickel Copper Company of Ontario, and many other concerns sent samples of ore widely representative of the Sudbury district. Particular mention is due the Canadian Copper Company who shipped 15 tons of samples in all, one from mine number four weighing 5 tons. Every variety of ore was fully shown and all stages of treatment from the raw ore to the Bessemer matte were illustrated by massive specimens. Samp'es sent by the Orford Copper Company of New York completed the illustration of the process of refining nickel and copper down to the metallic anodes, cathodes and ingots ready for market, standard samples of which were included. The Orford Copper Company also loaned a valuable polished cast nickel rail of intricate design, 14 feet long. This served to enclose the front of the Nickel-Copper exhibit making the 18 or 20 tons of rather grim looking ore stand out more prominently.

Owing to lack of space the Iron ores could not be grouped together as was done with most of the divisions, the number and size of the specimens under the circumstances preventing any such plan of installation.

The Michipicoton and Atikokan ranges made a good showing, the credit for which belongs mainly to the Lake Superior Power Company of Sault Ste. Marie, Ont. and the Canadian Northern Railway Company.

Eastern Ontario's iron mines were also well represented, more particularly the Calabogie, Wilbur, Boyd-Caldwell, St. Charles, Seymour, and Lee-Mills mines as well as other locations under development. Full analyses when possible were published in the catalogue with a brief description of each locality.

Ontario's Iron and Steel products were shown for the first time side by side with those of the great plants of the United States. The Hamilton Steel and Iron Company and the Canada Iron Furnace Company furnished tastefully prepared exhibits in this line.

Display of Non-metallic Materials.

As the Standard Oil Company had their Paris exhibit, largely supplemented, in the Mines building next to that of Ontario, the problem of making an effective showing of Ontario's Petroleum industries with the space and funds at our disposal was a difficult one. It was however made simple through the offer of the Imperial Oil Company to supply all necessary material and help in the setting up of such a display as could be accommodated. This included 80 varieties of petroleum products of all kinds.

The structure of a peat bed and the various products manufactured from peat as a raw material, such as peat fuel, moss paper and moss litter, were illustrated in a novel manner by a six-foot section of a peat bog. This was set in one side of a tall glass case, while in the other compartments samples of the above mentioned products were shown. The exhibit was sent by the Peat Development Syndicate of Toronto.

Special effort was made to bring new or rapidly growing mining industries to the front, such as those based on graphite, corundum and felspar.

The Ontario Graphite Company undertook to build a large portion of the pedestal which supported the statue of "Canada" of blocks of crude graphite. The foundation was of limestone from the Queenston Quarry Company, St. David's, Ont., and stood three feet above the floor, measuring 4 feet by 5 feet on the sides. The next three tiers were of graphite (84 per cent. pure); the first, 2½ feet high, being built up of graphite bricks; the second was a solid block 25 by 40 by 30 inches dressed and polished on the faces; the top block dressed on the edges was a cube of 20 inches. Jars of refined flake graphite manufactured from the above ore were also exhibited.

The whole formed a striking feature of the exhibit, and the manner in which the Ontario Graphite Company carried out their part of the design, notwithstanding the most discouraging difficulties encountered in getting these large blocks into shape and to the railroad at such an unfavorable season, is creditable to the enterprise of that company. Several samples from less developed but promising locations were also shown in this section, notably those from Lanark county sent by Dr. R. A. Pyne, M.P.P.

The Crown Corundum Company provided a handsome case with specimens of their ore from Methuen township, Peterborough county. Some of the finer crystals exhibited in jars filled with clear water showed to particular advantage.

One of our most noteworthy sections was that occupied by the Canada Corundum Company. The crude ore in every variety was represented in samples up to 1,800 pounds in weight. The corundum grains as shipped to the manufacturers were shown in glass jars in twenty different sizes, and the numerous articles manufactured therefrom were arranged in artistic designs on panels of one of the main arches and on a special panel of conspicuous size built by the company for their supplementary exhibit on the front verandah. The division of the corundum exhibit was made necessary owing to lack of space for the accommodation of such large individual displays; hence the Canada Corundum Company filled almost half the extra space granted Ontario on the front verandah—one of the best located sections in the Mines department. A true sapphire found in the corundum deposits of the York branch was on exhibition and was favorably commented upon by experts, including Mr. George Kunz of Tiffany & Co., New York.

BUILDING AND ORNAMENTAL STONES.

The exhibit was greatly indebted to the School of Practical Science, Toronto, for the loan of a large number of dressed samples of native building and ornamental stones, there being no time to collect and prepare a uniform set of dressed cubes, which probably would have brought out the material to better advantage.

The T. J. Stewart Company of Hamilton kindly prepared a special monument of Gananoque syenite which attracted marked attention. Marble fashioned in ornamental shapes from the Hungerford quarries controlled by P. W. Ellis & Co. of Toronto, was another prominent feature of this section.

Dr. A. P. Coleman of the School of Science furnished several hand specimens of the syenites occurring in large areas near Peninsula Station on the C. P. R., which were polished by the Bureau of Mines with gratifying results. These syenites were compared by American monumental stone-workers with the best imported Norwegian syenites Larger pieces forwarded by the Canadian Pacific Railway Company from their quarry at Peninsula Station, when finished further demonstrated the valuable qualities of this stone, and from the number of parties interested in this matter throughout the summer, it is probable that these rocks will not be allowed to remain undisturbed much longer.

Jasper conglomerate from Bruce Mines and Desbarats, on the north shore of Lake Huron, was shewn in large polished blocks.

The important mica interests of Eastern Ontario were fairly well represented, although a considerable portion of the contributions promised were late in arriving, and by that time the space available was insufficient. However, the interesting display made by the Mica Boiler and Pipe Covering Company of Montreal attracted a considerable amount of interest to the whole subject. The value of this means of heat insulation has been fully demonstrated, this company receiving the highest award (gold medal) in that class.

As in many other divisions, the Portland cement exhibits had to be curtailed for the same causes as were stated above in respect to mica. The Canadian Portland Cement Company and the Imperial Portland Cement Company of Owen Sound sent samples and photographs of their plants. Marl and clay from a number of deposits favorable for the location of cement works were shewn.

Ontario mineral waters were represented through the Chatham Mineral Water Company and the Grand Hotel Company of Caledonia Springs. The latter company made a very creditable showing of this well-known water.

The Lake Superior Power Company took an active interest in the exhibit from its inception, and their interests were well shewn in nickel, sulphur, and iron ores, clay for the manufacture of brick, granite and sandstone for building purposes, and an interesting pile of ferronickel bars (carrying 6 per cent. nickel) the first made by the new electro-furnace process of smelting. Mr. C. H. Clark was detailed by the company for the work of collecting this material and preparing the maps, charts, photographs, etc., which had so much to do with bringing the Sault Ste. Marie district to the front at the Pan-American Exposition.

Only the most notable features of this exhibit have been referred to. Other economic minerals and ores such as Galena, Zincblende, Pyrite, Apatite, Asbestos, Actinolite, Talc, Felspar and Gypsum were shown in proportion to their importance. Inquiries were frequently received for Molybdendite, due to the increased use of molybdenum in the manufacture of steel.

A sample of lithographic stone from Marmora bore the photographs of Hon. G. W. Ross and Hon. E. J. Davis and other transfer work ; and upon another specimen from Harvey township, Peterborough county, a photograph of Hon. G. W. Ross was engraved. Impressions from these stones were freely distributed.

James Richardson & Son of Kingston contributed a number of large blocks of felspar of the variety microcline, used to give a white enamel glaze in pottery-making. Two large blocks weighing over a ton were, after the close of the exposition, secured by Tiffany & Co. of New York for experimental purposes.

An illustrated and annotated catalogue of all exhibits was compiled by W. E. H. Carter, B.A. Sc., Secretary of the Bureau of Mines. Particulars of interest relating to the characteristic mining operations of each district in the Province were briefly set forth with maps and views of important plants, showing the present condition of development of Ontario mining industries. Several thousand copies of this catalogue were distributed.

Benefits of the Exhibit.

How far the purposes of this Exposition of the mineral resources of the Province have been realized, and how much more practical interest will be taken in exploiting these resources as a result of the exhibit cannot as yet be fully recorded. That strong impressions of such object lessons are retained by the average visitor was well shown by the number of references to prominent features of the Ontario Exhibit at Chicago 1893 by Pan-American visitors who had been there. The general demand for further information and the number of inquiries by letter from visitors after returning home was a satisfactory proof of the interest aroused.

The Canadian Goldfields exhibit of arsenic ores and white arsenic caused surprise among those who believed all arsenic used in America to be of European origin. The manager of a manufacturing concern in Boston requiring considerable quantities of arsenic stated that he had been using Canadian arsenic procured from agents in New York, for some months believing it to be imported material until its Canadian origin was one day accidentally discovered. He could detect no difference in quality. The American Window Glass syndicate use a considerable quantity of Deloro arsenic and their representatives state that it is rapidly displacing the European product.

An unusual demand for "The Law of Mines in Canada" by McPherson and Clark was reported by Mr. Clark, a number of copies going to libraries in the large cities of the eastern states caused (as was stated in the orders) by the inquiries made by returned visitors from Buffalo.

Details of projects set on foot directly or indirectly due to the agency of this exhibit are for business reasons withheld.

The Sudbury nickel range came in for a full share of attention this summer and a new interest appeared to be excited in this important district. One prominent instance might be mentioned: while walking through the Mines building, Mr. Thos. A. Edison noticed two things of which he was in particular need at the time, namely, nickel and graphite, which with iron form the basis of his new storage cell. After repeated visits with one of his engineers, Mr. Edison expressed his intention of paying the district an extended visit and on receiving letters likely to be of use en route started north via Sault Ste. Marie.

A few weeks later it was learned that Mr. Edison had returned well satisfied with what he had seen and had opened an office in Sudbury with fifteen assistants in the field. It is expected that this number will be largely increased in the spring.

Many comments were made on the exorbitant prices put on undeveloped properties often remotely situated from railroads. While this practice has a retarding influence on the development of a district it will not deter men of Mr. Edison's resources or force them to consider unreasonable offers.

List of Awards.

In the matter of awards, the merits of the exhibit were on the whole fairly recognized. The silver medal was in many cases the highest award granted in a class. In the following list, the two gold medals which were received on the exhibit as a whole are evidence of the highest mark of distinction possible at this Exposition. The gold medal for Installation was the only one granted under that division in the Mines building.

GOLD MEDALS.

Mica Boiler Covering Company, Limited, Montreal, Que.; Mica covering for boilers and steam pipes.

Bureau of Mines, Toronto, Ont.; General exhibit of economic ores and minerals, maps and photographs illustrative of mineral resources of Ontario.

Bureau of Mines, Toronto, Ont.; Installation of exhibit.

SILVER MEDALS.

Canadian Goldfields, Limited, Deloro, Ont.; Exhibit of gold and arsenic ores.

Bureau of Mines, Toronto, Ont.; Collection of nickel-copper ores and their products.

The Canada Corundum Company, Limited, Toronto, Ont.; Corundum and corundum products.

The Hamilton Steel & Iron Company, Limited, Hamilton, Ont.; Iron and steel with ores.

The Lake Superior Power Company, Limited, Sault Ste. Marie, Ont.; Map of Ontario, charts, pig iron and iron ores.

Milton Pressed Brick Company, Limited, Milton, Ont.; Pressed brick and terra cotta.

The Ontario Graphite Company, Limited, Ottawa, Ont.; Graphite and products.

BRONZE MEDALS.

The Nickel-Copper Company, Limited, Hamilton, Ont.; Exhibit of ores and products illustrative of the various operations in the reduction of nickel and copper by the Frasch process

Bureau of Mines, Toronto, Ont.; Exhibit of mica.

Imperial Oil Company, Limited, Sarnia, Ont.; Exhibit of Ontario petroleum and its products.

The Peat Development Syndicate, Toronto, Ont.; Exhibit of peat and its products.

T. J. Stewart, Hamilton Granite Works, Hamilton, Ont.; Carved and polished syenite.

HONORABLE MENTION.

Dr. R. A. Pyne, Toronto, Ont.; Graphite and products.

James Richardson & Son, Kingston, Ont.; Felspar (microcline).

The Crown Corundum & Mica Company, Limited, Toronto, Ont.; Corundum.

Queenston Quarry Company, Limited, St. David's, Ont.; Limestone.

Canada Iron Furnace Company, Limited, Midland, Ont.; Iron ore and pig iron.

During the summer catalogues and reports of the Bureau of Mines, a pamphlet by Mr. Rendol Snell on Mining in Eastern Ontario and other literature descriptive of individual exhibits supplied by private concerns were liberally distributed.

One of the most pleasant features of the work was the harmonious relationship with the Exposition officials which prevailed throughout the summer. Special thanks are due to Dr. David T. Day, Superintendent of the Department of Mines and Metallurgy for his unfailing courtesy and valuable co-operation. The work contributed by Mr. J. Walter Wells in arousing interest and collecting specimens in eastern Ontario had much to do with the good representation of that section. The valuable assistance given at times by Mr. W. E. H. Carter of the Bureau of Mines was highly appreciated, as were also the services of Mr. P. J. Crotty of the Public Works Department in carrying out the plan of installation, and Mr. E J. Tarr of McMaster University, who served as assistant throughout the summer with marked advantage to the exhibit.

THE MINERAL INDUSTRIES OF SAULT STE. MARIE.

By A. B. Willmott.

A few years ago the falls of St. Mary's river were looked on only as an impediment to navigation deeply to be regretted ; to-day they are regarded as a source of power and of wealth and so to be esteemed. Three canals and locks have been built by the Canadian and United States governments at an expense of $20,000,000 to enable shipping to pass this obstacle. One canal has now been completed and two others are under way by the Consolidated Lake Superior Company at a total expense of $7,500,000 to provide power for manufacturing and consequently freight for these same vessels. What was an injury has become a benefit.

Mr. F. H. Clergue, under whose direction this work has progressed, has well described in an address before the Toronto Board of Trade in April 1900 the development of his company's undertakings. These are so clearly stated that they may well be given in a condensed form as an introduction to this article. In 1894 Mr. Clergue and his associates purchased from the town of Sault Ste. Marie its water power plant with the intention of completing it and selling the power. Applications for the use of power being limited, it became necessary for the company to branch out and develop its own manufacturing industries. First a mechanical pulp mill was erected, the raw material being found in the abundant spruce woods skirting the shores of Superior. Chemical pulp with its longer fibre commands a higher price, and Mr. Clergue, desirous of utilizing to the utmost the resources of Algoma, sought the materials for its manufacture. Sulphur, the most necessary chemical, was being wasted in large amounts daily at the roast heaps of the Canadian Copper Company at Sudbury, but being unable to make an arrangement for the use of the sulphurous gas, Mr. Clergue bought his own mine. This provided the sulphur for the sulphite pulp mill, but it also provided a residue of nickel and copper and iron, and these could not be wasted. After long and costly experimentation a plant was devised for utilizing the iron and nickel in the form of ferro-nickel. But this product was relatively too rich in nickel, and so an iron mine was sought that by mixing, the proper proportions of iron and nickel could be got. The search for iron resulted in the discovery not only of a rich mine but also of a whole iron range. To utilize the materials thus thrust upon him, Mr. Clergue has started the construction of four blast furnaces and a steel plant for the production of rails and other materials. Iron furnaces require coke or charcoal for fuel, and so a large charcoal plant has naturally followed to utilize the hardwoods of Algoma.

Alkali is necessary in the manufacture of sulphite pulp, so the Electro-Chemical Company came into existence. Its raw material is salt from Huron county, and its products, caustic soda and bleaching powder.

To transport iron and nickel ores from the mines, limestone from the quarries and pulp-wood from the forests, railways and steamboats became necessary, and consequently the organization of the Algoma Central and Hudson Bay Railway was brought about. Street railways and hotels, foundries and iron works, sawmills and brick plants, stores, laboratories and lighting plants have been established as the necessity arose. The whole plant is constructed on the broad plan of utilizing to the fullest all the natural resources of the region. Nothing is to be allowed to go to waste, and everything required is to be produced on the spot if economically possible. How one industry fits into another is well shown by the history of the development given above. The cheap power and excellent transportation facilities of Sault Ste. Marie, together with the immense natural resources tributary to it, make it exceedingly well adapted for a manufacturing point. These advantages together with the community of interests existing between the various companies make the organization a most powerful one.

The accompanying plan (p. 93) shows how well situated one enterprise is in relation to another. Two photographs show a general view of the completed works and the same place four years ago.

As at present organized all enterprizes are under the control of the Consolidated Lake Superior Company with a capital of $117 000,000, of which $25,000,000 has already been paid up in cash. Mr. E. V. Douglas is President, and Mr. F. H. Clergue, Vice-President and General Manager. The main offices are at Philadelphia, Pa., and Sault Ste. Marie, Ontario.

Subsidiary to this company and capitalized by it are a number of operating companies, the relation of which to one another and to the parent company it is not necessary to discuss here. The chief ones are the Michigan Lake Superior Power Company constructing the hydraulic canal in Sault Ste. Marie, Michigan, at a cost of $4,500,000, which will yield 40,000 horse power; the Lake Superior Power Company which has constructed one hydraulic canal on the Ontario side of the river yielding 17,000 horse power and has another under way which will develop 33,000 additional horse power, the two canals together costing approximately $3,000,000; the Algoma Commercial Company, Limited, which is engaged in exploring and exploiting the mineral, agricultural and timber resources of Algoma, and also builds the necessary railways, but does not operate them; the Algoma Central and Hudson Bay Railway Company with subsidiary steamship lines, the Tagona Water and Light Company, and the Sault Ste. Marie Pulp and Paper Company are other important companies tributary to the Lake Superior Company.

Independent of but closely allied with the Lake Superior Company are the Canadian Electro-Chemical Company, Limited, the Algoma Steel Company, Limited, and the Algoma Tube Works, Limited.

As this paper is to deal particularly with the mining and related industries, nothing further will be said of a number of these companies, important as they are in capital and product. Beginning farthest afield we may first consider

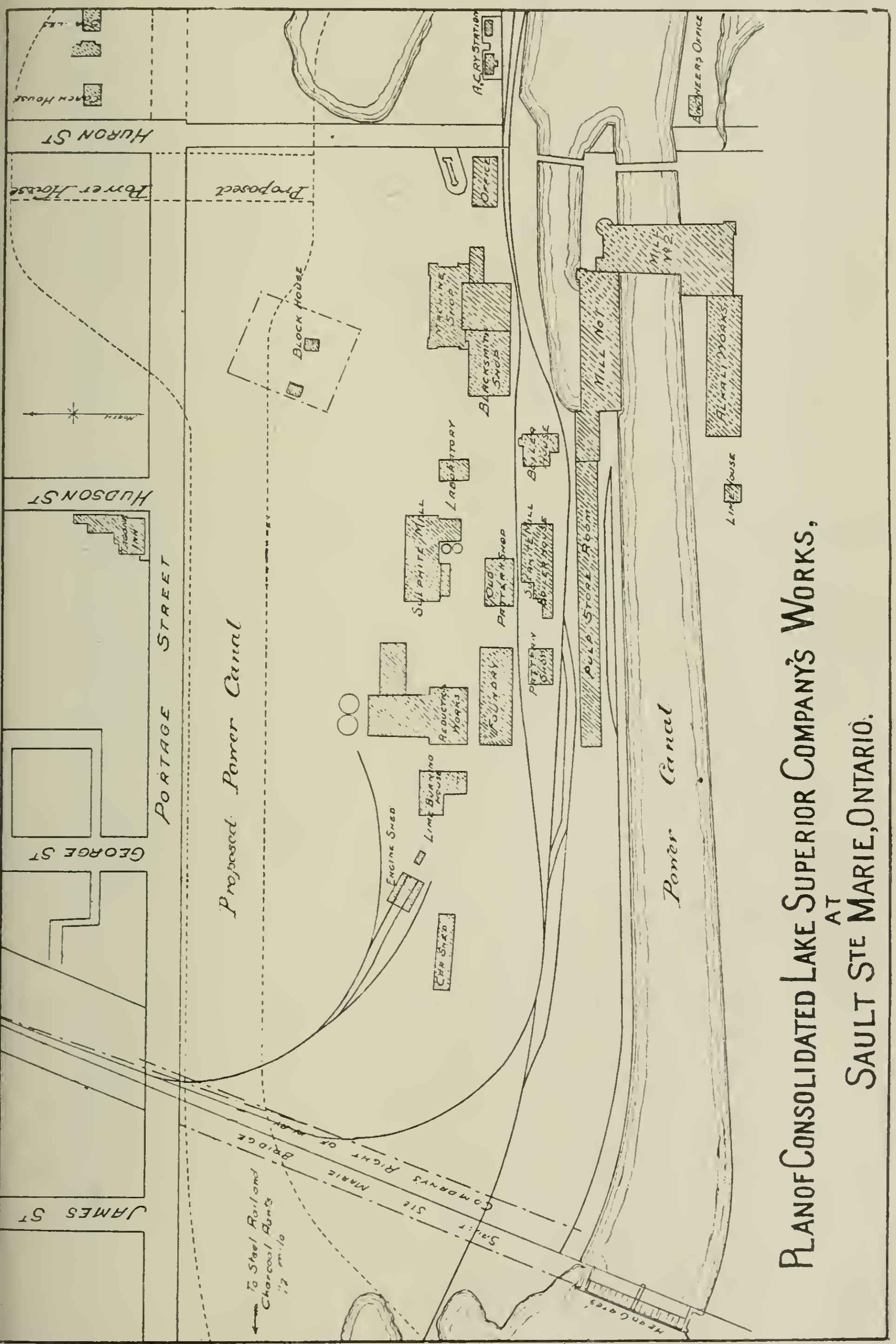
The Exploration Department.

Here surveyors, geologists and timber valuators have been working under the guidance of the late Mr. E. V. Clergue in studying the resources of Northern Ontario. The immensity of this enterprise is hardly realized by those not conversant with the extent of country to be examined and the difficulty of penetrating it. The Districts of Nipissing, Algoma and Thunder Bay embrace an area of about 100,000,000 acres, of which only the southern fringe along the C. P. R. and the great lakes is at all accessible.

To penetrate these regions in which there are no roads, only the old method of the Indian is available. All supplies for parties attempting to explore these vast regions must be transported by canoe and carried across the portages on men's backs. In many places the water route must first be discovered and the portages cut out. In addition to this difficulty, there is also the fact that very few maps are in existence which give details of the routes.

It is true that two years ago the Government sent out a number of exploration parties, and the results obtained by them have been of the greatest service. It must be admitted, however, that much of their work was of a somewhat rough character. The need of accurate survey lines to which properties, geological and topographical information can be attached is very great. Were the country divided off into townships, as has long since been done in the States to the south of lake Superior, the difficulty of exploration would be very much lessened. With lines established every six miles it would become comparatively easy to locate one's self in this vast wilderness.

In connection with its land grant the Company has the past summer (1901) laid out 122 townships and in doing so has run about 650 miles of survey lines. Accompanying each surveyor there have been one or more geologists who have not only reported on the topography and geology along the line, but have also crossed every township at intervals of a mile. In this way



PLAN OF CONSOLIDATED LAKE SUPERIOR COMPANY'S WORKS, AT SAULT STE MARIE, ONTARIO.

a more detailed topographical and geological map has been prepared than has ever been attempted in the northern part of Ontario.

In addition to this exploration work, a much more detailed geological map has been made of part of the Michipicoton Iron Range. This area has been crossed at intervals of a least a quarter of a mile and where the range has been found it has been followed closely.

By mutual agreement part of this work was undertaken by the Bureau of Mines, and part by the company and the results exchanged, as in this way a greater amount of territory could be covered.

Three geological exploration parties have traversed the country from the Canadian Pacific Railway to James Bay and up the east shore of Hudson Bay as far as Fort George. Other parties have been exploring in the vicinity of Lake Nepigon and also around Port Arthur and westward.

Altogether the company spent in geological exploration alone and not including railway exploration, a sum exceeding $100,000 during the past year, an amount quite in excess of that which the Government devotes yearly to similar surveys for the whole Province.

Mines and Mining.

As a result of these extensive explorations a number of properties are being taken up which carry indications of mineral. After they have been sufficiently developed, they will be rejected as useless or become working properties. Among the latter is one now known as the Helen mine, which was acquired by the company before any interest was taken in iron in the Michipitoton district by prospectors. In fact the presence of iron in any large quantities was quite unknown in that locality at the time the company made this purchase. It is true that the author in a report about two years before had called attention to the boulders of jasper and iron, similar to those which characterize the Minnesota iron range, but the clue had not been followed up.

The ore occurs exposed on a small point jutting into Boyer Lake, a little pond a quarter of a mile in diameter surrounded by high hills on three sides, and peculiar in that it is 120 feet deep in a rock-rimmed basin.

The hill to the east of the lake consists of cherty carbonate of iron and banded cherts. The theory that the ore has resulted from a solution of siderite redeposited as an oxide at the base of the hill is now accepted as correct. An accompanying illustration shows the point jutting into Boyer Lake. It is composed entirely of ore and when originally found only moss and trees covered this large ore body.

The ore itself is a mixture of red hematite and limonite and is quite correctly described by the commercial name of brown hematite.

The average cargo analysis of the ore shipped from the mine during the year 1901 is 58.709 per cent. metallic contents. A full analysis of the average sample is :—

	Per cent.
Iron	58.98
Sulphur	.067
Phosphorus	.069
Silica	8.02
Manganese	.04
Alumina	.63
Lime	.20
Magnesia	.19
Volatile matter	8.00

The similarity of the ore body and accompanying rocks to the Vermilion range in Minnesota is very striking. At the Helen as at Tower and Ely, the underlying rocks are greenstones and greenstone schists representing the oldest rocks of the Lake Superior Region. Interbedded with these are the ferruginous sediments which have later, through concentration by water, given rise to the ore bodies.

In order that the ore body may be more easily mined, it has become necessary to drain Boyer lake, and a pumping plant has been erected to lower the level of the water as development proceeds. The mining is carried on as an open quarry and the ore is hauled by skips or cableway some little distance up the side of the hill, and then put through a crusher to reduce it to an easier size for handling.

From the mine a railroad has been built eleven and a half miles in length to the harbor at Michipicoton. Here an extensive ore dock has been built, equipped with modern conveniences for the rapid handling of the ore cargoes. At this dock a vessel of 2,000 tons can be loaded in two and a half hours. The ore is carried from the mine to the dock in steel cars with hopper bottoms carrying 50 tons of ore each. During the winter the ore mined is deposited in a stock pile which is drawn on for shipments the following summer.

From the Harbor the ore is transported largely in the company's own fleet, which includes four Clyde-built steam-barges with a capacity of 2,500 tons each, and two tow-barges with a capacity of 2,200 tons each. This fleet will be increased during the coming summer by two large barges now in course of construction, each having a capacity of 5,000 tons

Last season 123 cargoes went out from the Harbor aggregating 231,032 tons. Of this 10,334 tons went to Midland, Ont.; 59,223 tons to Hamilton, Ont.; 87,690 tons to Ashtabula, Ohio; 58,582 tons to Buffalo, N.Y., and 15,202 tons to Cleveland, Ohio.

Along the Michipicoton Iron Range, indications of ore having been found at four other points, development work is now in progress from which it is hoped other mines will result.

One of these, the Josephine, was located by the company. Here boulders of ore were found on the shore of the lake, and the iron range was observed to pass through the lake. From this it was inferred that an ore body lies beneath the bottom of the lake, and a series of drill holes has been put down for the purpose of locating it, with encouraging results. The rocks here are similar to those surrounding the ore body at the Helen.

Thirty miles west is a prospect known as the Frances mine, on which considerable exploration work has been done with some encouraging results.

Ten miles west, on the iron range, other favorable indications have been observed, and a little west of this, there is a property owned by the Minnesota Iron Company on which very favorable indications were found, and considerable work has been done.

Six miles from Wawa the company after careful search, took hold of a gold property, and began development work. The results were encouraging, and other adjoining properties were secured, until at present the Grace properties include about 1,200 acres. A shaft has been sunk to a depth of 208 feet, and drifts have been run and other openings made. Above ground suitable machinery has been installed, and comfortable quarters have been put up for the men. The ore is quartz carrying a small amount of pyrites and free gold. The indications are that shortly the development work will have so far proceeded that the comp ny will be warranted in erecting a suitable stamp mill, and that another producing mine will have been started.

The Emily prospect located on Dog lake, near Missanabie, is somewhat similar to the Grace mine in the character of its ore.

Near Sudbury the companies are operating two nickel mines known as the Elsie and the Gertrude. These properties are connected with the Canadian Pacific Railway at Sudbury, about 13 miles distant by the Manitoulin and North Shore Railway, a line built and operated by the companies. The ore deposits are of the usual character in the Sudbury district, being a mixture of chalcopyrite and pyrrhotite, the latter carrying nickel, and need not be described at length. The ore from the Gertrude, which carries comparatively little chalcopyrite, is used in the Reduction Works at the Sault. The other ores are roasted at a central yard near the Gertrude, and the product will be reduced to a matte in a smelter being built there.

THE MANUFACTURE OF BRICKS.

One might properly include among the mining properties a brick plant, for it also uses raw materials obtained from the earth.

After testing a number of clays in the vicinity of Sault Ste. Marie, a location was finally chosen for a plant about a mile and a quarter from the main office, and on the line of the Algoma Central Railway, where a large area of suitable clay was found. A typical analysis of this clay is as follows :

	Per cent.
Loss	7.17
Silica	60.28
Iron peroxide	4.76
Alumina	15.73
Lime	5.00
Magnesia	4.58

The clay body is exposed on an old beach line of Lake Superior, and the quarry face is in the old terrace. The plant has been carefully laid out for the economical handling of this material.

From the quarry several dump cars carry the clay a few feet into the drying building 50 by 100 feet in which three tracks run the full length of the building and six coils of steam pipes extend between the tracks. On these the clay is placed to the depth of 6 inches and is allowed to dry for about 24 hours until about the right degree of moisture is removed. It is then again loaded on cars and transported a few feet to the main building, where it is elevated to the top and dropped into storage bins with a capacity nearly sufficient for 300,000 to 400,000 bricks. This has been done to provide material for work in the winter when it might be impossible to work the quarry.

The main building is 65 by 60 feet and 45 feet in height, well constructed and painted so that it far surpasses the ordinary brick plant.

From the bins, the clay runs down into a Chisholm, Boyd & White 9-foot dry-pan crusher. After being pulverised it is again elevated and run over screens, the larger material being sent back to the pulveriser and the finer material being run through a steam mixer. This consists of a "U" trough with a hollow spiral shaft which moves the clay along the trough and at the same time steam is discharged from small projections on the side of the shaft. In this way the clay is brought to the proper degree of moisture and is also somewhat warmed for winter work. The clay is then dropped into a Chisholm, Boyd & White four-mould dry-press brick machine capable of turning out 20,000 bricks in ten hours. All the main building is heated by steam to prevent the clay freezing during the winter time.

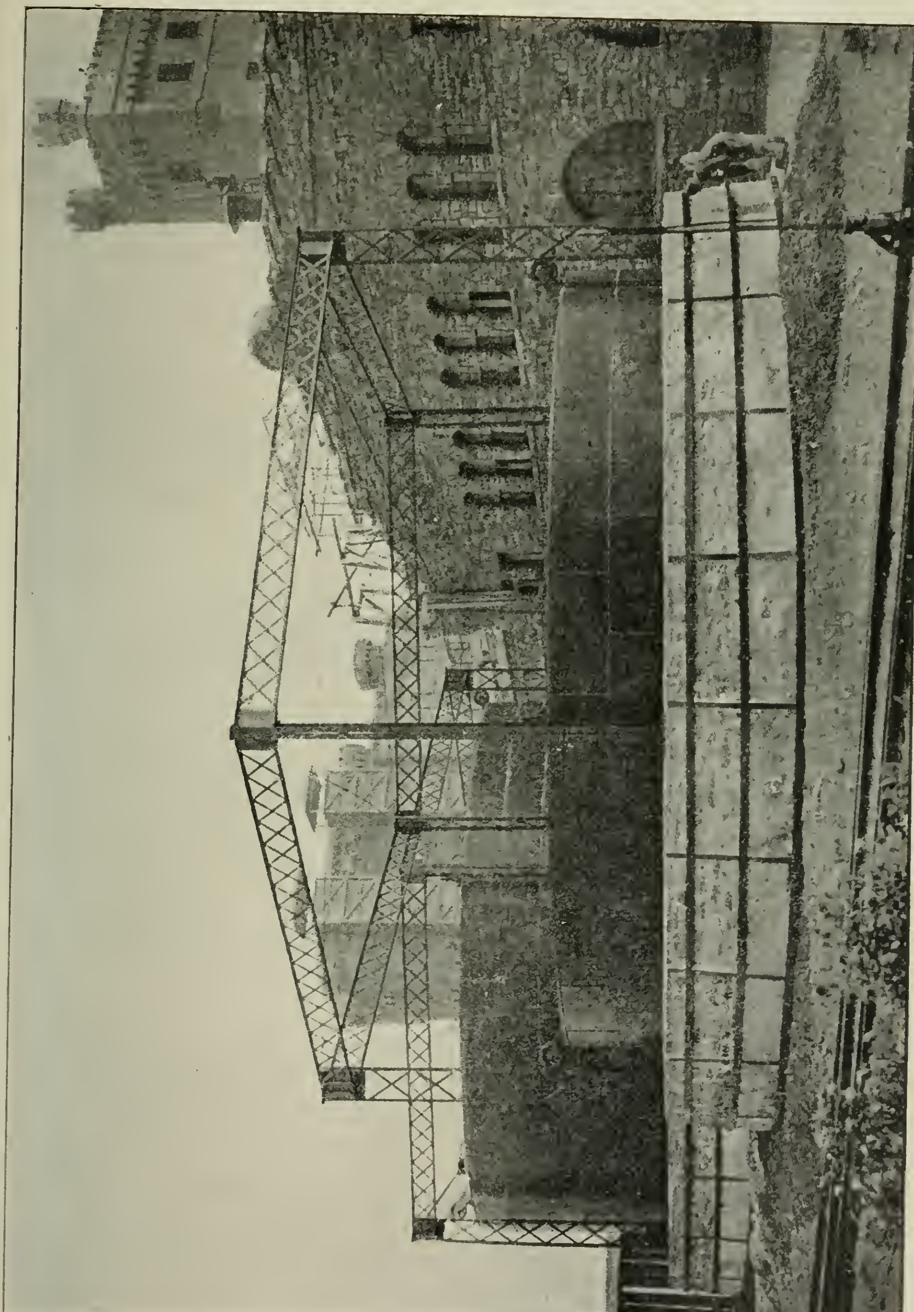
From the press the bricks are run on cars to the kilns near at hand. Three Flood up-and-down draught kilns are at present in operation, and a fourth will be completed in the early spring. Six or eight more kilns will be erected in the early summer of the Flood or Stewart pattern.

These kilns hold from 120,000 to 150,000 bricks. During the winter it is found necessary to place a few steam pipes in the kilns while they are being filled until ready for firing to prevent frost affecting the bricks. Both wood and coal are used for firing, 14 furnaces being in operation for each kiln. Along the end of the kilns runs a siding of the A. C. & H. B. Railway and on the far side of the siding a storage warehouse is being erected, and the bricks are either loaded direct on the cars or taken across the track and placed in the warehouse.

View of Consolidated Lake Superior Company's works, Sault Ste. Marie, Ont., showing Electro-Chemical Coy's plant; office; mechanical pulp mill; iron works; laboratory; sulphite pulp mill; block house, and reduction works.

Ship canal (left) and power canal (right), Sault Ste. Marie, Ont., 1896.

Consolidated Lake Superior Company, Sault Ste. Marie, Ont.; ferro-nickel reduction works.



Consolidated Lake Superior Company. Ferro-nickel plant; gas holders.

At present 15,000 bricks are being made daily and the severity of the climate does not seem to prevent the effective carrying on of this industry. Next summer when the additional kilns are erected, the plant will be run night and day and 40,000 bricks will be turned out daily. These will find a ready use in the buildings still to be erected by the Power Company.

From the mines we naturally pass to the great works in which the ore is reduced to metal and again transformed into structural material. First in importance is

The Steel Plant.

A mile above the main office on the shore of the river and above the rapids large docks are being erected for receiving iron ore as brought from the company's mines farther up Lake Superior. These docks will be 2,250 feet in length and will have a twenty-foot channel adjoining them. An area 3`0`by 3,250 feet has been devoted to the storage of ore, lime an coal for the iron and steel industry. The docks will be equipped with the most modern machinery for unloading such materials.

Adjoining the docks are four furnaces for smelting the iron ores. Two of these will employ charcoal as fuel, and will be 70 feet high by 14 feet in diameter. They will be equipped with seven stoves apiece aud will have a capacity of 150 tons of pig iron each per day.

The two other furnaces using coke are 90 feet in height and 21 feet in diameter equipped with eight fire-brick stoves, and have a capacity of 400 tons each. These four furnaces will have a capacity of 1,100 tons of pig iron a day and will require about 2,000 tons of ore daily or about three quarters of a million tons per annum.

There are three blowing engines with a capacity of 13,000 cubic feet of air per minute, the steam being supplied by Cahall vertical boilers. The coke furnaces will be blown by gas engines.

The metal is taken from the furnaces in iron ladles to the mixer building, in which are installed two metal mixers of 150 tons capacity each, served by an overhead crane for transferring the metal to the converting works of the steel plant or to the pig-casting machine as may be necessary. The latter is of the Heyl and Patterson construction, and consists of three chains or strands with ample capacity to dispose of the output of the furnaces.

Adjacent to the pig-casting machines is the ladle repair shop and "refractory" building. The crane which is issued for delivering the ladles of iron to the pig machine serves also to handle the ladles when being repaired.

The Bessemer steel works and rail mill consists of two convertors of five tons capacity each with three eight-foot cupolas for melting the iron, provision being made for a fourth. At present the steel plant is much further advanced towards completion than the blast furnaces, and it is expected to be in operation during the month of February. For this reason considerable quantities of pig iron have been assembled from various furnaces, among them that at Midland, for use in the steel plant. This metal must of course all be remelted, but when the blast furnaces are completed the process will be changed and the molten pig run directly into the convertors.

After being blown the metal is poured into cars which are kept running over a series of revolving rollers. When sufficiently cold, the cars are stripped by an overhead electric stripping crane which conveys the ingots to the pit furnaces. These consist of two four-hole furnaces, and provision is made for a third. The ingots are taken up and put into the furnace by an overhead electric crane and after being heated are withdrawn by the same machine

They are then passed through a 32-inch blooming mill driven by a pair of 28-inch by 48-inch reversing engines, built by the Southwark Foundry and Machine Company of Philadelphia. The blooms are next cut to the proper dimensions to yield the amount of steel necessary for a rail of the length and weight per yard desired. They are next conveyed to the heating furnaces, three modern Siemens regenerative furnaces. A fourth furnace of the same kind is provided for.

As before, the blooms are charged and drawn by means of an electric crane. This crane also delivers the blooms to the rollers which carry it along to a 23-inch rail mill driven by a 40-inch by 48 inch Porter and Allen engine. This mill consists of three stands of rolls, the first and second for shaping the rails roughly, and the third for finishing them. The bloom is passed eleven times forwards and backwards through the rollers, each time assuming more nearly the shape of a completed rail, and during this operation it is handled by electrically driven transfer tables.

From the rail mill the rails are run to the hot saws which are electrically driven, where they are cut to the required lengths. They are then passed through an electrically driven cambering machine and conveyed to the hot beds, where they are permitted to cool sufficiently to be finished in the cold finishing department. Here they are straightened, drilled and inspected, then loaded on cars under cover for shipment.

The plant is laid out with a view to handling rails of 30- or 60-feet lengths and of weights up to 85 lb. per yard, and structural material consisting of angles, channels, beams, "Z." bars etc.

The boiler plant for supplying power for these works consists of modern type water-tube boilers 4,000- h. p. capacity. The fuel used in the pit furnaces and rail mill furnaces is supplied by Fraser-Talbott gas producers. About 1,200 additional horse power is used in the form of electricity, which owing to the cheapness with which it can be supplied is employed wherever possible.

The location of the plant was carefully considered, and that point chosen where the various items used in the manufacture of iron and steel could be most cheaply assembled. For years immense quantities of iron ore have been transported to Lake Erie ports, and carried thence to Pittsburg. Later there has been a great development of furnaces and steel plants on the south shore of Lake Erie, coal and ore meeting there. The Algoma Steel Company has gone but a step further in bringing the fuel to the ore, rather than taking the ore to the fuel. As it requires approximately a ton of coke to every ton of ore, one might reasonably expect transportation charges to be about equal, but in fact they are in favor of the Sault, as over eighty per cent of the traffic passing through the Sault canals is eastward bound and as boats having cargoes westward are few, the rates for west bound freights are comparatively low.

At the Sault, limestone and coke can be cheaply delivered at the company's plant, and all varieties of ore are equally accessible.

The limestone is at present brought from Petosky, Michigan, sufficiently pure limestone not having as yet been located in Northern Ontario. The location of the plant on the river front, with the facilities for transportation both by rail and water, enable it to obtain its materials, and also to ship its products, cheaply. The combination of iron, steel and tube works, affording a ready market for the production of the blast furnaces, will make possible an iron industry in the Lake Superior region, where furnaces alone could hardly hope to succeed.

The buildings have been most substantially constructed and are of artistic design, being built of Lake Superior sandstone, with steel frames and corrugated roofing. An idea of their extent can be gathered from the fact that the main building is fully a quarter of a mile in length.

This industry is carried on in the name of the Algoma Steel Company, the chief officers being F. H. Clergue, President, E. V. Douglas, Vice-President, and D. D. Lewis, General Superintendent, to whom I am greatly indebted for the information given above.

Adjoining the steel works will be the plant of

The Algoma Tube Works, Limited.

This company, chartered by the Government of Ontario 28th December 1901, has acquired the Perrins patents for the manufacture of seamless tubes, and will erect works of a very extensive nature, comprising blast furnaces, puddling furnaces, rolling mills and tube works, with all the necessary finishing departments.

The method of manufacture, up to the point of delivering the section bars to the tube mills proper, will be carried out on ordinary lines, but a large quantity of charcoal iron will be used, as this quality is to be a special feature of the output. The section bars are of special form covered by the Perrins patent, constituting a self-sustaining pile which is placed in the welding furnace, and afterwards removed at a welding heat and passed through rolls and welded over a plug or ball in the ordinary way. The essential difference in this process consists in the weld being put in to the short heavy section of metal, and thus a hollow bloom of uniform shell thickness is formed.

This bloom is passed on at the same heat to the stretching rolls, where it is drawn out by a hammering action into a tube of ordinary shell thickness and length.

The whole process, from the time of taking the pile out of the welding furnace until the tube is finished ready for threading, occupies about five or six minutes. Tubing from one and a half inches to twelve inches in diameter will be drawn, the latter size being the largest seamless tubing yet made.

The works on the Canadian side will not include blast furnaces or steel plant, as the Algoma Steel Company will supply the necessary raw material.

The building will cover about nine acres of land, and will be supplied with electrical power from the power house of the Lake Superior Power Company.

For the above details of the proposed plant I am indebted to the superintendent of the Tube Works, Mr. H. J. Waddie, late general manager of the British Mannesmann Tube Company Limited of Lordore, South Wales.

Though Northern Ontario is deficient in coal for a blast furnace, there are large quantities of hardwoods, particularly maple and birch, which make admirable charcoal, and as is well known charcoal though a more expensive fuel than coke makes a higher grade of iron. Because of the supplies of fuel along the Algoma Central and Hudson Bay Railway and of the superior steel that could be made by its use it was decided to erect a

Charcoal Manufacturing Plant.

The two charcoal blast furnaces now under construction will require the charcoal from about 600 cords of hardwood per day. To supply this a charcoal plant of 300 cords daily capacity is now being built near the steel plant, and the balance will be supplied from two or more plants at convenient points along the Algoma Central and Hudson Bay Railway. All of these plants are to be erected in accordance with best modern practice involving the utilization of the bye-products for other purposes.

The charcoal works near the steel plant will carbonize wood by two different methods, namely, in beehive kilns and in steel retorts.

The retort plant will consist of twenty 8-cord oven retorts, each 46 feet long 6 feet three inches wide, and eight feet four inches high.

The retorts are set between brick walls in a way similar to the setting of a steam boiler. A track of standard gauge runs through each retort. The wood, placed on iron cars holding 2 cords each, is run into the retorts, the doors at each end are closed, fires are started under the shell, and the wood thus carbonized. The gases from the carbonized wood are drawn off as rapidly as formed, then condensed and delivered to the bye-product building for further treatment. In 18 to 24 hours the wood is carbonized and is then removed to an iron cooler of the same size and shape as the retort. In this cooler the wood remains 24 hours, and is then drawn into a second cooler, where it remains 24 hours longer, being then thoroughly cooled and ready for the blast furnace. The charcoal, still on the same iron cars on which it entered the retort as wood, is then taken by a steam engine to the furnace where it is used as required. The process is continuous ; and as soon as a retort or cooler is emptied it is immediately refilled.

The advantage of this process lies in the small amount of handling given to the wood and charcoal, no manual labor being required after the cars are filled until they are emptied. It also gives the highest yield of bye-products. This plant has a capacity of 160 cords per day, yielding about 8,000 bushels of charcoal.

The kiln plant at the steel works will consist of 56 kilns 30 inches in diameter at the bottom, 28 inches at spring of arch, 14 inches to spring of arch, and five feet to top of arch, each kiln holding about 65 cords of wood. These kilns will be arranged in four batteries of 14 kilns each. The gases will be drawn from the kilns as formed, and forced through a series of copper condensers, from which the condensed product passes to the bye-product plant, and the condensible gases are led to the boilers. The coal will be forked into cars operated somewhat upon the cable system of street cars, by which it will be carried to the furnaces in any quantity or at any speed desired. This plant will have a daily capacity of 150 cords of wood, yielding about 7,000 bushels of charcoal.

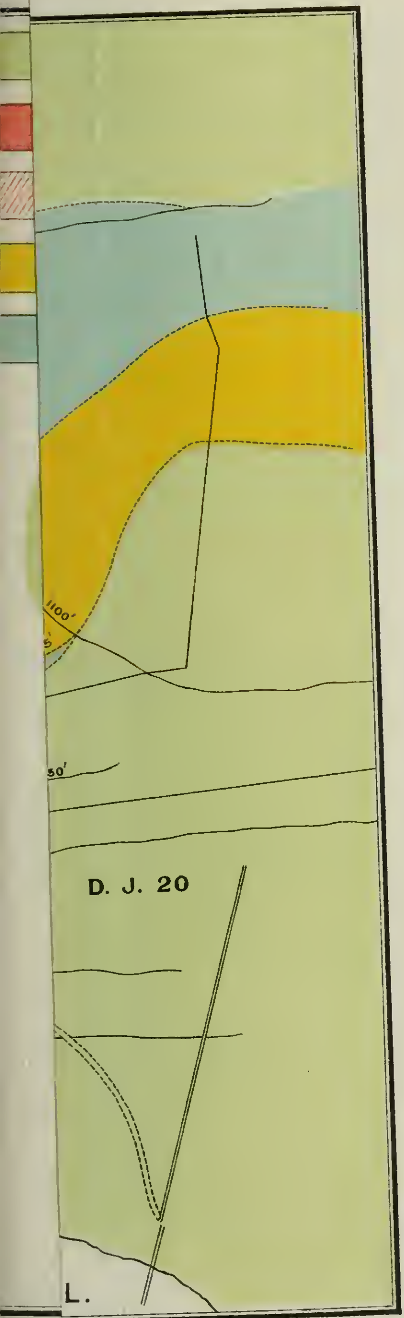
In the bye-product building will be recovered the wood alcohol (about 100,000 gallons per month having a strength of 82 per cent.) the acetate of lime (about 750 tons per month) and various distillates of wood tar as creosote, guaiacol, etc.

For the handling of this liquor there will be a boiler plant consisting of 2,400-h.p. Stirling boilers to be increased to 5,000-h.p. when complete plans are finished. There will also be a pumping station of 8,350,000 gallons daily capacity.

The method of carbonization to be adopted for the remaining 300 cords will be determined later on. The product from these works will be shipped by rail to the Sault—the charcoal in pecially designed cars to the furnaces, and the bye-product liquors in tank cars to the bye-product works, which are capable of handling the product from 600 cords of wood per day.

The electro-chemical works for the manufacture of caustic soda and bleaching powder from common salt procured from the salt wells of the western peninsula of Ontario, and the sulphite pulp mill in which spruce chips are digested with chemicals to produce a long-fibred pulp superior in quality to pulp made by the mechanical process, were fully described in last year's Report of the Bureau of Mines, and are here mentioned only to give completeness to this paper.

Other metallurgical industries are planned for utilizing to the fullest the natural resources of the region. These will follow just as soon as the materials in sufficient abundance are found. The transformation so far accomplished in the industrial status of the town is the admiration not only of the old inhabitants but of all visitors.



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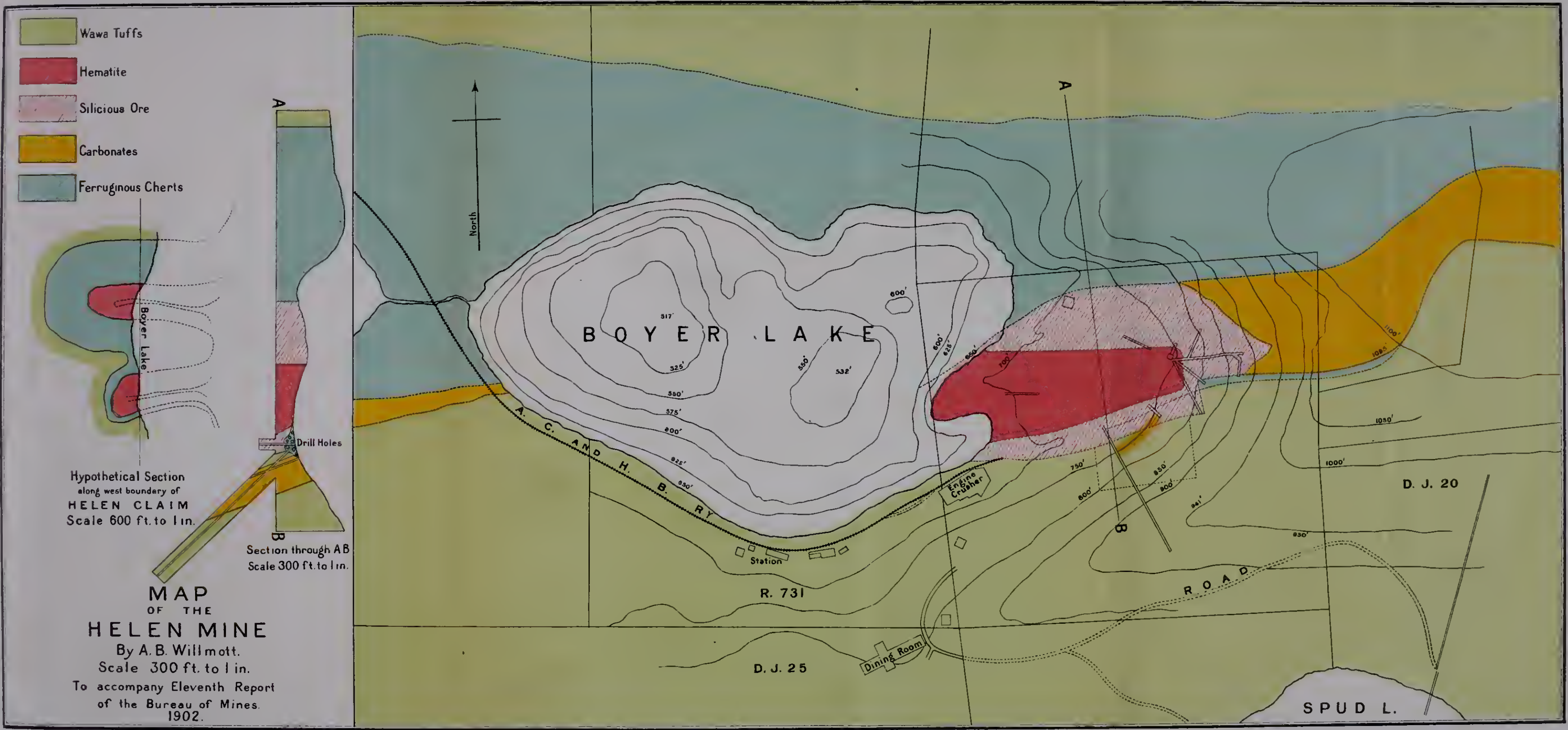


MAP
OF THE
HELEN MINE
By A. B. Willmott.
Scale 300 ft. to 1 in.
To accompany Eleventh Report
of the Bureau of Mines.
1902.

ARSENIC IN ONTARIO.

BY J. WALTER WELLS.

There are many minerals to be found in different parts of the world carrying arsenic in varying proportion, such as arsenical pyrites, orpiment, realgar, metallic arsenic, leucopyrite, lollingite, cobalt glance, white arsenical nickel, red arsenical nickel, smaltine, pyrite, pyrrhotite, etc. These minerals may occur in Ontario alone or associated with other minerals, but the writer confines his attention to the most important namely, arsenical pyrites, otherwise arseno-pyrite or mispickel.

This mineral is found abundantly in eastern Ontario, and it is believed by many that the future world's supply of white arsenic will come from this district.

As it occurs in the county of Hastings, Ontario, arseno-pyrite or mispickel has the following average composition when pure: metallic iron, 34.35 per cent.; sulphur, 19.64 per cent.; arsenic, 46.01 per cent.; and may be represented by the formula $FeS_2 + FeAs_2$ or $FeAsS$. Its hardness is 5 to 5.5, and its specific gravity about 6.2. It is usually found in masses, also as small irregular crystals, prisms of the orthorhombic system. Its color is silver-white with metallic lustre, but in the case of most samples, it assumes a dull gray color when exposed to atmospheric action. It fuses easily, giving off white fumes at a moderate red heat and leaves a magnetic residue. The products formed by roasting it at a red heat in air are sulphurous acid, arsenious oxide (easily detected by the garlic-like odor of the fumes), and ferric oxide.

Arseno-pyrite is found widely disseminated through rock-matter, especially along with sulphides. It is known in most mining districts, the associated minerals being quartz, calcite, copper pyrites, iron pyrites, zincblende, antimony sulphides, tin ore, pyrrhotite, etc. It is occasionally found with other sulphides, and frequently alone.

Ordinary iron pyrites (FeS_2) often contains arsenic in small quantities but not sufficient to destroy for most purposes the value of the pyrite as an ore of sulphur. Cases of poisoning due to arsenic in beer have recently been known in the Manchester district, England, and the arsenic was traced back to the raw pyrite used in making sulphuric acid. (See discussion on Arsenic as a poison.)

Mispickel in Foreign Countries.

The following are the known localities where mispickel is found in quantities either alone or associated with tin, copper, wolfram, sulphur, gold, silver or other minerals and metals.

1. San Miguel mine, Province of Madrid, Spain, which is said to be a very extensive deposit; also in Province of Catalonia, Spain.

2. Cornwall, England, where ten mines during 1900 produced arsenical pyrites ore *per se* or along with other ores such as those of tin, copper and wolfram.

3. Devon, England, where six mines produced arsenical ore in 1900 of the same nature as that of Cornwall. The Devon Great Consols at Tavistock has been worked since 1844 and has produced an enormous quantity of white arsenic.

4. Freiberg, Saxony, where mispickel occurs with fahl-band ores. This district is the largest producer in Germany, and the refining of white arsenic is a well-established industry.

5. Bovisia,[1] Italy, where deposits of mispickel and pyrite have been worked to produce gold, sulphur and white arsenic by the Clerici process.

6. The Salzberg district and Idria quicksilver mines in Austria, where arsenic has been obtained in considerable quantities. These are the principal producers in Austria, although other deposits are known.

[1] Vol. 5 Mineral Industry, p. 40.

Deposits of sulphide ores carrying more or less arsenic are known to occur in Portugal, Asia Minor, Turkey, Persia, in the provinces of Nova Scotia and British Columbia in Canada. in the state of Washington, U.S.A., Mexico, and other countries ; but so far these have not been worked for arsenic to any considerable extent. No large deposits of arsenical ore are reported to date from the United States. There is no record of any mine or factory in that country producing refined white arsenic or any of its compounds from raw arsenical ore[2].

Deposits in Hastings County, Ontario.

Many deposits of arsenical pyrites in Ontario have been reported. The writer has examined the following locations in the county of Hastings .

1. Jeffry prospect ; located in the ninth concession of Faraday township, 7 miles directly west of L'Amable station, Central Ontario Railway, and owned by James Best of Bancroft. It shows a vein of mispickel, quartz, etc., four feet wide but opened up at one spot only, where a shaft has been sunk 10 feet. A sample taken by the writer and assayed at the Government Assay office gave per ton of ore ;

Gold	0.06 ounces
Silver	3.01 ounces
Metallic arsenic	27.54 per cent.

2. Sophia mine ; lots 14 and 15 in the tenth concession of Madoc township showing a narrow vein of mispickel, rich in gold, with quartz and diorite rock matter. A shaft is sunk 40 feet, and a 10-stamp mill has been erected but is not being operated at present. It is owned by Hon. Peter McLaren of Perth, Ontario, and others. Considerable development work has been done on veins on this property which do not contain mispickel, but it appears the gold values they carry are small, the gold being mainly found in the narrow veins of mispickel.

3. Sovereign mine ; located on lot 17 in the eleventh concession of Marmora township. This property was worked for several years as a gold mine. The ore body which appears to be irregular and not well defined shows streaks of mispickel and carries gold. A 10-stamp mill has been built but is not being worked.

4. James property ; consisting of 308 acres in the fourth concession of Elzevir township at the village of Actinolite. The Grand Trunk Railway have a track graded from Madoc about eight miles distant, and the Canadian Pacific Railway is only five miles away at Tweed. The owner is Joseph James, Actinolite. On the property are large deposits of mispickel, and two good water powers, one of which is developed by five turbine wheels. The other, with a fall of over 50 feet, is undeveloped. The ore bodies contain large quantities of mispickel associated with quartz and a little iron pyrites ; of these there are at least four distinct occurrences, one of which appears to be nearly 100 feet wide. Five shafts have been sunk from twenty to forty-two feet, all in mispickel ore intermixed with quartz and compressed dioritic rock matter.

There are good facilities here for the establishment of arsenic works, provided the ore bodies are of sufficient size and the ore is capable of being concentrated so as to produce first-grade white arsenic.

An average sample of the ore body is said to carry $1.50 gold per ton of ore, also twelve per cent. of metallic arsenic. Considerable development work has already been done.

5. Clapp property ; at Actinolite village, adjacent to the last mentioned property. It has not been developed so as to prove the value of the showings of mispickel, which is apparently of the same origin as the ore of the James deposit, being segregations of mispickel and quartz in a schistose diorite with no well defined ore body.

6. Cook property ; The Cook Land Company, Limited, of Toronto, own the following lots in Marmora township in the mispickel belt :—part 2, east half of 6 in the eighth concession ; 7,

[2] Arsenic has recently been produced from a mine near Everett, Washington.

8, and west half of 9 in the ninth concession; and the west half of 10, 11 and 12 in the tenth concession; in all about 1,004 acres. On the 500 acres in the ninth concession there are showings of mispickel. On lot 7 is the Dean and Williams mine, worked many years ago for gold. An average of $15 a ton is said to have been taken out for a time, but the ore became refractory below the water line and although the process of treatment was changed it was not successful. A shaft is down 160 feet and some stoping has been done. A 10-stamp mill of ancient style is on the property, and after lying idle for several years is now being used to work over the ore in the old dumps which is said to carry paying quantities of gold. The 500 acres in the tenth concession have not been examined carefully, but show veins of mispickel. The vein on lot 7 in the ninth concession is apparently a continuation of the vein on the property of the Canadian Goldfields, Limited. There is an abundance of arsenical ore on the property made more valuable by the accompanying gold.

7. Atlas Arsenic mine; This mine is in the mispickel belt and is owned by the Atlas Arsenic Company of Belleville. It is situated on part of lot 10 in the ninth concession of Marmora township, adjacent to the Deloro mine. Considerable development work has been done and a modern plant erected consisting of a 10-stamp mill, 10-drill air-compressor plant, shaft houses, blacksmith shops, repair shops, etc. The ore is of exactly the same character as that of the adjacent Canadian Goldfields property.

The main shaft of the mine is now down over 200 feet. Levels have been run at 80 and 200 feet; the first level has been drifted on 400 feet. Development work has also been done on other parts of the property.

8. Deloro mine; This mine is situated at the village of Deloro in the ninth concession of Marmora township, one mile east of Marmora station on the Central Ontario Railway. It is owned along with other mining lands by the Canadian Goldfields, Limited, of London, England.

The following account of the mine, condensed from two excellent papers read by Messrs. P. Kirkegaard, superintendent, and S. B. Wright, metallurgist, at a meeting of the Canadian Mining Institute at Montreal in 1901, gives a short but accurate description of the treatment of the auriferous arsenical ores found in this mine :—

The ores consist generally of quartz more or less heavily impregnated with mispickel, with occasional copper pyrite and frequently a large percentage of iron sulphide. These ores are worked for their gold and arsenic contents. Shafts follow the lode on the incline and levels are driven north and south. The lode is irregular, varying from 4 to 25 feet in places the average width being about five feet. There are no defined walls; as a rule the quartz merges into the wall rock, which is in some places talcose schist and in others diorite, the latter being the country rock. The Gatling lode is now being worked to the fourth level, 340 feet, and 00 feet is being sunk to open up a fifth level. As a rule the pure white quartz carries little value and is not milled.

A modern system for hoisting, sorting, and carrying the ore a distance of 800 feet to the mill has been adopted. There are 20 stamps weighing 850 lbs. each, 10 dropping 100 times to the minute with 7 to 8 inches drop, and 10 dropping 110 times a minute with 6 to 7 inches drop. Screens are 40 mesh burr slot. Crushing capacity is 80 tons a day. Many difficulties have been overcome in amalgamating these ores of varying character. The average saving is 57 per cent of assay value by amalgamation only.

The concentrating plant consists of three hydraulic classifiers, and five 6-foot smooth belt vanners for the old 10 stamps; and three Wilfley tables, one classifying cone, and one Bartlett table for the new 10 stamps The tailings carry only 2 to 2.5 per cent of the original gold values and 0.5 per cent of the arsenic contents of the milling ore. The concentrates are transported in cars to the leaching plant, where they are treated by the bromo-cyanide (Sulman-Teed) process. This consists of (1) Extraction of gold by leaching the finely ground ore with a solution of potassium cyanide to which is added a small quantity of a solution of cyanogen-bromide—a haloid salt of cyanogen; (2) Precipitation of the gold from this bromo-cyanide solution by means of metallic zinc; (3) Removal and smelting of the zinc-gold slimes, thus obtaining the pure gold.

The plant now in use, situated in a two-story building below the mill, consists of four leaching vats fitted with sand and pebble filter bottoms and bottom discharge gates, four solution or "liquor" tanks on the floor above, three small Northey duplex steam pumps for circulating the liquors, three small "sump tanks" each of 40-gallon capacity, two 50-gallon tanks holding stock solution of cyanogen-bromide, one Sulman's patent precipitating cone for zinc fume, filter press, one zinc box, pipe systems, one acid-treatment tank, one settling tank and one filter tub.

The extraction of gold from the concentrates gives an average of 90.5 per cent. This with the values saved by amalgamation gives a total saving of 88 to 90 per cent. of the original gold contents of the ore, a result which, as an average of two years' steady work, is generally admitted to be exceptional on so refractory an ore. The concentrates, after the extraction of the gold, are sent to the arsenic works, where they are calcined for the arsenical contents. The crude arsenic resulting from the roasting is refined, and produces white arsenic of a pure white color, analyses of which show 99.6 to 100 per cent. pure arsenious oxide (As_2O_3). The production is eighty tons per month.

The above description shows in brief the various operations necessary to get the values from the arsenical auriferous ores of the Deloro mine. The motive power is supplied by (1) a 200-h.p. compressor, furnishing air for the drills and for general purposes ; (2) a 60-h.p. air compressor for pumping only by the Harris air-lift system ; a 75-h.p. engine for driving stamps and other machinery ; (4) a 40-h.p. engine for driving dynamos to furnish light for the whole plant.

9. Campbell-Blomfield property ; situated on the east half of lot 6 in the eighth concession of Marmora township, and owned by Messrs A. H. Campbell, of Toronto, and C. J. Blomfield, of Lakefield, Ont. The only vein that has been opened lies on the northeast part of the lot, across which it runs diagonally. Two shafts have been sunk, one about 60 feet deep, and the other 12 feet. The ore is exactly of the same character as elsewhere in this belt.

Prof. Chapman's report on the property is as follows :—

A well-defined quartz vein carrying a large amount of mispickel or arsenical pyrites with frequent shows of gold traverses the lot in a general northwest and southeast direction, with a westerly dip or underlie of apparently about thirty degrees. The vein is at least six feet wide, but the width evidently increases at lower depths. A seam of talcose slate lines the foot wall as in the Gatling mine in lot 9 of the same concession, where a shaft has been carried down to a depth of 50 feet, and where it presents a width of from 16 to 18 feet. This ore is of exactly the same character. If the vein on lot 6 be not a continuation of the Gatling vein, of which there is every probability, it will run closely parallel with and adjacent to the latter.

Prof. Chapman's report also testifies to the high gold values of the ore.

10. Pearce mine ; located 300 yards east of the Deloro mine on lot 8 in the ninth concession of Marmora township, and operated by the Atlas Arsenic Company. A shaft is down 110 feet in an ore body consisting of quartz, mispickel, pyrite, copper pyrites and calcite. The average gold value of the ore already milled is said to be $\$$?0 per ton. ?

11. Gawley mine ; located in the east part of lot 18 in the ninth concession of Marmora township, and owned and operated by the Atlas Arsenic Company. It shows a vein averaging 10 feet wide and a shaft down 100 feet. The ore body consists of quartz, mispickel, calcite, pyrite, copper, pyrites, etc., and carries about $7 gold per ton of ore, also 14 per cent. metallic arsenic.

12. Gawley property ; a prospect located in lot 9 in the tenth concession of Marmora township, and owned by Andrew Gawley, Malone. Assays made on average samples at the Government Assay Office, Belleville, show : gold, $5.80 to $6.60 per ton of ore ; silver, 50 cents to $1.75 ; metallic arsenic, 12 to 18 per cent.

13. Rollins property ; lot 16 in the fourteenth concession of Wollaston township, about five miles northeast of Coe Hill.

On this location there is a vein of almost pure mispickel about five feet wide. A shaft is down thirty feet, and stripping has been done to uncover the vein. The ore, according to assays made in the Belleville laboratory, carries about 80 cents gold values per ton of ore, also 35 per cent. metallic arsenic on the average.

It is being worked by D. E. K. Stewart of Madoc, who ships the solid ore to the Canadian Goldfields' works at Deloro, where it is treated for the arsenic contents.

The following additional deposits of arsenical ore in Hastings county are reported but the writer has not had an opportunity to examine them :

(1.) H. Nobbs' property ; lot 23 in the fifth concession of Marmora township.

(2.) John Quinn's farm ; lot 18 in the sixth concession of Marmora township.

(3.) McKellar property ; lots 1 and 2 in the third concession of Elzevir township. The property is owned by D. E. K. Stewart, of Madoc.

(4.) Properties in Tudor township owned by Isaac Golding, Millbridge, Ont.

(5.) Emily mine, Rawdon township. This mine was worked many years ago.

(6.) Lots 4 and 5 in the eighth concession of Marmora township, owned by the Canada Company, A. Bell, Almonte, Ont., agent.

(7.) Lot 5 in the ninth concession of Marmora township, owned by the Canada Company.

ELSEWHERE IN EASTERN ONTARIO.

The following deposits are known to occur in other parts of eastern Ontario :

(1.) Kennefic property ; located on lot 7 in the fifth concession of Anglesea township, showing a vein 8 feet wide of mispickel mixed with quartz, rock matter and pyrite. It is owned by D. E. K. Stewart of Madoc, and others. The ore carries very little gold value, but contains abundance of arsenic, about 25 per cent. on the average.

(2.) Rebstock mine ; located on lots 2 and 3 in the fifth concession of Kaladar township, one and one half miles east of Flinton village. It is owned by J. H. Stone of Flinton, and others. There are two shafts down about 80 feet in mispickel, which is mixed with pyrite, quartz, calcite, and a large quantity of hornblende. Assays made in the Government Assay Office on samples taken by the writer show : gold, 0.07 ounces per ton of ore ; silver, 1.18 ditto ; metallic arsenic, 14.50 per cent.

(3.) Cook property ; located five miles south-east of Plevna village, two miles south of Boerth gold mine. Clarendon township.

A shaft has been sunk forty feet by J. W. Cook, Marmora, and stripping done on the surface. The ore on the dump shows mispickel mixed with quartz and schistose diorite, the latter being the country rock. There is no well defined vein on the property. The ore carries gold values $4.00 to $18.00 per ton according to samples taken and assayed by the writer, and an average of 14 per cent. of metallic arsenic.

IN NORTHERN ONTARIO.

The following prospects showing mispickel in quantity are to be found in northern Ontario :

(1.) Big Dan claim ; located on the shores of Net Lake near Lake Temagami and owned by D. O'Connor, Sudbury, Ont.

Dr. A. P. Coleman reports to the Bureau of Mines on this claim as follows :

The Big Dan claim, a half mile inland on the southwest shore of the lake, contains a large deposit of auriferous mispickel, the surface of gossan stretching more or less continuously for about a third of a mile in the direction North, 30 degrees East, as disclosed by stripping, with a width running in places up to one hundred yards. A number of test pits have been sunk upon it, two of them of considerable dimensions. The most southerly pit is twenty-seven feet long, four feet wide and three feet deep ; and the ore pile beside it consists of altered slate as country rock mixed with a large amount of pyrite, chalcopyrite and arsenopyrite (mispickel). The next large opening to the north is a trench on the side of a steep hill disclosing a band of nearly solid mispickel, fifty-nine feet long and a foot thick on the average, running down at least ten feet as shown in the trench, but having no distinct walls. Assays show this ore to run $3.70 in gold, $2.52 in silver, and 14.4 per cent. of arsenic per ton. At the foot of the hill and a little northwest of the trench there is another large pit yielding ore rich in mispickel and containing considerable quantities of copper pyrites, but running low in gold and silver. A hundred yards to the north there is another large pit showing a band of ore rich in mispickel, a sample of which assayed \$9.30 in gold and \$1.32 in silver. The assays made on these ores run from less than \$1.00 to \$31.20 in gold and silver, with an average of \$5.75 ; and all the samples of ore contain more or less arsenic, so that their treatment by ordinary methods would be difficult. It is probable however that the arsenic from carefully selected ore may be an object of importance, since white arsenic is now quoted at four and one half to five cents per pound. It is hard to estimate at present the amount of ore likely to be found in the deposit, but it is probably very great. Although an arsenical ore, it differs greatly from the well known ore of Deloro, since it is largely mixed with other sulphides, is associated with little or no quartz, and does not occur in distinct veins, but rather in shear zones, or fahlbands in slate, penetrated by dikes and masses of diabase.[3]

(2) Mr. J. F. Black, Sudbury, Ont., reports a find of mispickel in Davis township, Nipissing district.

(3) The Mines Contract and Investigation Company, Toronto, report a deposit of mispickel and pyrite, at location 776X and 777X near Schreiber, on the C. P. R.

(4) W. A. Preston, Mine Centre reports a find of mispickel in quartz in Rainy River district carrying \$1.60 in gold, with a considerable quantity of arsenic.

Recovering Arsenic at Deloro.

The writer has had an opportunity of examining the Canadian Goldfields' arsenic works at Deloro, and the following brief description will serve to show the practical working of the plant.

The arsenical concentrates obtained from vanners and concentrating tables come from the leaching plant to the arsenic plant as sulphides of about 40-mesh fineness and quite damp, and with these is mixed pulverized arsenical ore bought from outside mines.

A sample of the dry concentrates taken and analysed by the writer contains :—

	per cent.
Silica	18.63
Metallic iron	29.26
Sulphur	15.44
Metallic arsenic	28.75
Undetermined	7.92
	100.00

The roasting is done in two inclined revolving cylinders of the Oxland type as used in arsenic works in England but modified in several ways. Instead of the longitudinal rows of projecting ribs there are four walls made of tiling, 12 inches wide, extending from the axis of the cylinder and dividing the latter into four separate chambers. The upper cylinder is 29 feet 6 inches in length, with diameter of 5 feet 6 inches, and is connected by a tube conveying the ore to the second cylinder placed lower down.

In the upper half of the furnace the ore remains in one of the four compartments exposed to considerable heat and to a current of air, caused by an exhaust fan placed near the chimney, which passes through slits in the diaphragms, the latter also allowing the ore to sift into the lower compartments.

Extending for a distance of four feet from the upper end are spiral shelves allowing the ore to work down into the compartments.

The greater part of the arsenic is driven off as fumes in the upper cylinder, and the reddish residue coming from the lower cylinder is practically free from arsenic, being a mixture of ferric oxide with silicious matter, as shown by the following analysis made on a sample taken by the writer :—

	per cent.
Silica (SiO_2)	43.23
Ferric oxide (Fe_2O_3)	44.66
Sulphur (S)	5.06
Arsenic (As)	0.36
Undetermined (lime, etc.)	6.69
	100.00

[3] Bur. Mines Vol. 9, p. 173.

The sulphur is probably present as a sulphate of iron due to oxidization of the iron pyrites.

The lower cylinder is 60 feet in length and 6½ feet in diameter and has an independent fireplace and chimney with natural draft. It contains four division walls, as in the upper cylinder, extending from the lower end to within four feet of the upper end, the remaining distance being likewise provided with spiral brick shelves or ribs.

The fumes from both furnaces pass into a large, high dust chamber situated above the higher end of the upper cylinder. The walls of the dust chamber are inclined at a steep angle, allowing the dust which settles in passing through the chamber to work back into the upper cylinder, together with raw ore which is fed to an apron projecting into the upper cylinder by a tube passing through the wall of the dust chamber near the top.

The hot gases partially free from dust rise about 12 feet, pass over a bridge wall and enter the condensing chambers.

The condensing chambers built of brick are on arches, and are 12 feet wide internally, with side walls inclined so as to allow the condensed white arsenic to settle into the trough forming the bottom of the chambers, from which it is drawn from time to time into cars run under the arches.

The mechanical draft allows no escape of arsenical fumes from the condensing chambers.

REFINING THE CRUDE PRODUCT.

The crude arsenic is conveyed in wheelbarrows to a chamber over the refining furnace which is an ordinary flat reverberatory furnace using hard wood as fuel. The external dimensions are 16 feet by 24 feet, the height of the arch above the bed being 1 foot 8 inches. There are three doors for hand rabbling.

The feed is through a hopper at the back near the fire box and the ore is discharged on the bed just behind the fire bridge.

From the furnace the fumes are conveyed by mechanical draft through a flue made of brickwork about 100 feet long where dust particles settle, then into twelve zig zag chambers in which the pure arsenious oxide is deposited. These brickwork chambers are built in duplicate, so that by closing or opening an iron damper the current may be turned into either set while the other is being cleaned. The set of 12 chambers allows the fumes to be conveyed about 175 feet, and it rarely happens that arsenic is found escaping with the chimney flue gases.

An examination of the chambers during a clean-up is most interesting. In the chambers nearest the hot flue beautiful irregular and coarse interwoven crystals cover the interior, while in the other chambers the fine-grained crystals and fines are collected.

The arsenic is removed from condensing chambers to the grinding-room and put through buhrstones, falling into a hopper below, and being fed directly in barrels by an automatic filler is securely packed ready for the market.

The refined white arsenic analyzes 99.6 to 100 per cent. of arsenious oxide, the only impurity being silica in a finely divided state, and it commands the highest price in the market owing to its excellent quality.

The White-Howell Roasting Furnace.

It is claimed that the White-Howell roasting furnace is a very satisfactory furnace for use in arsenic works and the following description taken from a catalogue issued by the makers, Allis-Chalmers Company, Chicago, will be of interest :—

The well-known White-Howell roasting furnace consists of a long telescopic shaped iron cylinder, made in sections to facilitate transportation, slightly inclined, supported on friction rollers and revolved between a stationary fire-box and a flue. That portion of the cylinder nearer the fire has a larger external diameter than the part next to the flue, but it is lined with fire-brick to make its internal diameter the same as that of the smaller part, which although unlined, stands the heat very well. Projecting fire-brick arranged spirally in the brick-lined portion assist in oxidation by raising and showering the ore through flame, which it will be understood passes directly through the cylinder, and for the same purpose the unlined part is provided with cast iron shelves.

The furnace is fed at the upper end with dry pulp by means of a suitable feeder, and the pulp makes its way automatically toward the lower end of the furnace where it passes out, dropping between the end of the cylinder and the fire-box into a vault.

Sometimes an auxiliary fire-box is placed at the flue end of the roaster (see plate) for roasting the flue-dust as it passes, suspended in the air, into the dust chamber.

The advantages claimed for this style of furnace are :—The ore is exposed to an increasing temperature on its passage through the furnace. It is continuous in operation, discharging the finished product into a pit. By means of adjusting screws the angle of inclination may be changed, thereby exposing the ore to the action of the flame for a longer or shorter period as desired

Manufacturing Arsenic at Freiberg.

The Muldenhutte Works, near Freiberg, Saxony, produce white arsenic ($As_2 O_3$) in powder and glass, yellow ($As_2 S_3$) and red ($As_2 S_2$) arsenical glasses, and metallic arsenic (As). The raw materials used are arsenical iron and copper pyrites, arsenical lead ores, and flue dust. The fine dust carries 25 per cent and upward of arsenic ; the pyrites and other ores carry 10 to 40 per cent. The pyritous ores are bye-products from the concentrating works.

Arsenious oxide, or white arsenic ($As_2 O_3$), is produced from arsenical ores and flue dust, at present almost entirely from the latter. The raw material is roasted in an ordinary English reverberatory calcining furnace called a sublimating furnace, which is externally square, and with but two rabbling doors on each side. The hearth measures inside 4.40 metres (14 feet 6 inches) in length and 3.20 metres (10 feet 6 inches) in width. The roof is very low, not more than 18 inches above the hearth at the ends. Coke fuel is used to produce a flame free from soot. Each furnace has, besides the ordinary underground condensing chambers connected with the main chimney, another system about 100 metres in length above the ground for condensing the sublimated $As_2 O_3$. Each furnace has a capacity of 3,300 kilograms (3 tons 1,277 lb) of pyrites or 2,400 kilograms (2 tons 1,292 lb.) of flue dust in 24 hours. The time of roasting is about 8 hours for each charge of 1,100 kilograms (1 ton 426 lb) of pyrites or 800 kilograms of flue dust, and each furnace is charged three times in 24 hours. While the furnaces are being charged through funnels in the roof the $As_2 O_3$ condensing chambers are shut off and the fumes are conducted into the underground chambers leading to the chimney. To thoroughly purify it, the white arsenic is given a second sublimation in a furnace similar to the one used in the first operation.

Fig. 1 (p. 109) shows the reverberatory calciner for white arsenic production, giving an elevation and section of the furnace. In the elevation will be seen on top of the furnace the flue for the $As_2 O_3$, the hopper in the middle serving to charge the ores and that at the end for feeding the coke.[4]

The fuel at present used in refining white arsenic at Freiberg is said to be producer gas made from coke. The gas fuel gives uniform heat, is easily controlled and free from dust, while the cost is somewhat less than that of coke.

[4] Albert Doerr in Mineral Industry Vol. 4, 1895, p. 27.

Recent experiments conducted on a commercial scale by the Peat Industries, Limited, of Toronto, have shown that producer gas can be made from ordinary dry Canadian peat, and it would be worth investigation to see how far this producer gas could be used as a fuel in making white arsenic, as it offers many advantages over wood, coke or coal for such purpose.

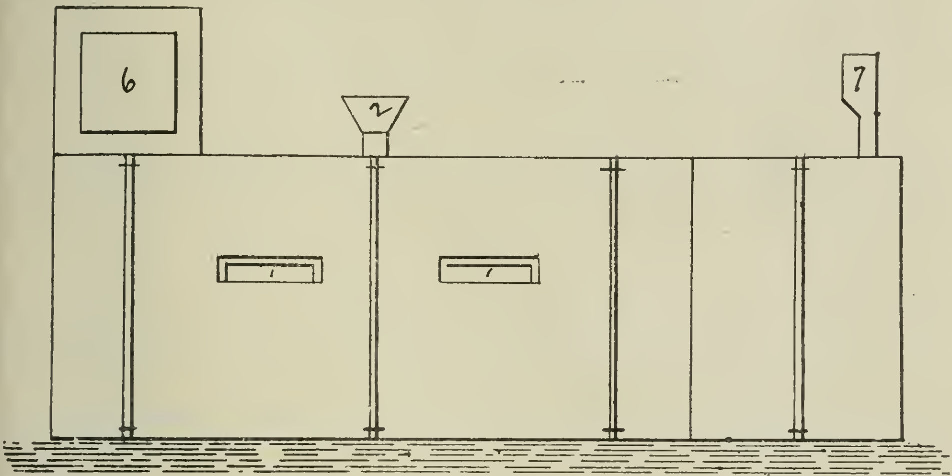


Fig. 1. Reverberatory calciner. Elevation.

1. Rabbling doors ; 2, feed-box for raw ore ; 6, flue to condensing chambers ; 7, chimney for fire-box.

According to a circular issued by this company from one ton of compressed peat analyzing moisture 15 per cent., volatile combustibles 57 per cent., fixed carbon 21 per cent., and ash 7 per cent., valued at $1.50 per ton, delivered at gas retort, and figuring wages at 20

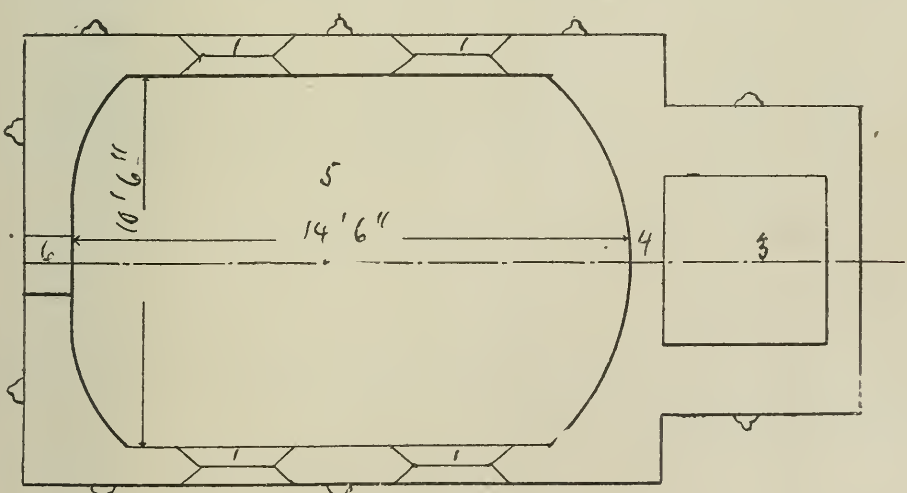


Fig. 1. Reverberatory calciner. Section.

3. Fire-box or grate ; 4, fire-bridge ; 5, bed of furnace.

cents per hour and yearly depreciation at 6 per cent upon the value of machinery, in a plant capable of producing 40,000 cubic feet of gas per hour, a yield will be had of about 100,000 cubic feet of fixed gas, carrying not less than 150 B T U's per cubic foot, at a cost not exceeding 2½ cents per 1,000 cubic feet.

Recent reports from parties who have investigated arsenic refining in Cornwall and Devon, state that three types of furnaces are employed for roasting arsenical pyrites and refining crude white arsenic :—(1). Reverberatory furnace, similar to the sublimating furnace used at Freiberg and to the refining furnace employed at the Deloro arsenic works. (2). Oxland calciner, a revolving, tilted, cylindrical furnace similar in principle to the White-Howell furnace. This furnace gives the best results and is generally used. (3). Brunton calciner, a convex circular table revolving horizontally, with fires on two sides playing diametrically on the arsenical ore which is distributed equally over the table.

W. Thomas has published in Mineral Industry, volume 2, a full description of the practice employed in Devon and Cornwall, England, in roasting and refining arsenic, with a discussion on the relative merits of each furnace. It is beyond the province of the writer to deal in detail with the English method of making white arsenic.

Production of White Arsenic.

The chief producers of white arsenic are : Cornwall and Devon in England, Prussia, Saxony, Italy, Spain, Austria, Portugal and Ontario, Canada.

The following statistics compiled from official reports of the respective countries and published in Mineral Industry, Volume 9, 1900, show the comparative production of arsenic throughout the world.

IN CONTINENTAL EUROPE.

Year.	Prussia.		Saxony. (a)		Italy. (b)		Spain. (c)	
	Tons	Valne.	Tons	Value.	Tons	Value.	Tons	Value.
		$		$		$		$
1895	1 788	98,363	1,217	108,826	100	8,000	184	18,390
1896	1,750	130,539	882	90,626	320	24.400	271	27,100
1897	1,924	143,775	1.063	152,122	200	18,600	244	29.256
1898	1,624	121,818	1,053	131,710	215	15,700	111	13,320
1899	1,470	128,678	953	138,572	304	26,483	(d)	.. ..

(a) Arsenious acid. (b) Metallic arsenic and arsenious acid. (c) Arsenic sulphide. (d) Statistics not available but not likely to vary much from preceding year.

IN ENGLAND.

The following table giving the production and value of arsenic (crude and refined) obtained at mines and open works in the United Kingdom is taken from the reports of the Inspector of Mines and Quarries, Home Office, England :

Year.	Tons.	Value.
		£
1895	4,798	52.198
1896	3,616	45,483
1897	4,165	74,795
1898	4,174	53,787
1899	3,829	54,236
1900	4,081	67,028

This arsenic was obtained mainly at tin and copper mines in Cornwall and Devon, and is exclusive of that obtained from the arsenical pyrites shown in the following table :

Year.	Tons.	Value.
		£
1895	2,951	2,785
1896	8,808	8,007
1897	13,137	10.734
1898	11,144	8,144
1899	13,519	12,138
1900	9,573	8,710

The product for the year 1900 was derived from ten mines in Cornwall and two in Devon. The bulk of the ore, 7,840 tons, was produced by two Cornish mines, the Great Wheal Busy at Chacewater, and the Trelawney at St. Ive.

According to the official report, the ore is mined for arsenic contents only, and is either sold in the crude state to refiners or refined at the mines.

IN CANADA

The production of arsenic in Canada since 1885 has been as follows :

Year.	Tons.	Value.
		$
1885	440	17,600
1886	120	5,460
1887	30	1.200
1888	30	1,200
1890	25	1,500
1891	20	1,000
1894	7	420
1899	57	4,842
1900	303	22,725
1901	700	41,677

No arsenic was produced in the years not enumerated in the foregoing table. The whole output was white arsenic from the Marmora district, Hastings County, Ontario.

Consumption and Uses of Arsenic.

The German product is largely used in aniline dye works, in making Paris green, Scheele's green, arsenical salts, in glass works, etc.

The English output is mainly employed in making sheep-dip, Paris green, in glass-making, paints, arsenical salts, etc. It is also exported to all parts of the world.

The product of other European works finds similar use, while the Canadian article is used partly in making Paris green and paints at Montreal. Most of it however goes to the United States for a variety of purposes. The Canada Paint Company, Montreal, state that they expect to use at least 175 tons of white arsenic made at the Deloro works to be converted into Paris green during the year 1902.

As the United States is not a producer of arsenic, the imports as obtained from the Treasury Reports may be taken as a fair index of the consumption in that country for various purposes, as follows :

Year.	Imports.	Value.
	lb.	$
1895	6,984,273	237,747
1896	5,813,387	215,281
1897	7,242,004	352,234
1898	8,686,681	370,347
1899	9,040,871	386,971
1900	5,765,559	265,500

These figures include white and metallic arsenic and the arsenic sulphides (orpiment, realgar, etc.)

The imports into Canada for the last seven years have been as follows :

Year.	lb	Value.
		$
1895	1,115,697	31,932
1896	664,854	27,523
1897	152,275	8,378
1898	291,967	14,270
1899	582,383	24,203
1900	230,730	11,035
1901	159,263	8,361

Arsenic is imported into Canada free of duty.

CHEMICAL COMPOUNDS OF ARSENIC.

White arsenic enters into innumerable chemical compounds, the following having commercial importance at present :—(1) White arsenic, (2) Paris green, (3) Scheele's green. (4) Lead arsenate, (5) Sodium arsenate, (6) Potassium arsenate, (7) London purple. Other compounds such as orpiment and realgar are used in commerce, but as their uses are not extensive no further mention is made of them.

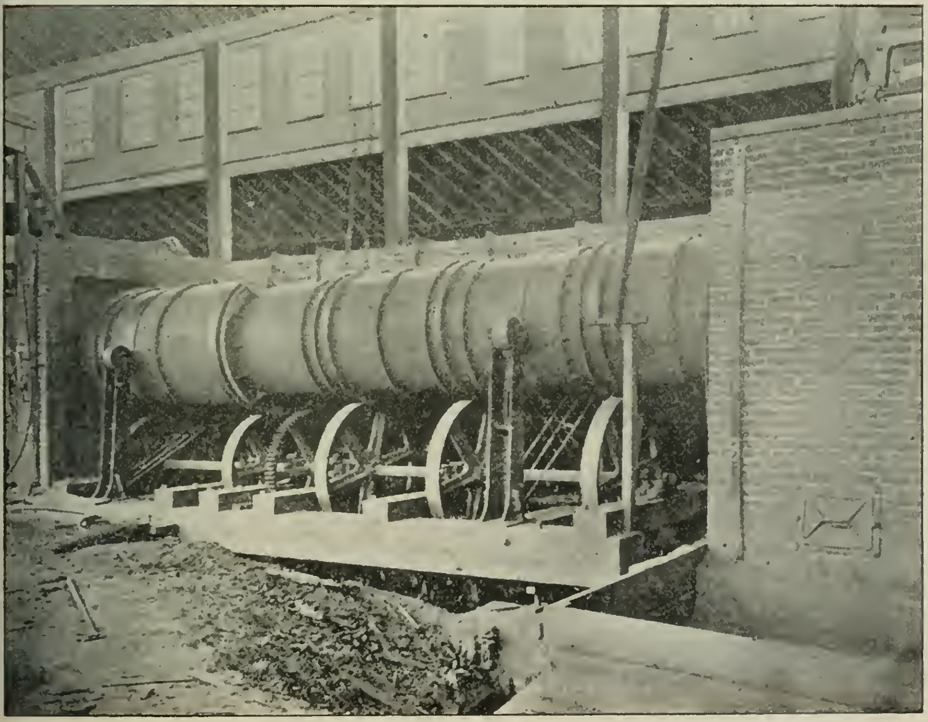
(1) White arsenic, as made at the Deloro works, is a colorless, amorphous and rather vitreous mass, being arsenious oxide represented by the formula As_2O_3. It volatilizes at about 200 degrees centigrade, and often assumes an allotropic form in an opaque crystalline structure, the crystals being regular octohedra, although some appear to be rhombic prisms. The crystalline form may be obtained by condensing the vapor below 200 degrees centigrade. The amorphous form is slightly heavier than the crystalline, which has a specific gravity of 2.7 (distilled water = 1).

White arsenic acts as a weak acid, the aqueous solution giving a slight red tinge to litmus paper. It dissolves readily in solutions of alkaline carbonates and caustic alkalies. It is soluble in cold water, but more easily in hot water. Its composition and the specific gravity of its vapor show that it may be represented by the formula As_4O_6, although the formula As_2O_3 is more commonly used. It has a disagreeable taste and is a very active poison, three grains being sufficient to cause death, although by taking smaller doses the system may absorb larger quantities, even as much as 15 grains at one time. Its uses are given in detail below.

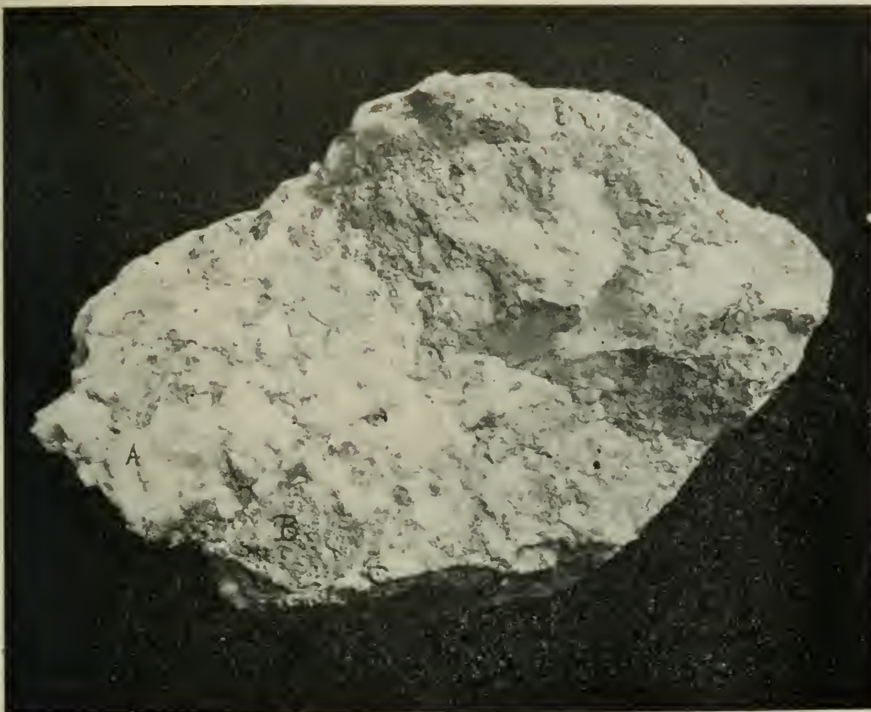
Canadian Goldfields, Limited ; arsenic refining plant.

Canadian Goldfields, Limited ; condensing chambers for crude and refined white arsenic.

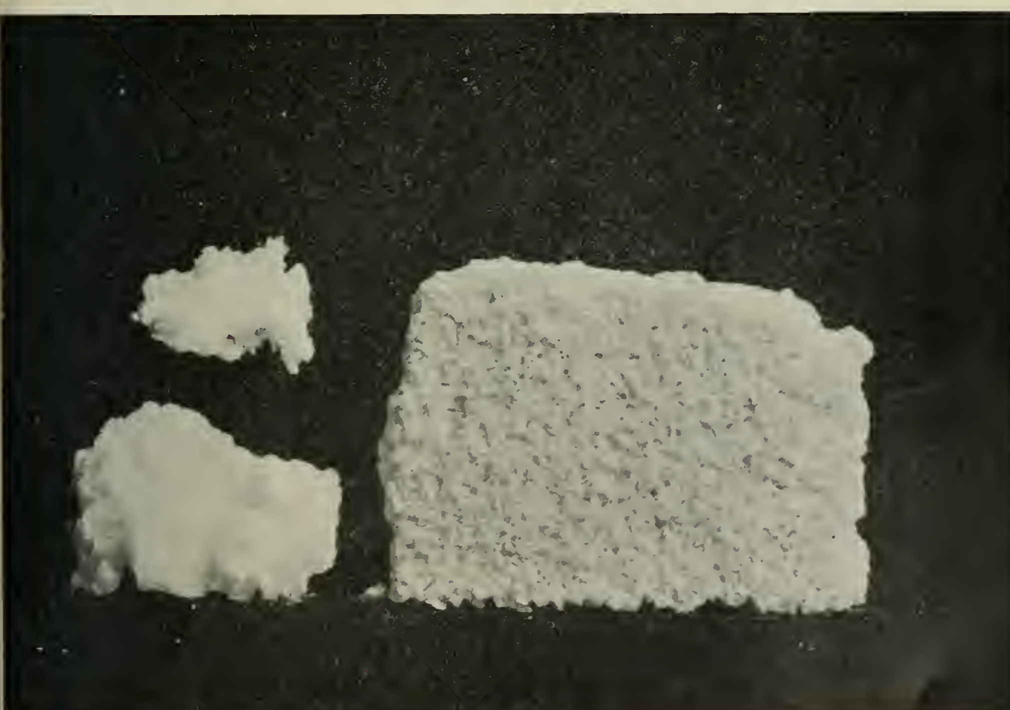
Canadian Goldfields, Limited; stamp mill, cyanide plant and assay office.



Canadian Goldfields, Limited; White-Howell furnace for roasting arsenical ores.



Auriferous arsenical ore from Gatling mine ; A, white quartz ; B, gray mispickel.



Canadian Goldfields, Limited : refined white arsenic, showing coarse and fine crystals.

James' arsenic mine, lots 2 and 3, concession 4, Elzevir township.

(2) Paris green is a chemical compound of copper, arsenious oxide and acetic acid known as aceto-arsenite of copper with the following composition :—Copper arsenite, 82 per cent.; copper acetate, 18 per cent., which may be expressed thus :—

Arsenious oxide (As_2O_3) -	58.64	per cent.
Copper oxide (CuO) - -	31.30	"
Acetic acid - - -	10.06	"
Total - - - -	100.00	"

It may be prepared by mixing aqueous solutions of ammonium-copper sulphate and arsenious acid, the bright green precipitate forming only where there is no excess of either ammonia or acids, as it is soluble in either. Or it may be made by adding sodium carbonate to a copper sulphate solution to precipitate about one-fourth of the copper. Then add acetic acid till the precipitate of copper is re-dissolved and heat the solution to boiling. Add a solution of sodium arsenite, and the precipitate formed is Paris green, which can be removed by filtering and drying.

The writer has not had an opportunity of examining the commercial methods of making Paris green, which is supplied to the Canadian market partly from England and Germany, and partly from makers at Montreal.

Paris green retails for about 25 cents per pound, and its use as an insecticide in killing many insects and in spraying trees is well known. Its excessive cost to consumers prevents a more common use, and is certainly a great disadvantage to fruit-growers and gardeners in Canada, as no composition has yet appeared which is so efficient an insecticide for many pests affecting trees, plants and fruits. In paints it is known as emerald green, a very durab'e, bright green paint.

(3) Scheele's green is arsenite of copper, similar to Paris green in color, but lacking acetic acid. It is a fine powder and can be kept in suspension in water. It is cheaper than Paris green, retailing for about 15 cents per pound, and it is stated to be more prompt in its action as an insecticide, and less liable to hurt the foliage of plants.

(4) Lead arsenate may be prepared by combining seven parts of lead acetate (sugar of lead) with three parts of arsenate of soda. The product is a white precipitate, very easily suspended in water, and of special value in destroying the gypsy moth. It makes an admirable spraying mixture for trees, etc.

According to A. H. Kirkland,[5] the cheapest method of making lead arsenate is to use 888 pounds of pure sodium arsenate, costing \$46.18, and 2,398 pounds of lead nitrate, costing \$161.87, the total cost being \$208.05 to make a ton of arsenate of lead.

(5) Sodium arsenate may be formed by combining sodium carbonate with pentoxide of arsenic, the product being a white powder, soluble in water and forming a very active poison. Another method is to dissolve arsenic trioxide in a solution of sodium carbonate. This salt is used as a basis for sheep dips, skin-preserving mixtures, weed-killers, insecticides, etc.

(6) Potassium arsenate is a similar compound used in medicine as "liquor arsenicalis."

(7) London purple is obtained from waste liquors in aniline dye works and consists of dyes mixed with lime, arsenious oxide, etc. It contains variable proportions of arsenious oxide. It is used as a insecticide for spraying trees, etc., but according to reports from many fruit-growers is not so satisfactory as Paris green.

[5] Paper read before American Association of Economic Entomologists, 19 August, 1899.

Uses of White Arsenic and its Compounds.

White arsenic, arsenious oxide ($As_2 O_3$), or compounds made from it, may be used for the following purposes in the arts, trades, etc :—as a weed killer for destroying rank vegetation, as a vermicide in the shape of a dip or wash for parasites affecting animals such as sheep and cattle, as a hardening substance in babbit metal and lead bullets, etc., as a flux in making the finer grades of glassware, as a fixing and conveying substance for aniline dyes, (as in calico printing,) being a substitute for tartaric acid but not entering permanently into the texture of the cloth, as a dressing for raw hides in taxidermy, as a preservative powder in storing hides for leather manufacture, as pigments in painting and coloring, and for certain medicinal preparations, some of which have valuable properties.

In the Destruction of Weeds.

Regarding the use of arsenic as a weed killer and destroyer of rank vegetation such as is found in Cuba, the writer is not aware of any experiments that have been made in Ontario to test its value for this purpose. According to the late R. P. Rothwell, who erected the original arsenic works at Deloro, experiments were made on the farm of Mr. W. H. Stevens of Detroit, Michigan, where it was mixed with manures and fertilizers and spread on the land. Over 1,000 acres were treated in this manner, the effect being more noticeable where worms were known to have destroyed plant life. His condensed report is as follows :—

> The common crude arsenic from the condensing chambers was employed in barnyard compost or in superphosphates or other fertilizer Experiments with quantities up to 900 lb. of white arsenic to the acre showed no injurious effect upon the plants. If put upon the leaves of plants it killed them, but in one case an army of locusts was destroyed by sprinkling the dry arsenic on the grass and plants in front of it. This use of arsenic in agriculture appears to be of incalculable importance, for it is estimated that a very large proportion of all the crops in every country is destroyed each year by worms. If this use of arsenic shou'd be generally adopted the supplies now manufactured in the world, amounting to between 8,000 and 9,000 tons, would be wholly insufficient.[6]

The observations of the writer have led him to the conclusion that white arsenic will certainly destroy plant life if used in excess, but this is not extraordinary, as common iron pyrites (sulphide of iron) or even magnetic iron pyrites will also kill vegetation if burned in air or applied in excess to farming land. For example, the vegetation around the roast heaps at Copper Cliff mines, Sudbury district, is entirely destroyed by the sulphurous acid fumes in the air and in solution in the surface waters.

The place which arsenic occupies in Mendeléef's table of the elements and their properties seems to afford ground for the conjecture that it may in some way act as a stimulant to plant growth when used in small quantities. It stands next in the table to phosphorus, well-known as a fertilizing substance, and there is a great similarity between the acids of arsenic and those of phosphorus which are used in making fertilizers. Hence their effects on plant life should be the same or nearly the same. This deduction finds support in the fact that vegetation improved while commercial white arsenic was used on the farm lands of Mr. Stevens before mentioned. This may have been due to absence of worms, but also perhaps to the arsenic acting as a tonic on the plants, as it is known to affect the animal system in this way when taken in small doses. It is interesting to note, too, that the employees of the mines and arsenic works in southern England claim to get the healthiest crops of potatoes in their garden plots nearest the arsenic stacks, owing to the fumes destroying the blight which often affects the potato plant.

If white arsenic or any of its compounds should prove to be a cheap and efficient exterminator of common field pests such as the Canada thistle or mustard, the producers of white arsenic will have no difficulty in disposing of their product at a fair price.

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[6] Mineral Industry, Vol. 2, p. 36.

Some experiments with arsenical preparations have been made at the Central Experimental Farm, Ottawa, and the chief chemist, Mr. F. T. Shutt, reports as follows on an arsenical weed-killer called "Harvesta chemical compound," analyzed at the request of the chief botanist to the Farm :—

This is a brownish colored fluid, made in New Orleans, La., and sold for the purpose of destroying weeds in gravel paths. The mixture was neither caustic nor alkaline, and by analysis was found to contain arsenite of soda and common salt. These together amounted to 4.0 per cent., or 6.4 ounces per gallon ; the common salt being 1.69 per cent., or 2.7 ounces per gallon. No doubt this is an effective weed exterminator, since both its constituents have long been known and used for this purpose. It is, perhaps, scarcely necessary to point out that such preparations should only be used on paths or where it is desired to kill all vegetation.[7]

The report also recommends the following formula as a cheap, easily prepared, and effective weed killer :—white arsenic, 1 pound ; washing soda, 2 pounds ; water, 3 gallons ; boil and dilute with from two to three times its volume of water. Apply while still warm in fine weather. This solution is highly poisonous.

The Government analyst of New Zealand reports as follows on two samples of weed-killers used in New Zealand, and submitted for examination :

These are essentially strong aqueous solutions of arsenite of soda with a little free arsenic (commercial white arsenic) as sedimentary matter. In the article "Unknown," there is besides a very small proportion of carbolic acid, a substance which I have no reason to suppose has any particular value for the purpose desired. The really active, the poisonous part, of these compounds is without doubt the arsenic, particularly that which is combined with the soda. An approximate analysis of these samples gave results as follows :

	Brooke's Weed-destroyer.	Unknown.
Arsenite of soda	39.64	43.71
Arsenic (free)	1.69	1.14
Water, etc	58.67	55 15
	100.00	100.00

From this it appears that in reality Brooke's weed-destroyer should prove only little less effective than the other—that, in fact, the one styled Brooke's weed-destroyer has not had a fair trial ; too small a quantity of it may have been administered, or the administration may have been imperfectly effected. There may be a season of the year that is best for the use of the preparation, and, possibly, this is the fall of the year, as the sap is descending for the winter. This article should be had very cheaply, and it certainly has been shown to be a very effective and valuable one for purposes of this nature. For the eradication of wattles it should prove excellent. The best method and the best time requires to be found out.[8]

IN THE PREPARATION OF INSECTICIDES.

Regarding the use of arsenical compounds in destroying vermin on sheep and cattle, there are, according to chemical trade directories, at least 20 factories in England making sheep-dip, in which arsenical compounds are claimed to be the effective agents. Most of this product goes to the Argentine Republic, Australia, Canada, the western United States and other sheep-raising countries. The arsenical sheep-washes, of which there are numerous patented formulæ and secret preparations, are according to the observations of the writer, efficient and cheap preventives of the skin-diseases known as sheep-scab, due to minute biting parasitic mites which destroy the wool fibre, cause eruptions on the skin and seriously affect the health of sheep.

The long-continued use of arsenical washes on stock farms tends to prove that they provide a cheap and successful method of exterminating parasitic vermin in spite of the attempts of manufacturers of other non-arsenical dips to discredit their efficiency. The Bureau of Animal Industry, United States Department of Agriculture, has issued a bulletin (No. 21 revised) entitled "Sheep-scab ; its Nature and Treatment," which discusses the value of arsenical dips in the treatment of that disease. Some opinions are quoted tending to discredit the usefulness of arsenic as a constituent of sheep-dips ; and it should be added that Bruce, chief inspec or of

[7] Annual Report, Dominion Experimental Farms, 1900, p. 157.

[8] 23rd Annual Report of Colonial Laboratory of New Zealand. p. 37.

live stock for New South Wales, pays his respects to arsenical dips with the statement, "Arsenic and arsenic and tobacco (with fresh runs) cured 9,284 and failed with 9,271."

It may be said on the other hand, that arsenic really has excellent scab-curing qualities; it enters into the composition of a number of the secret dipping powders and forms the chief ingredient in one of the oldest secret dips used. This particular dip has been given second place (with some qualifications) among the officially recognized dips in South Africa. In deference to the opinion of those who prefer an arsenical dip several formulæ are quoted here:

Finlay Dun recommends the following: Take 3 lb. each of arsenic, soda ash (impure sodium carbonate) or pearl-ash (impure potassium carbonate), soft soap and sulphur. A pint or two of naphtha may be added if desired. The ingredients are best dissolved in 10 to 20 gallons of boiling water, and cold water is added to make up 120 gallons. The head of the sheep must of course be kept out of the bath. A mixture highly endorsed by certain parties consists of the following ingredients: commercially pure arsenite of soda, 14 pounds; ground roll sulphur, 34½ pounds; water, 432 (U.S) gallons. The arsenite of soda is thoroughly mixed with the sulphur before being added to the water.

Any person using an arsenical dip should bear in mind that he is dealing with a deadly poison.

There seems to be abundant opportunity for manufacturers of chemicals in Canada to absorb a large proportion of the white arsenic product from the Deloro arsenic works in the manufacture of sheep-dip, as the United States, Australia, the Argentine Republic and Canada are largely dependent on the foreign makers of that article, while the process of its manufacture is neither secret nor expensive.

FOR KILLING PLANT ENEMIES.

Allied with the use in killing parastic vermin of biting habits, is the use of arsenical compounds in destroying insects which kill plant life by biting, thus destroying the vegetable fibres. Enormous quantities of white arsenic have been used in making Paris green, so effective on the Colorado beetle, the most destructive enemy of the potato plant. Arsenical preparations also destroy the following common insects which live on plant life; the cotton-boll weevil, a dangerous pest among certain of the cotton-growing sections in the southern United States, the grasshopper or locust, which often invades the fields of grain in vast swarms, cabbage worms, cutworms and army worms—so destructive to standing grain—caterpillars, slug worms, and many larvae, wire worms, codling moth and various insects affecting fruit of all kinds.

The arsenical compounds commonly used by agriculturists and horticulturists are: London purple, Scheele's green, Paris green and arsenate of lead, and for practical purposes they are the best destroyers known for all biting insects preying on plant life or animal fibres. A full description of these chemicals is given above and they are well known to every druggist and progressive horticulturist.

The chief chemist of the Central Experimental Farm, Ottawa, reports as follows on a sample of an insecticide called "Paragrene" which was put on the Canadian market at a very much lower price than Paris green, namely, 14 cents per lb:

"Believing that a knowledge of the composition of this material would be of interest to fruit-growers and orchardists, we obtained a sample for analysis and found it to be a green powder, similar in general appearance to Paris green, though of a lighter color. On mixing with water it remained longer in suspension than Paris green similarly treated. The mixture had a faint but still distinctly alkaline reaction. The analysis of the powder afforded the following data:—

	per cent.
Arsenious acid (As_2O_3)	44.2
Copper oxide (CuO)	24.1
Lime (CaO)	3.7
Sulphuric acid (SO_3)	3.5
Acetic acid	undetermined

Of this, 4.56 per cent was found to be soluble in water.

It is probable from the above that this substance is a mixture consisting chiefly of aceto-arsenite of copper (Paris green) and small amounts of white arsenic and of arsenite and sulphate of lime.

As regards arsenic, the essential toxic, Paragrene falls somewhat behind Paris green, which by law is required to contain 50 per cent arsenious acid. It is possible that the claim of the manufacturers in the matter of this constituent would receive more favorable support from the examination of further samples, as strict uniformity in composition is scarcely obtainable in the preparation of substances, much depending upon the conditions under which the precipitation is made.

In the consideration of the properties of this new compound as a practical insecticide, there are two features worthy of mention. The first is the slightly alkaline character of the mixture with water, thus probably obviating the necessity of adding lime in order to guard against injury to foliage, as in the case with Paris green. Secondly, we have the fact that Paragrene does not so readily settle out as Paris green after the necessary dilution with water, thus enabling an easier and more equable distribution of the poison.[9]

The following formulae of standard remedies for insects and fungi affecting apple and other fruit trees, also vegetables, are recommended by Dr. Fletcher, entomologist and botanist, at the Central Experimental Farm :

Paris green 1 lb., lime (fresh) 1 lb., water 200 gallons. For dry application. 1 lb Paris green with 50 lb. flour, land plaster, slaked lime or any perfectly dry powder.

Poisoned Bordeaux mixture, for fungi and insects on fruit trees : copper sulphate (bluestone) 4 lb., lime (fresh) 4 lb , Paris green 4 oz., water 40 gallons. Dissolve the copper sulphate (by suspending it inside a wooden or earthen vessel containing 4 or 5 or more gallons of water.) Slake the lime in another vessel. If the lime, when slaked, is lumpy or granular, it should be strained through coarse sacking or a fine sieve. Pour the copper sulphate solution into a barrel, or it may be dissolved in this in the first place ; half fill the barrel with water, add the slaked lime, fill the barrel with water and stir thoroughly. It is then ready for use.

Stock solutions of dissolved copper sulphate and of lime may be prepared and kept in separate covered barrels throughout the spraying season. The quantities of blue-stone, lime and water should be carefully noted.[10]

Farmer's Bulletin No. 127 "Important Insecticides," issued by the United States Department of Agriculture, Washington, D.C., gives an excellent account of the proper methods and seasons of applying arsenical preparations in destroying the various biting insects which destroy fruit, vegetables, grains, etc. The bulletin corroborates the statements made by the experts of the Canadian Department of Agriculture of Canada regarding the uses of these compounds and contains matter well deserving the attention of fruit growers, gardeners and farmers generally.

The field for the employment of arsenical vermicides and insecticides is practically unlimited, and the consumption in Canada is certain to increase enormously, provided the selling prices to consumers are reduced to a figure allowing universal use on fruit, vegetable and stock farms. It does not seem to be a rash statement to say that all the white arsenic which might be produced from arsenical ores in Ontario could be absorbed in these two important uses if the retail price of the manufactured article were considerably lowered. There is no reason why Paris green and similar commercial arsenical compounds could not be made in Canada at a profit to manufacturers, as the process is neither difficult nor costly. There are at present at least thirteen manufacturers of Paris green in the United States, while the Canadian demand is supplied mostly from English and German factories.

Other Uses of Arsenic.

With regard to the use of white arsenic in hardening bullets and babbit metal, only a small quantity is used for this purpose. Ordinary commercial lead shot is made by mixing 1 lb. of commercial arsenic with about 500 lb. lead.

[9] Annual Report Central Experimental Farm 1899, p. 117.

[10] Bulletin No. 37, Department of Agriculture, Canada.

Generally speaking, metallic arsenic does not make useful alloys with the other metals, as it renders metals hard and brittle, a minute quantity according to experiments made by the writer being sufficient to make gold britle.[11]

Small quantities of white arsenic are used by tanners in dressing raw hides. It is said to keep the raw skins supple, prevent decay and ward off attacks of injurious insects. According to the Columbian Cyclopedia, the following arsenical soap has been used in dressing hides with success :—white arsenic, 1 oz.; white soap, 1 oz.; potassium carbonate, 1 dram; distilled water, 6 oz.; camphor, 2 drams.

The following formula is said to be used as a preservative powder in keeping dressed hides free from decay and the attacks of insects: white arsenic, 1 lb.; burnt alum, 1 lb.; powdered oak bark, 2 lb.: camphor, ½ lb.

IN THE MANUFACTURE OF GLASS.

The writer has had the opportunity of examining a glass factory where the finer grades of glass in which some white arsenic is used are made. According to the statements of practical glass-makers, this compound is used to give brilliancy to the glass. The effect is no doubt due to the presence in the glass of finely divided metallic arsenic which has a peculiarly brilliant sheen.

According to R. Linton white arsenic is used in glass-making mixtures as an oxidizing agent converting iron oxides in the ferrous state to the ferric state, hence decolorizing the iron which might otherwise stain the glass, as ferric silicate is yellow, imparting no color when mixed with silicates of potash, lime and soda, while ferrous silicate is green, giving a tint to glass.[12] Dr. Carl Schnabel, a renowned German metallurgist, states as follows :—"Arsenious oxide is a powerful reducing agent and is extensively used on this account as a decolorizer in glass-making, in the manufacture of copper colors, and for the manufacture of yellow arsenic glass"[13]

It is probable that it acts as an oxidizing agent with some mixtures for glass, giving up its oxygen and being reduced to metallic arsenic, while with other mixtures it may take oxygen from other compounds to form arsenates, also taking other elements away as in the case of oxygen. This does not affect the question of its usefulness in the manufacture of the finer grades of glass, which appears to be undoubted.

The consumption of white arsenic in glass-making is not large, as it is apparent from an examination of glass-making mixtures that it does not enter into the glass as an essential component. Furthermore, its use is confined mostly to the finer grades of colorless glass such as window glass, plate glass, crown and flint glass.

The following mixtures are taken from Heurvaux's Le Verre et le Crystal, Gessner's Glass Maker's Hand Book and Tscheuschner's Hand buch der Glasfabrikation :—

Window Glass.

Components.	American.				German.				French.		
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)
Sand	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100 0	100.0	100.0
Salt-cake	44.0	40.0	42.0	43.0	35 0	45.0	45.0	35.0	35.0	40 C	42.0
Soda ash	......	4.0	......	......		......	......	6.0		......	......
Limestone	26.0	38.0	40.0	34.0	30.0	38.0	32.0	30.0	25.0	35 0	34.0
Carbon	4.0	8.0	6 0	5.0	12.5	3.0	2.0	3.0	1.5	2.0	2.0
Arsenic	2.0	1.0	2.0	0.5	.....	......	......	.....	0.5	1.0	.....

11 Proceedings Federated Canadian Mining Institute, 1897, p. 130.

12 Mineral Industry, Vol. 8, p. 236.

13 Schnabel's Handbook of Metallurgy, 1898, translated by Henry Louis.

Plate Glass.

Components.	American.			German.		
	(1)	(2)	(3)	(1)	(2)	(3)
Sand	100.0	100.0	100.0	100 0	100.0	100.0
Salt-cake	....	....	40.0	38.0	....	....
Soda ash	30.0	36.0	....	....	35.0	33.0
Limestone	24.0	24.0	38.0	38.0	....	....
Slaked lime	....	....	....	....	20.0	14.0
Carbon	1.0	0.75	4.0	2 5	....	....
Arsenic	....	1.0	2.0	0.5	....	....

Lime Flint.

Components.	German.			
	(1)	(2)	(3)	(4)
Sand	100.0	100.0	100.0	100.0
Soda ash	....	....	30.0	33.0
Potash	32 0	58.0	....	....
Limestone	....	....	36 0	36.0
Slaked lime	13.0	12 0	....	....
Saltpetre	....	8.5	1.5	....
Arsenic	0.3	0 4	....	2 0
Manganese	0.2	0.3	0.5	1.0
Cullet	100 0	100.0	100.0	100.0

Lead Flint.

Components.	American.		German.				French.		
	(1)	(2)	( )	(2)	(3)	(4)	(1)	(2)	(3)
Sand	100 0	100.0	100 0	100.0	100.0	100 0	100.0	100.0	100.0
Potash	36.0	34.0	35 0	28 0	30.0	34.0	31 0	33.0	30.0
Red lead	40 0	48.0	67 0	67.0	66.0	42 0	67.0	67.0	67.0
Nitre	5.0	6.0	....	6.0	3.0	16 0	....	....	4 0
Borax	0.3	....	....	....	....	....	....	....	....
Arsenic	0.5	0.15	0.3	0.25	0.3	....	....	0.6	....
Manganese	0.25	0.06	0.2	0.2	0 2	0.5	....	0.45	0.025
Antimony	....	0.02	....	....	....	....	....	....	....

Some of the Deloro arsenic is now being used in American glass works and is said to have proven of first-grade quality for this purpose. As there are at least 100 plants in the United States making the finer grades of glassware, the Deloro arsenic works are likely to find a steady market for at least a portion of their product in glass-making.

White arsenic is also used in making enamels and certain glazes.

The writer is informed by an expert pottery manufacturer that the addition of white arsenic to certain glazing mixtures increases the brilliancy and fluidity of the glaze. As art mosaics and enamelled tiling are coming into more general use in interior decorations, the consumption of white arsenic is likely to be increased by their manufacture.

The following analyses of Venetian enamels have been made by Dr. Schwarz of Graz,[14] showing arsenic to be a component in variable proportions.

[14] Mineral Industry, Vol. 8, p. 263.

Analyses of Venetian Enamels.

Components.	Carmine.	Blue.	Violet.	Purple.
	Per cent.	Per cent.	Per cent.	Per cent.
SiO_2	46.95	49.90	52.08	52.40
Sb_2O_5	1.42	3 75	3 15	5.26
As_2O_5	9 96	1.12	4 29	2.35
PbO	18.98	21.45	9.53	4.04
CuO	....	....	0.22	.
Cu_2O	....	0 67	.	0.10
CoO	....	0.91	0 09	0.15
FeO	....	1.12	.	....
Fe_2O_3	0.63	....	0.76	1.60
MnO	...	1.59	....	....
Mn_2O_3	0.15	. .	5.28	11.50
CaO	3 80	5.50	4 97	7.61
MgO	1.40	1.26	0.86	0.86
K_2O	9.99	8 25	9.59	1.41
Na_2O	5 43	4.50	8.57	11.84
B_2O_3	1.29	....	....	....

The consumption of white arsenic in dyeing and coloring textiles, such as calico, is not important in comparison with other uses in America. It does not enter into the permanent coloring of the texture, serving only as a fixer or conveyor. Arsenic acid or one of its salts (arsenates) is used to act on the aniline dyes, bye products consisting partly of arsenious oxide, lime etc., or one of the salts (arsenites) being formed.

The composition, London purple, is obtained in this way as a bye or waste product from dye works. Processes have been devised to reconvert this waste arsenic into white arsenic, but as the raw material for making white arsenic is very cheap the process is not now in use.

In Germany coal-tar dye-works are numerous, and according to reliable trade reports, consume the larger proportion of white arsenic produced in that country.

As to the use of arsenic in painting and coloring, Paris green gives a bright green permanent color, and other colors may also be made. Their use, however, is being diminished especially in wall-paper and interior work owing to their poisonous nature and to the cheap and excellent colors which may be made by combining lead compounds and other bases with coal-tar dyes such as anilines.

Regarding its use in medicine, all arsenical compounds may be classed for practical purposes as poisons. Small quantities are believed to act as a tonic, but they should not be used without advice from a physician.

Saturated solutions of white arsenic are said to make good preservatives for wood, preventing dry rot and killing wood-borers, also larvae and other insects destructive to dried woods.

Its use in embalming fluids is well known.

Arsenic as a Poison.

The writer has investigated the methods of preventing arsenical poisoning employed at arsenic refining works, and so far as he can learn the method used at Deloro is the best known, provided the directions posted up are carried out by the workmen. Only two serious cases of arsenical poisoning are reported at the Deloro works, and these were due to gross carelessness and lack of personal cleanliness on the part of tne two employees affected. Unless absolute cleanliness is adopted, arsenic particles are apt to lodge in the arms, neck, etc., and cause painful raw sores. It is stated that in Austria the arsenic workers regularly take doses of arsenic inwardly, which acts as an antidote, but the safest antidote is to follow the rules as to cleanliness.

Mechanical drafts are being adopted at Deloro by which the dangers of poisoning will be reduced to a minimum.

The works there are provided with a room for the use of employees in changing working clothes at the end of each shift, also a wash room furnished with three hot and cold water douche sprays as well as bath tubs. Rules requiring the changing of clothes and washing at end of each shift are posted up, and any employee not obeying the rules is liable to dismissal.

A supply of freshly prepared ferric oxide is always ready for emergency in case of poisoning. This is an immediate and very efficient antidote for arsenical poisoning caused by the fumes, and raw sores may be washed with the ferric oxide with beneficial results. It is prepared as follows : sulphate of iron crystals, 280 parts ; sulphuric acid, 100 parts ; nitric acid, 35 parts ; water, 500 parts. Dissolve the sulphate of iron in the water and sulphuric acid, warm solution in a large dish and add the nitric acid gradually. Precipitate with ammonia until the iron is precipitated, filter and wash precipitate well with water. The precipitate may be kept under water in bottles for some time.

The question of arsenical poisoning has recently received considerable attention in England on account of an epidemic of arsenical poisoning among beer drinkers, particularly in the Manchester district. The poisoning was traced to beer made by fermenting glucose which in turn was derived from starchy substances by using sulphuric acid which had been made from iron pyrites containing small quantities of arsenical sulphides, the arsenic not having been eliminated from the acid in the process of manufacture. It is, however, beyond the scope of this paper to discuss at any length poisoning due to arsenic, but it may be said that all the compounds of arsenic are poisons and should be used only on the advice of physician and with care.

Bibliography of Arsenic.

The following publications may be consulted with profit by those wishing to obtain fuller data regarding arsenic :

(1) Mineral Industry ; published by Scientific Publishing Company, 253 Broadway, New York city. Volumes 1 to 9, especially Volumes 2, 4 and 5, which give information regarding the technology of the arsenic industry in England and Germany.

(2) Arsenic ; by Prof. J. A. Wanklyn, being a discussion relative to the recent investigation on poisoning in England, due to arsenical beer. Published by Kegan, Paul, Trench & Co., Charing Cross Road, London, England.

(3) Proceedings of Canadian Mining Institute ; Volume 4 (1901-2), Ottawa ; containing papers on treatment of auriferous arsenical ores.

(4) "Sheep-scab : its Nature and Treatment"; being Bulletin No. 21, Bureau of Animal Industry, United States Department of Agriculture, Washington, D.C.

(5) "Important Insecticides"; being Farmer's Bulletin No. 127 issued by United States Department of Agriculture.

(6) Reports of the Dominion Experimental Farm, Ottawa, giving information regarding insecticides. etc.

(7) Reports of Inspectors of Mines, etc., Home Office, London, England. Published by Eyre & Spottiswoode, Harding St., London, England.

(8) Lodeman's "Spraying of Plants."

(9) Annual reports of the Bureau of Mines of Ontario.

(10) The Journal of the Federated Canadian Mining Institute, volume 2 (1897), Ottawa ; Mispickel Ores of Deloro, Ont.

Arsenic Manufacturers in America.

Following is a list of manufacturers of and dealers in arsenical compounds in the United States and Canada, compiled from trade directories :

(1) Schoelkopp, Hartford & Hanna Co., aniline dyes, Buffalo, N.Y.
(2) Billings, Clapp & Co., 165 Hight street, Boston, Mass.
(3) Zucker Levett Chemical Co., Flushing, L.I., N.Y.
(4) Mallincroft Chemical Co., St. Louis, Mo.
(5) Chas. Cooper & Co., 194 Worth street, New York city.
(6) Adlers Sons, corner Maiden Lane and Pearl streets, New York city.
(7) Roessler & Hasslacher Chemical Co., 100 William street, New York city.
(8) Fuerst Bros., 2 Stone street, New York city.
(9) Canada Paint Company, Montreal, Canada.
(10) Acme Color Works, 5 Hanover street, New York city.
(11) A. B. Ansbacher & Co., 14 Murray street, New York city.
(12) J. A. Blanchard, New York city.
(13) Cawley, Clark & Co., Newark, N.J.
(14) Chas. M. Childs & Co., 225 Pearl street, New York city.
(15) Eckstein Bros., New York city.
(17) M. Hermann & Co., New York city.
(18) Fred. L. Lavanburgh, 165 William street, New York city.
(19) Leggett & Bros., New York city.
(20) N.Y. Enamel Paint Co., New York city.
(21) C. T. Reynolds & Co., New York city.
(22) John Lucas, 89 Maiden Lane, New York city.
(23) E. Hills Sons & Co., New York city.
(24) Harshaw, Fuller & Goodwin, Cleveland, Ohio.
(25) P. D. Dodds & Co., 188-190 McGill street, Montreal, Canada.
(26) Standard Chemical Co., Toronto, Ont.

THE CORNIFEROUS EXPOSURE IN ANDERDON.

BY REV. THOMAS NATTRESS, B.A.

Three varieties of the Corniferous formation, to a depth of about 75 feet, are exposed in the quarries of Anderdon township in the county of Essex, Ontario. These are the overlying magnesian limestone, the true Corniferous limestone, and an underlying brown dolomite.

Little more than ten miles distant, north by west, and on the opposite side of the Detroit river there is, as indicated by a blue print of five borings,[1] a depth of 325.25 to 346 feet of limestone before the sandstone is reached. This fact and the fact that the three varieties of the Corniferous named run out here at the extreme southwesterly limit of Ontario, within the distance of a few hundred yards from south to north, would together indicate that the Oriskany sandstone would be found at no great depth.

According to Rominger,[2] strange to say, the Helderberg formation covers the whole surface extension from end to end of Detroit river and around the end of lake Erie. Apparently in support of this, the Salina runs out at a point about opposite the Anderdon quarries, westward in the neighborhood of Trenton, Michigan, a fact ascertained during the past summer. Let it be observed, however, that Rominger shows only these formations, Helderberg, Hamilton, Black Shale, Waverley, Carboniferous and Coal Measures, on his Geological Map of Michigan, leaving out the Corniferous and Oriskany formations altogether. He furthermore figures the Helderberg as the surface extension on both sides of the Detroit river, whereas three facts are known :—(1) there is Corniferous at the southern end of the river on the Canadian side, instead of Helderberg, as a surface extension, (2) a greater depth of it than he describes of Helderberg on exactly the opposite side of the river, though the dip at this point is south by west, which would indicate an increasing and not a diminishing depth westward, or else a later formation and not an earlier one as a surface extension ; and (3) at Windsor, at the head of the Detroit river, the salt is down a very considerable depth below the surface, allowing abundant space for the Oriskany and Helderberg in the miles of country between the Salina at Windsor and the outcrop of Corniferous in the Anderdon quarries in the vicinity of Amherstburg.

In the same report, p. 24, Rominger speaks of the "transitory groups between the Helderberg and Hamilton groups." It still remains to be noted that the borings made just south of Detroit by the Solvay Process people show a minimum and maximum depth of 368 and 383 feet of limestone *under* the sandstone and *over* the salt ; but one deposit of sandstone ; and a superincumbent depth of limestone of minimum and maximum depth (in the five borings referred to) of 325.25 and 346 feet. Now the order in nature of these several formations, taking the oldest first, as very neatly figured by Winchell,[3] is, Salina, Helderberg, Oriskany, Corniferous[4], Hamilton, Chemung, Catskill (Waverly), Carboniferous Limestone, Conglomerate Measures and Coal Measures.

The Magnesian Limestone.

It is many years since quarrying first began in the Corniferous formation in Anderdon. The stone for the locks on the first canal on the American side at Sault Ste. Marie was taken out here. So was also the stone for the new locks on the Canadian side at the same

1 It is interesting to note that this log of brine wells, Brandy Island, (The Solvay Process Co., Detroit, Michigan), shows a total maximum depth of 1,060 feet of limestone in a rock boring of 1,622 feet ; a maximum of 413 feet of salt in a boring of 1,624 feet ; and but one deposit of sandstone, averaging a depth of 90.6 feet in five borings, the minimum being 80 feet and maximum 103 feet.

2 Report of the State Geological Survey of the State of Michigan, 1876.

3 Walks and Talks in the Geological Field, by Alexander Winchell ; p. 85, Table of Geological History.

4 The key to the misunderstanding is furnished, probably, by a sentence in Geology of Canada, 1863, pp. 361, 362 :— "The name of Corniferous Limestone is, by the New York geologists, restricted to the upper division which has in that state a thickness of about seventy feet. These two portions, with the addition of the local Schoharie grit, make up what they have described as the Upper Helderberg group."

place. A depth of about 32 feet of magnesian limestone has been exposed. There are five beds. The first and second, two feet and eight feet in thickness respectively, are much weathered and are of inferior quality. The third bed is about four feet thick; the fourth and fifth, eight and ten feet. The three lower beds or strata are of fine quality, the eight-foot bed unsurpassed as dimension stone, being remarkably free from every kind of imperfection The lowest stratum rests immediately upon the true limestone

The approximate dip is seven-eighths of an inch to the foot, south by west, corresponding very closely with the dip of the underlying limestone, both in amount and direction, and at least in direction with that of the rock-beds on the farther side of the Detroit river. The glacial striæ trend east by southeast and are plainly defined, but do not show any remarkable feature such as the fluting that may be seen on the surface of the same formation on Pelee island in Lake Erie. On a surface recently stripped the trend of the striæ is from northeast to southwest, what appears to have been an earlier striation (southeasterly) being slightly discernible.

Crystals occur at intervals in cavities of small to medium size. Some of these cavities have been left by decaying or absorbed spreading corals, and none are too large to be so accounted for. The prevailing crystals are of quartz, semi-transparent and shading from white to a rich brown. There are also fluorite and calcite crystals, the former beautiful sparkling purple cubes, the latter shading from white to purple and forming tight, thin, transverse seams.

A large deposit of minute, loosely cohering grains of quartz was discovered but lately in the river bed abreast of Amherstburg. A space 200 feet square was dredged to considerable depth, and not a dipper full of anything but this was brought up. An analyst in Detroit pronounced the substance to be 99 per cent silica. There is evidence that a stratum of the same material extends in the direction of the dip of the dolomite.

Crystallites, a formation well figured and described in Geology of Canada, 1863, pp. 632, 633 and 346, occurs at varying depths, between the strata. The mould left by the dissolving salts is found to be filled by a dried up deposit[5] of what was doubtless petroleum. In the earlier days of quarrying in the magnesian strata here the children of the neighborhood used to amuse themselves building little fires with the blackened chips of stone. But the supply has evidently gravitated to lower levels.

It has not been found easy to get good specimens of the fossils contained in this rock, for the twofold reason that most of these have persisted only in the form of casts or moulds, and the anciently weathered exposure was of very limited area besides being a glacier-planed surface in which there is neither fault nor bluff. So far as investigated, they are :—

1. Zoophyta.

Zaphrentis prolifica,
Cyathophyllum exiguum (Billings,)
Cyathophyllum Zenkeri, B.,
Heliophyllum Halli, B.,
Diphyphyllum Archiasi,
Crepidophyllum Archiasi,
Strombodes pentagonus ;
Phillipsastrea Verneuili (Edwards,)
Michelinia convexa,
Favosites turbinata,
" *Nitella (Winchell,)*
" *hemispherica (Milne Edwards,)*
" *basaltica (Goldfuss,)*
Syringopora Hisingeri,

[5] Described in Geology of Canada, 1863, page 346, as "a thin film of black argillaceous mud which generally divides he beds."

Syringopora perelegans,
Cladopora cryptodens,
" *labiosa*,
" *aspera* (*Rominger*,)
Monticulipora ——.

2. Brachiopoda :

Parazyga hirsuta,
Orbiculoidea——,
Atrypa reticularis,
" *intermedia*,
" *spinosa*,
Leptœna rhomboidalis,
Stropheodonta demissa,
" *perplana*,
" *inaequistriata*,
Chonetes ——,
Cyrtina Hamiltonensis,
Camerotechia tethys,
Pentamerella arata,
Orthis Livia,
Spirifera mucronata

3. Lamellibranchiata :

Paracyclas elliptica,
Conocardium trigonale,
An unidentified fragment.

4. Cephalopoda and Gasteropoda :

Orthoceras,
Platyceras ——,
Pleurotomaria ——,
Gomphoceras eximium (*Hall*,)
Gomphoceras ——,
Gyroceras Numa,

And other badly worn fragments, not like any of these, indicating a radius of three to seven and one-half inches.

5. Trilobita :

Phacops bufo, and the pygidium of a specimen of *Dalmanites* (*Coronura*) *aspectans*, the *Asaphus aspectans* of Conrad.

6. Of Echinodermata, but sections of crinoid stems have been obtained.

7. Of Molluscoidea, also, the specimens are few and not well defined ; none of the polyzoa thus far secured have been satisfactory.

8. Conularidae :
Conularia.

In the large majority of instances the actual shells have not persisted. *Orthis*, *Stropheodonta atrypa*, *Conocardium trigonale* and *Spirifera mucronata* are exceptions. *Parazyga hirsuta* is a notable exception, and the rock immediately about the few clustered specimens obtained is dark colored and remarkably hard. In the underlying brown dolomite to be described only casts and moulds are found.

The Corniferous Limestone.

This rock lies immediately under the magnesian limestone, and is not a dolomite. It is a very fine-grained rock. The late George M. Dawson, Director of the Geological Survey at Ottawa, pronounced it useful as a lithographic stone "if obtainable in large slabs." It is however exceedingly brittle, and has been found available only for lime, of which it makes an excellent quality, foundation stone, and road-making. A large amount of it has been put upon the market as crushed stone. There is a probability that in the near future it will be burned extensively for lime.

There would seem to be next to no fossils in this limestone. The remarkably fine-grained quality of the rock would doubtless indicate a comparatively deep-sea deposit, in which case the probability of organic remains would be lessened. A certain rugose coral is present and an indefinable gasteropod of medium size.

In a quarry recently opened up by Mr. T. B. White, son of the late Wyandotte Chief, Mondoron, just east of the Amherstburg quarry, there are small waterways worn down through this formation, following some small ancient crack, showing the rock to be soluble, despite its unusual hardness.

In this quarry, commencing where the limestone runs out and the brown dolomite is first exposed, there is a surface deposit of moulding sand of good quality. No analysis has yet been made of it. With an admixture of cement it makes what has the appearance of being a durable pressed brick.

The Brown Dolomite.

The brown stone cropping out north of and from under the true limestone is described by Dr. Hoffman, chief chemist in the laboratory of the Geological Survey at Ottawa, as "a light-brownish, slightly ferruginous, faintly petroliferous, fine-crystalline dolomite."[6] It is a massive rock, and except in certain strata that abound in branching corals, is not only a suitable building stone but a very desirable one, because of its color (though it shows a tendency to bleach) and fine-crystalline quality. Strata permeated with corals are exposed in the bed of the Detroit river, about a mile west of the exposure in the Anderdon quarries. The durability of the stone may be judged from the fact that the first specimen examined, a fossil-free bit of rock taken from the immediate neighborhood where the dolomite and limestone had been planed off by the last passing glacier, a chip little more than an inch in thickness and running off to an edge, weathered on both sides, *was not weathered through*, though the covering of earth was not more than three or four feet.

The deposit runs out only a short distance north of the outcrop of true limestone, just as the latter does in relation to the overlying dolomite. The depth begins to increase south-eastward, however, as exhibited in Mr. White's quarry; and the limit of the deposit circles northwesterly. Judging from these facts and from the rapidity with which the two overlying formations increase in depth in the direction of the dip, there is probably a very considerable deposit of brown dolomite.

So far as examined the fossils of this deposit differ largely from those of the overlying dolomite and are fewer in number and variety. There are ill-defined specimens of *Stropheodonta*, a possible *Chonetes*, a probable *Orthothetes*, a probable *Meristella* and a *Spirifera fimbriata*. The characteristic bivalves are the lamellibranchiata *Conocardium cuneus* (var. *trigonale*), and a *Panenka*, which Mr. Whiteaves, of the Geological Survey, Ottawa, has lately named *Panenka Canadensis*, the largest bivalve found in the Corniferous of this section, but smaller than *Panenka*

[6] An analysis made at the Solvay Process Works, Detroit, shows calcium carbonate 57.28, magnesium carbonate 41.15, trace of calcium sulphate, silica 1.25, ferric oxide and alumina 0.32.

grandis (Whiteaves) of the deposit at St. Mary's. The most numerously represented genus is the gasteropod, of which there are several species and varieties, including *Platyostoma*, *Pleurotomaria*, *Straparollus Canadensis*, *Pleuronotus de Cewi*, and a small elongated abounding specimen not very well defined. There is also *Cyrtoceras Ammon*, *B.*, and a small narrow-cepted *Orthoceras* with the siphuncle at the maximum distance from the centre. A modiform cast is found, but can only be referred to as doubtful. Three specimens of a small cup-coral were obtained, probably *Cyathophyllum*, but in so ill-preserved a condition as to be impossible of accurate definition. Nor has it been found possible to identify the branching corals in their badly decayed condition.

When it is remembered that the only opportunity of studying the fossils of this particular variety of the Corniferous is afforded by the dredge-scows on Detroit river, as the newly blasted rock is brought up by the dipper ; that this rock has been overflown and saturated with water for untold ages ; and that completer saturation has been brought about by the rotting out of the corals of the exposed strata, the difficulty of getting well-defined specimens will be appreciated ; especially if the fact already noted be also borne in mind, that only casts and moulds have persisted.

The characteristic crystals of the brown dolomite are scalenohedra of calcite, or carbonate of lime. These crystals occur in clusters in small cavities, or singly embedded in the rock. Strontianite, or sulphate of strontium, also occurs filling up narrow crevices. No considerable deposit of it has been found, however, as on Put-in-Bay island in lake Erie. Nor is there a probability of its being found in quantity, inasmuch as there has evidently been no disturbance of the rock beds hereabout to leave cavities by elevation and subsequent parting of the strata by partial subsiding.

Occasional somewhat large nodules of hornstone, and smaller nodules of a fine-crystalline massive quartz were observed.

Though the strata from which these specimens were taken are decomposed in the manner described, the recent exposure of the same rock in Mr. White's quarry reveals a stone of marked purity, free of fossil remains and all foreign matter.

Acknowledgments are due to Mr. Andrew Green, Manager of the Solvay Process Company's Works at Detroit ; to Mr. T. W. Bellhouse, the Company's manager of the Amherstburg quarry; to Mr. L. P. Smith, of Cleveland, whose dredging outfit worked in the brown dolomite during the past summer ; and in particular to Mr. J. F. Whiteaves, F.G.S. F.R.S.C., palæontologist to the Geological Survey of Canada, for facilities afforded and assistance given in the study of the palæontology and geology of the Corniferous deposit in Essex county.

IRON RANGES OF NORTHWESTERN ONTARIO.

BY A. P. COLEMAN.

In accordance with the instructions of Mr. T. W. Gibson, Director of the Bureau of Mines of Ontario, the field work of last summer was directed mainly towards following up the iron ranges of northwestern Ontario in completion of the work commenced in the previous year. Mr. J. A. Johnston was appointed assistant and proved very efficient.

As usual much aid was given by prospectors, mine managers and others interested in mining, for which thanks are due ; and particular mention should be made of assistance provided by the Messrs. Clergue in the form of maps, etc., largely the work of Professor Willmott, now in charge of their geological operations.

In general, we may say that the widespread interest aroused by the recent demand for iron ores, causing several important American companies to fit out parties for the exploration of northwestern Ontario, has been of material help in our work by pointing out the most important localities where iron ranges occur. With the exception of the extensive iron ranges in Hunters Island and east of lake Nipigon, which were not examined for lack of time, all important districts have been visited and will be more or less fully reported on. The greatest amount of work was naturally devoted to the most highly developed region, that of the Helen and Josephine mines ; and here materials have been gathered, in conjunction with Prof. Willmott, for a somewhat detailed map and report.

It may be well to mention that the most serious drawback to the field geologist in northern Ontario is the lack of sufficiently accurate topographical maps on which to plot his field work. On this account he must in many cases spend much time in fixing points and measuring distances before it is possible to go on with the geology.

In addition to the work done on the iron ranges, expeditions were made to the Sturgeon lake gold mining region and one or two other districts of interest, which will be separately reported on. The opening of the new Canadian Northern Railway will, it is hoped, improve the condition of affairs in the Seine river and Shoal lake gold mining regions by giving easy communication and furnishing supplies and machinery at reasonable freight rates. The rock cuttings of the railway promised to afford interesting sections also, and on these accounts a trip was made by rail and foot to Steep Rock lake, and thence by canoe and on foot to Sturgeon Falls, after which travel by steamer and canoe took us to Fort Frances and Rat Portage. In future this journey may be much more easily made.

Iron Ranges West of Port Arthur.

Banded jaspery iron ores of low grade have long been known from the region west of Port Arthur, especially along the Mattawin river and on Hunter's island, the latter including the northeastern extension of the famous Vermilion Iron range of Minnesota. Mr. W. H. C. Smith has briefly described the latter jaspery bands in his Report on the Geology of Hunters Island,[1] and calls attention to the fact that they are an extension of the iron range at Tower and Ely in Minnesota. Dr. Bell also gives a short list of localities where silicious iron ores were known to occur, mentioning Hunters Island and a point on the Kaministiquia where the Canadian Pacific Railway crosses it[2]. The Mattawin range has been referred to in the Bureau of Mines Report for 1895, a series of hills consisting of low grade hematite with seams of red jasper occurring for several miles along the river[3] ; and the same belt is mentioned by Mr.

[1] Geol. Sur. Can., 1890-91, G. [2] Rep. Royal Com., 1890. p. 22. [3] Bur. Mines, 1895, pp. 82-84.

Consolidated Lake Superior Company; Helen iron mine.

Atikokan station, Canadian Northern Railway.

Tip-Top copper mine ; camp on Round lake.

McInnes in the Geological Survey Report for 1897[4]. However no detailed study of these western iron ranges has yet been put into print, though it is stated that Professors Pumpelly and Smyth have carried out extensive surveys, chiefly by the dip-needle, for the purpose of locating the more desirable claims. Unfortunately, their work has been for private parties and is not available for the public. Their long experience in geological work on iron ranges should make their results of great value. The Clergues too have been carrying on explorations in the regions and have taken up some locations, but their work also is for commercial purposes.

IN CONMEE TOWNSHIP.

The nearest exposures of the iron range to Fort William and Port Arthur are in the neighborhood of Kaministiquia station on the C.P.R. and to the south in Conmee township. One occurs about a mile south of the station, on a steep hill a little east of the railway. Here rich red jasper is interbanded with magnetite and hematite, the former ore giving rise to a strong local attraction rendering the compass useless The banded material strikes about east and west, and has a nearly vertical dip. A test pit or two have been sunk upon the flanks of the hill, but only thin bands of good ore are to be seen.

The other outcrops of the iron range are on the west side of Kaministiquia river, which may be crossed by the railway bridge a little north of the station. One is surprised to find here instead of the customary trestle or steel structure a handsome bridge of three arches made of grey granite. The railway has excellent granite quarries at Ignace and other points in the Laurentian, and is making use of the material quite largely along the line between Fort William and Rat Portage.

Along the west bank of the river the Canadian Northern track has been laid, and cuttings at various points to the south disclose iron range rocks, the first cutting being largely in banded black chert with a little jasper and some siderite. The next is in greenstone, and the third in beautiful banded jasper of various tints with layers of blue-black ore, the whole often greatly folded. Two or three hundred yards farther there is a fourth cutting showing a small outcrop of conglomerate or breccia most of the pebbles and boulders being of jasper,—evidently a basal conglomerate, possibly of the Upper Huronian, but more probably of the Animikie.

About a mile south of a still unnamed station on the Canadian Northern (between Kaministiquia and Kakabeka on the C.P.R. across the river) where a creek comes into the river from the west, iron range rocks occur once more. A location has been taken up here on a pyrite deposit, where a small shaft has been sunk, disclosing nearly solid pyrites in places, though generally some fine-grained silica is mixed with it, suggesting strongly the iron range rock south of Sayers lake at the Helen mine. At the edge of the pyrit s is a band of brecciated grained silica, striking about northeast and southwest, and up the creek 200 paces there are banded chert and jasper with magnetite, running about north and south for at least 140 paces. A few yards east of the pyrites deposit a conglomerate, perhaps Upper Huronian, is found in very large boulders probably not far from their source. The only other rock observed was greenstone, and owing to the thickly wooded character of the region and the amount of drift the general associations of the iron range were not worked out.

Half a mile down the track from the creek there is a cutting in fine-grained greenstone weathering white, and no more iron range rocks were observed, other cuttings to the southeast near Kakabeka Falls being chiefly in clay and sand which will be described in another place.

At the bridge over the Kaministiquia not far above the splendid Kakabeka Falls a contact of the overlying Animikie with the Huronian was found and deserves some mention. Immediately under the bridge are finely banded Huronian schists looking quite like iron range rocks at

[4] Geol. Sur. Can., 1897 pp. 20 and 57, H.

a little distance, but consisting of fine-grained hornblende schist interbanded with felspar weathering white, and also glassy quartz. The schists strike about 100° and dip 45° to the north. They are penetrated by dikes apparently coming from adjoining gneiss and generally running parallel to the schistose structure, the gneiss being probably Laurentian though not of a typical kind. Overlying both rocks are thin sheets of Animikie forming small patches, no doubt remnants of a complete covering, consisting of impure oölitic dolomite and of cherty layers, also oölitic in part, both lying nearly horizontal

A short distance below this is the falls, whose canyon displays more than 100 feet of cherty and slaty material with no Laurentian or Huronian in sight beneath them so that the original Archæan surface must have been rugged in character.

It is worthy of mention that the gravel used for the railway contains many cherty and jaspery pebbles, often somewhat banded with iron ore, generally however looking more like the ferruginous bands of the Animikie than the lower Huronian iron range rocks.

A more extensive series of iron range rocks occurs somewhat farther west in Conmee township, best visited by leaving the C.P.R. at Sunshine siding and following a trail through the woods for about four miles south. Locations B J 130, R 704 and R 705, near Pewabic lake afford good examples of it, and my thanks are due to Mr. A. L Russell, the veteran land surveyor of Port Arthur, for giving me the opportunity to examine them.

The iron range rocks are mostly banded jasper and chert but include also much impure siderite, and have an extreme width of at least 25 chains, interrupted however by a considerable exposure of a pecculiar breccia having a gray fine-grained matrix, sometimes arkose (crushed granite), with angular fragments of jasper, etc., enclosed in it.

The strike of the banded material is about 45° and the dip is high, and at one point a breccia of white or gray granular silica resembling that of Sayers lake is to be seen. Owing to the dense woods and the large amount of drift and swamp the work of exploration is hard, though the dip-needle helps out in many cases. The ore, which is chiefly magnetite, was seen only in thin sheets between the layers of jasper, and no large mass of solid ore appears to occur.

Farther south in Conmee township, on the south half of lot 7 in the sixth concession, the iron range is found again with a trend of about northwest and southeast and a nearly vertical dip on a long ridge about 150 feet wide. The silica is mainly jasper, often of beautiful color, banded with magnetite, the bands often folded in complex ways, and here also there is more or less of a peculiar breccia of grained silica or jasper in a fine gray matrix.

In the southeast end of lot 7 in the fifth concession, there is finely banded jasper and some impure carbonate intermixed, but on lot 4 in the third concession, the rock is unusually black from the presence of magnetite, and some specimens are heavy enough to make fairly good ore. Bands having a width of one or two feet appear to be nearly solid magnetite and seem rich enough to work, though a small amount of pyrite present would lower the grade of the ore. The banding varies in direction from southeast to south ; and here again a conglomerate or breccia is commonly found mixed with the ore, the whole having a length of ten chains and a width of 135 feet.

Altogether, this series of iron deposits has been traced for about eight miles ; running parallel, it is said, to a similar range located by Pumpelly and Smyth two miles to the southwest ; and probably both are continuations of the Mattawin ranges, though curving in a somewhat different direction.

There is a considerable amount of good hardwood land in Conmee township, which some day may be of value if mines of importance are developed here.

As the Mattawin range had been to some extent worked over before, and the time available was limited it was decided to examine next the iron ranges farther west following up the line of the Canadian Northern Railway.

Along the Canadian Northern.

In July 1901 the Canadian Northern was not running regular trains, though it was possible to go by construction trains to the 15th siding at the first crossing of the Atikokan river, the route following the Kaministiquia, then its tributary the Mattawin and a tributary of the latter, the Shebandowan, to lake Shebandowan, which is touched at a few points and left to the south. The few rock cuts up to this after the ones which have already been described as containing rocks of the iron range show only green schist; most of the road running through clay or gravel deposits or over muskegs. Near the 10th siding however the contact of Laurentian and Huronian is well shown, granitoid gneiss being interbanded with gray-green schist, and the railway follows the contact to the 11th siding; but at the 12th siding, on lake Windigoostigwan, granite and gneiss only are seen. Between the 13th and 14th sidings dark gray Huronian schist once more appears, but with Laurentian forming a range of hills a little to the north; and at the 14th siding, south of Magnetic lake, the line is once more on the contact, Laurentian and Huronian being interbanded.

In a general way the railroad follows the strike of the Huronian schists, and this no doubt is the line of least resistance, since the water courses generally follow the same direction.

The interesting drift deposits and the wide spread areas of peat will be described in another part of the report.

On the Atikokan River.

At the first crossing of the Atikokan by the Canadian Northern green Keewatin schist is seen with a strike of 60° and dip of 70° to the south, and a short distance up the river is the expansion called Sabawe lake, still in the Keewatin band though near its northern border. Some gold locations which have been taken up here will be referred to in another part of the report. A little above Sabawe lake and just to the north of the creek are several iron locations including the one formerly belonging to McKellar, Graham and Horne, but now, it is said, transferred to J. and R. N. Hunter of Duluth. This has been opened up by a tunnel, giving a better opportunity for study than the others. The range is here disclosed as a steep narrow hill of green schist interbedded with lenses of magnetite, and is to be seen from the canoe route, so that it has long attracted attention.[5] The tunnel is 288 feet long and runs through the ridge from side to side a little above its base; but the rock is now much stained with drippings and powder smoke so that the section could not be very accurately determined, though enough was seen to prove that large bodies of magnetite were cut by it. Through the kindness of Mr. Horne the following details of the section as worked out at the time the tunnel was driven are given, beginning at the south.

Rock, pyrrhotite and ore	70 feet
Ore	44 "
Rock	62 "
Ore	10 "
Rock	21 "
Ore	16 "
Rock	65 "
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The materials on the dump include good-looking magnetite, partly coarse and partly fine-grained; magnetite with some rock and pyrite or pyrrhotite, and the country rock, partly hornblende chlorite schist, and partly a massive pyroxenite. The large lenses of magnetite run somewhat north of east and south of west and stand nearly vertical, like the schist enclosing them.

[5] See Peter McKellar's testimony in the "Mineral Resources of Ontario", p.144; and Bur. Mines, 1894, p. 75.

In addition to the tunnel several diamond drill holes have been made at various angles.

Drill hole No. 1 is 500 feet west of the tunnel, driven horizontally in a northerly direction. The section, beginning at the south, is as follows:

Rock	72 feet
Pyrite	26 "
Rock	4 "
Ore	2 "
Rock	3 "
Ore	4 "
Rock	18 "
Ore	16 "

Another drill hole, No. 2, 500 feet east of the tunnel, shows the following section, beginning at the south :

Drift	32 feet.
Rock	38 "
Rock and narrow ore bands	18 "
Ore	11 "
Rock	64 "
Ore	35 "
Rock	110 "

The third drill hole, 500 feet west of the tunnel, directed north at an angle of 37½°, shows :

Rock	97 feet.
Ore, rock and pyrite	10 "
Rock	46 "
Ore, rock and pyrite	14 "
Rock	28 "
Ore, rock and pyrite	13 "
Rock	27 "
Ore and pyrite	4 "
Rock	33½ "
Mixed ore	8 "
Rock	4 "
Ore	3 "

The fourth drill hole, 40 feet west of the tunnel, direction north, angle 45° shows :

Drift	28 feet.
Rock	32 "
Mixed ore	10½ "
Rock	9½ "
Mixed ore	6 "
Rock	13 "
Ore and rock	17 "
Rock	42 "
Ore	4 "
Rock	1 "
Ore and some rock	36 "
Rock	20 "

Ore	11 feet
Rock	6 "
Ore and rock	12 "
Rock	25 "
Good ore	10 "
Rock	12 "
Narrow bands of ore and rock	60 "

On an adjoining property, R 400 and R 401, belonging to Pumpelly and Smyth, where the associations are similar, it is said that diamond drilling demonstrated the presence of large bodies of ore.

Some small test pits at the foot of the ridge show a little impure limonite, soft ore, but it is unlikely that any large amount of it exists, and what was seen is probably due to post-glacial weathering and decay of the iron-bearing rocks above.

Very similar magnetite deposits, though not rising as prominent ridges, have been developed by diamond drilling farther down the Atikokan, below Sabawe lake, by the Messrs. Wiley, but owing to lack of time these were not visited.[6]

The magnetite deposits just mentioned are of an entirely distinct type from the banded jasper and magnetite, or chert or granular silica and magnetite, hitherto referred to, and there is every reason to think that their origin is different. Instead of having been formed as sediments of siderite and silica in the beginning, they may have been deposited directly as lenses of magnetite between the layers of green schist or pyroxenite, both probably originally charged with iron in large quantities, but low in silica.

As to the age of these rocks there is no great certainty beyond the fact that they belong to the Keewatin, and are probably lower in the geological scale than the silicious iron range rocks, which come near the upper part of the Keewatin or Lower Huronian.

Beyond siding 15 to Steep Rock lake the railway runs largely through stratified clay and muskeg, but a few cuttings show chlorite schist striking roughly east and west, and so parallel to the direction of the road. The Atikokan is crossed six times in the distance, its valley providing the best grade for the track.

ON STEEP ROCK LAKE.

Steep Rock lake has attracted much attention both from its geological interest and also because small blocks of very pure hematite have been found on its shores since it was described in some detail by Mr. Henry Lloyd Smyth ten years ago.[7] Parts of the shore are formed of limestone, the only rock of the kind in the region ; and some cliffs toward the north end of two bays of the M-shaped lake are very rusty owing to the amount of iron oxide set free on weathering, but the source of the boulders of hematite was not yet known at the time of our visit, though a later newspaper report states that valuable ore deposits have been found there. As Steep Rock lake has already been described in our reports nothing need be added here.[8]

We found development going on vigorously at the Elizabeth gold mine on Rice lake a few miles west of Steep Rock lake, under the management of Mr. Alan Sullivan, and this work will be described later under another head. It is worthy of mention here however that the quartz of one of the wide veins now being opened up for gold ores is very white and granular, not glassy, and proves in thin section under the microscope to have the same structure as the granular silica found in the iron range. In this respect this vein of gold ore is like several

[6] See Mr. McInnes' report, Geol. Sur. Can., 1897, pp. 55 and 56 H.

[7] *Am. Jour. Sc.*, Vol. xiii, Third Series. 1891, pp. 317-331.

[8] Bur. Mines 1895, pp. 70-71 ; and 1896, p. 78.

which have been worked more or less in the Wawa region near the Helen mine. Whether these gold ores are related in origin to the iron range rocks is not known at present, but their similar structure suggests such a relationship.

The railway cuttings west of Steep Rock lake show mainly green chlorite schist, sometimes having almost a slaty cleavage, but in other places more massive in character; a large part of the road however is built on stratified clay or sand as happens farther east. As one approaches Sturgeon Falls some yellow sericite schist is found with the greener schists. From Sturgeon Falls to Mine Centre we travelled by steamer and had little opportunity to observe the rocks, but some details of them have been given in previous reports.

The only point requiring mention here in the geology of the Mine Centre gold region is the thick series of conglomerates occurring between Shoal lake and the Golden Star mine, evidently the basal conglomerate of the Upper Huronian, and charged to a considerable extent with pebbles of granular silica or of black cherty silica belonging to iron range rocks. This conglomerate has been described before in our reports,[9] but the source of the iron range pebbles was not then very certain, though a specimen of the original rock had been obtained by the writer near the Olive gold mining property on the south shore of Little Turtle lake years ago, suggesting that iron-bearing rocks might be found in the region. Since then the iron range has been traced more or less extensively from the Little Turtle westward to Nickel lake near Grassy Portage bay in Watten township of the Rainy lake region. Mr. W. A. Preston of Mine Centre was good enough to serve as guide to the part of the range near Nickel lake, which is apparently one of the best developed parts. The Canadian Northern crosses Rainy lake via the peninsula between the two arms of Rainy lake and along the north shore of Grassy Portage bay, and there are some good exposures of the rock in its cuttings.

IN HALKIRK AND WATTEN TOWNSHIPS.

Where the railway crosses Bear pass by a trestle into Halkirk township on the peninsula a few small outcrops of granular silica with magnetite occur embedded in rusty gneiss charged with great numbers of garnets, a variety of Lawson's Couchiching. These do not appear to be of any importance, nor are the locations taken up for iron ore somewhat to the west of much promise, since the rock cuts show only diorite porphyrite or unporphyritic rock somewhat impregnated with magnetite.

On the south side of Nickel lake in Watten township however, a few miles farther west, the railway cuts through a considerable stretch of the iron range, here of a somewhat unusual character, consisting largely of granular silica occasionally banded with magnetite, but more often heavily charged with sulphides, especially pyrrhotite. In places the sulphides become massive, hardly anything else being present, and one band of pyrites 15 feet thick just at the shore of Nickel lake may in the future be of importance as a source of sulphur. A little copper pyrites may be seen from point to point along the cutting but perhaps in too small amounts to be of value. Along with the granular silica of this narrow bulb of the iron range which strikes east and west on the south shore of Nickel lake, there are strips of black carbonaceous slate just like the black shale or slate of the Helen mine and many other parts of the iron ranges to the east. These are graphitic and soil the fingers, are often porous, perhaps because crystals of pyrites have been weathered out, and may contain thin sheets of the white granular silica interbedded. To the south of the iron range rock in the railway cuts there is hornblendic or chloritic schist, sometimes containing garnets, perhaps the underlying rock of the series, though this can only be surmised, as both rocks are about vertical and no careful section has been made across the region.

[9] Bur. Mines, 1895, pp. 97-98.

On the northeast shore of Nickel lake opposite to the railway cuttings just mentioned, a banded silicious rock with much pyrrhotite is exposed on a small island, and a little inland there is a wide belt of granular silica interbanded with magnetite, both with a steep dip as a rule and a strike of about east and west. The banded silica and magnetite are at least 300 feet wide near the shore of the lake, and are present in large amounts a quarter of a mile to the east, where the bands are somewhat contorted, but strike on the whole about 110°.

To the south of the magnetic part of the range there are in places about 200 feet of very pyritous rock, in which the silica is often shattered and brecciated with pyrites enclosing and cementing the fragments.

Mr. Preston states that in addition to the narrow strip of iron range along the south shore of Nickel lake and the one on the northeast there is a third parallel range half a mile farther north like the one just described but 600 feet wide. Apparently the iron range is cut off toward the west, for the rock on that side of Nickel lake is a hard, fine-grained greenstone.

None of the iron range examined can be called marketable ore, though some parts of it strongly charged with magnetite are quite heavy; but the finding of so much of the iron range here suggests that secondary ore deposits may be looked for somewhere in the region.

Owing to lack of time no work was done on other parts of this range, which runs with some interruptions not far from the railway to Little Turtle lake. Mr. Preston states that it is everywhere very much like the deposit just described, but less extensive Exposures of a similar sort are reported near Sturgeon Falls and Calm lake evidently extensions of the range.

Iron ore deposits have been located in several other parts of Watten township, though of a different character from those near Nickel lake On lot 11 in the third concession. there is a lens of magnetite somewhat mixed with green schist fading off into a mass of slightly schistose greenstone near the contact with a ridge of granite or gneiss a little to the south, perhaps belonging to the Laurentian. The lens is about 24 feet wide and 270 feet long with a strike of about east and west. Except for the presence of a little pyrite the ore seems to have no injurious ingredients, but the green silicate mixed with the magnitite lowers its grade considerably. This lens evidently does not belong to the typical iron range, but may be compared with the magnetite lenses of the Atikokan. It lies about a half mile to the southwest of the Nickel lake deposit but cannot be considered a continuation of it, since the banded silica is absent.

Somewhat southeast of Nickel lake and south of Grassy Portage bay, along the line between the townships of Watten and Halkirk, magnetite has also been found, but only in small seams accompanied by pyrite.

Going inland from the bay one crosses first green schist, then coarse diorite, then green schist again with a few seams of magnetite.

Magnetite has been found too on lots 3 and 4 in the fifth concession of Watten township, about two miles north of the Nickel lake iron range, but only in small veins or segregations in a very silicious rock looking like sandstone. Some of the ore is soft and yellow or red in color; other parts are of a very pure blue-black material, mostly magnetite. No work had been done on the deposit, and it is doubtful whether there is any large body of ore. The rock between the magnetite and the shore of the bay to the west is a fine-grained grayish gneiss, Dr. Lawson's Couchiching.

Rocks very like those of the regular iron range occur on Mr. Fair's farm a mile or two southwest of Fort Frances along the shore of Rainy river, in an area mapped by Dr. Lawson as Couchiching, and possibly to be looked on as a continuation of the range in Watten township. We find the same rather coarsely granular silica banded with darker stripes, but containing very little magnetite, most of the dark mineral being hornblende. It seems as if the amount of iron in the range diminished to the west, becoming insignificant beyond Fort Frances.

It is probable that the sandstone-like rock at the Scramble mine near Rat Portage is of the same kind, and that the black graphitic slates of Lake of the Woods also indicate an outcrop of the iron range, though no ore deposits have ever been reported from that region.

Many years ago a large number of iron locations were taken up along the north shore of Seine bay, Rainy lake, the ore being magnetite associated with greenstones. Apparently the ore bodies are not very large, and as they have been proved to contain considerable amounts of titanium, greatly lowering their value, no special attention has been paid to them of late.

The Iron Range Near Dryden.

It is reported that banded iron ore has been found in large amounts to the north of Mine Centre on an expansion of Turtle river, but we were unable to visit the locations taken up here for want of a guide. It is probable also that iron range rocks will be found in the future east of Upper Manitou lake, since a basal conglomerate of the Upper Huronian with many pebbles of banded silica occurs on Mosher bay. A band of the iron range 50 feet wide is reported to cross Beaver Head island in the Lower Manitou.

A number of locations have been taken up along the Canadian Pacific railway near Dryden on an undoubted iron range of the typical variety; and the general character of the rocks may now be described. It should be mentioned that lean iron ores were referred to by Dr. Bell twelve years ago as occurring east of lake Wabigoon,[10] perhaps on the same range; but no further attention seems to have been paid to them until recently. Rocks of this nature have been found on both sides of the Wabigoon river near the village of Dryden, and they are fairly well displayed on the railway just east of mile 216, on lot 23 in the fourth concession of the township of Zealand. Here the granular silica banded with magnetite is interbedded with gray garnetiferous gneiss or mica schist, like the Couchiching of Rainy lake, the widest belt of silica and magnetite being about 10 feet across. The strike is about 50° and the dip 80° to the northwest, but the bands are a good deal contorted, and the schists are penetrated by some dikes of granite.

A stretch of drift hides the range for some distance to the east, but it is found again north of Barclay siding. Following the line between lots 16 and 17, fine grained gray mica schist or gneiss, striking 140° and dipping 70° to the northeast, is the first rock seen; but about three-quarters of a mile north of the railway at the corner between lots 16 and 17 in the fifth concession and the corresponding lots in the sixth, silicious rock banded with magnetite is found, sometimes interbedded with garnetiferous schist or gneiss, having a strike of 100° to 110° and a dip of 70° or 80° to the north. The banded magnetite seems to be more crumpled and contorted than the bands of schist, sometimes into sharp folds of a few inches or feet in length, the white silica layers bringing out the shape in a striking way.

Toward the north side of lot 16 a low range of hills consists of coarse or fine-grained tourmaline granite containing large strips and masses of the schist and cutting across its strike, so that it is evidently in eruptive contact with the Huronian.

A third of a mile to the west the contact is more clearly seen, and dikes of pegmatite run off from the granite into the schist.

At Barker's farm on the west side of Thunder lake the iron range rocks crop out interestingly as knotted, crumpled masses sometimes very rich in magnetite, but often containing a considerable amount of silica and of hornblende. A very little pyrite was seen, but in general the ore seems free from injurious impurities, though too low in grade from the large amount of granular or quartzitic silica to be of value. It is stated that a picked specimen assayed 68 per cent iron, but the average iron contents would probably be less than half that proportion. While no ore of workable quality has been disclosed, the very large amount of iron in this

[10] Min. Resources of Ont., p. 20.

range, eight or nine miles long and in places a quarter of a mile wide, suggests that at some point there may have been secondary concentration yielding ore bodies of importance. To determine this however may require much outlay in test pits or other exploration.

The Slate Islands.

Banded iron ores having long been known to exist on the Slate islands[11] a visit was made to them in order to gain an idea of their extent and importance, as the locality could not be surpassed for shipping facilities if ore bodies should be found.

The Slate islands are not easy to reach, since they lie about eight miles off shore in lake Superior, the passage being almost without shelter from easterly or westerly storms, and at present there is no steamer available for the trip. The only method of reaching them is by fishing boat with sails or oars, and the two or three fishermen of the little village of Jackfish are loath to take the time for such an excursion. My thanks are due to Mr. J. A. Bow, formerly Inspector of Mines, for his assistance in rowing out a heavy boat and aiding in the geological work.

The group consists of a large island to the south and a smaller one to the north with a narrow well sheltered channel between. A number of quite small islands and islets complete this compact little world out in lake Superior, the whole having a north and south and also an east and west diameter of about seven or eight miles.

As the iron ore had been reported from the large island only, we put all our time upon that, rowing due south from Jackfish bay to the eastern end of the channel between the islands, and then by sheltered waters to an unused mining camp at the west end of the large island. The islands to the north seem to consist of green eruptives and schists, one on which we landed showing splintery fine-grained green Huronian schist. The main island displays much more variety though almost entirely formed of Huronian rocks penetrated by various eruptives. Our examination was chiefly confined to the western end, where a small amount of work had been done in the previous year to develop a supposed deposit of gold bearing quartz.[12]

On the north side of the main island near the west end schist conglomerate is seen along the shore, with a green matrix and rather small pebbles of felsite, the strike being 60° or 65° and the dip 80° to the south. At the west end of the island, where two tunnels have been run and two houses erected, the shore consists of a curious conglomerate or breccia, the ground mass being of green schist banded with various colors, apparently due to sedimentation, while the pebbles are largely jasper, though yellowish felsite and various greenstones occur also. The jasper pebbles, which are often bright red and vivid against the green background when wet by the spray, are frequently angular and of considerable size, one measuring 15 inches in length by 6 in breadth. The strike of the sedimentation as shown by the banding is from north and south to 160° with a dip of 70° to the east, while the schistose structure runs nearly east and west. Just to the east of the breccia is a band of white coarsely granular silica with a little jasper, apparently in position but considerably shattered and brecciated. It is in this material the two tunnels have been run, evidently with the idea that it was gold-bearing quartz. The band of silica is not wide but seems to run right across the west end of the island, and the conglomerate with jasper pebbles along the shore to the west of it is at least 200 yards wide and possibly much more.

To the east of the white silica are green-spotted schists and brownish schists with many blebs of felspar, no doubt sheared porphyries, the whole somewhat cut up with rugged dikes of diabase forming ranges of hills, which makes progress difficult. To the south of the camp, but separated by diabase hills, are conglomerates or possibly agglomerates, of a different

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11 Mineral Resources of Ontario, p. 23.

12 Bur. Mines, 10th Rep., pp. 87 and 88.

character from the conglomerate at the landing, since jasper pebbles seem absent in most outcrops, though a few were found at one point.

A small patch of amygdaloid and of purple conglomerate, evidently of Keweenawan age, covers the Huronian rocks at the extreme west point of the island, the first outcrop of rocks of this age northwest of Michipicoten island, though the Keweenawan is widely found along the shore of lake Superior still farther to the west.

Going inland toward the east, the prevalent rocks are green and brownish rusty schists with a strike of about 70° and vertical dip, though here and there similar schistose rocks contain tiny rounded pebbles of quartz. It is likely that some of the schists are sheared acid and basic eruptives, and others metamorphosed sediments At a few points small exposures of banded jasper are found, one a quarter of a mile southeast of the camp standing out as a ridge traceable for about 90 feet in a direction ten degrees west of north and with a vertical dip. One or two other similar outcrops occur still farther to the southeast, and black chert with a little jasper, which probably belongs to the iron range also, is to be seen near a small bay on the south shore.

It is said that low grade iron ore has been found in large masses on the south shore, but we did not come upon it. Jasper conglomerate is reported as widespread on the east shore of the island, which we did not visit.

The most prominent geological features of the island are the great dikes and bosses of eruptives, largely diabase, which stand up as rugged ridges and hills, forming the highest points, the softer schists having crumbled and fallen into debris between them. The island is not lofty, however, the highest summit reaching only about 230 feet above lake Superior. In spite of the small size of the island, there are several lakes or ponds among the hills, with a respectable stream connecting some of them; and in former days numerous beaver occupied the ponds, but these have been exterminated.

The geological history of the main island as shown in our brief examination is a complex one, including the Lower Huronian with its iron range rocks and probably also sheared porphyries and diabases, the Upper Huronian conglomerates, and the Keweenawan consisting of surface eruptions, lavas now turned to amygdaloids, and coarse conglomerates. A quite unusual series of later eruptives, especially diabase, have penetrated the older rocks and have probably furnished the solid nucleus of this island group rising out of the deep water of lake Superior, when the weaker rocks between it and the rugged shore have been hollowed to a channel having a depth, according to the Admiralty charts, of 450 or 500 feet.

Another unusual feature is the excessive amount of surface erosion to be seen, the schists being in general quite rotten and in ruins, as if the last Ice Age had done little or no work upon them.

Ores of Other Localities.

Mention may be made of some other localities not referred to in last year's report. Mr. Titus Ulke has been good enough to provide some notes regarding the iron range rocks of the Woman river Huronian area, 120 miles west of Sudbury, but best reached by a canoe route from Biscotasing station on the Canadian Pacific railway.

The ore is of the usual character, jasper and chert interbanded with iron oxides, the country rock being much altered grayish green diorite. The range is 600 feet wide and measures 3,000 feet along the strike, which is northeast and southwest. An analysis of the ore shows that it is low in iron having only 37.20 per cent., while there are 44.34 per cent. of insoluble matter and 0.163 of sulphur.

Iron ore has recently been found on the Indian reserve near Goulais bay, on lake Superior, but little is known of its surroundings since the specimens were taken in winter. The locality is probably Upper Huronian, as mapped by Logan and Murray, unlike the deposits a few miles from Batchawana bay to the north, where typical banded silica of the Lower Huronian is found. The specimens consist of very impure slaty red hematite and of rusty magnetite.

Assays made at the Provincial Assay Office, Belleville, show the following results :

	I.	II.
Total Metallic Iron	33.75	64.42
Silica	37.07	4.48
Sulphur	0.03	0.02
Phosphorus	0.015	0.007
Titanium	none	none
Manganese	0.24	traces
Alumina	1.61	1.51
Lime	3.11	1.05
Magnesia	0.22	1.10
Moisture	1.89	0.38

Analysis No. I is of the hematite, which is evidently too low in iron to be considered an ore, though it is free from injurious elements. The analysis of the magnetite, No II, shows it to be of excellent quality, well within the bessemer limits, so that if found in large enough quantities it should be of value.

Mr. C. C. Jones, consulting engineer for the Breitung Iron Co., Marquette, states that specular hematite in banded quartz or quartzite occurs in the township of Deroche one and a half miles southeast of the Algoma Central railway near Wilde station. It rises as a steep hill 400 feet above Breitung lake, is 300 feet wide on the average, and has been traced about a mile, with slate on one side and granite on the other, while it is cut off toward the northwest by diorite. A tunnel is being run into the hill to open up the deposit.

It is reported also that jasper with magnetite, having a strong attraction for the compass, occurs eight miles southwest of the Hudson Bay post. Sturgeon lake ; and that a small outcrop of conglomerate occurs near it.

Types of Iron Bearing Rocks in Ontario.

Although the iron ranges of the upper part of the Lower Huronian are far more extensively developed in Ontario than other varieties of iron bearing rocks. yet examples of several other kinds of iron ore deposits are found in the province, and it will be of interest to characterize each type briefly.

The oldest of the iron bearing rocks, as well as in all probability the most important, belong to the Lower Huronian, or Keewatin, as Lawson has named the rocks in the western end of the province ; and among them we may distinguish three well marked types , that of the iron range proper, which is apparently the uppermost group ; lenses of magnetite interbedded with green schist, as at the Atikokan , and titaniferous magnetites associated with basic eruptives.

Parallel with these ancient western iron ore deposits we should perhaps place the magnetites of Eastern Ontario. which are associated with what are usually called Upper Laurentian rocks, really the equivalents of the western and northern Huronian so far as can be ascertained in comparing crystalline rocks of different characters and at wide distances from one another. It is possible however that the Grenville series is really Upper Huronian and that the conglomerates found in it are the basal Upper Huronian conglomerate, like those of the Hastings series which is intermediate in position and character between the Grenville series and the rocks generally classed as Huronian. If so, the iron ores of the area between the Ottawa and the St. Lawrence should be classed as Upper Huronian.

The Upper Huronian of northern and western Ontario has not yet proved to be iron bearing in any important degree, though the states to the south of lake Superior appear to have valuable iron mines of this age.

Ascending to the Animikie, which is perhaps lower Cambrian, we find the largest and most easily worked iron mines in the world in the Mesabi range in Minnesota, but no workable deposits of this age have yet been discovered in Ontario, though thin sheets of ore are found near Thunder bay at the base of the Animikie.

No important iron ores, such as the "fossil ore" of the Clinton rocks in New York state, have been discovered in the palæozoic rocks of Ontario, though some beds of the Medina, just below the Clinton, are red from the amount of hematite they contain, and small quantities of hematite have been found in the Clinton of Cabot Head.[13] All the later rocks are absent from our province until the Pleistocene is reached.

Deposits of iron ore of two kinds occur in post-glacial beds, bog ore in various places, though mined only in Charlotteville township north of lake Erie; and magnetic sand, widely found and taken up as locations near Peninsula, north of lake Superior, but not yet mined.

Putting the matter in tabular form, we have in Ontario the following types of iron ore deposits:

Archaean.	Upper part of the Lower Huronian or Keewatin;
	Silicious and sideritic iron ranges.
	Probably lower part of the Lower Huronian;
	Magnetite lenses in green schists.
	Titanferous magnetite in basic eruptives.
	Grenville series, probably Huronian.
	Magnetite.
	Hematite.
Animikie.	Probably Cambrian;
	Impure siderite and limonite.
Pleistocene.	Bog and lake ores
	Post-glacial magnetic sand.

Each type of deposit may now be briefly described, mentioning localities where it is found in Ontario.

Archæan Iron Ores.

The most widely spread of the iron bearing rocks of Ontario, as well as of the adjoining states, are the silicious ones, commonly of jasper or chert or white or gray granular silica, finely interbanded with magnetite or hematite, the whole usually more or less crumpled or brecciated and standing nearly vertical. The unchanged iron range rock seldom carries iron enough to be an ore, running usually below 35 per cent., though some magnetitic banded ores in Conmee township west of Thunder bay seem almost rich enough to be mined. Nor are the siderites often associated with them considered pure enough to be used as ores, since they are generally quite silicious and contain considerable quantities of pyrites. Possibly some of them, as at Hematite mountain, if roasted would make serviceable ores. On the other hand the secondary ore bodies, chiefly hematite or hematite mixed with limonite, formed in special pitching troughs of the underlying schists or eruptives are often of excellent quality. At present the only mine working in Ontario on a deposit of the sort is the Helen mine at Michipicoton, of which so much has been said that further description is not required. The silicious iron range rocks occur in practically every Lower Huronian area in Ontario, and have now been traced, with breaks of importance only where Laurentian rocks intervene, all across the northern half of the province.

[13] Geol. Can., 1863, p. 320.

The lenticular bodies of magnetite interbedded with green schist and eruptives are best known at Atikokan, where they extend for miles parallel with the strike of the schists and in a nearly vertical attitude. They contain no jaspery or granular silica, are not associated with siderite or graphitic slate, and seem to be of a totally different origin from the iron range rocks proper ; perhaps representing original deposits in the schists or segregations from schists rich in iron.

The only indication that they occupy what were once open fissures is the finding of small amounts of carbonates with them ; but the amounts are too small to signify much. The only impurities in this type of ore are admixtures of the adjoining silicates, which are of an easily fluxable kind, or pyrites which often occurs in considerable quantities, but might be removed by roasting. The ore is generally hard and massive. Assays of samples from the Atikokan range, made in the laboratory of the Geological Survey, Ottawa, show from 64 55 to 68.03 per cent of iron,[14] with no titanium. There is every likelihood that millions of tons of high grade magnetite will be mined on the range in the future, though only exploratory work has yet been done.

The other Lower Huronian or Keewatin ores are also magnetites, but of a very different type, being strongly titaniferous and occurring as ultra-basic segregations in such rocks as gabbro or diabase, with associated chlorite and other schists.

In the early days of the exploration of Rainy lake a number of iron locations were taken up along the north side of Seine bay, some of them containing considerable bodies of ore but with more or less pyrites. The presence of titanium robs these ores of their value at present, so that for a number of years no interest has been taken in them, and there are no workings in which their relationships can be studied ; but from the examination of one of them, 213 X, where magnetite with some pyrite forms a mass in diabase, it appears that the ore was probably separated while the diabase was still fluid, in the manner suggested by Vogt for certain Scandinavian ore bodies, and by Dr. Adams for the Sudbury nickel ores.

The iron ore deposits belonging to the Grenville series in Eastern Ontario probably equivalent in age to either the Lower or Upper Huronian, have been worked to a greater or less extent for many years, and are described in several reports of the Geological Survey [15] They occur associated with bands of crystalline limestone, certain varieties of gneiss, and green eruptives ; and the ores are chiefly magnetite, often containing pyrite and sometimes mixed with apatite. Most of them contain little or no titanium, though occasionally there is a small percentage of this element, and in one instance, from an island in Mud lake, South Crosby township, as much as 9.80 per cent. of oxide of titanium. Hematite has also been mined to the extent of some thousands of tons in eastern Ontario, as at the Arnprior mine.[16] The Blairton mine north of Rice lake appears to have been the largest producer in eastern Ontario, though the magnetite from that locality is rather silicious and contains some pyrites. None of the deposits are large as compared with western iron mines, commonly not going beyond a few tens of thousands of tons, and only rarely reaching into the hundreds of thousands.

Granular or jaspery silica banded with the iron ore is unusual in the eastern iron district, though Prof. Wilmott has found banded chert and hornblende alongside the ore at the Dominion Iron mine, lot two, in the second concession, Madoc.

Ores of the Lower Cambraix.

The Animikie (probably lower Cambrian) iron ores are known chiefly from the neighborhood of Thunder bay, where impure siderites and limonites occur ; and also, near Algoma mine,

[14] Geol. Sur. Can., 1897, pp. 55 and 56 H.

[15] Geol. Sur. Can.; Vennor's reports from Vol. 1863 to 1876-77, and analyses of iron ores by Sterry Hunt in same volumes.

[16] Min. Resources of Ont., p. 129.

magnetic ore mixed with a dark gray sandstone, said to contain 37.73 per cent. of iron. According to Mr. Hille of Port Arthur, somewhat silicious siderite west of Port Arthur at 6-mile creek on the Dawson road, occurs for 400 or 500 feet with a width of 100 feet. and a thickness of at least 12 feet ; but as it contains only 32.93 per cent. of iron, the deposit will hardly prove of value. Somewhat richer ores form thin sheets at the base of some of the Animikie outliers north of Thunder bay ; but no ore bodies suggesting the great Mesabi mines of the same age in Minnesota have yet been found.

Pleistocene Ores.

The Pleistocene ores of Ontario are of two kinds, bog ore and magnetic sand, both of which are widely found, but at present not put to use. The beds of bog ore in Charlotteville township, Norfolk county, on the north shore of lake Erie, were mined in 1813 for use in a charcoal furnace at Normandale on the lake shore, producing, it is said, an excellent quality of iron.[17] Bog ore occurs in Welland county and various other parts of Ontario, but at present is not in demand, though the charcoal furnaces near Three Rivers in Quebec make a valuable brand of iron from bog and lake ore of a similar kind.

The only known attempt to use magnetic sand as an iron ore in Ontario was made at the same furnace in Normandale, where this material from the shore of lake Erie was mixed with the bog ore mentioned above ; but no details are given as to the results.[18] Similar sands are widely spread on the shores of the Great Lakes, and some thousands of acres of old beach sand, now above the level of the lake, have been taken up as iron ore deposits east of Peninsula on the north shore of lake Superior. Some layers consist chiefly of magnetite mixed with a little garnet, and the ore could easily be separated magnetically. A small quantity of iron has been prepared from this sand by an electrolytic process, and has proved to be of good quality. Probably however the sand would have to be briquetted for use in ordinary furnaces.

It will be seen from the sketch above that a considerable variety of iron ores exists in Ontario, counting only those which have some promise of being useful in the future ; but at the present time the only mine worked on a large scale in the Province is the Helen in the Michipicoton district. In the east several of the old mines more or less actively worked years ago are again providing some ore under the stimulus of bounties granted by the Provincial and Dominion governments. In the meantime great activity is displayed by prospectors in the west and north in the search for ore bodies along the bands of silicious iron range so widely distributed. Much of the exploration is being done for American capitalists interested in iron mines or steel works of the United States. who foresee the importance Canadian mines may have when the rich and easily worked mines of the states south and west of lake Superior begin to be worked out under the steadily increasing demand for ore. It must be admitted however that the two years' activity has not brought to light any new deposits of great promise, perhaps because of the superficial character of the work done. The dip needle, which has been largely used west and north of lake Superior, enables one to follow out the iron range itself, but gives no certain information regarding secondary ore bodies consisting of hematite or limonite, which are by far the commonest ores. For instance, the great ore mass of the Helen mine causes surprisingly little disturbance of the needle, while the lean banded silica and magnetite of many other portions of the range have a great effect upon it. Prospectors should recall the fact that only magnetite and to a less degree some varieties of hematite are magnetic ; while the really important ores, except such magnetite lenses as those of the Atikokan cannot be discovered by the dip needle.

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17 Min. Resources of Ont., pp. 319-320. 18 Geol. Sur. Can., 1866-69, p. 262.

It is to be hoped and expected that the much greater length of iron ranges on the Ontario side of the Great Lakes will ultimately prove not less productive than the ranges of Michigan, Wisconsin and Minnesota. The only apparent reason why the Ontario ranges should be less rich in ore is one suggested by Professor Van Hise, viz., that the glaciers of the Ice Age scoured our region more thoroughly than that south of the lakes, so that less of the relatively soft secondary ore bodies may have been preserved toward the north than toward the south.[19] However, this should hardly be of weight along the southern side of the province where the large ore deposits of the Chandler and other mines are only a few miles south of the boundary and in a region precisely similar as regards the scouring action of the ice.

PETROGRAPHICAL NOTES.

The petrography of the iron range rocks of the Michipicoton district has been taken up in connection with the detailed mapping and description of that district ; and so far as the rocks of the Lower Huronian iron range in other parts of the province are concerned, to describe them individually would be to repeat what has been done elsewhere. The fine to coarse-grained granular silica of the Helen mine is repeated in many places, though sometimes replaced by dull or bright-red jasper, which however does not differ essentially from the granular silica, being simply finer in grain, though never cryptocrystalline, and mixed with red hematite scales. Occasionally, as at Thunder Lake, east of Dryden, the magnetite bands are associated with coarse-grained hornblende as well as silica, the blades of hornblende being sometimes an inch long. The hornblende is the ordinary variety with an extinction angle of about 15° and blue green, green and greenish brown dichroism ; so that grüenerite is not present. Epidote in large grains is mixed with the hornblende and coarsely granular silica.

In the Seine River-Rainy lake iron range, the granular silica toward the eastern end and in the middle of the range is banded in the way usual with magnetite ; but contains also more or less sillimanite in unusually large prisms, suggesting the presence of clayey sediments along with the iron and silica.

Toward the western end of the range, a mile or two west of Fort Frances along the shore of Rainy river, the magnetite seems to have nearly vanished, only scattered crystals being seen in the granular silica ; and the dark bands consist of silicates, chiefly hornblende. In thin sections the quartz grains are large and very sharply polyhedral, sometimes by accident six-sided, not as crystals however, since the six-sided grains generally have bright colors between crossed nicols and are clearly not cut at right angles to the chief axis of the crystal. The hornblende is usually pale brown in thin sections with only a slight change of color when rotated over the lower nicol ; but some parts are green and more dichroic and the extinction angle of both is 15°. Tiny grains and crystals of the hornblende occur in the quartz grains, which however are unusually free from cavities or inclusions. The only other mineral present except magnetite is probably sillimanite, as minute colorless rods included in the quartz.

The black slates forming thin sheets along with the granular silica at Nickel lake, have the same characters as at the Helen mine, consisting of granular silica, graphite and pyrite ; the latter often weathering out, leaving holes, or where present in large amounts bleaching the rock during their decay, leaving it a porous white or brownish mass of grains of silica with a few scales of white mica.

The siderite so important in the Helen region is not so extensively found in the ranges west of lake Superior and has not been studied in detail.

[19] Iron-Ore Deposits of the L. Sup. Region, 1901, 21st Am. Rep. U.S. Geol. Sur., p. 411.

The Couchiching Rocks.

While the customary rocks accompanying and underlying the iron range at Michipicoton are quartz-porphyry schists, in the western region they are replaced in many cases by gray mica schist or fine-grained gneiss, Lawson's Couchiching, sometimes enclosing the iron range, sometimes interbedded with it as east of Dryden, but sometimes separated from it by green schists.

It might be supposed that these Couchiching rocks are the equivalents of the quartz-porphyry schists, and more completely rearranged acid eruptives ; but there are reasons for thinking otherwise. Dr. Lawson held them to be metamorphosed clastic sediments, sands and clayey sands, and there is much to be said for this view.[20] His account of these schists places them beneath the Keewatin, which he showed to be largely of eruptive origin, as a series of ordinary sediments of great thickness, covering a large area in the Rainy lake region It is perhaps doubtful whether they are so sharply separated from the Keewatin as he supposed, since there are transitions between them on some of the islands in Rainy lake and elsewhere; [21] and since he distinguished them from the Keewatin, very similar if not identical schists have been found in many other parts of the western Huronian.

Megascopically these rocks are fine-grained, of various shades of gray, quite cleavable, with the shimmer of mica on the cleft surfaces, and frequently more or less filled with accessory minerals, such as garnet or staurolite. Under the microscope the usual minerals observed are quartz and biotite, neither of which is absent from the 25 thin sections examined, and often also felspars and muscovite, but less often chlorite. Among accessory minerals, in addition to the garnets and staurolites mentioned above, there are tourmaline and sillimanite, though not very frequently.

The quartz often has dusty margins and sometimes rounded forms as if clastic, and the felspars occasionally show the same character ; but no later growth of the grains by additions from without has been seen, a point of difference from the quartzites and arkoses of the typical Huronian region. The felspars include both orthoclase and plagioclase, often strikingly fresh, perhaps because of regeneration, but sometimes very turbid. The biotite is usually brown and only seldom green, and a small amount of muscovite is frequently present, hornblende less often. As secondary minerals chlorite and epidote as well as limonite occur.

The garnets are, as usual, clean cut dodecahedra or tetragonal tris-octahedra which have pushed aside the other minerals in their growth. They seem to have been formed earlier than the staurolite, which often accompanies and encloses them. The latter mineral is usually so far rearranged as to form an aggregate of minute scales, probably largely kaolin, though sometimes looking like muscovite, but in some sections the crystals are still fresh enough to show parallel extinction and dichroism (amber brown and pale brown). Even in the completely weathered examples the shape of the crystals and the occasional twins crossing at an angle of 60° are sufficient to determine the mineral. The staurolites, like the garnets, elbowed aside the other minerals in their growth.

In texture these rocks run from exceedingly fine-grained almost felsitic looking varieties to examples that are distinctly granular to the eye, a few reaching even medium grain, though the finer-grained ones predominate ; and in appearance the quartz and felspar grains run from almost certainly water-rounded particles to a completely interlocking mosaic of individuals suggesting a massive rock or a sediment entirely recrystallized. In composition, they have the character of quartz-mica schist or gneiss or rearranged arkose.

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[20] Geol. Sur. Can., 1887-88, pp. 107-111, F.

[21] See McInnes in Geol. Sur. Can., 1897, p. 24 H.

The structure and composition of many of these rocks, and the character of their accessory minerals afford satisfactory evidence that they were originally waterformed sediments ; and from the general uniformity of the series we may infer that the whole of them, or at least the greater part, had the same origin. Stress is laid upon this point, since these schists and gneisses are in some cases the adjoining rocks to the iron range, and not seldom are found interbedded with them, as happens along the range east of Dryden for long distances.

Have we here a hint that the actual iron bearing rocks are clastic sediments completely recrystallized ?

Eruptives.

The eruptives collected in connection with the western iron ranges are on the whole less interesting than those of the Michipicoton region, and only a few of them will be noticed.

Along the north side of the mixed iron range and Couchiching gneiss in the township of Zealand east of Dryden is a considerable area of coarse granite or gneiss generally looked on as Laurentian. Its contact with the Lower Huronian is very irregular, and evidently eruptive, since large masses, often rods long, of the Huronian have been floated off by the granite, and dikes of the latter or of pegmatite, no doubt offshoots from the large granite mass, penetrate the schists for at least a quarter of a mile. The granite boss was followed for half a mile in length along the contact, but no attempt was made to measure its width ; and it probably belongs to the large Laurentian area to the north.

The rock is pale flesh-colored or white on weathered surfaces and a little darker when fresh. It varies from fine-grained to coarse, often running into pegmatite , and some parts of it have an imperfect gneissoid arrangement. Many parts at the edge of the Huronian are highly charged with black, triangular prisms of tourmaline. Some of the apophysae run out into veins of quartz intergrown with tourmaline with hardly any felspar left, and much of the actual margin of the granite and schist consists of the same mixture [22] Small inclusions of the schist in the granite are occasionally more or less completely changed to tourmaline and quartz, which may be looked on as forming a kind of reaction rim between the two rocks.

Under the microscope one finds quartz, orthoclase, microcline in large amounts, plagioclase and muscovite as essential minerals ; while large crystals of deep blue to violet tourmaline, a few small crystals of garnet and tiny prisms of zircon occur as accessories. The crystals of tourmaline, sometimes several inches in length, are often broken and cemented with quartz, and thin sections show that a certain amount of crushing has gone on, though all the minerals except the muscovite are very fresh. The crossed twinning structures of the microcline are unusually coarse, sometimes leaving a doubt whether the felspar is not a soda-lime plagioclase instead of microcline. The few garnets observed are apparently older than the microcline in whose crystals they are partly enclosed. The large microcline individuals often have quartz intergrown in a coarse pegmatitic structure.

The basic eruptives found associated with the western iron ranges are all in a badly weathered condition unsatisfactory for study. They include diabases, gabbros and perhaps diorites and diorite porphyrites, though the hornblende of the latter rocks may perhaps have been derived from augite. The felspars, so far as they are fresh enough to determine, are labradorites.

The country rocks enclosing the great magnetite lenses of the Atikokan are hornblende or hornblende-chlorite schist and pyroxenite, the latter being a gray-green medium-grained rock consisting almost entirely of dull-green augite, sometimes finely fibrous looking, like diallage, but often without that appearance. Strangely, there is no magnetite to be seen in the thin section made by this rock, though it is within a short distance of the solid ore.

[22] Compare with the similar association described by C. H. Smyth, jr., from the Thousand Islands, 19th An. Rep. N.Y. State Geol., 1901, p. r 291, etc.

PLEISTOCENE GEOLOGY.

The building of the Canadian Northern railway has opened up a new belt of country west of lake Superior and south of the Canadian Pacific, much of it covered with drift deposits of various kinds. The eastern end of the new railway runs over the flat alluvium of the Kaministiquia delta, composed chiefly of stratified clay, rich in silty materials, and forming a good soil where sufficiently drained. When the railway rises out of the flat lower valley numerous beds of gravel are encountered, some of them kame-like with the irregular stratification and mixture of large boulders with finer materials found in deposits made at the edge of an ice sheet The number of pebbles and boulders of iron bearing rocks, chiefly Animikie in appearance, in these gravels is striking, and proves that much of the iron ranges here has been destroyed. This gravel is largely used as ballast on the railway.

As the railway rises towards the Kakabeka falls on the Kaministiquia, there are cuttings showing 20 feet or more of stratified gravel overlying about 10 feet of brownish silt. The gravel serves as a water bearing stratum, and copious springs pour out from it just above the impervious silt. Other cuttings are mainly in clay, one a little above the falls displaying 10 or 15 feet of brown stony clay over one or two feet of blue clay, both containing polished and scratched stones, often of iron range rocks ; below which there are 25 feet of stratified sand and silt, evidently interglacial. The farmers on the plain above the river stretching to Murillo station on the Canadian Pacific, report that loamy clay stands highest, then come sand plains, and still lower, gravel plains. When the farmers on the clay soil sink wells they have to go down a few feet through tough clay, then through 50 or 60 feet of sand and silt before reaching the bed of water bearing gravel.

In one shallow cutting the boulder clay consisted largely of crushed Animikie rock, weathering brown and looking like iron ore half-way down, probably the raw material of the tough red clay so widely spread farther west along the railway.

Following up the Mattawin and Shebandowan rivers this red-brown clay occurs as rolling hills or plains, sometimes overlying bluish boulder clay, and sometimes having gravel beneath it, but always giving a tough sticky surface, very troublesome for teams in rainy weather. More or less of the red clay is found along the line as far as lake Shebandowan, where stratified gravel shows along the shore and eskers or sharp gravel ridges are cut by the railway. From here to the 10th siding large peat bogs make the floor on which the road bed is laid.

Just west of siding 12 well stratified beach gravel rises about 20 feet above the track, and a ballast pit has been opened. Then come rocky tracts until the 14th siding is reached, south of Atikokan, when gravel flats, evidently lake deposits, rise about to the level of the track, followed by extensive peat bogs, some of which have been sounded to the depth of 15 feet, so that they must contain large quantities of peat ; though much of it seems to have stopped growing, since it is no longer covered with moss but with grass or low bushes. The upper foot or two is often filled with branches or trunks of small trees, but at present in many places only a few spindling spruces grow upon it. The peat below the layer filled with wood as seen in ditches is compact and black, standing up sharply where cut through more than a year ago.

The muskegs, with some red clay, at times interstratified with white clay, occur frequently to the west as far as Steep Rock lake, while near Sturgeon falls there are rolling surfaces of gray clay which, when not too strong, should furnish a good soil ; and gray stratified clay forms level plains along the river Seine to the west, much like those of the Rainy river valley on the other side of Rainy lake.

From the Seine river westwards to Minnesota gravel deposits are apparently wanting, so that ballast of good quality is hard to find ; but wide plains and hills of sand occur north of Mine Centre on Shoal lake.

The stratified clay of Rainy river, forming broad plains of excellent soil to the north of the river, was laid down in an eastward extension of lake Agassiz, the huge body of water which covered much of Manitoba toward the end of the Ice Age: but this part of the region has been so often referred to that no detailed mention of it is required here.

About twelve species of fresh water shells were found in the silty beds where cut by the river just below the falls at Fort Frances, and also fragments of two species of fish, one apparently a bony plate of a sturgeon.

STURGEON LAKE GOLD REGION.

The lately discovered gold region on Sturgeon lake seemed of so much promise from the reports of prospectors and the richness of the specimens brought out from it, that a short visit was made to the more important properties during the latter end of September, unfortunately however under very adverse conditions as to weather.

From the Railway to Sturgeon Lake.

The starting point is Ignace, a divisional point on the Canadian Pacific railway 150 miles west of Fort William, where however there is no store and very few conveniences for outfitting, which should be attended to at Port Arthur or Fort William. The nearest point on the railway to the chain of lakes running northeast to Sturgeon lake is the siding at Osaquan, five miles west, where a good road over sand plains leads a mile and a quarter north to Camp lake. About midway between the two points on the railway a low mound of pale gray granite rises through the drift and furnishes an excellent building stone used at Ignace and other points along the line for bridging, etc. The sand plain with some kame-like deposits and many scattered boulders extends from some distance east of Ignace to Butler, the next siding west of Osaquan. Beyond Butler the sand plain is broken by granite hills with muskegs between, and before Raleigh, the next station, is reached a fine-grained gray gneiss or mica schist with some bands of green chloritic schist crop out, indicating the beginning of the Huronian. The gray schist is equivalent to Lawson's Couchiching. These rocks which strike 130° and dip 70° or 80° to the southwest, are probably the continuation of the Huronian band extending eastwards to the Sturgeon lake gold region, curving to the northeast along the chain of lakes followed by the canoe route.

Crossing Camp lake from the end of the tote road to Osaquan, a paddle of a mile and a half brings one to the sluggish creek two and a half miles long draining Camp lake into Indian lake, which is nearly at the same level and about 17 miles long with shores mainly of sand and gravel, but with granite outcrops enclosing some green schist at Gibraltar point. Entering Indian river, a rapid with a fall of three or four feet is passed by a short portage over gneiss. The river below this is sluggish and expands into Bear lake where green schist occurs, cut by eruptions of granite; and then empties into English river.

From this point the course is easterly and up stream on the latter river, through Huronian rocks and with two short portages past falls or rapids, until Otter lake is reached: then through Rice creek to Jackfish or Hub lake. Above this there is a rapid stream to Apostel lake where green agglomerate with an east and west strike is found, and then Lily creek to White Rock lake, followed by a short creek with no fall and Young's lake.

A portage of 43 chains across drift deposits with some green schist near the western end leads to Sturgeon lake. The route of about 50 miles is a good one for canoes of moderate size, though in the autumn, as we found, there may be delays on account of high winds on the larger lakes. The large canoes used for freighting, Peterboro's carrying a cargo of 2,800 lb. or Lac Seul 5-fathom bark canoes carrying as much as 4,500 lbs., had much difficulty in getting through the small marshy streams towards the eastern end of the route ; and freight is naturally expensive, $45 per ton to the Sturgeon lake portage in summer, though the rate is only $25 per ton in winter over a road 48 miles long when teams do the work. From the portage the small steamer Ladysmith, belonging to the Jack Lake Gold Mining Company, takes the freight up the lake for $10 per ton, so that there is a total freight charge of $55 per ton on all supplies brought into the mining camp in summer. In winter the total freight charge to Steele's mining camp is $40 per ton.

From the portage at the west end of Sturgeon lake to Steele's camp is 39 miles, and there is navigation for three miles farther to the north end of the lake ; while an eastern bay adds largely to the possible range of the Ladysmith. Sturgeon lake is large enough to make canoe travel dangerous in heavy weather, and even the little steamer can hardly make head against the September gales, as we had occasion to discover. In the heavy weather experienced we should have accomplished little but for the kindness of the Jack Lake Gold Mining Company, in giving us the use of the steamer, and the perseverance of the captain in driving her against the storms.

Jack Lake Company's Mine.

As work of any magnitude had been done only on two properties we devoted most of our time to their investigation, turning first to Steele's mine, belonging to the company mentioned above. Mr. Ezra Rust is president of the company ; Mr. Geo. W. Weadock, vice-president ; Mr. J. S. Steele, manager, and at the time of our visit Mr. B. Z. Kasson, assayer, was in charge in the absence of the manager, and served as guide to the workings. Mr. R. Andrews is mine captain.

The prevalent rock near Steele's camp is coarse grayish to greenish white granite, of the chloritic or sericitic variety sometimes called protogine, in eruptive contact with various gray and green schists, partly sheared felsite or quartz porphyry and partly ellipsoidal trap or agglomerate much rolled out. The granite rises as a boss near the margin of the Laurentian and Huronian. It has been greatly shattered and in places squeezed into schistose varieties. On locations B.G. 151 and 152 numerous fissures filled with quartz form large irregular masses in the granite as well as along the contact with the schist and in the schist and greenstone to the south, the general direction being north and south. There is no distinct vein with definite walls, but ramifying stringers and masses of quartz with some greatly altered rock matter enclosed between them run as an irregular band, having the general character of a stockwork, for about 1,000 feet, as shown by test pits from point to point. The width is sometimes as great as 71 feet, not all of which however could be looked on as ore, and in several places a width of 20 feet or more of solid quartz has been opened up. In all seven cross cuts have been made, as well as a number of smaller openings, with depths of from 6 to 44 feet ; and a very large amount of quartz has been disclosed.

From the largest crosscut, No. 1, it is estimated that 1268 tons of ore and rock have been taken, and a large number of assays of the material obtained from this and other cuts have been made, yielding, as tabulated by officers of the company, results from 40 cents to $186 per ton. As a check on these assays a considerable number of samples were sent to the Provincial Assay Office in Belleville, and the returns bear out the results mentioned above. In the rock on the dumps there are pyrite, often very coarse and cubic, galena, brown and coarse zincblende and some free gold to be seen ; and on the whole the ore seems promising, especially since the stripping shows so extensive an ore body. However, one would prefer to know the results of sinking one or two hundred feet and of drifting in each direction at various levels before coming to a conclusion regarding the permanent value of the deposit.

Until easier means of transport into the region have been provided the development of the property will be expensive. There was great difficulty in hauling in the small steamer, but it has been of much service during the past summer. The camp at Steele's consists of three well built houses, and the force at work was about twenty men, mining in two shifts with the aid of two steam drills. The camp is on the east side of the northern bay, and the mining operations are carried on a little to the east near the shore of a small lake named Couture.

Sturgeon Lake Mining Company.

The only other company working on a large scale in the region is the Sturgeon Lake Mining Company, of which Mr. Geo. Dawson is president, Mr. T. B. Bate, vice-president, Mr. H. J. Taylor, treasurer, Mr. D. E. Varley, secretary, and Mr. Wm. Smaill, general manager. The company consists mainly of St. Catharines men, and their property includes locations B. G. 155 to 159, about 200 acres.

The vein on which most work has been done is about four feet wide interbedded with green schist and with dikes of gray granite sheared in places so as to resemble felsite schist. The vein dips about at an angle of 65° away from the lake, and a shaft 55 feet deep follows the dip, though most of the work has been an open cut. Stripping has been done on three or four other veins, and some test pits have been sunk. One vein running 400 or 500 feet along the strike of the green schist, which stands about vertically, has a dip of 65°, like the vein on which the work has been done, and thus cuts across the dip of the schist, in this respect being a true fissure vein in spite of the fact that in strike it is parallel to the country rock. None of the veins seen are wide, and the one on which the sinking has been done appears to pinch in depth. The quartz contains galena, blende, pyrite, as well as free gold and a little native copper ; and some exceedingly rich specimens of gold were taken from the surface.

A Jenckes 10-stamp mill and Blake crusher were taken in very unwisely during the previous winter, and about 500 tons of ore were put through. It is stated that a little over half the gold was saved, and that the tailings run from $4 to $26 per ton, averaging about $10 per ton, the ore being quite refractory.

The mining camp comprises 12 buildings of various sizes including the mill, assay office, blacksmith shop and houses for the staff and men, of whom there were 23 at the time of our visit.

Owing to lack of time only one other location was examined, that of Messrs. Magee, McEdwards, Gourley and Boucher, 679 H W, on the east bay, where two veins were seen, bedded in greenstone schist and associated with dikes of porphyry. They run northeast and southwest and may be followed perhaps half a mile, but do not seem to be very continuous, opening and pinching from point to point. On one of them a pit disclosed about five feet of good looking quartz, but too little work had been done to give any certain idea of the value of the property.

Mr. H. W. Selby, who has done much of the surveying of the region, states that there are a number of other properties of interest, though little but stripping has been done upon them. Among them are H. W. 680, where quartz occurs in protogine as at Steele's : H. W. 710 and 711 on the south shore of Sturgeon lake near the portage, similar to the last one ; and Mr. Alan Sullivan's location, F.M. 206, where there is a large lenticular vein, from two to six feet wide and stripped for 600 feet ; but lack of time prevented me visiting any of them.

Near the junction of the northern and eastern bays with the western arm of the lake there is a Hudson bay store and a fairly comfortable stopping place considering the adverse conditions. Excellent potatoes were dug from stony morainic soil for a meal which we took there.

North of Sturgeon lake placer ground is said to have been discovered on Savant lake, stretching for 13 miles or more with a width of half a mile, as a row of islands running down the lake. The islands are perhaps an esker and rise higher than the shores of the lake. The gold which is very fine, and with rounded colors, will not average more than 8 cents per cubic yard.

GOLD MINES ON THE SEINE.

In spite of the general depression in gold mining along the Seine river, we found one or two new properties in process of development near Atikokan and Steep Rock lake. The first is B J 118 on the north side of Sabawe lake, the property of Mr. J. J. Walsh, who has sunk a shaft 39 feet near the contact of Keewatin green schist with a mass of protogine, probably Laurentian. There are two parallel bedded veins in the green schist, the widest extent of quartz being 7 feet, with some bands of schist included. The quartz looks well and contains iron and copper pyrites, with some azurite and malachite stains, and free gold. It is said that four miles have been taken up as claims along the strike of the veins, which run about northeast and southwest corresponding to the strike of the schist.

The other property visited is the Elizabeth mine on Rice lake a little west of Steep Rock lake, and belongs to the Anglo-Canadian Gold Estates, Limited, Mr. Alan Sullivan being manager. Here a considerable amount of exploratory work has been done, including the sinking of two shafts, one 110 feet in depth, and the other 130 feet. In No. 1 shaft drifts had been run 50 feet north and 50 feet south at the 80-foot level ; and in No. 2 a level was begun at 65 feet and a second level was to be commenced at 130 feet. Diamond drilling has been done to the extent of 2,000 feet and cores show the vein 250 feet below ground. The veins can be followed for considerable distances on the surface, with widths of four to six feet or more, and the shafts and drill cores show that a similar width exists in depth. The quartz from one vein is granular, like the coarsely granular silica in some parts of the Iron range, in this respect resembling the quartz from the Grace gold mine near Wawa in the Michipicoton region. It is stated that ore from the main vein of the Elizabeth mine runs ¾ oz. per ton, and from the other 6 or 8 dwt. per ton. The country rocks are chloritic granite or protogine and greenstone.

There are ten buildings for various purposes on the property and the clearing of a mill site and making of a tram line from the shafts to the mill were in progress as well as a dam to provide permanent water supply. A steam drill, a hoist and a Bullock diamond drill were at work, and 25 men were employed on the average, 10 or 12 of them miners. It was pleasant to find an unburnt grove of excellent white and red pine on the property. Since the opening of the Canadian Northern railway it will be a simple matter to bring in machinery and supplies to this hitherto remote region approachable only by canoe in summer and by a long sleigh road through the bush to the C.P.R. in winter.

THE GRACE MINE, MICHIPICOTON.

The only gold mine in the Wawa region, Michipicoton, at work last summer was the Grace mine belonging to the Clergues. This may be reached from Wawa station on the railway to the Helen iron mine, by a government road leading to Wawa city and thence to the Minto and other mines ; or better by the road from the Mission, at the mouth of Michipicoton river, a distance of about seven miles, partly over sand plains. The rocks observed on the way are largely quartz-porphyry schist, striking northwest and southeast or north and south with nearly vertical dip, or green schist. At one point some openings made beside the road show banded granular silica and siderite accompanied by iron pyrites, the whole very like portions of the iron range to the north. Some of the quartz however is massive and not granular, probably a later vein deposit.

At the Grace mine bands of coarsely granular quartz run parallel to the strike of the gray or greenish gray schists, about 140 degrees, and dip 70 degrees to the east. Near by are massive looking gray rocks, apparently greatly weathered porphyrite. The vein has been traced 200 feet on the surface a greatest width of about five feet but pinching at several points. The quartz contains pyrite, pyrrhotite, chalcopyrite and arsenopyrite, as well as free gold ; and some of the adjoining grayish schist is gold bearing.

A shaft has been sunk 120 feet at an angle of 67 degrees to correspond with the dip, and has been timbered with tamarack down to 32 feet, leaving a space 4½ by 9 feet inside the timbers. There are drifts at 100 feet, 46 feet in one direction and 20 in the other.

A fire had destroyed the shaft house a short time before, and a new building of corrugated steel was nearly completed when we visited the mine in July. A new hoist was being installed and also a new air-compressor in preparation for more extensive work. In order to test the value of the ore 50 tons were being bagged up to be shipped by steamer and rail to the Keewatin reduction works near Rat Portage.

The gold locations south of Wawa are all along the very irregular Laurentian-Huronian boundary, the Laurentian being eruptive as usual, and the Huronian having much the same character as the Lower Huronian near the Helen mine, including small quantities of iron range rocks which, rather strangely, appear to be gold bearing in this part of the region. It remains to be seen whether any of them will prove to be of importance, however. No certain Upper Huronian rocks were found, though some conglomerates or agglomerates which may correspond to the Dorè conglomerate occur at more than one point. The Huronian is even more mixed with Laurentian and other eruptives to the south of Wawa lake than has been shown to be the case to the north, so that very detailed field work would be necessary to map the region.

THE MICHIPICOTON IRON REGION.

BY A. P. COLEMAN AND A. B. WILLMOTT.

Brief accounts of the rocks associated with the now well-known Helen mine have been given in reports of the Bureau of Mines of former years[1]; but the great importance of this mine, which contains much the largest deposit of iron ore yet opened up in Canada, and the desirability of determining the geological associations likely to accompany iron ores in other parts of Ontario made it advisable to study the region in greater detail.

As agreed upon by the authors the work has been taken up jointly, the economic side and the immediate surroundings of the ore bodies being studied by Professor Willmott, and the general geological associations by Professor Coleman. The topographical groundwork of the map accompanying this report has been obtained from various sources, the most important being the surveys carried out by the Lake Superior Power Company, under the direction of Messrs. Clergue, in the way of fixing the boundaries of claims and of townships, as well as running exploratory lines. The work done by the same company in locating the railway from Michipicoton Harbor to the Helen mine, a distance of nearly 12 miles, and also the extension of the line from Talbott lake to the Josephine mine, has aided in fixing the topography and has furnished valuable rock sections in the necessary cuttings. The immediate vicinity of the two mines has, of course, been carefully mapped by their engineers.

Where the lines provided in the ways suggested have lain too far apart to give a sufficient groundwork for the geology an attempt has been made to fill in the gaps by micrometer and prismatic compass surveys or by paced compass surveys through the woods, a dial compass being used to check the results of the magnetic compass where the proximity of the iron range made this necessary. It may be noted however that in most cases very little correction of the compass was needed, even when working along the iron range itself; no doubt because most of the iron contained in the range is not in the condition of magnetite but as siderite, limonite or hematite.

It will be understood of course that both the topographical and geological work have been done with much greater minuteness in the neighborhood of the two mines than elsewhere in the region, and that the mapping of other rocks than the iron range has been done in a much broader and less accurate way than was deemed necessary in the case of the iron bearing rocks. As the Laurentian rocks of the region may be considered barren of economic minerals, in general the lines surveyed or paced have been confined to the Huronian, or have been carried only far enough to examine the contact of the two groups of rocks.

As a rule outcrops of rock are frequent in the region, which is hilly or even mountainous in parts; though the dense forest with its carpet of thick moss is apt to hide the rocks where the surface is level; and the wide-spread sand plains representing the shallow water deposits of lakes once standing at a higher level than Superior cover large areas completely, unless where rivers have cut their valleys deep enough to uncover the solid rock at the bottom.

While the greater part of this report, dealing with the general geology of the region, has been written by the Geologist of the Bureau of Mines, and the special report on the Helen iron mine, as well as the final compilations of the maps, are the work of Professor Willmott, there has been so much interchange of views in regard to most of the matters coming up that the report is properly a joint one for which both geologists are responsible. Where the two authors differed, both views are presented as alternatives, though there has seldom been need for this.

[1] Bur. Mines, 8th Rep., p. 255; 9th Rep., pp. 155–157; and 10th Rep., pp. 126, 137 and 191–198.

The contour lines given on the map at levels 100 feet apart were fixed mainly by aneroid readings checked by readings at a central station at the Helen mine. While they represent fairly the prominent variations in level as measured above lake Superior, the excessively rugged and hilly character of much of the region finds little expression in them. To have worked out in detail the topography of the hills and ridges would have demanded a much more elaborate survey than was possible under the circumstances.

Topography of the Region.

The region studied is about 25 miles in length from southwest to northeast, with a greatest width of about seven miles, and runs from the mouth of Doré river to a few miles beyond Parks lake on the northeast. It lies to the northwest of Michipicoton river near its entry into the bay of the same name on the northeast side of lake Superior, and shows the rugged topography so characteristic of that shore. There are several of the small lakes so commonly found in the Archæan of Ontario ; and two considerable rivers, the Doré or Pickerel and the Magpie, cross the region with the succession of water falls and rapids customary in rivers on the north shore of Superior. The latter is a tributary of the still larger Michipicoton river, which runs to the south of the district mapped.

The country rises rapidly from the lake in steep hills, often ridge-like, with the general direction of the strike of the schists about 70° east of north, and culminates in the ridge of iron range rock just east of the Helen mine, called Hematite hill, or mountain, which reaches a height of 1,100 feet above the lake or 1,700 feet above the sea This is the highest point for many miles around, and makes a conspicuous landmark, though other hills reach a level of 800 or 900 feet.

As Hematite mountain is only seven miles from lake Superior the rise is rapid, and the location of the railway to the Helen mine, which is at a level of 650 feet, just at the foot of the mountain, required some skill in the choice of a route, old lake beaches and sand plains being utilized where possible.

Beginning at the southwest, from the mouth of Doré river to Gros Cap is low ground, largely sandy plains, with rocky hills rising 300 or 400 feet toward the northwest. Gros Cap itself is a very rugged mass of greenstone standing out prominently, square in shape and about half a mile in length and breadth, with a narrow neck of low ground connecting it with the mainland. This promontory provides a well sheltered harbor to the east where the ore docks and village of Michipicoton Harbor are situated.

Immediately north of the harbor rocky ridges rise to heights of 300 or 400 feet, looking down on sand plains and wide muskegs with small lakes to the west, in the direction of Doré river, and to the narrow valley leading northwest toward Magpie river, which a row of greenstone hills separates from the bay.

Along the Magpie when crossed by the railway the plains of sand and gravel are extensive, rising as well defined terraces and hiding the rocky structure almost entirely. Beyond the Magpie at about Wawa station on the railway the sand plains once more give way to rocky hills of quartz porphyry, felsite and their schists toward the southwest, and various green schists toward the northeast. A chain of small lakes leads up to Talbott lake, from which there is a rise of 125 feet to Sayers lake and of 25 feet more to Boyer lake at the foot of Hematite mountain. Here for the first time the rocks of the iron range dominate the region with various schists on each side sinking as ranges of hills to Wawa lake 336 feet above Superior, on the southeast, and to smaller lakes and the Magpie river on the northwest.

From the top of Hematite mountain one sees that the hills sink rapidly toward the northeast and a number of basins such as those of Gull lake and lake Eleanor with broad sand plains interrupt the course of the rocky hills. Still to the northeast rises an irregular range of greenstone hills with swamps and lakes between, and beyond them are seen the steep ridges of the iron ranges and their associated schists north of Brooks lake.

A chain of comparatively large lakes including Loonskin, Bauldry and Goetz lakes once more interrupts the course of the hills, and beyond this toward the northeast the region is sprinkled with small lakes between comparatively low hills of greenstone and quartz-porphyry schist.

On the whole, the district presents more than the usual variety of surface ; lake bottoms with wide muskeg borders or with steep rocky shores, broad lacustrine plains with some bosses of eruptives rising through them, the lower hummocky or ridge-like hills so usual in Huronian countries, and a few loftier summits, reaching at the central point near the Helen mine an altitude that may be called mountainous. The valleys include ponds and small lakes of every size up to five miles in length, and at every level up to 800 feet above the wave-swept beaches and rocky promontories of lake Superior ; and also rivers of considerable magnitude, sometimes lake-like for miles at a stretch, then forming rapids over beds of drift boulders or plunging as splendid waterfalls over cliffs, the highest being about 113 feet, none of them however clear leaps, the descent being broken by steps. The rivers descend about 300 feet in the last three or four miles of their course before reaching the base level of lake Superior, and provide water-powers that may be of importance in the future.

Classification of the Huronian Rocks.

Since the finding of wide-spread schist conglomerates like the Doré conglomerate of Michipicoton in all the more important areas of Huronian in Ontario from lake Temiscaming to Lake of the Woods, it has become necessary to take a step farther than was possible for Sir William Logan and his assistants who gave these pre-Cambrian rocks their name. At that time no clearly defined break in the Huronian series was known, and though Logan and Murray subdivided the most carefully studied area north of lake Huron into numerous groups, no attempt was made to extend the subdivisions over other areas.[2] Some later writers have however attempted to distinguish an upper from a lower Huronian in the region mapped by Logan, making the division at the base of the "upper slate conglomerate"[3] ; but the break at this level is not important, and the real gap is at the base of the whole series of rocks described from the north shore of lake Huron as Huronian, since their conglomerates contain pebbles of iron range rocks. Evidently the conglomerates with such pebbles must be separated by a profound unconformity from the underlying rocks generally mapped as Huronian which have as one of their upper divisions the band of iron range supplying the material for the pebbles.[4]

It is probable that the length of time which elapsed between the two series is as great as that between any two successive formations, so that it seems almost necessary to provide a new formational name, such as Keewatin, the term introduced by Dr. Lawson for the schists of Rainy lake and Lake of the Woods. Since the time of Lawson's work in that region it has been found that there too the division can be made between an upper part containing extensive conglomerates with iron range pebbles and a lower containing more or less of the banded silicious iron range rocks, the greater part of the area however appearing to belong to the lower division. Under the circumstances it might be advisable to call the upper division simply Huronian, which is justifiable, since the type region mapped by Logan and Murray as Huronian consists mainly of rocks belonging to the upper part, and to re-define Lawson's Keewatin as including only the rocks below the great unconformity. Before settling finally on the usage

[2] Geol. Can., 1863, pp. 55-57. In the text 13 subdivisions are described, but the map in the accompanying atlas shows only 11.

[3] Bull. U. S. Geol. Sur., No. 86, Van Hise, p. 47.

[4] Bull. Geo. Soc. Am., Vol. 11, pp. 107-114, Upper and Lower Huronian in Ontario.

there should however be a general agreement of the Canadian geologists who have studied the Archæan as to the terms to be employed.

The terminology used by Van Hise in his latest work on the American iron ranges, would naturally be adopted if he had not ignored the work of Sir William Logan and later Canadian geologists and given the name Upper Huronian to the Animikie, which is probably much later in age than the original Huronian.[5]

It is perhaps well to retain the terms Upper and Lower Huronian for the present, though recognizing that distinct names would be better, such as Huronian for the upper series and Keewatin for the lower one.

For the subdivisions of these two series we suggest the following scheme :

Laurentian	Gneisses and Granites.
Upper Huronian	Acid eruptives. Basic eruptives. Doré conglomerate.
Lower Huronian	Eleanor slates. Helen Iron formation. Wawa tuffs. Gros Cap greenstone.

In the classification as given here the Lower Huronian is the oldest series of rocks known in the region, since the gneisses and granites usually mapped as Laurentian are distinctly eruptive in their contacts with them, as well as with the overlying Upper Huronian conglomerate.[6]

The Gros Cap greenstones are greatly weathered basic eruptives sometimes with the ellipsoidal structure supposed to indicate surface lava flows, and sometimes distinctly schistose.

The Wawa tuffs are usually greenish, yellowish or pale brownish schists containing much silica and sericite, as well as carbonate in some cases, and at times showing so little schistose structure as to be properly called quartz-porphyry or felsite.

The Helen Iron formation consists principally of cherty or white granular silica interbedded with iron ore, and of siderite, the latter sometimes schistose.

The Eleanor slates are gray fissile rocks with a cleavage crossing the banding due to sedimentation. They form thin bands, and their relative position is not certain. Their proper position may be under the Iron formation instead of over it.

The most important rocks in the Upper Huronian are the Doré conglomerates, best displayed near the mouth of Doré river. They are usually schistose with the pebbles more or less rolled out.

The eruptives, except those mentioned above as shading into the Gros Cap or Wawa schistose rocks of the Lower Huronian, are classed with the Upper Huronian, though they penetrate both Lower and Upper Huronian impartially, and in reality may be later in age than the Upper Huronian. There is no means of determining their exact age and it is convenient to take them up in the way suggested.

In the accompanying map the subdivisions given above are indicated by different colors, with an additional color for the individual Huronian, since in some parts of the region it was found impracticable to separate them No separate color is provided for the acid eruptives,

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ron-Ore Deposits of the Lake Superior Region, U. S. Geol. Sur., 1901, p. 317. [NOTE]. See in reply to this Willmott in Jour. Geol., Vol. X, No. 1, pp. 67-76.

6 See The Michipicoton Mining Area, by Willmott, in Am. Geol., Vol. xxviii, No. 1, July, 1901, pp. 14-19.

the color used for the Laurentian including both gneisses and massive rocks. Dikes of either basic or acid rocks have not been indicated, since their width is not usually great, and they have seldom been traced out completely.

THE LOWER HURONIAN.

As seen from the classification given above, the Lower Huronian of the Michipicoton region includes a considerable range of rocks, the Gros Cap greenstones, the Wawa tuffs, the Helen Iron range and the Eleanor slates ; which may now be taken up in detail, beginning with the lowest.

The Gros Cap greenstones. The oldest rock in the lake Superior region, according to Professor Van Hise, is the Ely greenstone, which corresponds to the Gros Cap greenstone of Michipicoton in position and character, consisting largely of an ellipsoidally parted basic igneous rock, no doubt partly formed of lava flows. The character of the rock is best seen on a weathered surface which brings out the rounded blocks with a small amount of cementing material between. On the freshly broken surface it is very difficult to distinguish the blocks themselves from the matrix which surrounds them. Evidently both the blocks and matrix are of the same composition, and the rock is believed to be a lava which has partly cooled on the surface, while the lower part was still somewhat fluid and in motion, thus breaking up the cooler layer into blocks which were rolled along and given the ellipsoidal forms. These rocks are well exposed just west of Michipicoton harbor and on the trail to the old fishing station at Gros Cap.

Many parts of the greenstones do not show the ellipsoidal structure, and are apparently greatly weathered diabases, while still other parts are distinctly schistose ; but the three varieties run into one another and can hardly be separated in mapping. The chloritic schists are probably tuffs of the volcanoes which poured out the lavas. The whole series is greatly weathered and saussuritic in thin sections.

The Gros Cap greenstones are the lowest rocks in the region except the Laurentian which is eruptive through them, and so may naturally be looked on as oldest ; but there is evidence to show that part of them at least are younger than the Helen Iron range rocks, since the latter are sometimes embedded in them in a way suggesting that the greenstones carried them off eruptively. Examples of this are found along the south side of Gros Cap and on the shore of the harbor, just east of the village. What parts are younger and what older than the iron range would be very hard to determine in most cases, and no attempt has been made to separate them. It is even possible that most of them are later eruptives.

Besides the greatly weathered greenstones mentioned here as probably Lower Huronian, there are numerous diabases undoubtedly much later in age, since they have penetrated the Upper Huronian ; but these will be discussed at another point.

The Wawa tuffs. Above the greenstones come acid schists generally having the composition of quartz-porphyry or felsite, and in some cases evidently sheared and rearranged rocks of the kinds with crystals of quartz and felspar still to be seen in them. In general however, they are apparently tuffs or ash rocks, probably erupted in connection with the quartz-porphyry, and deposited in water so as to have a more or less stratified character. A few of them are brecciated, some crush-breccias, others perhaps agglomerates formed of larger volcanic fragments than the ash. Some rare forms have much the appearance of water-formed conglomerates with rounded pebbles, one singular example of the sort occurring on a steep hill slope at the west end of lake Wawa. In a general way, this resembles a beach deposit with pebbles cemented by a finer-grained greenish or yellowish matrix, but on closer examination the apparent pebbles are found to be really concretions.

There is no sharp line between this phase of the rock, which occurs in smaller amounts at other points also, and varieties like ordinary quartz-porphyry schist, so that one may suppose it to be merely a phase of the series of acid schists in which there has been concretionary action.

A small outcrop of conglomerate on some islets across lake Wawa, a mile to the southeast, and along the shore to the south has more the appearance of a water-formed rock, since well rounded pebbles of more than one kind occur in it, but here again the rock seems to blend into quartz-porphyry schist.

The points where anything like clear evidence of original stratification is to be found are infrequent, while a schistose structure is very commonly well marked, so that its strike and dip are easily determined. In some cases the stratification and schistose arrangement are not parallel, the latter evidently having been caused by shearing or squeezing stresses not at right angles to the original planes of deposit, and at a time later than the most important period of folding. Sometimes, even when the strikes of the original and of the schistose structures are parallel, the dips differ in angle, in one case the original dip, as shown by harder and softer layers of schist, being 82°, while the planes of schistosity dip at an angle of 57°. In this case only the layers of softer schist show the schistosity.

Since the materials forming the schists were laid down, or else during their deposit, important chemical changes have taken place in them, probably by circulating hot water, so that the sheared and crushed quartz-porphyry or porphyrite has been greatly silicified, at times even transformed into thick bands of pale gray or green chert or chalcedony with a small amount of sericite. In other cases a considerable amount of siderite or of a carbonate like ankerite, dolomite or calcite has been deposited with cryptocrystalline or microcrystalline silica, suggesting a change to the iron range rocks which form the uppermost series of the Lower Huronian. It is probable that this change went on at the time when the original iron range rocks were deposited and under the same conditions.

Associated with the pale greenish or yellowish acid schists, evidently formed from quartz-porphyry or felsite, are numerous bands of darker gray and softer schist with much less silica, but a considerable amount of siderite and also dark silicates, such as chlorite, biotite or less often hornblende. Finally there are bands or irregular areas of green schist in which chlorite is the predominant mineral, evidently representing basic ash rocks or sheared dikes of the greenstone often penetrating the series of schists.

One variety of the green schists which may be specially mentioned, consists of a rather coarse-grained mixture of green chlorite and a pale gray carbonate, suggesting at first a schistose diorite in appearance. That the carbonate is either siderite or ankerite strongly charged with iron is clear from the fact that an inch of the surface of the rock is changed to impure brown iron ore. The origin of this rather wide-spread schist is not certain, since the very large amount of iron present in it does not correspond to the composition of any commonly occurring basic eruptive or ash rock.

In addition to the chlorite-ankerite schist just described, in some parts of the field there are biotite dolomite schists, good examples of which occur southwest of Bauldry lake, where the biotite is in quite broad flakes giving a sheen to cleavage surfaces.

Small amounts of dolomite or of a carbonate containing calcium, magnesium and iron occur rather frequently in the western part of the region as buff or gray fine-grained rocks with little or no schistose structure. Examples are seen along the railway northeast of Goetz lake and also as a band along the north side of the Brooks lake iron range. In a general way it may be stated that the Wawa tuffs are accompanied by lenses or bands of carbonates including impure siderites, dolomites and limestones. In most cases also some granular silica is present, and it may be that these lenses or bands are chemical sediments.

The Eleanor slates. In addition to the slates just mentioned slates of a distinctly sedimentary kind occur as thin bands in the northeastern part of the region near Eleanor lake and elsewhere. They are buff to dark gray or black rocks with slaty cleavage sometimes forming an angle of 25° with the well marked bedding. Some varieties of them are carbonaceous, and at a point east of Wawa lake such a slate was taken up as a coal mine. Whether the black graphitic slate often connected with the iron ranges belongs with the Eleanor slates is not certain, nor has it been determined positively whether the slates are older or younger than the adjoining iron bearing rocks.

Slate or shale of the kind described is traceable at intervals for a mile along the north shore of Parks lake, and is found underlying the Doré conglomerate north of Eleanor lake on the Grasett road.

The Helen Iron range rocks will be described at another point.

Attitude and Distribution of the Lower Huronian.

The lowest of the Lower Huronian rocks, the Gros Cap greenstones, are commonly so massive in character that a strike or dip cannot be determined, but there are considerable bands of green schist among them which have the usual strike and dip of the schists of the region, showing that they have undergone the same stresses as the more commonly schistose rocks. As the greenstones in several cases underlie the Wawa tuffs and appear on each side of them we may suppose that they have the same synclinal structure ; but later eruptive masses of diabase interfere with the regularity of the arrangement and make attempts to estimate the thickness of the group very uncertain. As much of the rock consists of lava flows the thickness must be very variable.

The most extensive area of the Gros Cap greenstones is the one extending from Gros Cap eastwards to Magpie river and thence north from Michipicoton river to the eastward bend of the Magpie. Other large areas exist northeast of Eleanor lake, including most of the shore of Loonskin lake, and along the Josephine branch railway from mile 13½ to mile 17. Numerous smaller areas will be found indicated on the map, and there are bands of greenstone and green schist in the Wawa tuffs that have the same characteristics but are on too small a scale to be conveniently indicated by the coloring.

The Wawa tuffs have on the average a strike of 70° east of north, though with considerable local variations, and a dip towards the south of from 50° to verticality. Near the Helen mine they are shown to form a syncline pitching towards the east and enclosing in their trough the iron range rocks. As the dip is much the same on each side of this synclinal axis the fold must have been a closed one ; and since it was formed erosion has eaten down the Archæan surface until at various points, such as west of the Helen mine and south of lake Eleanor, the iron range in the central trough has been completely removed, leaving the lower schists across the whole width.

The greatest measured thickness of the schists is to the south of Sayers lake, where they are known to reach across lake Wawa, a distance of about two miles and a quarter, which at a dip of 70° would give more than 11,000 feet. Included in this however are some diabase masses which would have to be deducted to find the exact thickness. As many parts of the schists are known to be eruptive, their thickness is probably irregular ; and if we consider also the large amount of squeezing and shearing they have undergone, and the fact that various later eruptives have invaded their margins, and that there may be repeated close folds in the section, any estimate of the original thickness of the series can have little value.

The extent of the Wawa tuffs and their boundaries can be given only approximately, partly because of the sand plains covering them and partly on account of the intermixed later eruptive rocks. Beginning at the southwest we find a narrow band of quartz-porphyry schist and felsite schist along the northern boundary of the great conglomerate area, between the latter rock and the Laurentian. If it underlies the conglomerate in a synclinal fashion we should expect to find it outcropping again to the south along the shore of lake Superior. Here however wide-spread greenstones seem to replace it, the only point where similar schist is known to occur being just north of the old harbor behind Gros Cap, where a narrow band of gray schist is found along with a band of the iron range. Where the conglomerates narrow down toward the northeast, the northern fringe of quartz-porphyry schist seems to widen correspondingly, though greatly interrupted by later acid and basic eruptives. Still farther northeast the sand plains of the Magpie valley hide the rocks almost completely, not to reappear until near Talbott lake, where the lower schists are extensively developed. From this to the northeast end of the region mapped the Wawa schists are found on each side of the bands of the iron range as the immediately enclosing rocks except where broken by masses of greenstone or of later diabase, and they extend northeast to the end of the region mapped. Exactly how they are related to the small areas of Upper Huronian near lake Eleanor and a mile and a half to the northwest is not quite certain, since some of the Upper Huronian schists are almost indistinguishable from the rocks in question. If the conglomerate alone is considered Upper Huronian the two areas are entirely enclosed in the Wawa tuffs.

In a general way the Wawa tuffs tend to be more silicious and to contain more siderite as they approach the iron range ; and to be somewhat coarser in grain and gneissoid in look on the sides toward the Laurentian ; as though the proximity of these rocks had influenced their crystalline character and chemical composition. The boundary between them and the Helen Iron range rocks is sometimes quite sharp, a thin sheet of black slate occasionally intervening between the two, but in other cases there are schistose varieties of the siderite of the iron range which form a transition towards the quartz-porphyry schists.

The margin toward the Laurentian granite and gneiss is less sharp, since the schists are composed of about the same materials more or less recrystallized and assuming a gneissoid character. The boundary is uneven, as if the eruptive Laurentian rocks had encroached unequally on the older schists.

Distribution of the Helen Iron Formation.

The upper portion of the Lower Huronian includes the Iron range rocks, parts of which are treated in detail in connection with the geology of the Helen and Josephine mines, and therefore will be omitted here. The Helen Iron formation, while most fully developed at the two mines mentioned, is found at many other points in the region described. Beginning at the southwest several bands of the granular silica variety occur on the Gros Cap peninsula, the largest being at the Gros Cap mine on the south shore of the peninsula[7]. The materials here are chert and granular silica interbanded with hematite, and the width is in all about 150 feet. To the east another narrower band of rusty silicious rock is seen, and just round the eastern point near the beacon is a third still narrower band, differing from the others in containing magnetite and much pyrite. All of these bands of iron range run about northwest and southeast and have a dip of perhaps 50° to the southwest. A similar band is seen on the west shore somewhat south of the portage across the neck of the peninsula, probably an extension of one of the bands mentioned before. About 150 yards north of the portage are several narrow bands of the rock, usually very pyritous, associated with quartz-porphyry schist and striking about east and west with a dip to the south. This belt probably extends to the east where an outcrop of brown sandy-looking grained silica occurs a little inland from the old fishing station. The band just mentioned is nearly parallel to the great area of schist conglomerate to the north

[7] Geol. Sur. Can., 1863-69, p. 131 ; also Bur. Mines, 8th Rep., pp. 145 and 254.

and is the nearest part of the iron range to it, so that it may have furnished part . the numerous pebbles of granular silica in the conglomerate.

Two or three small patches of iron range are found in the greenstone east of Michipicoton harbor, after which no more is known for about eight miles, when the Helen iron range begins. All of the outcrops mentioned thus far appear to be enclosed in the greenstones as if swept off eruptively.

The range at the Helen mine, consisting not alone of silicious iron-bearing rocks but also of siderite, will be described later. It runs for a mile and three-quarters a little north of east, when another interruption occurs, thought by some to be caused by a fault. The evidence for this does not seem conclusive, however, and more careful exploration may bring to light in the heavily wooded region to the east some links connecting it with the lake Eleanor band, which commences after a gap of a mile and a half and runs northeast to the Grasett road between lakes Wawa and Eleanor. The road follows a depression between hills that probably represents a line or zone of faulting, for the iron range here jogs three-eighths of a mile to the north and then continues the usual strike of about 60°. Between the two main outcrops and just east of the road are two small ridges of rusty granular silica pointing a little east of north, perhaps remnants left during the dragging of the strata in faulting.

SOUTH OF LAKE ELEANOR.

The iron range south of lake Eleanor was known many years ago, attracting attention by its rusty cliffs rising vertically just to the east of the old portage road, and was taken up as one of the Johnston locations. As it was somewhat carefully studied it may be described here as giving the best exposure of the range between the Helen and Josephine mines. In a general way it suggests that of the Helen mine though on a smaller scale.

A section going south from lake Eleanor shows greenstone, partly with ellipsoidal (lava flow) structure, partly massive looking, very fine-grained and splintery. A little lake occupies a valley between the greenstone and the iron range, which rises as a steep ridge commanding the country. The north side of the ridge is of granular silica interbanded with a small amount of iron ore to the width of 250 feet, followed by 25 feet of siderite somewhat interbedded with quartz-porphyry schist, and then by about 1,000 feet of the schist with little siderite. Still to the south is an area of diabase.

The strike of the iron range rocks at the extreme southwest end is not far from north and south with a dip running from 30° to 90° to the east, pointing towards the two small hills of granular silica to the east of the road. Less than 100 paces eastwards along the top of the ridge the strike becomes 60° to 80°, and keeps this direction until the east end of the little lake is passed, when it changes to 45° for a short distance, and the range ends abruptly in a mass of greenstone. Beyond this it has not been traced, but the country is very mossy and forest covered, so that it is hard to say positively that there may not be exposures of the iron range yet undiscovered.

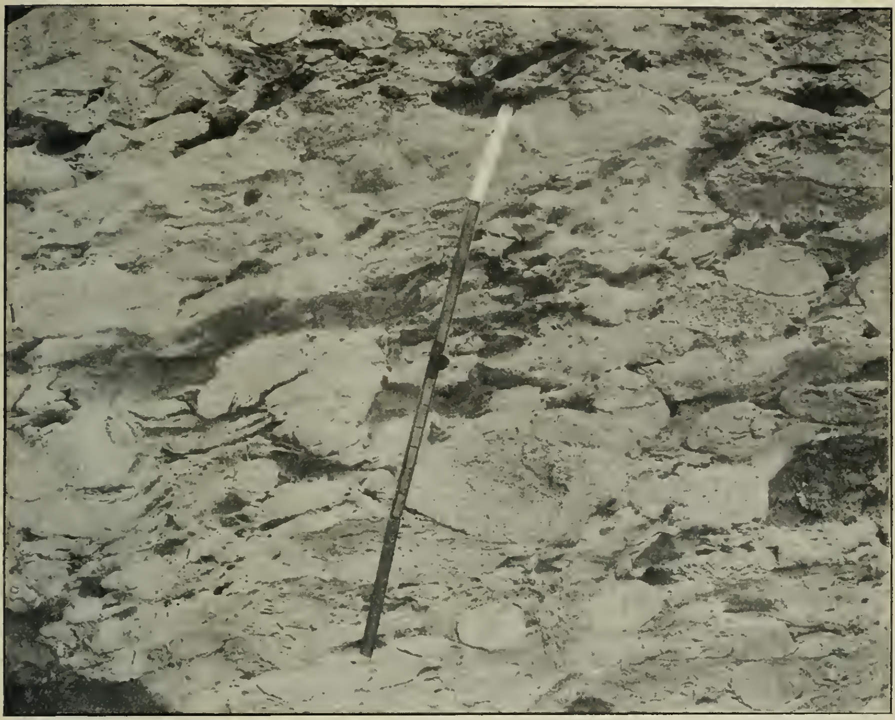
Associated with the granular silica and siderite are the usual thin sheets of black slate pitted with small cavities, once occupied by pyrites. The slate is not more than a foot or two thick and appears to underlie the other members of the iron range, resting between them and the quartz-porphyry schist.

At the west end of the range, where the relationships are well exposed in the face of the cliff, the siderite underlies the granular silica and seems to pass down into quartz-porphyry schist, which however appears to have been folded so as to overlie the iron range on top of the ridge with a steep dip to the south, indicating that the range is probably enclosed in a syncline of the schist. At the foot of the cliff greenstone apparently underlies the fold, which has a pitch to the eastwards like that in the Helen mine region.

Steam shovel at work on upper bench, Helen iron mine

Concretionary quartz-porphyry, south of Helen mine.

Felspar-porphyry, near mouth of Michipicoton river. Crossed nicols.



Schist conglomerate, Michipicoton Harbor.

Ellipsoidal trap, Michipicoton Harbor.

BROOKS LAKE IRON RANGE.

The next point at which the iron bearing rocks have been found is two and one-eighth miles to the northwest of the lake Eleanor range, where they begin just east of a long unnamed lake and run about 60° east of north, past the north side of Brooks lake almost to Bauldry Lake, a distance of about two miles. Here again a fault of great magnitude has been suggested, the plane of faulting running northwest and southeast ; and there is much in favor of this view, though it cannot be said to have been proved, since very little work has been done on the geology of the country between the two iron ranges. The only rocks known to exist between them are greenstones and green schists.

The two main varieties of rock found in the iron range occur along the whole length of this belt, generally rising as a sharp ridge 100 or 200 feet above the adjoining country. Along the northwest side, as near lake Eleanor, narrow lakes run parallel to the ridge, suggesting a band of rocks, perhaps dolomites, more easily eroded than the range itself. The silicious rock varies from dark, compact, cherty or quartzitic varieties to soft granular and very rusty kinds or occasionally sugary white granular quartz which crumbles under the fingers. The sideritic rock, as usual, is greatly charged with pyrite, weathers to a very rusty surface or to crusts of brown iron ore, and seems to blend into quartz-porphyry schist, which is ordinarily the next rock to the south and often also on the north, though a band of dolomite is found for much of the way on that side.

The silicious variety is sometimes bent and contorted, but in general strikes parallel to the range as a whole ; while the dip is always steep and often vertical. In many places it has been greatly crushed and recemented into a breccia. As the whole range is wooded and moss covered, its associations have not been as closely worked out as elsewhere, though it probably forms a syncline enclosed in quartz-porphyry schist, with some bands of dolomite or green schist and also outcrops of diabase along its margin.

A small band of granular silica a quarter of a mile north of the northeast end of the ridge just described is probably an extension westwards of the range including the Josephine mine, suggesting here also a fault along a plane running northwest and southeast as in former cases.

Another small outcrop of iron range rock has been reported south of the portage between Loonskin lake and a pond to the southwest, about a mile southeast of the range described above, but the region is in general low and swampy and little is known of the rocks adjoining it.

In a general way, the rocks of the Helen Iron formation, though so narrow, rarely exceeding 1,000 feet in width, are the most distinctive feature of the Lower Huronian, since they are very easily recognized and nearly always rise as sharp ridges above the surrounding region. Except on Gros Cap, where the bands strike about northwest and southeast, the different ridges have a surprising uniformity of strike, about 60° or 70° east of north, the same direction as one finds prevalent in the adjoining schists. Though the general strike is so uniform, it is evident that along with the other rocks of the region the Iron formation has been interrupted frequently by eruptive masses, and apparently also by faults of great magnitude, the effect always being to shift the part east of the fault plane towards the north.

It is probable that the bands of iron range are not simple tilted strips of rock but closely folded sheets, only the lower portion of which is still preserved ; and it may be that the apparent gaps between the ranges are really due to the erosion of the general rock surface so far down as to cut off the folded upper part of the Lower Huronian altogether, leaving only the schists beneath. If this is the case the depth to which the iron-bearing rocks descend may be quite limited, though the small amount of mining and diamond drilling done on the range does not give very certain evidence in this respect.

Immediately underlying the granular silica and siderite there is in some places a thin sheet of black slate consisting of granular silica charged with graphite; in other places the iron-bearing rocks seem to pass into schistose varieties of siderite with sericite and other minerals, and then without any sharp break into the wide-spread pale gray or green schists of the Wawa tuffs. Among the latter there are very sideritic bands and also very silicious, almost cherty, bands, as mentioned before, suggesting that the causes producing the present characters of the iron range rocks had a powerful effect on the underlying schists also. The source of the immense quantities of iron and silica contained in these rocks is not at all clear, so far as the results of the study of the immediate region are concerned ; but those interested in the matter will find various theories suggested to account for similar facts in the works of the American geologists who have studied the iron ranges of the states to the south and west of lake Superior.

One point in the association of rocks is peculiar, that a bed of rock so rich in iron as the upper part of the Lower Huronian should be uniformly and intimately connected with a rock so poor in iron as the quartz porphyry or porphyrite whose schistose varieties make so much of the Lower Huronian. The source of the iron must be sought for perhaps in some of the basic eruptives of the series if it is not looked on as a direct sediment, perhaps of a chemical nature, on the sea bottom of the time.

The Upper Huronian.

The Upper Huronian rocks of the Michipicoton region consist mainly of the Doré conglomerates, usually very schistose, but often crowded with boulders and pebbles Sir William Logan gives a detailed account of the section of these rocks exposed at Doré river, evidently considering it a typical example of the Huronian, since he includes it in his discussion of that formation ;[8] but he was able to study only the rocks lying on or near the shore, which he found to have a thickness of 1,700 feet. Of the formation to the north (inland) he says " towards the lower part it assumes more the character of the gneiss which usually succeeds it, and becomes interstratified with reddish yellow felspathic layers ; but sufficient data have not yet been ascertained to determine what may be the total thickness of the slate rock in this part, though it must probably attain several thousand feet.[9] The Doré conglomerate has also been referred to briefly in the reports of the Bureau of Mines,[10] and in 1899 the section was proved to have a width of more than 2,500 feet at the mouth of the Doré, and to extend for three miles west along the shore, where it is interrupted by a mass of granite.

It is now known that the conglomerate occurs from point to point along the shore as far as Dog river, ten miles to the west, and eastward to about the third mile post on the railway from Michipicoton harbor to the Helen mine, a distance of four miles ; while the greatest width measured during last summer's work is about a mile and a half, on a line due north of the harbor. The field work proves that the Huronian slates (schists) do not gradually merge into Laurentian gneiss, as supposed by Sir William Logan, since beyond the schists with felspathic layers the conglomerate is found again, nearly a mile inland from the mouth of Doré river.

The conglomerate is in many places penetrated by dikes of quartz-porphyry, or sometimes quartzless porphyry, running parallel to the stratification as a rule and in many cases squeezed or sheared into felsite schist in which the porphyritic structure is almost lost. It is these bands of reddish schist no doubt which Sir Wm. Logan took for a transition to the Laurentian. In one sense, they may still be looked on as closely related to the Laurentian, since the dikes are probably off-shoots of the eruptive masses of granitoid gneiss which we generally include under that name.

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[8] Geol. Can., 1863, pp. 52-55. [9] Ibid, p. 54. [10] Vol. 8, p. 132; and Vol. 9, pp. 183-4.

In addition to the porphyry dikes there are numerous masses and dikes of diabase rising through the conglomerate, apparently later in date than the porphyries, since they are seldom squeezed into schists so far as observed. The diabase seems to be the most resistant rock of the region with the exception of the iron range of the Helen mine, and accordingly forms in many cases the tops of the highest ridges.

In general, the topography of the conglomerate band is very rugged and hilly, with numerous successive ridges running parallel to the strike, which averages about 70° ; and with very steep slopes on each side but especially toward the north, where the narrow hills often drop off vertically or even overhang. The cause of this is to be found in the unequal resistance of the different layers to weathering, and in the fact that the dip is usually very steep, from 60° to 90°, averaging about 75° to the south. Dips to the north have only rarely been noticed. The steep cliffs formed in the way described often have a height of 50 or more feet, and on the north side are frequently unscalable for considerable distances. Perhaps the most rugged portion of the region is directly north of Michipicoton harbor, where within two miles of the shore there are several of these ridges, with valleys between, rising finally to over 600 feet above lake Superior.

While the general strike is about 70° there are great local variations, especially in the vicinity of eruptive masses. Near the second mile on the railway the strike is nearly north and south for more than four hundred yards, but on each side the usual directions of from 70° to 75° are found. There is good reason to believe that in general the strike of the schistosity corresponds to that of the sedimentation, for bands of rock free from pebbles follow the same direction, but in a few cases the schistose structure seems to cross the direction of sedimentation, having a bearing of about 45°, while the general course of the ridges is 70° or 80°.

CHARACTER OF THE CONGLOMERATE.

The best sections for examining the conglomerate are along the shore and on a number of small islands near the mouth of Doré river, where wave action gives a clean surface kept well scoured and showing the varying colors of the pebbles just under water. To give an idea of the rock the pebbles of each kind occurring in a square yard of surface were counted, with the following result :

Dark green schist	38
Granite	13
Granular silica (iron range rock)	11
Spotted gray green schist	8
Porphyry	7
Felsite	3
Conglomerate or breccia	1
Total (omitting pebbles less than an inch in diameter)	81

The matrix at this point (a small island southeast of the mouth of the river) consists almost entirely of smaller pebbles somewhat squeezed and flattened, and on the wave worn cross section the rock does not look schistose, so that Logan's term "slate" conglomerate does not seem inappropriate.

The pebbles and boulders on the islands seem to have been less rolled out than in most other parts of the region and afford the best chance for study. The list just given includes the majority of the rock species occurring, and it will be noticed that all except the granites and porphyries, which are eruptives, are characteristic Lower Huronian or Keewatin rocks. No Laurentian looking gneisses have been found, and the only gneissoid boulders have evidently been greatly flattened, being in some cases four or five times as long as they are thick, so that their schistose appearance is probably due to squeezing and is not original.

The granites have in most cases stood the stress better than the other rocks, and are often still round when the green schists have been rolled out into thin sheets and wrapped about them. Most of the granite boulders when broken have a greenish color and appear to have been modified to the protogine variety in which the mica is turned to sericite or chlorite, but a few of them are still red and little different from the ordinary granites of the adjoining region.

The pebbles of granular silica are generally small and dark in color like chert, though some are white and coarse in texture, sugary like the quartz of some of the Wawa gold bearing veins. A few of them contain more or less siderite, while many carry pyrites and weather to the appearance of a friable rusty sandstone. The sparse conglomerate or breccia pebbles and boulders are very curious. Some of them consist of small pebbles of granular silica enclosed in small amounts of a greenish chloritic matrix. No rock exactly like them has been found in the Lower Huronian.

While the pebbles are very distinct at the mouth of the Doré river, there are other parts of the area where they have all been rolled out thin and are almost invisible on cleavage surfaces, so that they are easily overlooked altogether. As the majority of the pebbles are of green rocks the resulting schist is generally green also, a chloritic or sometimes hornblendic schist, not differing in appearance from the schists of the Lower Huronian and often difficult to separate from them.

The matrix of the conglomerate, while probably formed of small grains and pebbles in the beginning and still having that appearance in places, is generally changed into green schist, chloritic, hornblendic or micaceous.

SECTIONS ACROSS THE CONGLOMERATE.

Inland from the lake the country is in general heavily wooded and covered with thick moss, so that satisfactory exposures of rock are not always easy to find, but the hill tops and steep declivities often provide fair outcrops. Going north from the schist conglomerate at the mouth of the Doré undoubted conglomerate is not again found for about a mile, the rocks being the felsite schists mentioned by Logan and soft gray and green schists with some dark eruptives; then a belt of distinct conglomerate about 200 yards across occurs, followed by quartz-porphyry schist and then by Laurentian rocks. It is probable, however, that much of the gray and green schist encountered between the two bands of conglomerate is really the same rock squeezed and sheared till unrecognizable. The felsite schists are no doubt porphyry dikes subjected to the same process.

A section north from Michipicoton harbor shows more than half a mile of undoubted conglomerate, then gray schist with a few pebbles visible, followed by a quarter of a mile of level swampy region with no rock exposed. A ridge of diabase then rises above the valley, and is followed by another half-mile of well defined conglomerate.

A mile east of this a section shows almost unbroken conglomerate from a point somewhat south of the railway for a mile and three-eighths to the north, when Laurentian rocks appear. A mile farther east the conglomerate is narrowed down to only five eighths of a mile in width but has distinct pebbles the whole way where not hidden by the plains of sand and clay covering the middle of the section.

At the northeast end of the large area of Doré conglomerate, near mile 3 on the railway the strike changes to north and south, and a tangle of dikes and eruptive masses, greenstones felsites and porphyries, with some bands of schist free from pebbles, cuts it off. Beyond this eruptive area and a sand plain along the Magpie river, a small strip of conglomerate just south of Black Trout lake, having a strike of northeast and southwest, may be looked on as its continuation.

At the western end of the main band of Doré conglomerate little work has been done, so that its width in that direction is unknown, but a broad hill of diabase rising a quarter of a mile west of the river mouth appears to cut it off at least partially, and still farther west its continuity is broken by eruptions of granite.

ASSOCIATIONS OF THE DORÉ CONGLOMERATE.

The Doré conglomerate near Michipicoton harbor is nowhere found in contact with undoubted Lower Huronian rocks, though what look like Wawa tuffs and have been mapped as such occur as a narrow band to the north between the conglomerate and the Laurentian ; and schists with some granular silica, certainly Lower Huronian, are found near the north end of the peninsula of Gros Cap, though a small sand plain separates them from the conglomerate. The Laurentian eruptives have not been seen in actual contact with them on the north, though some belts of green schist in the Laurentian a little way from the hidden contact may be greatly metamorphosed conglomerate swept off at the time of eruption.

The relationship to the south is more distinct, and the Gros Cap greenstones appear to be the underlying rock folded into a syncline with them ; so that south of the railway half a mile from the harbor the greenstone seems to overlie the conglomerate, both having a dip of about 70° to the south.

There is however one point near the tote road south of the railway where rock mapped with the greenstone appears to cut across the schist conglomerate eruptively, the contact being vertical and crossing the schist diagonally. This relationship may be due to faulting or to an eruption of basic rock later than the Gros Cap greenstone.

The general attitude of the large area of schist conglomerate just described suggests a continuous series of strata, as supposed by Logan, since in most cases the dip and strike are fairly uniform ; and any marked variations may be accounted for by the presence of eruptive rocks. This would give them a thickness of about 7,500 feet, for the greatest width is 8,000 feet with an average dip of about 75°.

However, it is not easy to imagine the mass as tilted bodily, and it is more natural to think of the series as forming a close fold, most probably a syncline with the two sides closely squeezed together, and tilted slightly against the Laurentian mass to the north. In this case we may suppose that the schists were to some extent pulled asunder at the base of the fold, which was in tension, allowing the felsites and diabases to penetrate parallel to the cleavage. There is no doubt however that some of the diabase dikes are later in age and cut diagonally across the schistose structure.

One feature of the arrangement of the conglomerates supports the view that they form a syncline. Toward the western end of the series of rocks we find bands of well defined conglomerate along each side with gray and green schists showing few or no pebbles between, as if there was an upper layer of finer sediments nipped in between the two sides of the conglomerate. The absence of pebbles in this central area may however be due merely to a greater amount of compression, flattening them beyond recognition. Toward the eastern end there are very few gaps where pebbles have not been seen.

Assuming a synclinal fold, since we cannot conceive of this great belt of rocks a mile and a half thick continuing downwards indefinitely, we may imagine it sagging trough-like into the plastic Laurentian foundation with a relatively thin sheet of Lower Huronian beneath it, in which case its thickness will be 3,700 feet as measured north of the Doré. From this should be subtracted the considerable thickness of felsite and diabase dikes ; and to it should be added, in order to get the original magnitude of the formation, the reduction in thickness due to squeezing. As in many cases the pebbles and boulders are flattened until they are five or ten times as long as they are thick in cross section, a large allowance should be made for this.

OTHER CONGLOMERATE AREAS.

The other areas of Doré conglomerate in the region mapped are relatively small and have not been very carefully studied. The largest is at the third falls of the Magpie three or four miles north of the Helen mine, and its strike suggests a continuation of the band south of Black Trout lake. Between this and the mine, where the Josephine branch of the railway crosses Speight's north and south line, pebble-bearing schists are again seen in cuttings along the railway. The exposures on the railway are not entirely satisfactory, and the rocks may be crush conglomerates or possibly in some cases agglomerates. A few well-rounded pebbles of granular silica however give support to the view that these green schists are really water-formed conglomerates and probably the equivalent of the series just described, though the general appearance is very different.

Crossing half a mile of sand plain to the east of this, a small area of very characteristic Upper Huronian conglomerate is met with, which might be described in much the same terms as the larger western area. It is best seen a little east of the Grasett road where low hills rise above the sand plains. Here the rock is crowded with pebbles and boulders, some of the latter reaching a diameter of two feet, and being very little flattened. Gray and green schist, and felsites or quartz-porphyries, are the commonest rocks, and granite and iron range pebbles seem rarer than at the Doré. Where the boulders are most crowded it is hard to determine the strike and dip, but farther to the southeast one finds some bands with few or no pebbles, occasionally with a structure suggesting cross bedding, having a strike of 90° or 95° with a dip of about 50° to the north. Still farther east on the road the rock is seen to be crowded with small pebbles of various kinds, greatly flattened, among them many angular ones of black or gray slate much like a thick bed of Eleanor slate, which dips under the conglomerate and forms the uppermost member of the Lower Huronian at this point.

No dikes of either acid or basic rock were observed in this small area of conglomerate nor any of the green schists frequently found in the western area, but certain gray schists readily decaying into coarse brownish gravel are frequent—probably ash rocks of the same general age as the conglomerate, and therefore Upper Huronian.

A mile and three-quarters southeast of this, just to the south of lake Eleanor, another small mass of well defined conglomerate has been found, having a known length of three-quarters of a mile from east to west, and a greatest width of an eighth of a mile, with a strike varying from 65° to 90° and a dip of about 60° to the north or northwest. It is best exposed in hills a short distance west of the southern bay of lake Eleanor, and has not been seen on the shore, though interbedded ash rocks like those observed to the northwest along the Grasett road crop out by the lake and on some small islands near by. Just to the south of the conglomerate is a narrow band of dark gray Eleanor slate resembling that found beneath the northwestern conglomerate.

There is reason to think that the rocks to the west of lake Eleanor are cut off by a fault of considerable magnitude from those to the east, which accounts for the absence of the conglomerate on that side. The country to the west is thickly wooded and little explored, so that a continuation of the Upper Huronian in that direction may yet be demonstrated.

The two small areas of conglomerate just described run parallel to one another about a mile and a quarter apart, the space between being in general low ground, occupied by lake Eleanor and a wide sand and gravel plain.

Small outcrops of conglomerate or agglomerate of a different appearance from the rocks just described are found at the west end of lake Wawa on islands near the south shore of the wide southwestern bay. At the latter point well formed pebbles of several rocks may be seen in a matrix like quartz-porphyry. The varieties distinguished are mainly felsite and gray schists, a very few looking somewhat like the granular silica of the Iron range ; but it is doubtful whether this narrow strip of conglomerate should be classed with the others, and in any case it is present in insignificant amounts.

Whether any of the various schists and slates to the east of the main area of conglomerate should be placed in the Upper Huronian is very hard to decide, except in the case of the small amount of ash rock interbedded with the two eastern conglomerate areas, and no attempt has been made to separate the different schists in the mapping.

Various small outcrops of conglomerate have been found at other points in the region, one on Magpie river, three miles above its mouth, and another at the second portage some distance down stream,[11] and also several miles to the southeast, at a point a mile and a half south of the high falls of Michipicoton river,[12] so that the conglomerate probably covered a large part of the region at one time, though now greatly cut up by later eruptives.

In addition to the stretches of conglomerate thus far referred to there is a considerable area at the falls of Dog river, 10 miles west of Doré river and again near Eagle river and to the east of Pucaswa river, in the latter case extending as a fringe along shore for about a mile and a half. From the conglomerate near Pucaswa on the west to the outcrop south of the high falls of the Michipicoton on the east is a distance of about 57 miles, the longest stretch of this rock yet reported ; but it should be added that there are several long gaps between the outcrops. That they were originally continuous is however very probable.

Relationship Between Upper and Lower Huronian.

There is one rather puzzling relationship between the Upper and Lower Huronian at Michipicoton, due perhaps to the large areas of eruptive rocks which interrupt them and also to the extensive faults cutting them across from northwest to southeast. The synclines of the Lower Huronian have a core of iron range rocks running through their center, but one never finds the Upper Huronian conglomerate nipped in between the folds of the siderite and granular silica. On the other hand the great syncline of the Upper Huronian, from Doré to mile 3 on the railway, does not rest on rocks of the iron range but on what appears to be a thin sheet of the Lower Huronian quartz-porphyry schists.

Again, the lake Eleanor iron range clearly rests in a syncline of the quartz-porphyry schist, but the nearest outcrop of conglomerate, which is only a quarter of a mile to the northwest, has no apparent connection with it and seems to lie in a separate synclinal fold of the Wawa tuffs, though this is not certainly proved.

The only certain relationship between the Upper Huronian and the upper part of the Lower Huronian is to be found in the iron range pebbles occurring in such numbers in the conglomerate, clear evidence that there had been great destruction of the iron bearing rocks before the later rocks were formed. It cannot be said therefore that the succession outlined at the beginning of this paper has ever been found complete, with the Gros Cap greenstones, the Wawa tuffs, the Helen Iron formation and the Doré conglomerate, arranged one above the other. It may even be that the Lower Huronian had already been consolidated and thrown into folds before the erosion took place which furnished the pebbles of granular silica and other Lower Huronian rocks now contained in the conglomerate, so that the synclines of the Upper Huronian may be of entirely later age.

The Helen Iron Region.

Beginning on the west the iron range as found at the Helen mine is in two long fingers reaching the shore of Talbott lake but not crossing it. The southern finger, long and narrow,

[11] Bur. Mines, 1899, p. 144. [12] Ibid., 1897, p. 191.

possibly reaches a short distance into the water of the lake but does not appear on the opposite side. It extends eastwardly up the valley of a small creek until it reaches the main body of the formation near Sayers lake. Following the boundary northwards are several minor folds which are seen to rest on Wawa tuffs. Then crossing the railway track near the outlet of the lake, the range extends westward down to the shore of the lake, where it comes to an end within a few feet of the shore, being bottomed by Wawa tuffs.

On the north side the range seems to extend quite regularly towards the east, the formation standing almost vertically.

At the outlet of Sayers lake, as shown in cuttings along the railway, the formation has been thoroughly shattered and a beautiful breccia has resulted. A small tunnel driven at right angles to the formation at the foot of the outlet of Sayers lake disclosed cherts carrying pyrites and a small amount of carbonate.

South of the railway track and west of Sayers lake Mr. Ely did considerable work in stripping the formation, but nothing was shown by his trenches except pyritic quartz rock and ferruginous cherts with a small amount of surface oxidation.

On the south side of Sayers lake, a little further east, a tunnel was driven by Mr. Goetz at right angles to the formation disclosing considerable pyritic quartz rock which in some places became almost pure pyrite. Wawa tuffs striking east and west bound the formation on the south.

Along the north side of Sayers lake, where the formation has been exposed by railway cuttings, the belt of cherty rock is shown to have been badly disturbed by folding and faulting, the strikes and dips changing very rapidly, but on the whole the formation is seen to run east and west. Near the inlet from Boyer lake a small amount of pyrrhotite is seen associated with pyrite.

At the outlet of Boyer lake the iron range contains considerable carbonates as well as banded chert carrying pyrite, and one hundred feet eastward along the railway track a lens of pure carbonate is found carrying as much as 35 per cent. of iron. This changes gradually until it becomes a quartz-porphyry schist by a progressive decrease of carbonate, but so gradual is the change that no definite line of demarcation can be drawn.

Along the south shore of Boyer lake the rocks exposed are the ordinary quartz-porphyry schists, though near the stairway there is a small dike of greenstone now altered to schist four feet in width. The southern boundary of the ore body is the same quartz-porphyry schist already described. On the surface at the top of the hill near the camps it is seen to contain a small amount of carbonate and in a drill hole to be described later which entered this rock several hundred feet deeper it is found to contain comparatively pure siderite.

On the eastern boundary of the Helen claim, as shown in detail on the accompanying map, succeeding the quartz-porphyry schists to the north is a band of grained silica, and following this almost to the northern boundary of the claim is a band of very pure carbonate of iron. On the northern boundary, and running almost parallel with it, are beds of ferruginous chert dipping almost vertically and extending for 450 feet to the north. This banded chert continues regularly along the north shore of Boyer lake to the part already described near the outlet of Sayers lake.

The ore body itself lies at the eastern end of Boyer lake and is surrounded on the three sides by steep and high hills and on the west by the waters of Boyer lake. A plan of the location which accompanies this report shows the contour of these hills as determined by aneroid barometer and the contours of the ore body as actually levelled. It will be noticed that the highest point of ore is almost 100 feet above the original level of Boyer lake and that the surface of the ore body dips from this point in all directions.

A small valley running east from Boyer lake on the south side of the ore body was originally filled largely with glacial materials, but in the eastern end with boulders of ore and siderite also. The ore body was for the most part covered with a very slight mantle of moss and earth, but on the east the glacial material was from 15 to 20 feet thick and in the valley just mentioned it was much deeper.

To the west of the ore body lies Boyer lake, a pond about a quarter of a mile in length and hardly as wide, rock rimmed throughout and 133 feet deep. This lake is now being pumped out and on some boulders exposed along the shore one notices a film of oxide which must have been deposited on them there. As one of these boulders was a gneiss certainly brought there in glacial times, the thickness of the crust on it from one-sixteenth to one-eighth of an inch represented the deposition which has taken place in the lake since that time.

Along the shore near the ore body a yellow ochre was exposed which on analysis showed:— Iron 49.50 per cent.; manganese 0.36 per cent.; silica 6.63 per cent.; lime, trace, carbon dioxide 4.13.

Near this yellow ochre was a dark green mud which apparently will be found to cover the bottom of the lake. Analysis showed :—

	Per cent.
Silica	47.58
Iron	11.23
Manganese	0.14
Lime	0.95
Carbon dioxide	3.19

THE HELEN ORE BODY.

Into the ore body several drill holes were put down, the locations and dips of which have been plotted on the map, and the cores of these were examined by Mr. C. H. Clarke, chemist of the company, analysis being made of representative samples at various depths.

Drill hole No. 1, located near the point, was sunk vertically 188 feet, all in ore containing on the average 63.89 per cent. of iron, 0.0345 per cent. of sulphur, 0.1159 of phosphorus and 2.24 of insoluble matter. The highest assay showed 69.16 per cent. of iron and the lowest 59.87.

Drill hole No. 2, located at the same point, was drilled at an angle of 45° towards the east to a depth of 152 feet, starting as in the previous case 654 feet above Lake Superior. Analyses show an average of 61.00 per cent of iron, 0.046 of sulphur, 0.062 of phosphorus and 3.81 of insoluble matter.

Drill hole No. 3, located 440 feet from these, was started at an elevation of 734 feet above Superior, and was put down vertically for 72 feet, the first 18 feet being soil. Below this ore was found running 56.73 per cent. iron, 0.015 sulphur and 0.017 phosphorus, with 8.40 per cent. insoluble.

Drill hole No. 4, at the same place but at an angle of 45° toward the northwest, reached a depth of 112 feet, and showed low grade ore running from 31 to 62 per cent. of iron.

Drill hole No. 5, on the old road from the top of the hill and 300 feet south of No. 1 hole was sunk vertically passing through 36 feet of clay and 59 feet of lean ore.

Drill hole No. 6, at the same point, was run into the hill at an angle of 45° and penetrated to a depth of 558 feet, passing through felsite, siderite and pyrite, chiefly siderite, however. The iron contents varied greatly, reaching nearly pure siderite at about 110 feet, with 44.03 per cent. of the metal. Samples from between 75 and 120 feet, omitting a small band of felsite, averaged about 37 per cent. of iron and 2.31 per cent. of manganese. One from about 380 feet contained 29.82 per cent. of iron and 2.69 per cent. of manganese.

The following average analyses of the surface of the ore body at various points as determined by Mr. Clarke give a general idea of the distribution of the ore as originally exposed :

1. From Boyer lake to a point halfway to the railway cut: Insoluble 5.11; iron 61.01; sulphur .042; phosphorus .071.

2. Average from halfway to the railway cut: Insoluble 3.30; iron 62.46; sulphur .025; phosphorus .047.

3. Average on north side of railway cut, depth 18 feet: insoluble 19.90; iron 51.70; sulphur .047; phosphorus .133.

At points in the ore body pockets of pyritic sand are occasionally met. The largest of these, which was exposed during an examination of the Helen mine last May, as seen in the bottom of the pit, was 45 feet by 8 feet, but was probably wider. At both ends, however, it was cut off very abruptly by the ore body, there being no gradation between the solid ore and the pyritic sand. Occasionally in this bed some boulders of solid ore were noticed, the largest being two feet in diameter. Little stringers of pure white fine sand were occasionally seen in the pyrites, but apart from these minor occurrences the pyritic sand seemed to be a pure concentrate. It is said that on the surface this deposit first made its appearance as a chimney of sand about 30 feet in diameter and that as followed down the silicious sand was gradually replaced by pyritic sand until the present level was reached, and that the pyritic sand has been replaced in the bottom with solid ore just as abruptly as it changed on the sides.

Back of the ore body as above mentioned is a high hill rising about 1700 feet above sea level where costeans made at several points have enabled the structure to be fairly well made out, the results being plotted on the accompanying map of the Helen mine. This costean was sampled by Mr. Clarke who made analyses of the siderite, beginning at the south and passing to the north with the following results:—60 feet of siderite, 5 feet of schist, 20 feet of siderite, 37 feet unsampled, 28 feet of siderite, 55 feet unsampled, 28 feet of siderite.

The siderite, which averaged 34.94 per cent of iron and 7.70 per cent of insoluble matter, has a total width of 136 feet.

GENESIS OF THE IRON BEARING ROCKS.

So far the description of the Helen mine has been confined to the facts observed, but we may now attempt to explain the manner in which the formation was probably deposited.

Apparently at one time volcanoes were in active operation in this vicinity, lava flows took place and ashes fell abundantly on the neighboring lands and in the adjoining seas. These on consolidation gave rise to the quartz-porphyry schists or "Wawa tuffs" as they are marked on the map. At intervals the volcanic activity would naturally diminish, and during such periods chemical sediments were precipitated from the waters, which seem to have been heavily charged with carbonates of lime and iron and also with silica. These intervals would be of varying duration and the rate of precipitation would also vary, and so lenses small or large of carbonates or of silica would occur in the tuffs. On the recurrence of volcanic activity the carbonates on being precipitated would be scattered throughout a large volume of volcanic ash. Largely in this way seem to have been formed the Wawa tuffs of the region and interbedded lenses of limestone and siderite, as well as the grained silica, small in amount but widely distributed.

Later there was an entire cessation of the volcanic ashes, and chemical sediments were precipitated for a considerable time, in some places carbonates and in other places silica having been precipitated first. The deposition of one or the other went on for a considerable time until beds perhaps 500 feet in thickness were built up.

Still later, the Wawa tuffs and the Helen iron formation were both folded and tilted, by which the schists were formed into a trough underlying the iron formation ; while that formation, lying closely on this, occupied the interior of the basin. In the sections accompanying both the general map and that of the Helen mine, this folding has been expressed.

These foldings were not uniform for the whole extent of the iron range but being greater in one part than another, pitches were given to the formation at approximately right angles to the axes of the folds.

At the Helen mine numerous observations along the shore of Boyer lake and the ore body seem to indicate that the Wawa tuffs pitch about 30 degrees to the east. By this change in the pitch the iron formation would become lower in some places, and after erosion had still further lowered the general level it would appear as isolated fragments rather than a continuous formation. That this is now the case can be seen by reference to the map. Similar conditions seem to have existed in the Vermilion Iron Range in Minnesota.

The folding and tilting of the iron range was naturally accompanied by a great fracturing of its component parts, and the breccia which often resulted is well shown on the railway track near Talbott lake.

The origin of the deep ponds Boyer and Sayers is doubtless connected with this brecciation, for they are rock-rimmed and have a depth of 130 feet, and can naturally be supposed to have been brought about entirely by solution. Brecciation of these rocks would promote the circulation of solvents and so assist in gradually deepening them.

Several solvents may have had an influence in dissolving and removing the carbonates, but probably the most effective would be a solution of acid ferric sulphate or sulphuric acid, probably resulting from the oxidation of the iron pyrites found in considerable quantity throughout the iron formation both in the chert and the carbonate.

The ore body itself is the result of the oxidation of the iron carbonates which existed in such large quantities at this point, the iron pyrites probably contributing very little to the ore body. On the surface of the hill where oxidation of siderite has progressed inwards about half an inch leaving that amount of brown hematite, it is found that grains of pyrites which were scattered through the siderite still remain unaltered, going to show that pyrites is changed with comparative slowness. Moreover, the presence of pyrites in the pit itself as described above shows that it may be deposited as concentrates and still undergo comparatively little oxidation.

THEORY OF ORE FORMATION.

Apparently the process of ore formation has proceeded as follows :

A solution of the iron carbonates derived from the overlying parts of the iron formation (which we may assume to have been several hundred feet higher than at present) penetrated downwards to a point where the ore is now found, where it came into contact with a current of water charged with oxygen. This would result in the precipitation of the iron as an oxide or as a hydroxide. The fact that the ore body seems to dip in all directions from its highest summit would suggest that at this point the precipitation must have occurred more rapidly than elsewhere and that here was the point where the water carrying the oxygen met the iron solution.

Apparently the upper parts of the ore body were formed much as stalagmite is deposited on the floor of caverns. This of course assumes that surrounding the ore at this time there were masses of the iron formation, probably in the main siderite, which formed the walls of the cavern. Such a hole as may have existed here may be observed on a much smaller scale on the south shore of Long lake near the Josephine mine. It is in this region very unusual to find caves or caverns, but at this point of the iron range a small opening about one foot in diameter comes to the surface, opening below into a cavern about 25 feet in depth and widening out to an unknown but probably small extent. No doubt this cavern has been produced in part by folding and in part by solution, and it is possible that a similar but larger cavern existed where the

Helen ore body is now deposited. In this cavern one can see how there might be deposited at times through the in-rush of water large quantities of pyritic sand, the residue from the solution of the overlying siderite. As already explained, the pyrites are observed to weather much less rapidly than the carbonate, and being comparatively heavy might be swept along by some stream but deposited where the velocity was checked. In this way one can see how at intervals in the ore body concentrates of almost pure pyritic sand could be brought about, and in these concentrates one can well understand finding some boulders of ore or partially decomposed siderite and even a little sand as already described.

Ths origin of the pure white sand is found in the silica distributed through the siderite which contains from 5 to 10 per cent. even when tolerably pure. Some of this may have been dissolved and removed but most of it probably remains in the ore body.

The siderite also contains commonly about two per cent. of manganese. This is not at all unusual in deposits of carbonates of iron and is found in other iron locations near lake Superior. It is to be noticed that almost no manganese occurs in the ore deposit, but as is well known the carbonate of manganese behaves somewhat differently from the carbonate of iron in regard to solvents. It seems in this case to have been dissolved at the same time as the carbonate of iron, and not to have been precipitated at the same place but to have been carried further, and so to have become dissipated.

After the formation of the ore body as outlined above the mass of siderite which formed the boundary wall to the south and also the silicious material overlying the ore body which was left after the leaching of the carbonates from them were removed by erosion. This would leave a valley almost 100 feet deep along the south side of the ore body between it and the green schists, which was filled at the time of the retreat of the ice with glacial debris and also with boulders of ore and undecomposed siderite from lenses known to exist in the overhanging green schists.

In the upper drifts several boulders of ore resulting from the decomposition of siderite are found, and mixed indiscriminately with these are beds of white sand. Pyritic sands also in these drifts are due to concentration.

In the section accompanying the map of the Helen mine an attempt has been made to show how the iron formation was probably folded,—two troughs resulting from a double fold, the limbs of which are so closely pressed that the parts now remaining stand almost vertical.

The southern one of these troughs probably at one time extended up the steep hill near the incline hoist, and many years ago may have resembled somewhat the southern finger shown on the map as now stretching to Talbott lake. Erosion has, however, removed all the upper part and it appears to be merely a widening of the main fold.

The northern fold is represented as being deeper, because it is believed to be part of the range which continues under Boyer lake to Sayers lake and Talbott lake.

As will be seen from this section the green schists form under the Helen ore body an impervious basin which is tilted about 30 degrees to the east. If this interpretation is correct, it will be quite possible that the ore body may be found to extend to the east beneath the siderite outcrops on the eastern part of the Helen claim. The section also shows that the southern fold has been slightly overturned and dips about 70 degrees to the south. No doubt the ore body will be found to follow this dip somewhat to the south, but it is not probable that it will go to any great depth in this direction.

The main formation on the north is also bottomed by the impervious basin of green schists, so that it is quite possible that in this basin deposits of ore may accur. Indeed they may have existed where Boyer and Sayers lakes are now found but may have been largely carried away by later erosion.

The reports that the drills operated by the owners of this property struck ore seem quite probable. From a geological standpoint exploration in both Sayers and Boyer lakes would be quite warranted, but there is absolutely no possibility of finding ore in Talbott lake.

It is also possible that under the hill to the east of the Helen, deposits of ore may be found, the most unfavorable feature in regard to this being the large amount of siderite on the surface of the hill which would seem to indicate that little oxidation had taken place on this part of the range.

The Iron Range at Other Points.

The four small ranges of the iron formation occurring on the trail from Wawa to Eleanor lakes are so narrow and so little iron is seen in them that they are probably entirely useless from an economic standpoint.

The same is to be said of the similar occurrence of banded silica on the Josephine branch of the Algoma Central Railway to the north of the Helen, and the small occurrence of banded silica carrying pyrites on the trail leading to the southwest end of Loonskin lake is also useless as an iron location. This one was originally taken up as a gold location, and an analysis of the pyritous material does show a trace of gold but not in economic amounts. Similar traces of gold are found in many points of the iron range, particularly where pyritous.

The iron formation exposed on the north of Brooks lake is about two miles in length and in places is several hundred feet in width. It consists of ferruginous chert with lenses of siderite, and is surrounded by Wawa tuffs which in all probability form an impervious basin at its base in which ore may yet be found.

The details of the iron belt occurring in the vicinity of Long lake are shown on the map, the narrow end of it extending from Long lake to Bauldry lake being too small to be of any importance, but where the belt widens out in the central part of Long lake it is of sufficient width to have yielded on concentration an ore body, other conditions being favorable. Considerable stripping has been done in this vicinity, exposing well the surface of the iron range, which is seen to consist of ferruginous chert, pyritic grained silica and lenses of carbonate. One of the latter on the south shore near Leg lake is of considerable size and of the usual purity, carrying about 35 to 38 per cent. of iron.

On the hillside overlooking Long lake there is a small cavern in the iron range probably due to folding which has been mentioned earlier in this report. Surrounding the formation here are the Gros Cap greenstones and Wawa tuffs which either singly or together doubtless form an impervious basin at the bottom of the belt. While no ore is visible at the surface, it is quite possible that at the bottom of this belt ore deposits may have formed.

The discovery of boulders of hematite on the south shore of Parks lake can only be explained by assuming that at one time there existed in the bottom of the lake a deposit of iron ore. Whether all this was removed by glacial action or whether the deeper parts still remain can only be proved by diamond drill work. As is already known, drill holes indicate that a considerable deposit of ore still lies at the western end of the lake.

Westerly from Parks lake towards Goetz lake there is a considerable belt of the iron formation underlain and surrounded by Gros Cap greenstone. As the siderite is not in large amount in the formation here, it would seem quite possible that at the western end of this formation test pits might reveal a body of ore. East of Parks lake the range continues for about two miles and was carefully examined as far as Kimball lake. In this distance the formation occurs as banded grained silica with more or less pyrite and small quantities of siderite.

The drill hole under the hill from the end of Parks lake showed nothing different from what can be seen on the hill top, but if there be any deposit here it will probably be at the contact between the iron formation and the underlying green schists, and not in the formation itself.

The four small patches of iron range shown on the map to the north of Parks lake are probably represented a little too large, their exact distribution not having been worked out. They are too small to contain important deposits of ore.

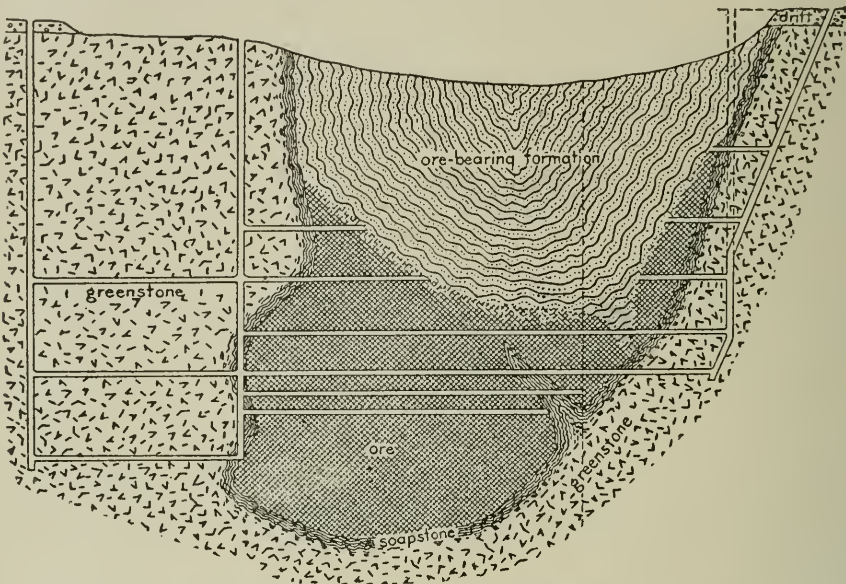


Fig. 1. Cross section Chandler iron mine, Vermilion range, Minnesota. (Van Hise).

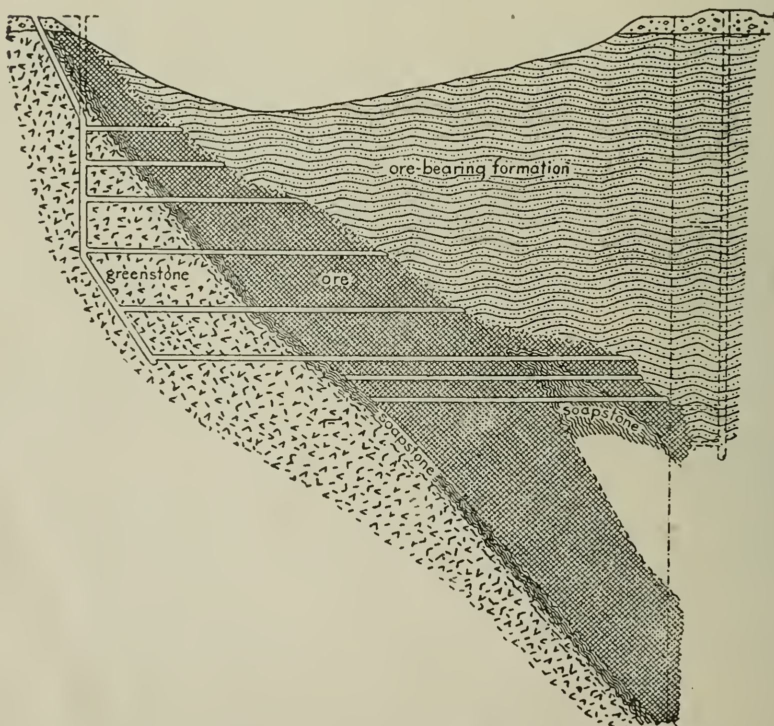


Fig. 2. Longitudinal section Chandler iron mine, Vermilion range, Minnesota. (Van Hise)

Analogy with Vermilion Range.

Given herewith (p. 174) are two figures of the Chandler mine at Ely, Minn., reproduced from Van Hise's recent report on the Iron-Ore Deposits of the Lake Superior region.

In the case of the Chandler as shown in *Fig.* 2, (which is a longitudinal section of the mine) green schists pitch rather steeply to the east. *Fig.* 1, which is a section at right angles to *Fig.* 2, shows the greenstones on both sides of the iron bearing formation and the concentration of the ore at the bottom of the trough. The ore reached the surface as is shown in *Fig.* 2 as a comparatively small area, and this was covered by drift, but following it down the ore body increased in thickness and also in width.

Just east of the Chandler are the Pioneer, Zenith and Savoy mines. The Pioneer property showed on the surface only hard banded jasper entirely without ore. Noticing, however, the pitch of the ore body on the Chandler it was inferred that at the bottom of the basin on the Pioneer property ore might be found though at a very much greater depth than on the Chandler property. A shaft was sunk about 700 feet before the ore body was reached.

These details are given because of the similarity of conditions to those obtaining in the Michipicoton district. The range between Goetz and Parks lakes as well as at other points compares closely with the conditions obtaining at Ely, and it is evident that any ore body found will be at the bottom of the iron formation in the trough made by the folded schists. How deep one may penetrate in Parks lake to reach the bottom of this trough cannot be determined. It is true that the trough reaches the surface near the shore of Goetz lake and from here pitches rapidly to the east, but how rapidly is unknown.

Many thousand dollars have been expended on the Vermilion range hunting for iron ores, some of which has been misspent in drilling green schists and Ely greenstones, while other parts of it have been lost in drilling in iron formation itself but with no results. Only two localities have been productive, the one at Tower and the other at Ely, 23 miles apart. If the analogy of the Michipicoton range with the Vermilion is perfect it must be assumed that many of the iron belts shown on the accompanying map of Michipicoton will likewise prove barren.

Indeed, if out of the areas shown on the map two productive areas at the Helen and Josephine are found it is perhaps all that can be expected ; nevertheless as already mentioned there are some possibilities of finding ore in other belts.

It should also be noted that more siderite seems to occur in the Michipicoton Range than on the Vermilion, and this fact is unfavorable to the occurrence of hematite ore. On the other hand, this siderite itself, carrying as it does from 35 to 38 per cent. of iron and admitting of concentration by roasting to 50 per cent. of iron, may prove of value.

PETROGRAPHY OF THE MICHIPICOTON REGION.

The band of Upper and Lower Huronian running from the mouth of Doré river northeasterly to beyond the Josephine mine consists partly of ordinary sedimentary rocks, partly of ash rocks and agglomerates or pyroclastic sediments, and largely of sheared and metamorphosed eruptives passing on the one hand imperceptibly into the pyroclastics and on the other into eruptives which show no schistose structure.

The Eruptive Rocks.

These eruptives are generally included in the mapping with the schists and sediments, since well defined boundaries are very hard to draw between them, and also because they are often intimately connected in origin and character with the adjoining schists. They include both acid and basic rocks, quartz-porphyries and porphyrites, as well as greenstones, all greatly metamorphosed. Their age relationships are not very certain, though it is probable that most of them belong to Huronian times, so that they have undergone all the squeezing, folding and faulting of the sedimentary rocks, and thus have been subject to great changes due to crushing and the circulation of water at considerable depths, in general below the level of plasticity.

Besides these more or less certainly contemporaneous eruptives, there are numerous others undoubtedly later in age forming dikes or bosses which penetrate the schists, in many cases across the strike, and which are seldom sheared or squeezed or greatly metamorphosed. Among them are acid rocks such as quartz-porphyrite and granite, and also basic rocks such as diabase, diabase porphyrite and picrite. At what date after the folding of the Huronian schists these later rocks were erupted is uncertain, though they are all supposed to be of comparatively ancient origin, pre-Cambrian or Cambrian. The later eruptives are often fairly fresh and furnish satisfactory materials for study, while the earlier ones are in general very unsatisfactory, the whole of the original minerals often having been replaced by secondary minerals.

THE ACID ERUPTIVES.

The acid eruptives include various types of granite, quartz-porphyry, quartz-porphyrite and felsite, belonging to the group of alkali-felspar-quartz rocks, and quartzless-porphyry, of the alkali-felspar rocks without quartz. The granites proper belong mainly or altogether to the Laurentian, even the rare, isolated bosses of granite in the Huronian having generally a thoroughly Laurentian appearance, and they merge into the schistose variety gneiss. Not much attention was paid to the Laurentian rocks, and comparatively few thin sections of them have been studied, but in general they are flesh-colored to pale gray, coarse-grained rocks, with comparatively few darker bands or areas.

A boss of bright flesh-red granite from near the northeast boundary of the main Upper Huronian conglomerate may be spoken of as a binary granite, since neither mica nor hornblende is present in appreciable amounts. It is thoroughly leucocratic, and is made up almost entirely of quartz, orthoclase with a very little microcline, and a plagioclase having the low extinction angles of oligoclase. Though the rock has undergone considerable crushing, as shown by the granulation of some of the quartz and the "mortar structure" around the larger felspar masses, it is still quite fresh.

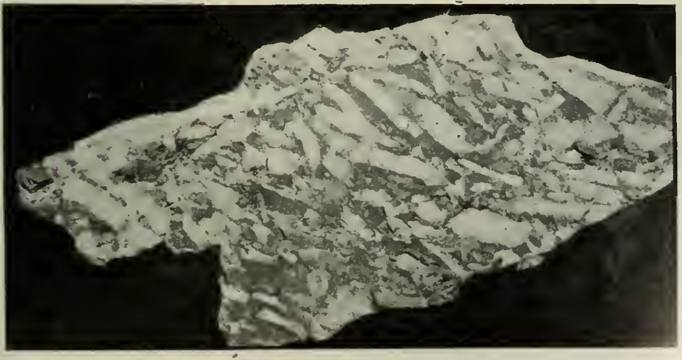
A specimen from the Laurentian boundary to the west of the rock just described is a normal granite, flesh-red, coarse-grained, and composed of quartz, orthoclase, microcline, oligoclase, muscovite and biotite.

A pale gray granite still farther west, near Doré lake has a similar composition, but with much muscovite and little or no biotite. The felspars in this case are not so fresh as in the others and contain many small scales of muscovite. All the granites studied from the north side of the Huronian band show evidence of squeezing and crushing.

From the south side of the Huronian only one Laurentian granite section has been examined, from a grayish flesh-colored outcrop a little south of lake Wawa. This rock is melanocratic and very different from the northern granites, containing biotite, hornblende and magnetite in considerable quantities. The quartz is extended into the felspars as micropegmatite, or is poecilitically intergrown with them, but the felspars are too greatly weathered to decide on their species.

A handsome flesh-colored granite porphyry with white dihexahedra of quartz sometimes a third of an inch in diameter, which forms bosses near the second falls of Magpie river and east of the Mission near the mouth of Michipicoton river, has much the composition of the last mentioned granite, but with a marked tendency to idiomorphy in the quartz and felspar, the latter

Falls at Steep Hill portage, Magpie river.



Breccia from Iron range west of Sayers lake.

Helen iron mine ; Sayers lake, looking west.

Helen iron mine ; Boyer lake, looking west.

often having good crystalline forms with quartz or sometimes biotite filling in the spaces between. The megascopic dihexahedra of quartz prove under the microscope to have been crushed or rearranged, and do not appear as single individuals. The felspars are quite largely striated, with very small extinction angles except one crystal which has an angle of 14° from the twin-plane, suggesting a variety like andesine. All the felspars are more or less turbid and contain muscovite scales or crystals. There is no definite ground-mass enclosing them as in true quartz-porphyries, so that this rock must be called granite-porphyry. In reality it comes near being panidiomorphic in the original sense of that word, since almost all of the components show more or less of their crystal form.

The quartz-porphyries vary much in appearance, some being flesh-colored, others pale greenish or gray and still others purplish gray ; and also in texture, some having large well formed phenocrysts of quartz and felspar, while in others the phenocrysts are obscure and the rock resembles felsite as seen in the field. Those which are associated with the Lower Huronian schists of the Wawa formation are usually greatly weathered, so that often only the cloudy outlines of the felspars and the clear spaces of the quartz crystals remain to show the character of the rock. Where the felspars are less completely weathered they include both orthoclase and plagioclase, often in equal quantities or with the plagioclase in excess of the orthoclase, when the rock should properly be called quartz-porphyrite. The two varieties are, however, so closely alike in other respects and so intimately connected in field relations as to make it difficult to draw a sharp line between them. Thin sections of the darker porphyries contain hornblende or biotite, the latter in porphyritic crystals in one case, and pyrite is a frequent accessory mineral. The ground-mass is generally micrographitic rather than felsitic, but is always in definite contrast with the phenocrysts, which are many times larger than the quartz and felspar of the ground.

Some of the specimens display no traces of shearing, but most have suffered in this way and show stages approaching the sericitic and other schists with which they are associated, and sometimes rhombs or irregular areas of a carbonate—dolomite or siderite—appear in them suggesting changes connected with the formation of the iron range rocks. There are a few examples in which the phenocrysts of quartz with inclusions of what was once glass, and the more or less weathered felspars are found, besides vague concretionary forms, apparently the beginning of structures found more complete in the conglomerate-like rock near lake Wawa.

The felsites are generally flesh-colored or pale greenish and are very much weathered and often penetrated by narrow seams of quartz, evidence that faulting and other effects of the Huronian readjustment of the region have left their mark upon them. Under the microscope they are very unsatisfactory, and beyond stating that they have the same character as the ground mass of the porphyries there is little to be said regarding them.

The quartzless-porphyries stand further from the quartz-porphyries than the felsites do, not only in their characters but also in their field relations, since they have not been found associated with the Lower Huronian schists, but only with the schist conglomerate of the Upper Huronian and the greenstone at Michipicoton Harbor. They are found as well defined dikes at the points mentioned and are evidently later in age than any of the Huronian rocks. The examples from the conglomerate between Doré river and Gros Cap are medium-grained rocks of a grayish flesh color, sometimes merging at the edge of the dike into a very fine-grained or compact felsitic phase. The phenocrysts, which are not large nor distinct, are chiefly plagioclase, often with very complex twinning, but a few orthoclase crystals occur also. The ground-mass is reddish and felsitic rather than micrographitic, and contains a second generation of tiny porphyritic crystals mainly of plagioclase. There is some undoubted quartz in the ground-mass.

The other dikes, near the shore southeast of the large mass of greenstone on Michipicoton Harbor, are more evidently porphyritic, being crowded with felspar phenocrysts up to a quarter of an inch in diameter. The rock as a whole might at first be taken for a syenite until it is noticed that the felspars have crystal forms. The color on fresh surfaces is speckled gray. Under the microscope the phenocrysts are found to be predominantly plagioclase, with low extinction angles, not far from oligoclase, but some of the crystals show no striations. The ground mass is distinctly granitic with comparatively large grains of quartz, felspar and biotite. About one half of the rock consists of badly weathered phenocrysts of plagioclase, but with no suggestion of shearing or of strain in their sections. It is doubtful if this rock should be called a quartzless-porphyry, since quartz forms an important part of it, though only seen with the microscope. The name felspar-porphyry or porphyrite might be more appropriate, thus suggesting the most striking feature, the phenocrysts.

THE BASIC ERUPTIVES.

Basic eruptives in the form of greenstones cover large areas in the Michipicoton region, especially south of the Upper Conglomerate on Gros Cap and the shore between Michipicoton Harbor and the river. There are also large outcrops of the rock on the shores of Wawa lake. They are usually dark green and fine-grained and often have the ellipsoidal structure supposed to indicate lava flows, the latter variety being well displayed just west of the docks near Michipicoton Harbor. Unfortunately these older greenstones, so far as examined, have almost completely lost their original minerals, so that it is not easy to decide their exact character, though they are assumed to have been diabases. Owing to the fact that they are so greatly weathered, little microscopic work has been done upon them. The name greenstone as used in this report is limited to these greatly weathered basic eruptives, those whose original composition is still distinct being taken up under separate names, diabase, etc.

The greenstone south of the railway near Michipicoton Harbor shows under the microscope mainly chlorite and epidote in forms vaguely suggesting plagioclase strips. A few clear grains of quartz are the only minerals which remain unchanged so that the rock seems to have been quartz-diabase.

Another area, between Gros Cap and Doré river, has some portions of coarser grain, which show under the microscope a somewhat different composition of pale green hornblende in fairly well defined prisms, chlorite, and lathshaped saussuritic areas evidently once plagioclase. The hornblende is probably secondary after augite, and often contains portions of chlorite in the central parts of the crystal. Quartz occurs in small amounts, partly interstitial and partly as micropegmatite. There appears to be little or no magnetite in any of the slides examined, and this fact with the presence of small quantities of quartz suggests that the original rocks belonged to the less basic varieties of diabase.

A coarse-textured rock from a boss rising near the railway through a sand plain east of the main conglomerate mass shows a small amount of quartz in still more marked pegmatitic intergrowth, but the change of the other minerals has gone further, so that only chlorite and a carbonate, probably dolomite, can be distinguished. Another coarse-grained one from north of the main conglomerate area is a weathered andesine gabbro, with augite changed to hornblende.

In marked contrast with the greenstones we find various dikes and bosses of diabase of later age still fairly fresh. They are dark gray or greenish gray and usually fine-grained but often highly porphyritic, with plate-like plagioclases an inch long and more than half as wide, but only a tenth of an inch thick. These consist of plagioclase laths with grayish augite wedged between and considerable amounts of magnetite, often rod-like in form, the whole having a marked ophitic structure. The coarsest-textured one containing the large phenocrysts has plagioclase with an extinction angle from the twin plane of 12° to 23°, so that the species seems to be andesine or labradorite. The absence of quartz and the presence of large quantities of magnetite show that these later diabases and diabase porphyrites are distinctly more basic than the older greenstones.

A still more basic series of rocks is exposed as wide dikes or bosses on islands in lake Eleanor and Goetz lake, as well as on the shore of the latter. These rocks are green black on fresh surfaces but weather brownish or gray green, and are marked by a very rough surface where weathered. They are quite coarse grained and show wide shining surfaces of biotite when broken.

The freshest sections, which come from islands in Goetz lake, consist essentially of olivine and augite with a few large individuals of biotite and a little white turbid material between the other minerals, perhaps originally plagioclase. The olivine is idiomorphic and the augite largely so, and the brown biotite is more or less filled, poecilitically, with olivine crystals. The olivine has a narrow rim of bright green serpentine and a good deal of serpentine and magnetite along fractures in the interior. In a section from lake Eleanor the whole of the olivine has been changed to serpentine in which are imbedded crystals or grains of augite and a little biotite. The composition of this rock corresponds to that of a picrite, though the Germans would probably call it palæopicrite.

A somewhat related rock is found at the second falls of Magpie river not far from a boss of porphyritic granite which has been described on a former page. The rock is apparently a dike, brownish black with many small scales of biotite on fresh surfaces, and consists of biotite, olivine, augite, magnetite and calcite. The brown biotite is not poecilitic, and forms more or less complete crystals between the larger crystals of olivine, the latter often weathered to serpentine. The augite, which is not in very large amounts, forms rather long prisms, with a tendency to radiate ; and the magnetite is in large square cross sections. The calcite or dolomite filling interstices is no doubt a decomposition product, perhaps representing small quantities of a calciplete plagioclase. This very basic rock may perhaps be called a biotite picrite, though it has relationships to the minettes also.

Acid Huronian Schists or Wawa Tuffs.

The schistose rocks of the Huronian may be divided into acid varieties corresponding to the quartz-porphyries, and basic schists having a composition like the greenstones and other basic massive rocks. They belong mainly to the Lower Huronian, though very similar schistose rocks result from the shearing of the Upper Huronian conglomerate. Among the more acid rocks those resulting from the shearing and modification of the quartz-porphyries or porphyrites are most widely spread and will be referred to first. In color they are pale greenish or bluish or yellowish gray. All gradations occur from varieties having slightly crushed phenocrysts of quartz and felspar to felsite or sericite schists in which the squeezing has gone so far as to destroy or rearrange all the original minerals In the less modified schists quartz, orthoclase, plagioclase and sericite may be recognized ; but by progressive steps the granular minerals disappear and a micrograpitic or felsitic looking mass of quartz, felspar and sericite results, with the development of a marked schistose structure. Often freshly deposited very finely granular quartz and sericite make the bulk of the more schistose varieties ; and near the iron range, rhombs of siderite or ankerite appear also, showing that there has been infiltration of silica and iron compounds, resulting finally at the edge of the iron range in sideritic sericite schists or a schistose variety of siderite.

Along with the changes mentioned some other minerals show themselves occasionally, such as tourmaline, which occurs as numerous tiny prisms in quartz-porphyry schist south of the Helen mine ; or rutile, as in a sericite schist from the railway cutting just west of Sayers lake. In the latter case the rutile is chiefly in thick bundles of very tiny needles, though some crystals show arrowhead or knee-shaped twins. The source of the large amount of titanium is not clear, since no other rocks in the region contain appreciable quantities of titanium minerals so far as known, and the iron ores are especially free from titanium.

The most peculiar variety of the silicious sericite schists is of a concretionary habit, best shown at the western corner of lake Wawa, where cliffs of the rock were taken at first for conglomerates. The concretions are from the size of a pea to pebble-like oval masses more than an inch in length. They show best on weathered surfaces, and then are often hollow in the middle with a rusty inner surface.

Thin sections show rounded masses of chalcedony without radial arrangement, but often containing some siderite in the middle, and sometimes enclosing a fragment of felspar, especially plagioclase, as if this had served as a nucleus, though the crystal is generally eccentrically placed. The silica is not always chalcedonic, but may become coarser in texture until a mosaic of quartz grains results. The matrix is of greenish sericite reticulating about the concretions and forming only a small proportion of the whole.

The concretionary schist occurs at several other points nearer the iron range than at Wawa lake, though only in small amounts, and has probably resulted from the circulation of solutions of silica and iron during the time when the iron range rocks took on their present form. The beginning of the process has been described and figured in connection with the quartz-porphyries. These concretions are probably not original structures formed during the consolidation of the porphyry, but were produced much later, after the shattering and shearing which caused the schistose arrangement of the minerals.

Near the margin of the Laurentian the quartz-porphyry schists sometimes become more gneissoid, so that one may be in doubt as to the exact boundary between the two formations; and at other points also, perhaps because of contact metamorphism near eruptive masses, quite gneissoid examples may be found. A fine-grained gray gneiss from a point north of a small swampy lake southwest of Bauldry lake consists of quartz, a little orthoclase, much plagioclase, and a large amount of sillimanite in fibrous bundles. A little biotite is more conspicuous on cleavage surfaces than in thin sections. It is probable that this rock is a metamorphosed sediment rather than a form of the quartz-porphyry schist, the large amount of sillimanite indicating a greater percentage of alumina as compared with alkalies than would be found in a quartz-porphyry.

A more schistose sillimanite gneiss associated with the conglomerate north of Doré River which has much the same composition with the addition of slender tourmaline prisms is certainly of later age than the quartz porphyry schists, and may represent a muddy layer of sediment interstratified with the conglomerate.

Basic Schistose Rocks or Gros Cap Greenstones.

There are transitions between the acid and basic schists in which sericite is largely replaced by chlorite and the quartz grains or chalcedonic aggregates diminish in amount, while carbonates become more frequent; but these are not extensively developed and will not be further described. The green schists are partly associated with the massive greenstones and partly interbedded with the lighter colored acid schists. They are usually very fine-grained and distinctly schistose, and have a monotonous uniformity of dull green. Under the microscope chlorite is universally found with a finely granular colorless material between, in some cases partly silica but more commonly plagioclase or its decomposition products. Epidote is always present, and well formed rhombs of a carbonate which weathers brown,—ankerite or siderite,—are usually to be seen; while magnetite and rutile are not infrequent.

By an increase in the amount of the carbonate we have chlorite-ankerite or chlorite-dolomite schists, which weather brown but do not form crusts of limonite; and chlorite-siderite schists, which are often changed for an inch from the surface into impure brown iron ore. Several coarse-grained examples of the last rock are found south of the Helen mine. They can hardly result from the direct rearrangement of any ordinary greenstone or volcanic ash, and are perhaps to be connected in origin with the rocks of the iron range, as sediments of a chemical nature. They form transitions between the siderite of the iron range and the ordinary chlorite schists, just as certain sericite schists rich in siderite connect the acid series of schists with the iron bearing rocks.

There are cases where the chloride-dolomite schists include also large amounts of biotite, forming a transition to biotite-dolomite schist, which occurs southwest of Bauldry lake as a coarse-grained rock with a brown pitted surface, having the appearance of a gray gneiss when fresh.

Here may be mentioned also the very cleavable green schist occurring north of the main Upper Huronian conglomerate area in the Laurentian granite, probably a long narrow strip of the Huronian floated off in the eruption of the granite. From its lustrous green cleavage surfaces, one would naturally call the rock a mica schist or mica-chlorite schist, but the microscope shows it to consist essentially of biotite and actinolite. This illustrates the same relationships as were noted by Dr. Lawson in the Keewatin region of Rainy lake, where green chlorite schists at a distance from the Laurentian contact become harder hornblende or hornblende-mica schists in immediate contact with the gneiss, in both cases evidence of the eruptive nature of Laurentian gneiss.

Upper Huronian Green Schists.

The green schists thus far spoken of belong probably to the Lower Huronian, most of them being associated with the quartz-porphyry schists and greenstones. There are, however, numerous green schists interbedded with the Upper Huronian schist conglomerate, some of them no doubt parts of the conglomerate originally free from large pebbles, others perhaps parts which have been so far squeezed that the soft greenstone pebbles have been rolled out flat and incorporated with the matrix as a uniform schist. Some of them may represent basic dikes turned into schist and so far rearranged as to destroy all traces of their original constituents. In many cases these schists are closely like those which have been described from the Lower Huronian, and need not be taken up in detail.

In general, the chlorite schists contain some finely granular silica and dolomite; often also more or less biotite Tourmaline needles were found in one. Others of the green schists have been more strongly acted on and are now hornblende schist, examples of the kind having been obtained from the tote road between Michipicoton Harbor and Doré lake, and also at the second falls of the Doré river. They are hard dark green fine-grained rocks consisting chiefly of hornblende prisms having strong pleochroism, (blue green green and yellowish brown) with a little quartz and plagioclase in the interstices.

Eleanor Slates.

The chlorite schists as well as the felsite schists pass by way of certain lustrous cleavable phyllites into slaty rocks which are widely enough spread to demand mention. They are greenish gray or "slate" gray in color, compact, splintery or easily cleavable rocks, sometimes showing bands of varying color, probably representing layers of sedimentation, across which the cleavage runs obliquely.

Most of the slates mentioned here do not contain carbon in sufficient amount to have their color lightened when heated in the blowpipe flame, thus differing from slates to be mentioned later in connection with the iron range rocks.

They consist of very minute scales of chlorite or sericite with equally minute clear granules, probably of quartz, particles of a carbonate (not siderite), rutile as stout prisms or arrowhead twins, and slender pale prisms of lower refractive index having parallel extinction, probably sillimanite. The darker gray varieties, as along Grasett road south of lake Eleanor, contain dirty looking particles of unknown nature arranged more or less in bands with the minerals mentioned above.

Though little direct evidence is available to prove the origin of the slates, they are supposed to have been fine clayey sediments not directly of volcanic origin.

In connection with them may be mentioned the graywacké or arkose found on the portage between Bauldry and Goetz lakes, which is clearly a mechanical sediment though of a coarser kind It is a dark gray rock, with specks of quartz visible on its surface when broken. Under the microscope the quartz is found to be in angular fragments with turbid completely weathered bits of felspar and also some brownish films between. It evidently represents a graywacké or arkose of the type so common in the Upper Huronian rocks north of lake Huron, and should probably be classed as of that age, though the nearest rocks adjoining have the character of the Lower Huronian schists.

Rocks of the Helen Iron Formation.

Though there are transitions between the Lower Huronian schists and schistose varieties of the siderites belonging to the iron range, in general the latter is a very distinct group of rocks, having peculiarities easily recognized in the field and of considerable interest when studied with the microscope. Four species of rock may be distinguished in the iron range of Michipicoton, banded granular silica with more or less iron ore, black slate, siderite with varying amounts of silica, and grüenerite schist. All are found well developed at the Helen mine, and all but the grüenerite schist have been found in the lake Eleanor iron range also, while granular silica and siderite occur in large quantities in every important part of the range, though small outcrops sometimes show the silica alone.

The name granular silica or grained silica has been chosen as most desciiptive for the silicious rock of the Michipicoton range, though varieties occur which are not granular to the naked eye. Jaspery varieties have not been found on this range, though they occur only a few miles to the north, and are common in most other iron ranges in Canada and the United States. The name jaspilyte used by the American geologists therefore seems inappropriate.

At first the grained silica was looked on as a fine-grained sandstone, since many examples are soft and pulverulent, but a microscopic examination proved that the grains are not at all water-worn. The rock is usually finely banded, white and light or dark gray, but is occasionally brown or purplish, the color in every case being due to the presence of iron oxides. Much of the banded rock has been crushed and now forms a breccia, often with fine-grained silica as a matrix, but sometimes with a cement of siderite. In evenly banded, unbrecciated parts, lenses one or two inches long of white or paler gray silica frequently occur running parallel to the general stratification.

Thin sections show that the white, sugary specimens of granular silica consist of quartz only, polyhedral grains closely fitting together, but not apparently cemented, since the jarring caused by grinding the section often slightly parts them so that a film of air separates the adjoining faces. The quartz shows few inclusions and no cavities, but colored specimens have films of yellow limonite between the grains, or small masses of limonite in streaks ; while gray specimens contain innumerable small black specks no doubt of magnetite, though the rock is not strongly attracted by the magnet. The black particles are in general too fine to separate from the silica.

None of the sections have cryptocrystalline silica, but always distinctly granular material, the grains generally of fairly uniform size in any given band of rock, though sometimes coarser grains form a row across a section, probably filling fissures in a vein-like way.

Some of the brownish examples contain many rhombs of siderite, indicating a transition towards the other usual iron range rock in the region.

The size of the grains in the sections examined runs from half a millimeter in coarse-textured examples at Gros Cap down to 18-thousandths of a millimeter in a somewhat cherty specimen from Sayers lake ; but a very similar granular silica from the Grace gold mine south of Wawa lake is larger in grain than the coarsest found in the iron range proper, having diameters up to 1¼ millimeters.

The origin of these curious rocks is somewhat puzzling since their granular structure is not due to the crushing of previously existing quartz. There is no hint of water-worn grains enlarged by deposition of silica on their surfaces until they meet, as in quartzites of the Upper Huronian near lake Huron ; and one must suppose that crystallization has taken place from centres about equally distant from one another. How were the partially formed grains or crystals supported ? In a thick jelly of amorphous silica which became crystallized about these centres until it was entirely used up ? As amorphous silica is lighter than the crystalline form one would expect the incipient grains or crystals to sink to the bottom.

Apparently, the process in these relatively coarse-textured varieties of silica is not different in kind from that which produced the finer-grained forms, jasper and chert seen in neighboring iron ranges. It may be mentioned here, however, that none of the thin sections prepared from jaspers or cherts of the Lower Huronian in other parts of Ontario show radiating or concretionary or typically cryptocrystalline characters. They are at most microcrystalline, while sections of Animikie chert and jasper from the Port Arthur region on the other hand have these characters well defined.

The black graphitic slate forming a thin sheet just under the iron range proper west of the Helen mine and at other points in the region seems closely related to the granular silica, being composed of the same material with a large admixture of carbon which smears the fingers. The grains of silica are, however, much more variable in size than in the rock described above. As the carbon is opaque thin sections are unsatisfactory. The slate generally contains rounded masses or crystals of pyrite, which weather out leaving curious cavities, looking like bubble holes, lined with a thin white layer of quartz more coarsely crystalline than usual in the rest of the slate. The carbon of the slate suggests organic material and the presence of life in the sea at the time the iron bearing material was deposited, but perhaps too much stress should not be laid on this point, since hardly any other evidence of living beings exists in the Lower Huronian. Possibly some of the dolomitic rocks found not far away may have an origin from shells, but the fact that they merge into chlorite-dolomite schists which are probably of eruptive origin seems to oppose this.

The siderite which rises in many cases to the summit of the iron range ridges beside the banded silica is usually weathered for half an inch into impure limonite, but beneath this crust it is still wonderfully fresh for a rock of the character. It is bluish or pale violet in color when fresh, some shade of brown when weathered, and has a very massive appearance in many places, though as it approaches the schists it may take on a schistose structure. Almost everywhere crystals of pyrite occur in the siderite, sometimes in large quantities.

Thin sections show mainly siderite, which does not differ greatly from dolomite in appearance though its frequent weathering into limonite distinguishes it from other carbonates. Finely granular silica is almost always present, and often small amounts of dirty bluish green hornblende of a peculiar sort, probably grüenerite, though some common green hornblende occurs also. There are very silicious siderites linking this rock to the granular silica.

Where the grüenerite is present in large quantities the rock becomes grüenerite schist, which is pale to dark bluish or greenish gray, and weathers to brown. Examples of the rock occur just west of Sayers lake near the black slate, apparently underlying the other iron range rocks; but it has seldom been found elsewhere in the region and is present only in small amounts here.

Sections show hornblende, magnetite, silica and often siderite. The hornblende is almost always in rather stout prisms with jagged ends, having a turbid central core and transparent bands on the edges, with faint blue green and yellowish dichroism. Between crossed nicols it is seen that these prisms are often twinned, with longitudinal strips extinguishing in opposite directions, generally with small angles. It is possible that the centre of the prism differs in composition from the more transparent edges; and an opaque margin often found on each side may represent the deposit of still another layer of material. No analyses have been made, but the relationships and general character of the hornblende suggest that it is grüenerite, the iron hornblende, or some nearly related species.

PLEISTOCENE GEOLOGY OF THE REGION.

The drift deposits of the Michipocoton region consist of glacial materials, such as boulder clay and moraines, and of stratified sand and clay laid down in lakes at a higher level than that of lake Superior. The latter form very well marked terraces which have attracted attention ever since the region has been studied by geologists.[12] The lowest lake deposits consist of stratified blue clay to be seen near the Mission on Michipicoton river and at the Harbor near the ore dock and in a cutting a short distance up the railway, where it rises 100 feet above lake Superior and is covered by five feet of brown sand. This clay is said to form much of the bottom of the harbor, where piles have been driven into it 160 feet, so that the whole thickness is not less than 260 feet. Near the harbor the clay is usually covered by the brown sand mentioned above, sometimes cemented into a soft sandstone on top by the deposit of limonite between the sand grains.

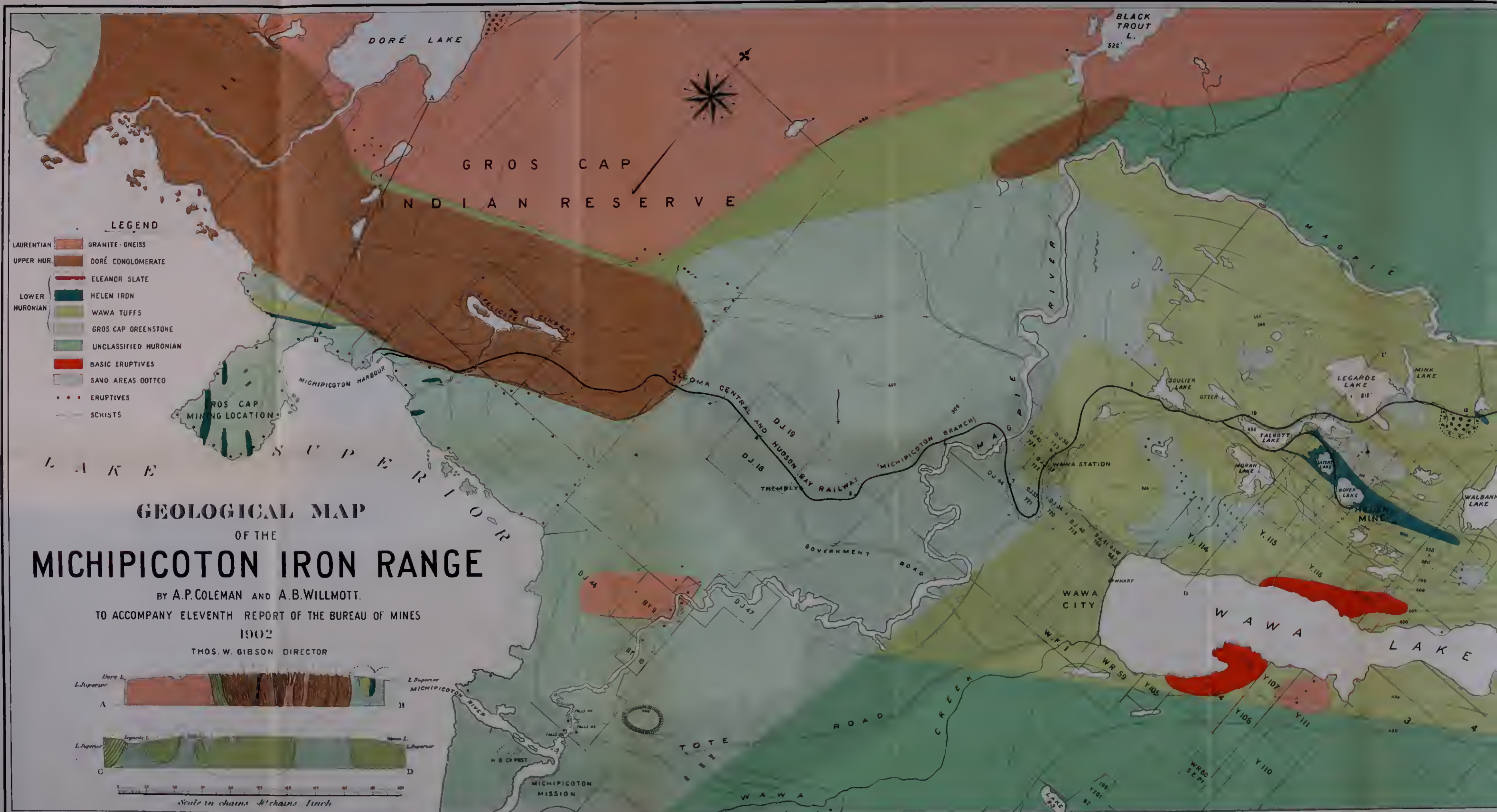
A similar cemented layer is found at other points, for instance a half mile west of the Harbor, south of the tote road to Doré lake, and results no doubt from the solution of iron from fragments of iron range rocks contained in the drift.

Going up the railway from Michipicoton Harbor there is a flat plain, probably an old water level at Brient, and at about mile 2 there are cuttings showing finely stratified clay-like material, which proves to be mostly quartz in minute angular grains when examined with the microscope,—probably the debris of the granular silica from the iron range.

The station at Tremblay is upon a wide gravel plain, and railway cuttings between this and Magpie river show a great thickness of cross-bedded beach gravels forming three terraces, one rising 300 feet above Superior, and another to 355 and the highest to 370 or 375 feet, corresponding roughly to terraces formerly measured between the Mission and Wawa lake two miles to the east, on the opposite side of the river, the highest of which reaches 360 feet.

The sand and gravel plains between Wawa and lake Eleanor reach a level of about 450 feet; and those to the north are 535 or 540 feet above Superior. In all, ten or eleven fairly distinct terraces have been measured between lake Superior and the north shore of lake Eleanor, indicating as many stages in the sinking of the great glacially dammed predecessor of Superior. No shells or other fossils have yet been found in these deposits.

[12] Bur. Mines, Vol. 7, p. 193; Vol. 8, p. 154; and Vol. 9, pp. 175-6.


LEGEND
LAURENTIAN
GRANITE-GNEISS
UPPER HUR.
DORÉ CONGLOMERATE
ELEANOR SLATE
LOWER HURONIAN
HELEN IRON
WAWA TUFFS
GROS CAP GREENSTONE
UNCLASSIFIED HURONIAN
BASIC ERUPTIVES
SAND AREAS DOTTED
ERUPTIVES
SCHISTS
GEOLOGICAL MAP
OF THE
MICHIPICOTON IRON RANGE
BY A.P. COLEMAN AND A.B. WILLMOTT.
TO ACCOMPANY ELEVENTH REPORT OF THE BUREAU OF MINES
1902
THOS. W. GIBSON DIRECTOR
DORÉ LAKE
GROS CAP
INDIAN RESERVE
BLACK TROUT L.
LAKE SUPERIOR
GROS CAP MINING LOCATION
MICHIPICOTON HARBOUR
ALGOMA CENTRAL AND HUDSON BAY RAILWAY
MICHIPICOTON BRANCH
MAGPIE RIVER
MAGPIE
WAWA STATION
WAWA CITY
WAWA LAKE
HELEN MINE
LEGARDE LAKE
MINK LAKE
SOULIER LAKE
TALBOTT LAKE
MORAN LAKE
BOYER LAKE
WALBANK LAKE
GOVERNMENT ROAD
TOTE ROAD
WAWA CREEK
MICHIPICOTON RIVER
MICHIPICOTON MISSION
TREMBLY
WHARF
Scale in chains 40 chains 1 inch

JOSEPHINE CREEK
MAGPIE
A.C. & H.B. RY MICHIPICOTON BRANCH
LEGARDE LAKE
MINK LAKE
TALBOTT LAKE
GULL LAKE
WALBAKA LAKE
ELEANOR LAKE
BROOKS LAKE
LOONSKIN LAKE
LOONSKIN LAKE
GOETZ LAKE
BAULDRY LAKE
JOSEPHINE MINE
PARKS LAKE
BOG LAKE
A W A
L A K E
TOTE ROAD
MERRICK'S LINE
A.C. & H.B. RY
HAWK L.

The great lake deposits somewhat hide the indications of ice action, especially in the lower ground : but boulder clay and morainic ridges are found in several places as well as striated rock surfaces. At the Helen mine itself there is boulder clay between the hill of ore and the "paint rock" against the south wall of the valley, as disclosed by mining operations ; and large boulders of the ore, one of them ten tons in weight have been transported from the ore body to the ridge on the south, where they now lie at least 70 feet above their original resting place. Smaller blocks of ore and boulders of iron range rock may be found in boulder clay two miles to the south near the shore of Wawa lake.

In spite of the sheltered position of Boyer lake between its steep walls of schist rising 150 or 200 feet above it to the north and to the south, rocks within the valley have been rounded and striated, as noted by Dr. Bell.[13]

A small point of rock on the south side of Boyer lake disclosed by the partial drainage of the lake shows distinct striæ running about 10° east of south, a direction transverse to the narrow valley and close to the steep cliff rising south of the lake. Beyond the hill to the south striations running 40° west of south have been observed, and on Wawa lake the directions noted are from 70° to 80° west of south, nearly east and west, conforming to the direction of the valley, which is deep and steep-walled. This larger depression seems to have turned the ice aside from its usual direction while the smaller basin of Boyer lake was not sufficient to do so,

South of Bauldry lake morainic ridges occur, very stony and in one case, near the pond to the south, containing a kettle-shaped valley 36 feet deep, but dry to the bottom, probably drained by some gravel bed. Bauldry and some of the other lakes appear to be dammed by glacial deposits ; while Eleanor and Wawa seem enclosed by old beach materials. The striæ near lake Bauldry have the usual direction for the region, 22° west of south.

13 Geol. Sur. Summary Rep., 1900, p. 116, striæ running 2° east of south on the surface of the ore mass.

THE EASTERN ONTARIO GOLD BELT.

BY WILLET G. MILLER.

The belt or strip of country in southeastern Ontario along which auriferous deposits have been found at various points extends from the township of Belmont in Peterborough county eastward across the counties of Hastings, Addington and Frontenac, and into the western part of Lanark, a distance of about 70 miles.

Numerous reports and papers have been written on this district since the first discovery of gold in it in 1866. Some of the most important of these are to be found among the publications of the Geological Survey.

The writer, at the request of some of the mine managers and with the consent of the Director of the Bureau of Mines, spent a few weeks during the summer of 1901 in the district. As the time at his disposal was insufficient for a detailed examination of so large an area, attention was paid chiefly to the working mines. Notes were, however, made on the general characteristics of the belt. This report attempts to give not much more than an outline description of the field.

Along this strip of country most of the auriferous deposits were found to occur under somewhat similar conditions, the rock in which they are situated being usually diorite or some closely related dark-colored igneous or metamorphic variety.[1]

It is only within the last four or five years that gold mining may be said to have been carried on successfully in this field. This is owing to various causes, chief among which are the refractory character of the ore in some of the deposits and the lack heretofore, to some extent, of technical skill and sufficient capital. Owing to the fact that the ore of certain of the deposits which have been worked is decomposed near the surface of the ground, thus being rendered free milling, companies have been organized to work such deposits under the belief that the precious metal could be extracted by ordinary means. After working downwards, however, the ore has been found to be not adapted to free milling plants, and thus numerous attempts have ended in failure, until recently when companies of sound financial standing and with experienced managers have entered the field.

Geology of the Gold Belt.

The geology of the district may be summarized as follows :

A series of diorites, crystalline limestones and various schistose rocks has been cut through by granite. This granite now forms most of the higher hills and ridges in the district, the diorites and accompanying metamorphic varieties occupying the valleys and lower lying areas. Overlying all the rocks mentioned are areas, here and there, of undisturbed Silurian limestone of the Black River and Birdseye formation, together with, occasionally, small outliers of sandstone which heretofore has been considered to belong to the Potsdam formation. This sandstone was however probably formed during the period immediately preceding the deposition of the limestone and is thus higher up in the series than the Potsdam which is now, in Canada, put at the base of the system. Glacial and recent deposits are of course also present.

The granite was found in all cases where opportunities were offered for observing the relations of the rocks to be younger in age than either the diorite or crystalline limestone, the latter two rocks being cut by dikes of granite and its fine-grained variety, felsite.

The relationship existing between the diorite and crystalline limestone in the more western part of the belt was not so clear as in some of the more eastern exposures. In the vicinity of the old marble quarry on the outskirts of the town of Madoc diorite dikes together with dikes of granite and felsite cut through the crystalline limestone. The diorite is also seen to be

[1] The term diorite will be used in the following pages in a wide sense to embrace not only dark-colored igneous rocks but gneissoid and schistose varieties as well. The origin of some of the latter is not definitely known.

younger than the limestones at Perry's mill on the Mississippi river and in the township of Clarendon and elsewhere. Of course it is possible that different outcrops of diorite along the belt may be of different age. Some may be older than the crystalline limestone while others are undoubtedly younger. Since the gold deposits in association with these diorites throughout the whole belt possess so close a resemblance to one another, especially in the occurrence of a high percentage of mispickel in many of them, it would seem likely that the diorites are of one age.

It is also possible that there are granites of different ages in this district. To determine this definitely would, however, take much more time than the writer had at his disposal during his trip along the belt last summer.

As stated elsewhere the term diorite is here used in a comprehensive sense to cover a considerable variety of dark, fine grained to coarse-grained, massive, and schistose rocks. The granite along some parts of the belt is also quite different in appearance from that along other parts. The typical granite of Marmora and Madoc is different from that of Kaladar and other townships. The granite passes into syenite in the northern part of Methuen township and in other localities.

The accompanying diagram (*Fig. 1*) shows the relationship which is believed to exist among the rocks of the district. It represents a hypothetical vertical section.

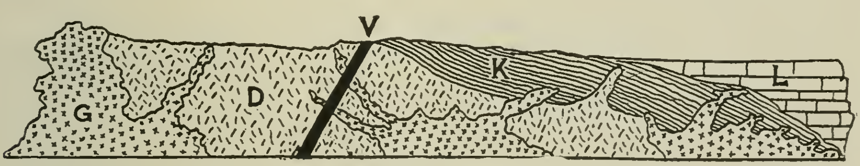


Fig. 1. Hypothetical vertical section showing relationships of rocks, Eastern Ontario Gold Belt. G, granite ; D, diorite ; K, crystalline limestone ; L, Silurian limestone ; V, vein.

Most of the gold deposits occur near the contact of the diorite and granite, although some important ones are found at a considerable distance from the granite. It would appear that the cavities occupied by the deposits owe their origin to the shrinkage of the granite on cooling which has caused fractures to be formed in the rocks near the contact. The cooling mass of granite was apparently tougher than the rocks near the contact. Hence fractures were produced in the latter when the granite began to contract. The openings now occupied by the gold ores evidently did not originally possess the width which they at present show. They may at first have been represented by narrow cracks which in course of time became enlarged by circulating waters dissolving away portions of the surrounding rock.

The granites, diorites and associated crystalline rocks to which reference has been made, are classified as Archæan, and, according to the nomenclature adopted by the Canadian Geological Survey, the granites are considered to be Lower Laurentian. The crystalline limestones and accompanying schistose varieties are put into the Grenville series of the Laurentian. It may be added that at one time it was thought some of these metamorphosed sedimentary varieties of the Hastings district were of different age from the Grenville and the name Hastings series was given to them. Recent work has however shown that the so-called Hastings series is of similar age and origin to the Grenville.

The relation which this sedimentary series of the Laurentian bears to the Huronian remains to be determined. The area in which rocks of the two series, Grenville and Huronian, have been found to occur most closely associated is in the district lying between lakes Temiscaming and Kippewa. Outcrops of the typical Huronian, jasper conglomerate and related rocks, are found on the shores of the former lake. Some miles to the southeastward, on the Kippewa river, crystalline limestone of Grenville age associated with garnitiferous gneiss and nepheline syenite is exposed. A mass of granite and gneiss occupies the area lying between these two points.

The Belmont Gold Deposits.

The most western township in the gold belt containing deposits on which any serious attempts at work have been made is Belmont in the county of Peterborough.

The buildings and main workings of the Belmont mine, which is owned and operated by the Cordova Exploration Company, Limited, of Great Britain, are on lot 20 in the first concession of this township. The company also own the southest quarter of lot 21 in the same concession and the land surrounding the foot of Deer lake, where the power plant is situated, together with the mineral rights of lot 20 in the first concession of Marmora and of the adjacent county roads. On the property there is a 30-stamp mill, completed about a year ago, which is equipped with machinery of the latest and most improved designs. It has been so arranged that the capacity can be increased to 100 stamps without disturbing the present plant or ceasing milling operations. The mill is furnished with a cyanide plant for treating the tailings.

A village is rapidly growing up in the vicinity of the mine. It already contains two or three stores, and the building of two churches was begun during the past summer.

The mine is distant about 12 miles from Havelock, a station on the main line of the Canadian Pacific railway, between Toronto and Montreal. The distance from the former city to Havelock is 100 miles, and from the latter 238 miles. Ten miles distant from the mine is the village of Marmora. The post office at the mine is called Cordova.

A branch line which connects with the Central Ontario railway near its junction with the Canadian Pacific railway runs to within about one-half mile of the mine and can be easily continued into the mill yard.

The mill is supplied with water from an artificial lake on the property which is estimated to hold about 10,000,000 gallons of water.

At the foot of Deer lake, which lies to the north of Belmont lake, a dam built of stone work and cement replaces an old timber structure. Water will be carried from here in a six-foot pipe to the southward along the east bank of the river a distance of about 1,500 feet. It is estimated that a fall of about 75 feet will be obtained at this point. The power will be used for compressing air for transmission to the mine, a distance of about two and one-quarter miles. The pipe for carrying the air to the mine is to have a diameter of 12 inches.

It will be seen that this mine is particularly well situated as regards supply of water and power. The claim is made that even during the dry season the compressed air plant will generate at least 1,000 horse power. This will suffice for a very much larger mill than the present one. On the head waters of the Deer river are other lakes of considerable size. If it were desirable the water in these could be held back by dams till needed. When this plant is completed compressed air will be the only power used in the mill as well as for hoisting and underground work. Fuel will then be required for heating purposes only. The power plant is unique among those of the mines of the Province and should ensure as low a cost of treatment of the ore, in proportion to the amount handled, as at any mine in the world.

Characteristics of the Ore Bodies.

Mr. D. G. Kerr, the general manager of the company, has made a careful study of the ore bodies. The results of the writer's work serve only to confirm the views held by Mr. Kerr concerning the character of the deposits.

The country rock at the mine is a dark igneous variety which varies from medium-grained to coarse-grained. In hand specimens it is seen to consist essentially of two minerals, a light-colored one, plagioclase, and a darker material, hornblende. In some facies of the rock the greater part of the felspar is segregated more or less into spots an inch or more in diameter. The hornblende grains forming the matrix are associated with a smaller amount of felspar. This segregation of the felspar gives the surface of the rock what has been called a "blotched" appearance and it resembles other rocks which have been described from eastern Ontario. The anorthosites of south Sherbrooke in Lanark and elsewhere frequently possess this structure, the hornblende however being the segregated mineral. The late H. G. Vennor in his geological reports refers to what he calls blotched diorites in different localities. The Belmont rock therefore from its general appearance and from its relations to the surrounding Archæan members seems to be merely a representative of the numerous outcrops of gabbros, diorites and anorthosites which are so abundantly developed in the eastern counties of the Province.

The rock surrounding the Belmont mine carries a high percentage of magnetite and pyrite, like other members of the gabbro family. In one or two places the magnetite, which is the titaniferous variety, is segregated into veins or masses a foot or more in breadth and a few feet in length. A sample was found to contain 11.49 per cent. of titanium dioxide.

The exposure on the hill immediately southeast of No. 3 shaft shows a fine-grained trap-like rock in association with coarse gabbro or diorite. The two rocks appear to be of different ages.

Descriptions of the microscopical characteristics of the rocks of this mine together with those of others from a number of points along the gold belt are given at the end of this report.

Cracks have been formed in the diorite or gabbro through the shrinkage of the mass itself or by the contraction of the later intruded granite masses which occur in other parts of the district. These cracks have formed channels, at some long distant period before the surface was worn down to its present level by agents of denudation, for the passage of what were in all probability more or less highly heated and impure waters. The waters have acted on the walls of the cracks and have dissolved them away to a considerable extent in many places, thus making cavities which were afterwards filled by the deposition of minerals from solution. Much of the rock matter acted on by these waters still remains in place along the water channels and is now represented by chloritic or biotitic schist. This schist forms a considerable part of the ore as it contains gold bearing stringers of quartz and highly auriferous pyrite through it.

A good example of the effects of water in changing an igneous rock of this character into a schist along the walls of cracks followed by the water is seen on the face of a cliff at the Deloro mine in Marmora, where a crack in the rock near the upper part of the cliff runs vertically for a few feet, then turns and runs horizontally, then takes a vertical direction again. The crack followed by the water is very narrow but is bounded by two or three inches of chlorite schist, the lamination of the schist being parallel to the direction followed by the crack in different parts of its course (*Fig. 2*).

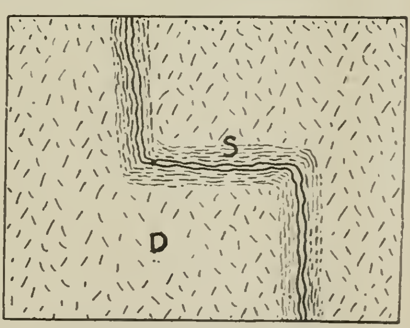


Fig. 2. Diagram showing diorite changed into schist along the course of a crack or fissure. D, diorite; S, schist.

The cavities occupied by the ore bodies of the Belmont mine have every appearance of having been formed in a similar way, the original narrow cracks having been enlarged and the rock at some points having been leached out or changed into schist across a distance in some cases of over 50 feet.

The diagram (*Fig. 3*), will give an idea of the relationship of the lodes of the Belmont mine to one another. It represents a surface plan. The different shafts and openings are indicated by numbers.

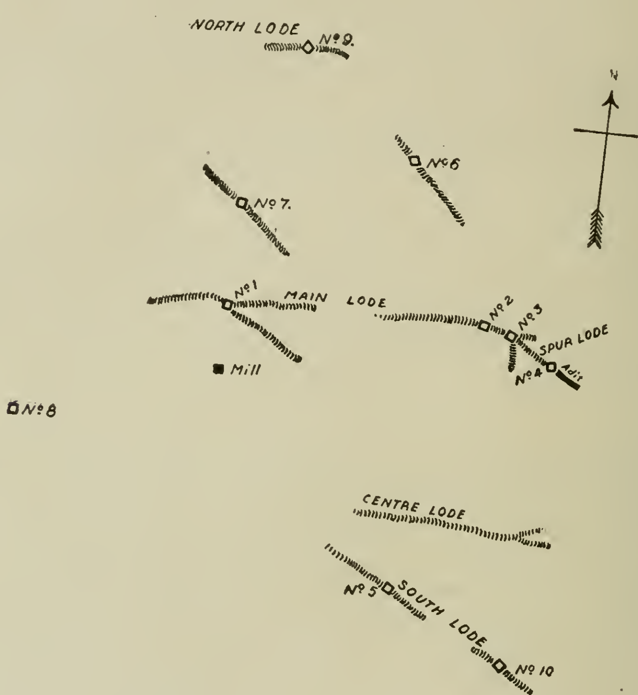


Fig. 3. Surface plan of Belmont mine, showing position of lodes.

The larger ore bodies are found at the points of intersection of two fissures and come to the surface in some cases in the form of what may be called chimneys.

A description of part of the development work which had been done previous to my visit will show that Mr. Kerr has sufficient data on which to base his opinion concerning the character of the several lodes and their relationship to one another. From the 400-foot level of shaft No. 1 a drift runs towards No. 3 a distance of 90 feet and faces in ore. From the 300-foot level of No. 3 a drift is being driven towards No. 1, which is about 1,200 feet distant, and extends in that direction a distance of 80 feet and is in ore 7 feet wide. This is part of the development done on No. 1 lode. On No. 7 lode there is a shaft down 93 feet with a drift in 120 feet on the 75-foot level. There has also been a quantity of ore stoped out from here.

On No. 6 lode a shaft is down 80 feet with drifts in a short distance northwest and southeast on the 75-foot level.

On the spur lode, southeast of No. 3, a shaft is sunk 35 feet with adit from hillside into the bottom of it.

On the south lode. No. 5 shaft is down a depth of 100 feet and a cross cut was being driven east on the 75-foot level. On the surface of this lode, east of the shaft, open cut work was being done on the outcrop. High grade ore was exposed. No 10 shaft is on the same lode 560 feet farther east.

No work has been done on the north lode further than putting in a few shots here and there.

On the centre lode no development has been done.

The positions of shafts Nos. 5, 6 and 7 will be seen from the diagram. The veins or fissures on which they are situated appear to cut the main vein containing shafts Nos. 1 and 3 at angles averaging approximately 45°.

It will thus be seen that the mass of diorite carrying the ore bodies is divided by the fissures into large blocks. The dip or hade of the fissures approaches the vertical.

The diorite in which these deposits occur, as shown on the accompanying map, covers an area of considerable size in this part of the district. The Ledyard gold mine which was not in operation at the time of my visit is located on the same area, being situated on the eastern part of lot 19 in the first concession.

THE GOLD AND ASSOCIATED MINERALS.

The gold at the Belmont mine is found in the free state in quartz, which forms lenses and stringers in the chlorite schist of the fissures, and in iron pyrites with which the schist is impregnated. Mispickel which is characteristic of the Deloro and other properties farther east on the gold belt does not occur here.

In addition to pyrite, pyrrhotite is occasionally met with. This pyrrhotite like the pyrite is gold-bearing, but does not carry such high values in the precious metal as the latter mineral. A sample of pyrrhotite from No. 3 shaft gave $13.00 per ton in gold, while a specimen of pyrite mixed with quartz taken from the ore pile at No. 1 shaft contained gold to the amount of between 5 and 6 ounces to the ton of 2,000 lbs.

Galena and copper pyrites are met with at times but only near the surface. These minerals are found occurring under similar conditions in other parts of the Hastings district. Their presence only near the surface in so many deposits is an interesting fact. It would seem that the galena, at least, owes its occurrence to the fact that at one time, before the district had been subjected to great denudation, the diorite was overlain by crystalline limestone. The limestone has apparently acted as a precipitant for the galena near the surface, and it has not influenced deposition in those parts of the ore bodies lying at a greater depth in the diorites and associciated rocks.

The main lode or vein on which shafts Nos. 1, 2 and 3 have been sunk runs in an east and west direction. Its dip, which is about 75°, is towards the south. Along the surface of the ground the lode shows outcrops of quartz in places, but it is chiefly indicated by chlorite schist which is more or less rusted through the decomposition of iron pyrites and is bounded on either side by massive diorite. A depression lies between shafts Nos. 1 and 2 and no outcrops are visible. A drift has, however, been run westward from No. 2 towards No. 1. Westward of No. 1 shaft the lode shows at the surface in a number of places. One of the most prominent of the outcrops is on the country road which was used for years before mining operations were begun on the property. The outcrop just referred to being composed chiefly of chlorite schist, was not suspected of being of economic value until long after the discoveries of gold had been made in the adjoining township of Marmora and others farther to the east. It was not till 1890 that this property was located as a mining claim, twenty-five years after the discoveries in Madoc.

Mr. A. W. Carscallen, M.P., was one of the original owners of the property and it is largely through the confidence he had in it that it is now a producing mine.

The rich ore zone has a pitch west from Nos. 2 and 3 and, according to Mr. Kerr, the highest grade ore in No. 1 is found at the 400-foot level. Lying over this ore zone is an old water course in a crevice of the rock, into which one can easily stick his arm. When this was struck between the 375 and 400-foot level in No. 1 it drained No. 3, from which it inclines towards the west. This shows a connection between the shafts over a distance along the vein of 400 yards.

The lodes, which run at an angle to the main lode, dip towards the southwest.

The cause of the lodes dipping to the south and southwest is probably the presence of masses of granite, younger than the diorite in which the ore bodies occur, to the north and northeast. The granite on contracting would tend to pull the rocks surrounding it, which it had cut through, towards it. The fissures in these, caused by the strain exerted on them by the granite, would tend to dip away from the mass of this rock.

This mine, which is situated at a considerable distance from these granite eruptions, contains only small dikes or stringers of granite through the diorite in which the ore bodies lie.

The fact that the sulphide accompanying the Belmont ore is pyrite while that associated with the ore of the Deloro, and other deposits in the diorite near the contact of the granitemasses with the diorite, is essentially mispickel is probably due to the distance of the Belmont ore bodies from the contact of the two masses of igneous rocks. It would seem that the heated waters accompanying or following the granite eruption were charged with the elements which gave rise to mispickel and that most of this material was deposited at no great distance from the contact, as in the case of the Deloro. While the fissures at the Belmont probably owe their origin to the disturbance of the diorite, in which they occur, by the granite intrusion it would appear that the pyrite which they contain may have been leached out of the diorites themselves, or on the other hand it may represent the remaining sulphide in solution after the deposition of the mispickel in other deposits near the granite contact. The fact that the country rock at the Belmont mine is considerably different from that surrounding other gold deposits examined may also have some bearing on the character of the sulphides.

Details as to the plant and the development work done at the Belmont mine will be found in the reports of the Inspector of Mines for the present and preceding years. It will suffice to state here that the results already achieved justify the belief of the manager that the ore bodies are large enough to supply a much larger plant. The deposits occurring. as they do near the centre of a large area of coarse-grained igneous rocks, may confidently be expected to extend to great depths.

Ledyard Mines and Neighborhood.

The Ledyard gold mine is located on the east half of lot 19 in the first concession of Belmont. On the west half of this lot is what is known as the Ledyard iron mine. Considerable of the ore, which is magnetite, has been shipped from the deposit. The ore body lies near the contact of coarse diorite, cut through by a finer variety, and crystalline limestone which overlies both these rocks along the western edge of the deposit.

At the time of my visit the openings were filled with water.

The mine is at the end of the railway which branches off the Central Ontario Railway near Central Ontario Junction.

Crystalline limestone also overlies the diorite along the boundary between the townships of Marmora and Belmont, on lot 20 of the first concession, just east of the Belmont mine.

Diorite outcrops near the east shore of the north end of Belmont lake on lots 19 and 20 in the third concession, about one mile and a half west of the Belmont mine. Along the road running from the mine towards this part of the lake exposures of diorite occur, alternating with knolls of dark crystalline limestone or calc schist The diorite runs in a north and south direction parallel with the east shore of the lake and occurs also immediately to the west of the lake, as shown on the geological map which accompanies this report.

On the east shore of the north end of the lake calc schist outcrops at the water level. It has a strike of about north 10° west and dips at an angle of about 45° to the eastward.

Five or six feet up from the surface of the water and 10 or 15 feet back from the shore a conglomerate with well-rounded pebbles, some of which have a diameter of 2 or 3 inches, forms a ridge parallel with the shore and is in contact with the calc schist. The matrix of the conglomerate is crystalline limestone.

A dark mica schist is exposed near the foot of a hill about half a mile west of the mine on the road leading to Belmont lake. This schist contains coarse flakes of black mica.

It would appear that the depression now occupied by Belmont lake owes its origin chiefly to the weathering away of crystalline limestone which at one time filled a hollow in the underlying diorite.

In the vicinity of the dam at the foot of Deer lake the rock belongs to the diorite series. At the compressed air plant this rock is in contact with calc schist which strikes in a north and south direction and dips at an angle of 45° or so to the eastward.

A glance at the map will show the detached nature of the diorite and crystalline limestone outcrops in the area lying in the vicinity of the Belmont mine and Deer and Belmont lakes The latter rock has at one time formed a mantle over the irregular surface of the former. Denudation has removed parts of the limestone especially on the higher ground and thus exposures of the two rocks are found irregularly distributed over the present surface.

It was not possible in many cases to determine the relationship existing between the coarser grained varieties of diorite and the finer-grained kinds in this and other parts of the district.

As shown on the map diorite occurs around the northwest shore of Deer lake. Further to the southwest on the road running from the head of this lake Silurian exposures are met with. A short distance past Taylor's bridge conglomerate which represents the lower layers of the Birdseye formation is exposed. Limestone of this formation is the underlying rock on several farms in the neighbourhood.

Round Lake and Oak Lake.

Turning northward on the road leading to Round lake settlement, the rock is chiefly diorite and slate for some distance before crossing the bridge over the river.

The Round lake settlement which occupies lot 22 in the seventh concession and adjacent lots is underlain by Silurian limestone. The first part of the road leading from this settlement to Whitney's, lots 30 and 31 in the sixth concession passes chiefly over diorite. Crystalline limestone, however, in which there are some openings made many years ago with the object of quarrying marble, crosses the road before coming to the buildings on Whitney's farm. The quarry lies to the west of the road, at the edge of the clearing, its location being marked on Vennor's map published in 1868. Exposures of Silurian limestone are seen at the road side at the north end of the farm.

Going northward along the road towards the school house of the Oak lake settlement which is on the north half of lot 4 in the third concession of the township of Methuen, a valley about half a mile wide underlain by Laurentian rocks is crossed. The first of these is crystalline limestone which lies on the southern boundary of the township. Then there are outcrops of diorite followed by hornblende and granite gneiss. Crystalline limestone then comes in again and is followed, to the northward, by Silurian limestone on which the farms of the Oak lake settlement are situated.

This settlement lies at a considerable elevation and a good view can be had from it of the country to the north-west. The valley in which are Oak lake and the comparatively large and irregularly shaped Koshkabogamog lake intervenes between the settlement and the Blue mountains. These so-called mountains are composed of nepheline and other varieties of syenite in which occur in places corundum and muscovite. Both of these minerals have been mined to some extent here. The syenite with its associated rocks is described by the writer in a former report[2]

[2] Rep. Bur. Min., Ont. Vol. VIII.

Much of the area surrounding the Blue mountains is underlain by granite. On the map which accompanies this report the granite and syenite are shown in the same color.

About half a mile north of Whitney's a little-travelled road turns off to the eastward and leads to the Van Sickle settlement. There is also a road running eastward, between lots 3 and 4 in the fourth concession, from the Oak lake settlement. The first mentioned road comes out on the main road on the south side of lot 4 in the first concession of Methuen. The rock at this point is crystalline limestone while that farther back is a diorite gneiss.

The Van Sickle settlement is partly in the township of Lake and partly in Methuen. The school house of the settlement is on lot 4 in the first concession of Methuen. Just before coming to the school house from the westward a belt of dark gneiss is met with which has a width of a few hundred yards and within 200 yards of the school house is an outcrop of white quartz on the roadside which has a width of 10 feet or so.

The distance from the Van Sickle settlement to the Belmont mine is about 7 miles. The road runs along the edge of the north end of Deer lake and is underlain by crystalline limestone. Southeast from this, before coming to the bridge over the Deer river, diorite and dark gneiss are encountered. From near this bridge to the vicinity of the mine there is a good agricultural area which is occupied by farms.

Marmora and Vicinity.

After leaving the Belmont mine a short distance the road to Marmora village passes over calc schist, chiefly, to near the boundary of the village where Silurian limestone outcrops are met with. This limestone is of a uniform fine-grained character and lithographic quarries have been opened up in it on the south side of the river not far from the outskirts of the village.

Some of the calc schist along the road between the mine and the village has a very striking banded appearance. The origin of this banding is obscure.

The road from Marmora village to the station of the same name passes over Silurian limestone of the Birdseye and Black River formation. At the top of the hill just before coming to the station a good view is obtained of the country to the eastward. A lower lying area extends between this point and the granite hills or as they are called, the Huckleberry hills, which are immediately to the east of the Deloro mine and adjacent gold-bearing deposits.

To the east of the station a hundred yards or so and crossing the road is an exposure of calc schist. Farther on towards the Deloro mine the road passes over an area of Silurian limestone, which runs up to within a short distance of the mine. The ore bodies at the mine are in diorite which dips under the Silurian limestone at the west and is overlain by crystalline limestone in places to the southward. On the east the diorite comes in contact with granite which rises into and forms the mass known as the Huckleberry hills. That the granite is younger in age than the diorite and associated crystalline limestone is shown by the fact that dikes of it cut both of these rocks. Some of the dikes are medium to fine-grained granite, while others are very fine-grained and can be classified as felsite. The dikes are felsitic in character, especially in the crystalline limestone which overlies the diorite.

In some parts of the granite mass quartz is absent or sparingly present. The rock then becomes syenite. The ferro-magnesian minerals are also absent in some of the granite. At other times there is considerable hornblende present. Quartz when present is often blue in color.

The Moira river follows a depression which runs near the contact of the granite and diorite on the lot on which the Deloro mine is situated and on adjacent gold-bearing lots to the north and south.

THE DELORO DEPOSITS.

The Deloro mine, formerly known as the Gatling and Canada Consolidated, which is operated by the Canadian Goldfields, Limited, of Great Britain, has been described, as regards its mining operations, by the Inspector of Mines in recent reports of the Bureau of Mines. Various papers and reports on the character of the ore bodies and on the kind and relationships of the associated rocks have been published during the last thirty years or more. The deposits have been described both as bedded or segregated veins in schistose rocks and as true fissure veins. The writer's work has led him to differ materially from all the descriptions which have been written concerning the character of the ore bodies and their enclosing rocks. No detailed descriptions have up to the present been published of the megascopic and microscopic character of the diorite and associated rocks.

The ore at this mine consists essentially of mispickel or arsenical pyrites together with gold in quartz. Associated with the quartz is at times considerable dolomite or calcite. This latter mineral frequently contains iron in the ferrous condition. After it has been exposed to the air it takes on a brownish color due to the oxidation of the iron. Iron pyrites in much smaller quantities than mispickel is also present. Copper pyrites is found at times. Other minerals are occasionally met with, such as fluor spar in very small quantities. Small crystals of zircon were found in some of the dolomite, but they appear to be of very rare occurrence in the ore body. Secondary minerals such as hematite, arsenolite and chlorite are also present.

The mispickel at times occurs well crystallized in characteristic forms.

Gold is found in visible grains and scales in the quartz and associated with the mispickel, sometimes, but rarely, occurring in minute rounded grains attached to the faces of mispickel crystals. The greater part of the gold is however mixed through the mispickel in a very finely divided and invisible form. It has been thought by some that a certain amount of the gold in this mineral probably existed in the combined state as an arsenide or otherwise, but from experiments which have been made this does not appear to be the case.

The diorite in which the ore bodies are found at the Deloro is finer in grain than that at the Belmont mine.

There appear to be two varieties of dark colored rocks in this vicinity, one which is clearly of igneous origin holding fragments at times of the other. The latter may be different in origin from the former and is often closely associated with crystalline limestone or calc schist.

The rock at the Belmont in addition to being coarser-grained than that of the Deloro is also somewhat more basic. Moreover, the Belmont diorite being situated farther from the granite contact is not cut through by so many dikes of the latter rock and they have not been met with in the walls of the ore bodies.

At the Deloro the ore bodies in the diorite cut across granite dikes, as is evident from the dump heap at the Gatling or main shaft. Among the waste rock on this dump are numerous pieces of granite. Since dikes of granite are never found cutting through or disturbing the ore bodies, it is evident that the fissures or cavities now occupied by the ore were formed subsequently to the period when the granite cut through the diorite.

These dikes run through the diorite in different directions and dip at various angles. Frequently angular fragments of the diorite of various sizes are surrounded by or enclosed in the granite. This phenomenon is well shown near the south-west corner of the mill.

The writer's observations only served to confirm the conclusions as to the form of the deposits which had been arrived at by Mr. Kirkegaard, the manager of the company, who has made a careful study of them.

On lot 9 in the eighth concession of Marmora, on which the chief operations of the company are being carried on, there are two main shafts, known as the Tuttle and the Gatling. These shafts are connected underground and all the ore is now brought up through the latter, which is down to a depth of about 360 feet on the incline. The dip of the Gatling vein or lode is at an angle of about 45° to the west, although the dip varies at different points in the shaft. The strike of the lodes is in a direction west of north and south of east.

The two shafts referred to are considered by Mr. Kirkegaard to be on different lodes, being separated near the surface at the western extremity of the Tuttle by a few feet of rock, this lode having a somewhat different strike and dipping at a lower angle than the Gatling. Below the surface at the western extremity of the Tuttle this lode forms a junction with the Gatling, and the latter then becomes the main lode as it retains the dip below the junction which it possesses above.

Other lodes occur on this property having a similar relation, as regards dip and strike, to the Gatling as the Tuttle. It is not necessary for our purpose to refer to them in detail.

Nature of the Ore Bodies.

The cavities, now occupied by the ore bodies at Deloro, were originally, it is probable, narrow cracks which have been enlarged by the action of impure waters circulating through them and decomposing the rock along their walls. The cavities have the form of lenses both in the direction of the dip and in that of the strike, a succession of them being encountered as the vein is followed downward. Between the lenses, following the dip, the vein is represented by a narrow crack which connects one lens with another. These constrictions are probably due to a difference in the character of the rock bounding the vein at different points. Along the narrower parts of the vein there may be considerable granite in the walls which would decompose less readily than the diorite that bounds the lenses. This appears to be the cause of the constriction of the lenses in a horizontal direction, at least, as at the southern end of the fourth level the rock is composed chiefly of granite which holds numerous angular fragments of diorite

Along the walls where the diorite has been decomposed the rock is a schist, talcose or chloritic in character. The edges of the ore lenses pass into this schist which is distinctly laminated. When rock of this character is met with in the workings it is an indication that an ore body is near at hand.

On lot 9 in the eighth concession near the Gatling and Tuttle shafts is the company's gold mill consisting of 20 stamps. This mill is modern in every respect, and is noted for the amount of ore it handles per day, about four tons of ore being treated by each stamp every 24 hours. The pulp from the stamps is concentrated by means of Frue vanners and Wilfley tables. The concentrates which carry a high percentage of mispickel are treated by a solution of bromo-cyanogen (Sulman-Teed process) by which means the gold contained in them is extracted.

The concentrates after being cyanided are taken to the roasting plant, situated some distance south of the mill, where the arsenic is driven off in the form of arsenious oxide, "white arsenic," collected in chambers, refined and put in kegs for shipment. This arsenious oxide is used largely by paint manufacturers in the production of variously colored paints. Compounds of arsenic also have other applications in the arts and the demand for them is likely to increase very materially in the future. The methods of preparing them and an account of their chief uses are given in Mr. J. Walter Wells' paper printed in this volume.

Details concerning the methods used at this mine for milling, roasting and refining these arsenical gold-bearing ores are also to be found in two papers published recently.[3]

The Deloro mine is almost unique among the mines of the world in that it is a producer of both gold and arsenic. It is unique in Canada in that it is the only producer of arsenic in this country.

[3] Treatment of Auriferous Mispickel Ores at Deloro, by Messrs. Kirkegaard and Wright, Jour. Can. Min. Inst., pp. 113-122 and 143-151.

Other Mispickel Deposits.

The Canadian Goldfields own other arsenical gold-bearing deposits along this part of the North Hastings auriferous belt. Lot 10 adjoining on the north the lot on which the mill is situated possesses ore bodies of similar character and mode of occurrence to those which have been described. It is known as the Hawkeye property. Still farther to the north along the contact is the Murray lot on which some work has been done.

On lot 6, to the southward, the company have sunk a shaft known as the Rankin.

Mr. W. A. Hungerford is manager of the Atlas Gold and Arsenic Mining Co. which controls what is known as the Gatling five acres, being part of lot 10 in the eighth concession. This property is completely surrounded by the holdings of the Canadian Goldfields. A 10-stamp mill is erected on it and mining has been done on a continuation of one of the veins of lot 9.

Mr. Hungerford and associates also control what is known as the Severn mine on lot 8 in the eighth concession, and the Gawley, which will be referred to again. At the time of my visit work was being energetically carried on in sinking a shaft on the Severn which is also known as the Pearce property. Ore bodies of high grade had been penetrated.

Messrs. Cook own a considerable tract of land on the mispickel belt consisting of the following lots, part 2, E ½ 6, in the eighth concession, and 7, 8 and W ½ 9 in the ninth concession, and W ½ 10, 11, 12 in the tenth concession. Considerable work was done on some of these lots years ago and the ore bodies are similar in character to those already described. There are also other gold-arsenic properties in the vicinity held by other parties. These lie on either side of the line between the eighth and ninth concessions, and not far from the granite-diorite contact.

It will be seen that the gold-arsenic ore bodies are somewhat numerous in this part of the township of Marmora and that there is a large reserve of ore to be drawn on. It would seem that the most feasible means of treating these ores would be by one large central plant, none of the properties mentioned being too far distant from the more central ones to make the cost of bringing the ore to a single plant impracticable. The process of extracting both the gold and arsenic from these mispickel ores has been perfected by the Canadian Goldfields, and no further experimental work, such as that carried on by numerous companies in times past, needs to be undertaken.

The greatest depth (about 500 feet) reached in mining operations in this part of the field is in the Deloro mine where a winze has been sunk a distance of about 100 feet below the fourth level, south of the bottom of the shaft. Bodies of fine-grained massive mispickel were passed through. The writer has not had an opportunity of examining this winze.

The occurrence of magnetite and pyrrhotite on some of the lots in this mispickel belt is due to the fact that the diorite was at one time overlain by crystalline limestone and associated schistose rocks. These now form small outliers at points near the granite-diorite outcrop. Magnetite associated with pyrrhotite occurs on the west half of lot 6 in the ninth concession. A pit has been sunk in the deposit which is known as the Marsh ore bed. Crystalline limestone is found near by, a little to the southeast of the Rankin shaft. Openings have also been made in pyrrhotite on lot 9 in the ninth concession, in an outlier of schistose rocks which rests well up on the western face of the granite hills. Pyrrhotite is again found on lot 11 in the ninth concession, on which lot there is also an outlier of crystalline limestone.

This pyrrhotite like all that found in this part of Ontario does not carry nickel in economic quantities. Samples from many localities have been analyzed by various persons in the hope of finding it to contain the metal in quantities, similar to the pyrrhotite of Sudbury. The mineral in this part of the Province is not found in association with basic igneous rocks such as those of Sudbury and appears to be of a different origin, the accompanying rocks being crystalline limestone and others usually of sedimentary origin.

Farther to the northward in the vicinity of Malone are other gold-bearing deposits which have been worked at various times. These deposits occur under somewhat different conditions from those in the vicinity of Deloro. The ore consists of gold in sulphide and in quartz, some very rich pockets or chutes of auriferous ore having been struck. Work, however, has not been carried on very systematically, those controlling the properties being apparently content to search for the richer and more easily worked pockets and not carrying on any very regular developement work. The chief of these deposits is now known as the Sovereign mine. It is situated on lot 17 of the eleventh concession. On the property is a 10-stamp mill erected in 1891. The mine is at present not being worked and was not visited by the writer.

What is known as the Gawley mine is situated on the east half of lot 18 in the ninth concession of Marmora. The ore consists of mispickel together with a lesser amount of copper pyrites and calcite and has a rather striking appearance, the color of the chalcopyrite which is mixed through the mispickel in pieces two inches or more in diameter contrasting strongly with the color of the latter mineral. The rock in which the ore body lies may be described as a calc schist intermixed with chlorite. The longer axis of the deposit lies parallel with the strike of the schist, which is somewhat east of north. The deposit may hence be called a segregated vein. The schist moreover contains ore through it, on either side of the line of strike of the deposit, to the southward. The shaft is said to be down a depth of about 100 feet.

The ore from this property should be particularly valuable as a source of arsenic, of which it contains a high percentage.

Mispickel and gold have been found on a number of other lots in the township of Marmora but the time at the writer's disposal did not permit of his examining them. Moreover, since this report attempts only to give an outline description of the gold belt it is not necessary for our purpose to refer to details concerning other deposits which occur under similar conditions to those already mentioned. This arsenic-holding ore is also found in townships lying to the northward of those visited and in others to the east and northeast. Reference will be made to the latter in the account of the distribution of the rocks.

Deposits of mispickel occur on the Jeffry property in the ninth concession of Faraday township, and on the Rollins lot five miles east of Coe hill in the township of Wollaston.

Township of Tudor.

The Craig mine is situated on the south half of lots 4 and 5 in the third concession of the township of Tudor. Considerable work was done on this property some years ago. The main shaft is said to be down a depth of 103 feet and the vein has been stripped for some distance. The vein matter is pretty massive quartz and has an average width of five or six feet. At the bottom of the shaft the width is said to be twelve feet.

The road running from Millbridge to this property passes for the greater part of the distance over crystalline limestone. In the vicinity of the mine diorite gneiss or schist is met with. Near the south end of the vein the rock is more massive and has the appearance, in hand specimens, of quartz-diorite. Quartz stringers run from the walls into the vein.

Northward from Millbridge the Hastings road passes over calc schist to the foot of the hill, the passage or defile over which is known as the "Hole in the Wall." The rock of which this hill is composed and over which the road passes some distance to the northward is a coarse-grained igneous variety belonging to the gabbro family. The writer did not determine the relation which it bears to the finer grained diorites and dark colored schists which have been referred to on preceding pages. The rock was examined years ago by the late H. G. Vennor of the Geological Survey and was described by him as an anorthosite. The felspathic constituent of the rock was analyzed by Dr. B. J. Harrington and found to have the composition of the basic variety known as bytownite. This felspar is described as having a greenish grey color. The other essential constituent is stated to be a dark olive-green hornblende [4]

Judging from Dr. Harrington's analysis, this rock is similar in composition to the anorthosite of South Sherbrooke which at times carries corundum.[5]

Township of Madoc.

Southward from Millbridge to Bannockburn the Hastings road passes over crystalline limestone or calc schist. On the western edge of the latter village is what is known as the Bannockburn gold mine, on which considerable work has been done at various times. Some very rich gold-bearing specimens have been obtained from this property, but those working the deposit do not appear to have met with sufficient encouragement to justify their carrying on further development. The ore is quartz associated with sulphides in a dark schist or gneiss of the diorite series. The rock is much discolored with iron oxide due to the decomposition of pyrite.

This pyrite or iron pyrites is found in a large massive deposit about one mile to the southeast of the village where it is being mined and shipped to the United States for use in the production of sulphuric acid. The ore body strikes in a north and south direction and dips at a rather high angle to the westward. The mineral in this deposit is associated with a talcose material. That it occurs in a pretty massive form is evident from the small amount of waste rock produced.

Deposits of another sulphide, galena, have been worked in the townships of Tudor and Madoc.

A few miles to the northwest of Millbridge in what is known as the Katherine lead mine, and about two miles northward from Bannockurn is the Hollandia mine. The galena in both these deposits occurs in veins with calcite, in a dark-colored schistose rock or as it may be called a diorite gneiss. At the Hollandia the veins cross the strike of the country rock.

Southward from Bannockburn, as will be seen by the map, the road leading to the town of Madoc passes over a variety of rocks, consisting of calc schist, and other members of the Archæan, and Silurian limestone.

At Eldorado village through which the road passes is located the Richardson mine. This deposit is of especial interest as being the one in which gold was first discovered in Eastern Ontario. A good account of the discovery of this deposit and the excitement consequent on it will be found in the reports of the Geological Survey and Bureau of Mines..

Mispickel has been found in various places in the area lying between Eldorado and the town of Madoc, the greater part of the road between these two places passing over diorite and calc schist, which are cut through by dikes of granite and felsite, the geological structure being similar to that on the west side of the granite mass, the Huckleberry rocks.

Township of Elzevir.

From the map it will be seen that the rocks which for convenience are here called the diorite series show outcrops on or in the vicinity of the road running from the town of Madoc to Bridgewater, Actinolite post office, in the township of Elzevir. It will further be seen that these rocks form an almost continuous band which bounds, on the southward, the large granite mass which occupies a large part of the township of Elzevir and adjoining townships to the eastward. Outcrops of crystalline limestone and associated rocks overlie the granite in places, usually in the valleys, but these cannot be indicated on a map of so small a scale.

This Elzevir granite area with its border of diorite presents a structure similar to that of the Huckleberry hills. The band of diorite stretches northeastward through the townships of

[4] Geol. Surv. Can., p. 310, 1874-75.

[5] Bur. Mines Rep., p. 226, Vol. VIII.

Kaladar, Anglesea, Barrie and Clarendon, the granite on the whole forming the higher hills and the more broken and barren tracts of country.

The Sophia mine is situated on lots 14 and 15 in the tenth concession of Madoc, not far west of the western boundary of Elzevir. A 10-stamp mill was erected on this property a year or two ago. The chief development work has been done on a vein which consists of rather massive quartz. Another vein which contains a considerable percentage of mispickel has been opened up. As will be seen from the map these veins occur in rocks of the diorite series.

The well known James mispickel property consisting of 308 acres in the fourth concession of Elzevir, adjoins the village of Actinolite and is owned by Mr. Joseph James. The ore bodies lie in schistose rock of the diorite series. Gold is associated with mispickel and would be obtained as a by-product in utilizing the latter as a source of arsenic. Quartz and a small quantity of pyrite form part of the ore. Five shafts varying from 20 to 40 feet in depth have been sunk on the deposits, thus affording a good opportunity of judging of the character of the ore bodies. On the river which runs through the property are falls, one of which has been developed. Another is said to have a drop of over seventy-five feet. Some years ago a railway was graded from Madoc to and beyond this property. Tweed, a station on the main line of the Canadian Pacific railway, is about five miles distant.

What is known as the Clapp mispickel property lies adjacent to the one just described.

The crystalline limestone or marble which occurs at the village of Actinolite or Bridgewater is used as a building stone and is well adapted to the purpose.

A sketch of the diorite hills in the vicinity of Bridgewater is given in one of Vennor's reports.[6]

Kaladar and Anglesea.

On the road from Actinolite to Flinton in the township of Kaladar a grey, coarse-grained granite with considerable quartz and flakes of black mica is first met with on lots 6 in the sixth concession and 7 in the seventh concession. This represents the southernmost part of the area of granite which spreads out over Elzevir and adjacent townships. The road passes over this granite to the vicinity of lot 13 in the tenth concession. Green schist is then in evidence for a short distance and is succeeded along the road towards Flinton, beginning at the bridge across the river, by a coarse-grained, dark, igneous rock of the texture of gabbro. This latter rock extends to within about half a mile of Flinton, at which point it is succeeded by a green schist, similar in appearance to that just mentioned.

To the northwestward across the Scoutamatta river which runs through Flinton granite comes in contact with the schist, the river not following the actual contact of the two rocks, but lying in the schist, generally a few hundred yards from the granite. The granite appears to cut the schist and the latter rock presents much more evidence of having been disturbed than the former.

Proceeding by the road from Flinton to Cloyne, rock similar to that underlying Flinton village is encountered, being overlain along the first mile or so of the route by sand as far as the sixth concession near the junction of this road with that running from Kaladar station to Cloyne, where an area of granite is again passed over.

A gold property, the Golden Fleece, on which some work has been done lies not far north of the road on lot 25 in the sixth concession. The deposit lies near the contact of the diorite schist and a conglomerate. The ore is found in association with the schist where it occurs in quartz in the form of a vein and in quartz more or less mixed with the schist. A shaft about 25

[6] Geol. Surv. Can. 1872-3.

feet deep has been put down on the vein and there is a pit of considerable size in the schist. Material taken from these openings was milled, with what is claimed were satisfactory results. The sulphide in the ore is pyrite.

The schist which strikes southwestward contains quartz stringers through it for a considerable distance along the strike. Exposures of quartz also occur on the more northern pa·t of the property. Very rich specimens of gold-bearing quartz were obtained at the top of the shaft when the property was discovered. At the present time there is no difficulty in obtaining "shows" of gold by panning the quartz and impregnated schist. The deposit cannot be considered a high grade one. Any attempt to work it should be made on the assumption that it is a large low grade ore body.

Some work has been done on a lot near the contact of the diorite schist and conglomerate to the south-west of the Golden Fleece. Mispickel associated with quartz and tourmaline is found in some of the openings. These pits lie farther west from the contact than the Golden Fleece. Numerous stringers of quartz occur near the contact, and garnet is found at times in the schist or diorite gneiss. The writer some years ago found the mineral kyanite in place on the Golden Fleece lot.

The metamorphic conglomerate referred to lies between the belt of diorite gneiss to the northwest and the granite area to the southwest, as will be seen from the accompanying map. It may not be a conglomerate in the ordinary sense,—that is it may not be a water-formed deposit. It would appear that it may be an autoclastic rock produced by the fracturing of the zone along the line of contact between the granite and diorite schist. The pebbles or fragments of which it is made up are chiefly quartz, but it also contains dark fragments of mica schist and some very white quartziferous material which has the appearance of a very acidic granite. All of the fragments have a more or less oval form and are drawn out in the direction of the strike of the rock.

This conglomerate band runs for some distance across country, outcropping again on the road between Spring Brook P. O. and Cloyne and farther to the eastward in the southern part of the township of Barrie.

On what is known as the Rebstock property which lies about one and one-half miles east of Flinton two shafts have been sunk, it is said, to a depth of about 80 feet. The ore is mispickel associated with pyrite, quartz and calcite.

Other occurrences of mispickel are known in Anglesea, which bounds Kaladar on the north and some work has been done on them. The lots on which these occurrences are found include 7 in the fifth concession and 9 and 10 in the third.

On the road from Flinton grey granite is met with on lot 22 in the eighth concession of Kaladar, and continues towards Spring Brook P. O. About a mile north of Spring Brook the conglomerate which has been referred to is passed over, being evidently continuous with that on the Golden Fleece property. North of this a massive diorite is encountered. Approaching Cloyne a more schistose variety of the rock comes in and is overlain at one point on the road before reaching Cloyne by crystalline limestone.

At Loon lake, in Anglesea, a dark rock is met with. It is more or less laminated, and has the appearance of the scapolite-holding varieties which are found in the townships to the southeast. Granite comes in near the middle of the east arm of the lake and the large island is also composed of it. The little island near the mouth of Wolfe creek is made up of the dark-colored rock referred to, through which run dikes of light-colored granite. On the shore west of the island is a massive granite similar in appearance to that outcropping on the road below Spring Brook. This granite is cut by dikes of fine-grained pink granite. For a distance of six miles along the road north of Cloyne, granite is the chief rock passed over, although outcrops of greenstone schist are frequently seen.

Turning off the Addington road, about 2 miles below Cloyne, towards Harlow P.O., conglomerate is met with about one-half mile from the turn. The band of this rock is narrow here. Alongside the conglomerate and between it and the greenstone schist is a mica schist. This latter schist encloses small fragments of rock and seems to pass gradually into the conglomerate. Immediately east of the conglomerate crystalline limestone is exposed and has greenstone showing through it in places. The higher hills around the Morgan lake settlement to the east are composed of greenstone schist. Neil's lake lies in the second and third concessions north of Morgan's lake.

Harlow P.O. is on the north end of lot 21 in the first concession of Barrie, the road to it running around the northeast side of Morgan's lake.

The conglomerate band comes out near the boundary between Barrie and Kennebec. Just south of the townline crystalline limestone lies in a small area on the greenstone schist. A school house is situated near this point on the townline.

A short distance to the southwest of Harlow the conglomerate rises into prominent hills which present clean, smooth surfaces and when seen from a distance have the appearance of granite. The strike of the rock, half a mile north of the school house, is about east and west. The conglomerate is said to extend eastward to Gull lake, in continuation of the band which was met with on the Golden Fleece property, lot 25 in the sixth concession of Kaladar. The band is thus proved to have a length of over 10 miles.

A road leads around from Harlow P.O. across the extreme northwest corner of Kennebec to Spring Brook, P.O., on the Addington road. On lots 30 and 31 of the eleventh concession of Kaladar it crosses granite, which also covers a large area to the southward in Kennebec.

Barrie and Clarendon.

The road from Cloyne to Perry's mill at the foot of Marble lake, on the Mississippi river in Barrie township, turns off the Addington road southwest of the village. After taking the turn towards Perry's most of the rock exposures met with are crystalline limestone with occasional outcrops of greenstone schist. The strike is approximately northeast and the dip generally to the southward.

At Perry's, Meyers' Cave, P.O., greenstone or fine-grained diorite is exposed at the rapids and also farther eastward in the vicinity of what is known as the Helena mine. Crystalline limestone is however intimately associated with the greenstone. The relationship existing between the two rocks is well shown at the dam, across which the road runs at Perry's mill. Fragments of the limestone, some of which are of considerable size, are enclosed in the diorite or greenstone. The lamination or dip of most of the fragments of the limestone is in a vertical direction in the diorite. It is plain that the diorite here is younger than the limestone and has cut through it. The relationship between the two rocks in some other parts of the field examined is not so easily made out.

Some years ago the writer visited the rapids at the head of Marble lake. Dikes of the rock here spoken of as greenstone were found cutting through the white crystalline limestone or marble along the rapids. The dikes weather less rapidly than the enclosing limestone and stand out prominently above its surface, the contrast between the colors of the two rocks also being striking.[7]

An air-compressor plant has been erected at the dam near Perry's mill. This plant was built for use in connection with the Helena mine which is situated not far east of the mill. At

[7] Bur. Min. Ont., vol. V, p. 219.

the time of my visit no work was being done on the property and I did not examine the deposit. Samples shown me from one of the pits consisted of pyrite, chalcopyrite and black copper ore.

Along the road running eastward towards Ardoch much crystalline limestone is seen. What is known as the Barrie silver mine is situated at the road side a short distance north of the shore of Long lake. A variety of minerals occurs in the opening which has been made in the deposit. They include galena, sphalerite, iron pyrites, meneghinite and others, which are said to show high values in silver together with some gold. The deposit lies near the contact of crystalline limestone and garnetiferous gneiss in the ninth concession.

At the cheese factory, lot 36 in the twelfth concession of Clarendon, the Brulé road branches off the main road and joins the Mississippi road in the vicinity of lot 26 in the southwest range, not far south of the village of Plevna. After leaving the factory the road crosses a creek, at which point and for a short distance beyond the rock is crystalline limestone. Massive diorite then comes in and the road runs over this rock to within about a mile of Plevna. In the vicinity of the village the rock is a greenstone schist. Along the swamp or valley which comes up to the southern edge of the village mispickel has been found in a number of pits to the west of the road. These pits lie on both sides of the valley. The strike of the schist here is northeast.

At the creek, Buckshot, in the village the strike of the rock was found to be N 60 E. magnetic, and the dip nearly vertical. On lots 42, 43 and 44 north of Plevna crystalline limestone is exposed. A deposit of iron pyrites has been opened up on one of these lots. Although the deposit is of a promising character it is apparently too far from the railroad to be worked profitably at present.

Granite comes in near the second lot north of the boundary in Miller. At the time of my visit some work was being done on a graphite deposit near a small lake in the second concession of South Canonto.

Going from Plevna to Ardoch the road passes over diorite or its schistose variety for the first three or four miles. Beyond this crystalline limestone is met with.

The Boerth mine which is situated on lot 28 in the seventh concession of Clarendon is equipped with a 10-stamp mill. A description of its plant and the development work done on the property has been given in a former report of the Bureau of Mines.[8] The deposits of auriferous mispickel and quartz occur near the contact of diorite and crystalline limestone. The two rocks in some of the pits have the appearance of being interbedded but it is likely that the diorite is younger than the limestone and has cut through the latter. Some of the quartz veins run across the strike of the rocks. Tourmaline occurs at times mixed with the mispickel and the ore containing this mixture is said to be the richest in gold. This association of mispickel and tourmaline, as already stated, is found on the property adjoining, on the southwest, the Golden Fleece location in Kaladar.

Mispickel deposits have been opened up on the Cook or Babcock property which lies about two miles south of the Boerth.

Work has been done on other gold-bearing deposits in the vicinity. On lot 33 in the southwest range an opening has been made on a quartz vein. Mr. Muldoon of Plevna showed the writer some specimens of bismuthinite which were found associated with quartz in this vein. Bismuthinite is also said to have been found on a lot lying north of Buckshot lake and in other localities in the northern part of Frontenac county.[9] The mineral was also fonnd years ago in a deposit on lot 34 in the third concession of the township of Tudor.[10] Chapman states that mispickel associated with this Tudor bismuthinite contains a small percentage of cobalt.[11] A variety of mispickel, known as danaite, is found in some districts which contains from 4 to 10

8 Vol. IX. p. 93,

9 Report Bur. Mines, vol. VII. p. 234.

10 Report Geol. Surv. Can. p. 9 L, 1883.

11 Min. and Geol. 3rd ed. p. 77.

per cent. of cobalt replacing the iron. Glaucodot is a mineral of similar composition but contains, theoretically, 23.8 per cent. of cobalt.

A small percentage of cobalt in mispickel would prove a valuable by-product where the mineral is used as a source of arsenic. Mispickel possesses the following percentage composition: Arsenic 46.0, sulphur 19.7, iron 34.3. It will thus be seen that the iron remaining after the arsenic and sulphur have been roasted off will contain nearly three times as much cobalt as did the original ore. The two metals can then be separated.

Other Gold Localities.

Gold has been found in other townships which are in proximity to some of those mentioned in preceding pages.

A specimen from the west half of lot 10 in the sixth concession of Lavant, Lanark county, was found to contain 0.195 ounce of gold to the ton.[12] The precious metal is also said to have been found, as the following quotation shows, in another locality in the same county.[13]

From the northeast half of lot 12, concession 2, of the township of South Sherbrooke, Lanark county. A white translucent quartz, carrying small quantities of copper pyrites, iron pyrites and coarsely crystalline galena. The specimen, which was, in parts, coated with hydrate peroxide of iron, weighed one pound eleven ounces. It was found to contain :

Gold	3.500 ounces to the ton of 2,000 lbs.
Silver	..0.408 of an ounce " " lbs."

The occurrence of gold in these two townships shows that the belt should be considered as extending farther eastward than the township of Clarendon.

A few years ago a sample of quartz taken by the writer from an outcrop which was found close to the west end of the north shore of Stony lake, near the boundary between lots 5 and 6 in the first concession of Harvey township, Peterborough county, showed a value of $2.25 of gold to the ton.[14] This township lies some distance west of Belmont which is the most western township in the belt, in which deposits have been developed.

Other Economic Minerals and Rocks.

The fact that crystalline limestone has been worked for building and decorative purposes in some parts of the district has been mentioned. Marble quarries have been opened in the vicinity of the town of Madoc, near Actinolite and elsewhere. The Silurian limestone makes a good building material, and is also used in the production of lime. Certain bands of this limestone in the vicinity of Marmora village have been worked for lithographic stone.

Some varieties of the granite and diorite occurring in the district are adapted to uses for which these rocks are employed.

A slate quarry was opened some years ago not far distant from Madoc village.

A rock which occurs in Madoc township attracted attention many years ago as being suitable for the manufacture of whetstones.

Corundum, another substance used for abrasive purposes, occurs in the syenite in the northern part of Methuen township.

Iron ores—magnetite, hematite and bog iron ore—have been worked at various times in localities adjacent to the gold belt. One of the first blast furances in the Province was located at Marmora village.

At the village of Actinolite or Bridgewater the mining and grinding of actinolite has been carried on since 1883. This is the oldest mining industry in continuous operation in the district.

12 Geol. Sur. Report, 1896, p. 56 A. 13 Ibid, p. 28 R. 14 Bur. Mines Ont., Vol. VIII, p. 213.

Practically, the total output is shipped to the United States where it is mixed with coal tar, pitch and other ingregdients in the manufacture of roofing material which has been used on some of the large buildings in the leading cities.

Talc has been mined during the last few years in the vicinity of the village of Madoc, near the shores of Moira lake. The material, as to the quality of which good reports have been obtained, is found in crystalline limestone. Talc in promising quantities also occurs in the township of Grimsthorpe.

Mica has been mined near the head of Mazinaw lake in Abinger. It is found occurring in dikes of coarse granite or pegmatite. Very clear white mica has been worked in the township of Methuen where it is found in dikes of syenite pegmatite, some of which contain nepheline and corundum.

Reference has been made in preceding pages to deposits of galena, pyrite and other minerals which are found at points along the gold belt and the occurrence of silver in association with galena and other minerals in the township of Barrie has been mentioned. This metal is also said, as the following quotation shows, to have been found in the township of Rawdon, lot 4 in the thirteenth concession, which adjoins Madoc on the south. "A somewhat fine crystalline galena, together with small quantities of iron pyrites and zinc blende, in a gangue composed of white crypto-crystalline quartz and white crystalline calcite The gangue constituted but a small proportion, by weight, of the whole. Weight of sample, one pound seven ounces. It was found to contain :

Gold .... none.
Silver .... 51.042 ounces to the ton of 2,000 lbs."[14]

Additional Notes on Rocks.

As the descriptions given on preceding pages of the rocks along the gold belt have been of a general character, it may be well to add a few notes on the microscopic characteristics of some of the more important of them.

BELMONT MINE.

The rock in which the ore bodies are found in this mine varies in size of grain in different parts of the mass. When examined in thin sections under the microscope it is seen to be much weathered. The two chief constituents appear to have originally been a basic felspar and a ferro-magnesian mineral. The outlines of the former can be readily seen, but the mineral has been replaced by a number of secondary materials, among which are epidote, zoisite, calcite, scapolite, kaolin and quartz.

In some sections the felspar is seen to be set into the ferro-magnesian mineral, thus producing the ophitic structure which is characteristic of diabase. This structure is found in certain facies of gabbros, and Dr. Barlow has recently shown that those of Sudbury, in which the nickel deposits occur, are of this diabasic character.[15] It is difficult to say what the dark constituent of the rock was originally. It is now represented chiefly by chlorite. Brown mica is also present in considerable quantity at times. Pyrite and magnetite with leucoxene are distributed through the rock mass. To sum up, it may be said that it appears the rock is a gabbro and that it has a structure, in some parts of the mass, closely related to that of diabase.

All stages of decomposition can be seen, from the type just described down to the highly schistose variety which forms the body of the ore. In this variety all the minerals are probably of secondary origin. They consist of chlorite, biotite, calcite, quartz, plagioclase, orthoclase

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14 Geol. Sur. Report, 1895, p. 35 R.

15 Sum. Rep. Geol. Sur. Can., 1901, p. 143.

and pyrite. The felspar and biotite appear quite fresh. Quartz and pyrite are found in large amounts in the schist at times, and form the ore. Biotite is present in some specimens of the schist in a higher percentage than the chlorite, although in hand specimens the rock appears to be composed essentially of the latter mineral.

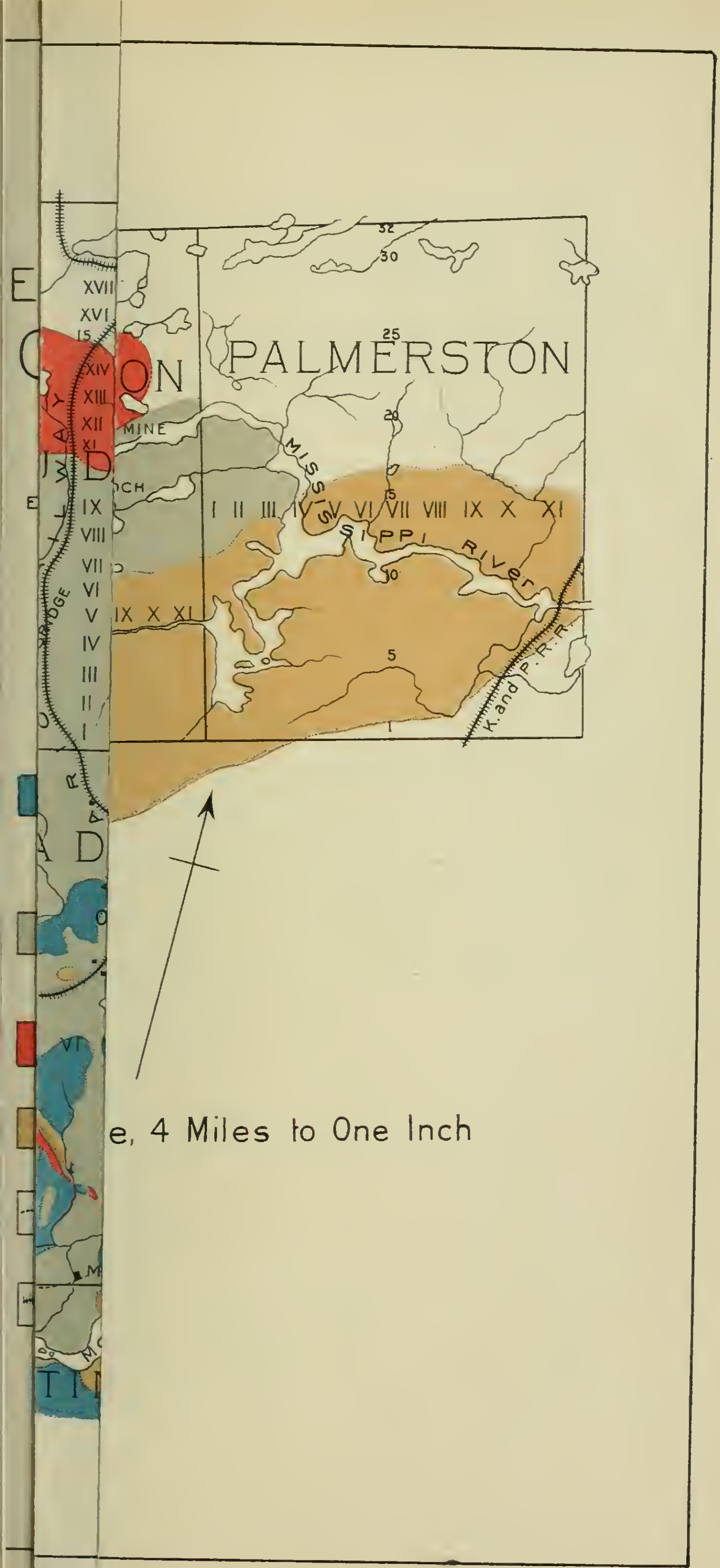
DELORO MINE.

The rock associated with the ore bodies at this mine which we have called diorite, presents considerable variety in character in different parts of the property. Typically, it is dark-colored and medium-grained. Where weathered it is often seen to contain considerable dolomite. On fresh surfaces this mineral is not easily detected, but it contains ferrous oxide which on exposure to the weather is oxidized and the dolomite then becomes distinctly visible, appearing in brownish rhombohedral forms through the mass of the rock. The fact that the rock is variable in character is not surprising when we consider the forces that have acted on it. Granite dikes cut through it in different directions, and ore-bearing waters have tended further to change it. The dolomite and calcite now present in the rock may have been derived partly as inclusions, as the diorite appears to have cut through the crystalline limestone which is found in the vicinity. Carbonates have, no doubt, also found their way into the body of the rock through the agency of water.

Under the microscope the essential constituents are seen to be plagioclase, hornblende and biotite. The secondary minerals chlorite and epidote, together with quartz and much calcite or dolomite are usually present. Muscovite and probably talc are seen. The accessory minerals include pyrite, sphene and apatite. It is difficult to make out what was the original character of the rock, but we shall classify it as a quartz diorite.

A rock called by the miners quartzite comes in on the foot wall of the 4th level of the Deloro mine, not far south of the shaft. It has been struck by the diamond drill at some distance, horizontally, from the upper levels, being farther to the eastward of the uppermost levels than from those lower down. It is thus seen that the mass of this rock dips in the same direction as the ore body, namely, to the westward, but at a smaller angle to the horizontal. Under the microscope it is found to be a binary granite, its two essential constituents, quartz and felspar, being almost of the same color. Some muscovite or talc is present, and the section examined contained a considerable amount of dolomite. The felspar, which is much more abundant than the quartz, consists of different acidic varieties, microcline, microperthite and orthoclase. Grains of pyrite were observed.

The wall rock of the Rankin shaft is similar to that just described. A larger proportion of quartz is, however, present. Dolomite occurs in sharp angular crystalline fragments which possess the outline of sections of rhombohedrons. This mineral, therefore, has the appearance of being an original constituent of the rock, and resembles the calcite which has been noted as occurring in nepheline syenite from different localities in eastern Ontario and Quebec. This has been thought by some to indicate that the nepheline syenite possessed some close genetic relationship to the crystalline limestones with which it is usually found associated in the field. It seems to the writer, however, that the occurence of calcite or dolomite in both the nepheline syenite and granite can be accounted for on the assumption that it was taken up by the latter rocks in the form of inclusions when the granite or syenite broke through the crystalline limestones. Conditions of pressure and temperature appear to be such as to have prevented the solution or breaking up of the included calcite in the molten magmas. Calcite is found under similar conditions in trap dikes which cut the crystalline limestone of Barrie township. Here it occurs not only in small or microscopic fragments in the igneous rock, but also in large fragments, several inches or a foot in diameter.



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OUTLINE MAP OF THE EASTERN ONTARIO GOLD BELT

To accompany Report of

W G Miller

ELEVENTH REPORT OF THE BUREAU OF MINES 1902
THOS W GIBSON DIRECTOR

LEGEND

CAMBRO SILURIAN
Birdseye and Black River Limestone

PRE CAMBRIAN
Crystalline Limestone and Talc Schist together with Conglomerate

Diorite Rocks

Granite and Syenite

Wagon Road

Railway

MADOC VILLAGE.

The rock which is found in the form of dikes in the crystalline limestone near the marble quarry on the outskirts of Madoc town and is spoken of as felsite on a preceding page, is seen under the microscope to possess a very fine-grained crystalline ground-mass, composed of quartz and orthoclase. Through this are set phenocrysts of the same minerals. The phenocrysts are not abundant, and only the larger of them show a tendency to take on a regular outline. Some of the orthoclase is twinned according to the Carlsbad law. A few flakes of brown mica and some calcite were observed.

Another rock which also occurs as dikes of a dark color cutting the crystalline limestone in the same neighborhood was found to have the composition of a diorite. It is rather fine-grained and consists of plagioclase and hornblende, the latter mineral being more or less altered to chlorite. Calcite and dolomite are present and probably represent fragments of the crystalline limestone which were taken up by the diorite at the time of the formation of the dikes. Pyrite is present, as is also apatite. Quartz occurs in subordinate amounts.

KALADAR TOWNSHIP.

Attention has been drawn to the fact that the granite of Kaladar and other townships in the eastern part of the gold belt differs in appearance in the field from that farther west. Under the microscope it is seen to be a somewhat coarse-grained rock, composed of quartz, biotite and orthoclase, together with considerable acidic lime-soda, felspar and muscovite. Accessory constituents include zircon crystals and gas bubbles.

ON ROAD WEST OF FLINTON.

The rock outcropping on the road about two miles west of Flinton which has been spoken of as being gabbro-like in appearance proves to be a more acidic rock when examined in thin sections. The larger phenocryst-like grains are felspar, orthoclase and an acidic, multiple-twinned plagioclase. The ground-mass in which they are set is medium-grained, and is made up of biotite, hornblende more or less altered to chlorite, orthoclase, plagioclase and quartz. The larger grains of felspar contain numerous small flakes of biotite. A chemical analysis would probably show the rock to have the composition of syenite.

KATHERINE LEAD MINE.

The most abundant minerals in the rock from this locality, which has a dioritic appearance in hand specimens, are calcite and biotite. Considerable hornblende is also present. Orthoclase, plagioclase and quartz are found in less quantity than calcite. It is difficult to say what the character of the rock was originally. From the microscopical descriptions which we have given of certain igneous rocks of the region, showing them to contain calcite in considerable quantity, it would appear that this rock may at one time have belonged to the igneous class.

SYENITES NEAR PORT COLDWELL.

BY A. P. COLEMAN.

A few years ago some very interesting dikes of a rock containing analcite named heronite or analcite tinguaite, were described from the north shore of lake Superior between Heron bay and Peninsula on the Canadian Pacific railway ;[1] and the opinion was expressed that nepheline rocks should be found connected with them somewhere in the region. Dr. Adams also has suggested the same idea, basing his belief on some rock specimens from the region of Peninsula in the Geological Survey collection. They are augite syenites of an unusual kind often associated with nepheline syenites.[2]

In connection with an excursion to the iron range of the Slate islands an opportunity was taken to examine the railway and shore near Port Coldwell, and it was intended to visit Pic island a few miles off shore, where Prof. Pirsson and others have suggested that nepheline rocks would probably be found, but unfortunately no suitable boat could be got at the little harbor, and this had to be given up.

An Extensive Group of Syenites.

No syenites of any kind were found between Heron bay and a point three miles east of Peninsula, where augite syenite had been obtained a few years before ; but west of Peninsula, more than half way to Port Coldwell, considerable stretches of nepheline syenite were discovered. So far as the study of the specimens has gone one can say that a great area of syenites and associated rocks, rich in alkali and differentiated into a whole series of related species, like those so elaborately described by Broegger in the Christiania region of Norway, occurs in this district.

The first rock of the group going west is the dark augite syenite, which commences three miles east of Peninsula and with some interruptions of red syenite and more basic rocks extends to a long trestle at mile 818, a distance of nine or ten miles, with an unknown width. From the trestle west to a cutting beyond Peninsula the prevalent rock is a gray or purplish gray nepheline syenite having in all an extent of about four miles. It is probable that detailed mapping of this little-explored region would show large areas of this syenitic group of rocks, including Pic island, and it is hoped that in the future these interesting eruptives may be studied more at length.

The only previous references to this group of syenites are to be found in the reports of the Geological Survey of Canada[3] where rocks containing red and white felspar, some grains of orange-red elaeolite, and a few zircons, are said to occur on Pic island and the mainland to the north ; and of the Bureau of Mines,[4] where the occurrence of augite syenite and other associated rocks is referred to, though the nepheline rocks were overlooked. Acknowledgments must be made to Professor L. V. Pirsson and Dr. H. S. Washington, for having been good enough to send chips and larger specimens of various nepheline syenites and related rocks from other localities, which have proved most useful for comparison.

NEPHELINE SYENITES.

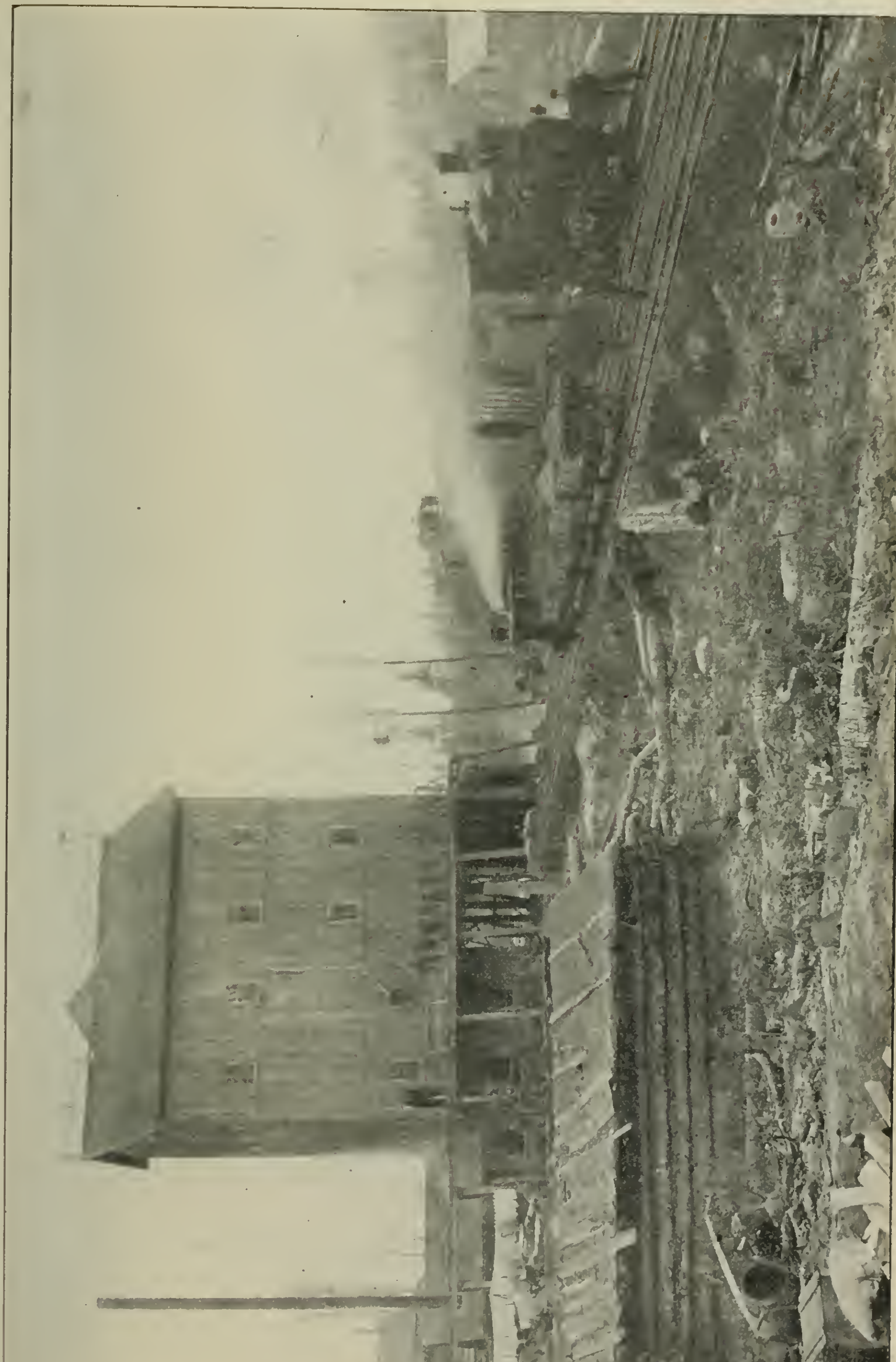
The syenites and associated rocks are very well exposed between miles 818 and 822 in the numerous rock cuts and cliffs where the railway winds along the rugged shore of lake Superior, so that an almost continuous section is presented. The first nepheline syenite observed is just east of the long trestle at Red Sucker lake, where it forms irregular dikes and larger masses in gabbro, which appears to be the older rock of the two ; and similar relations are found at the

1 Bur. Mines, 1899, pp. 172-174 ; and 1900, pp. 186-191.

2 Jour. Geol. Vol. VIII., No. 4, pp. 322-325.

3 1846-7 ; also 1863, p. 80.

4 1897, p. 147.



Gertrude nickel mine; rock house and railway.

Roast heaps at Gertrude nickel mine, showing method of constructing heaps.

rock cut west of the trestle, though red syenite interrupts it at the third cutting. Beyond this toward the west, hills of nepheline syenite rise 200 or 300 feet above the lake and continue with few interruptions to Port Coldwell station and the next cutting beyond it, the last point where it was observed being a little beyond mile 822. The second cutting west of the station is in red syenite.

The rock varies from almost compact to very coarse-grained kinds, having crystals an inch or more long ; and in color from pale to dark gray, sometimes running into purplish tones or having brilliant red spots. The black hornblende and augite crystals stand out sharply, giving a fresh look to the rock, which unfortunately is not borne out in thin sections. In some specimens the hornblende crystals are long slender prisms, but in others they are short and stout. The different textures are often mixed intimately, fine-grained parts enclosing coarser-grained ones or the opposite ; and large or small blocks of the gabbro mentioned above are enclosed in the nepheline syenite. Dikes of a fine-grained purplish gray rock related to the Essexites, sometimes with the look of an amygdaloid, cut the syenite ; and last of all, there are sharp-edged dikes of black diabase.

In general appearance the nepheline syenites are very different from those of eastern Ontario, never showing the gneissoid structure so common there, nor having dikes of pegmatitic rock consisting of large individuals of nepheline and muscovite. Nor are they like specimens from Barkevig, Norway, nor Litchfield, Maine ; but some of them have much the appearance of specimens sent by Professor Pirsson from Highwood mountains, Montana, and Multonborough, New Hampshire, having a tendency to plate-like forms of the felspars, and long prisms of the darker minerals. These would apparently be classed by Prof. Broegger as foyaites, though unlike a specimen of foyaite from Langenthal, Norway, sent me by Dr. Washington.

In the considerable number of specimens collected near Port Coldwell four fairly well marked types may be distinguished, so far as megascopic structure is concerned :

1. Medium to coarse-grained gray rocks, having a dioritic appearance with light and dark minerals in about equal amounts and the grains isometric.

2. Medium-grained reddish, purplish or violet gray rocks with about twice as much of the lighter colored minerals as of the dark ones, and with a tendency to plate-like or elongated forms in the minerals.

3. Violet gray fine-grained rocks with porphyritic felspars and other minerals.

4. Narrow veins of coarse-grained rocks, often mottled with red, gray and black.

There are however many intermediate varieties between the four here mentioned, illustrating the usual variability of the nepheline rocks.

1. The first variety occurs as fresh looking material about two miles east of Port Coldwell, and was supposed to be diorite when collected. The white minerals are nepheline, orthoclase and a less amount of finely striated plagioclase having a very small extinction angle, probably oligoclase ; all badly weathered and turbid, the nepheline sometimes changed into a brownish substance having aggregate polarization, perhaps a zeolite. The dark minerals include hornblende in fairly well formed crystals having a pleochroism of dark green, brownish green and brown, and an extinction angle of 23° ; and also augite in about equal amounts, sometimes enclosed in the hornblende. The augite has a slight pleochroism, sea green, gray green and brownish green, but its extinction angle is normal, and the nearly rectangular cleavages in cross sections show that it is really a pyroxene. The only accessory minerals noticed are magnetite and apatite, both in considerable quantities.

A very similar but duller rock occurs in the first railway cut west of Port Coldwell, with the difference, as seen under the microscope, that the hornblende is dark brown and the augite grayer and not pleochroic, One or two large masses of magnetite and serpentine probable represent olivines completely decomposed.

2. The gray or purplish gray variety, with relatively small amounts of the dark ingredients, contains all the minerals mentioned as belonging to No. 1, with the exception of the probable olivine ; but the ferro-magnesian minerals are, of course, less in amount, and occasionally a little brown biotite occurs in addition to the hornblende and augite. The red color of spots in the rock is due to infiltration of iron oxide in portions of nepheline completely changed to zeolites, and the usual reddish or purplish tone of the rock is due to the general diffusion of the same oxide. As distinguished from the previous variety this one is leucocratic. In some examples the minerals have plate-like or long, prismatic forms, with a suggestion of the trachytic structure. In one section the augite is almost entirely replaced by hornblende, often dark brown in the middle and green at the edge, with very deep colors but not strongly pleochroic, perhaps barkevitic in character.

3. The porphyritic varieties of tbe nepheline syenite occur partly a mile or two east of Port Union, and partly to the south of the station near the harbor. Specimens from the former locality are dark bluish gray, fine-grained, with porphyritic felspar, nepheline (rarely) and hornblende crystals. One thin section from mile 819 shows very small crystals of nepheline, having the prism and basal planes enclosed in orthoclase, and possibly oligoclase, as well as in hornblende, the latter mineral forming sieve-like structures, the holes being filled with lighter minerals, a good example of poecilitic intergrowths. The other minerals are augite, magnetite and apatite. A second specimen shows less of the poecilitic intergrowths, but contains one or two long porphyritic prisms of nepheline.

Porphyritic examples from south of the station have a purplish gray ground in which bluish crystals of felspar and black crystals of biotite are embedded. The ground-mass does not differ much from the former rock, but the numerous phenocrysts are orthoclase, oligoclase and brown biotite having strong dichroism.

4. The fourth variety forms narrow pegmatitic veins in the other varieties, and consists of the same minerals but of larger dimensions, sometimes more than an inch in length, though never rivaling the giant nepheline pegmatites of eastern Ontario, as described by Dr. Adams, with crystals more than a foot long. The nepheline in the Port Coldwell specimens is often changed to a turbid orange red material, mentioned by Sir William Logan as elaeolite;[5] the felspars (orthoclase) are pale gray, and the hornblende prisms black, making a very showy rock.

In spite of the striking differences in appearance of the varieties mentioned above, the range of minerals found in the thin sections examined is not great, much less, for instance, than in the nepheline rocks of Dungannon and York branch in eastern Ontario,[6] and none of the rarer minerals have been found by myself, though zircon is mentioned in the 1863 report. The absence of muscovite, scapolite, sodalite, and of the usual microcline and microperthite is peculiar ; though in some cases weathering has gone so far as perhaps to obscure the structures of the felspars.

AUGITE SYENITES.

The other important groups of rocks in the region include the augite syenites, which occur in two well-marked varieties, one dark brownish gray to black in color, coarse-grained and with more or less of a plate-like character in the felspars : the other red or reddish gray, finer grained and usually granitic in texture.

The first variety is much the more extensive of the two, and will be described first.

5 Geol. Can., 1863, p. 81.

6 See Bur. Mines, 1899, Corundum and Other Minerals, p. 205, etc.; and Corundiferous Nepheline Syenite, p. 250, etc

In the dark variety, no doubt the trap which Logan reports from the region, the felspars are the prominent ingredient, forming broad plates or narrow shining strips, often Carlsbad twins, attracting the eye in the sun; while the relatively small amounts of ferro-magnesian minerals escape notice. While dark brownish gray to black is the prevalent color, there are phases of a dull brown or a dull red; and weathered glaciated surfaces may even be white by the bleaching of the felspar, when the augite and magnetite show as angular black filling material between the felspar crystals, which tend to the idiomorphic.

The syenite is always coarse-grained, the crystals averaging about a quarter of an inch in length, and also in breadth when seen broadside, but often only a tenth of an inch in cross section. There are very coarse pegmatitic veins in the finer-grained rooks having individuals of felspar an inch or two in diameter, and often fairly well built out in occasional cavities.

As this rock has been quarried by the railway for bridge construction, etc., it is easy to get fresh material.

Thin sections consist of felspar in more or less idiomorphic forms with augite wedged in between, resembling, so far as one can tell from a description, Broegger's laurvikite[7]. The felspars show no twin striations but have partly the appearance of microperthite and partly of microcline. They are fairly fresh and in some directions have a handsome bluish shimmer. No nepheline nor sodalite nor quartz was observed. The dark minerals are chiefly augite with brown interior and dark green exterior, but some dark green and brown hornblende, and some magnetite occur also, as well as apatite.

An analysis of this rock made by Mr. A. H. A. Robinson of the Chemical Department of the School of Practical Science, Toronto University, gives the following results in column I:

	I.	II.
SiO_2	58.81	58 88
Al_2O_3	13.37	20 30
Fe_2O_3	3.88	3.63
FeO	6.97	2 58
MnO	0.20	....
MgO	0.51	0 79
CaO	3.89	3.03
Na_2O	4.96	5.73
K_2O	5 42	4.50
H_2O at 100° C	0.29	1.01
H_2O above 100° C	0.75	
TiO_2	0.70	....
P_2O_5	0.31	0.54
Total	100.06	100.99

Specific gravity at 17.5° C, 2.75.

For comparison an analysis of Norwegian laurvikite from Byskoven, Laurvik, by A. Merian, is given in column II.[8]. The two analyses agree fairly well, except for the relative proportions of alumina and of ferrous iron oxide, which differ greatly. In a rock consisting so largely of microcline and microperthite the alumina must be higher than 13.37 per cent., and it must be assumed that there is an error in its determination in I. No other feature requires comment except the fact that potash somewhat surpasses soda in the analysis, while Broegger's laurvikites contain somewhat more soda than potash.

Associated with the dark augite syenites with plate-like felspars are numerous other varieties in much smaller amounts, some merely having the red color of the ordinary syenite, due to diffused hematite particles, but with the same ingredients and the same shape of the felspars; others differing more widely in appearance and composition, but all more weathered

[7] Zeitschrift fuer Kryst. u. Min., Band 16, 1890, pp. 29 and 30. [8] Ibid., p. 30.

and less satisfactory for study with the microscope. It will be sufficient to refer to the kinds having granitic structure, grains with equal diameters. These are on the average finer-grained than the laurvikitic syenite, and may be divided into leucocratic red syenites with comparatively little of the ferro-magnesian minerals; and melanocratic syenites containing more than half dark minerals.

It must be admitted that the term leucocratic syenites is not happy for the less basic varieties, since they are strong red and not white or pale colored. Several specimens from east of Port Coldwell are in reality quartz syenite, consisting of felspar pegmatitically intergrown with quartz, and small quantities of hornblende, augite, magnetite and apatite.

The felspars, which tend to be porphyritic, so far as their weathered condition permits one to decide, are orthoclase, microcline and oligoclase. These rocks seem to have the same composition as Broegger's nordmarkites, though no mention is made of pegmatitic intergrowths in these rocks.[9] Aegirite has not been recognized in the rocks from Port Coldwell, another point of distinction.

The melanocratic syenites consisting to the extent of at least half of dark colored minerals are dark gray rocks, usually with a red tinge, not very coarse-grained, with about equal diameters to the grains. The light colored minerals are orthoclase, some plagioclase and occasionally nepheline; the dark ones hornblende, pale blue green augite and brown biotite in not far from equal amounts; while magnetite and apatite are always present, the latter often as numerous large prisms.

Plagioclase Rocks.

Three kinds of plagioclase rocks accompany the syenites of the Port Coldwell region, coarse-grained gabbro-like rocks older than the syenite and penetrated or carried off as blocks by the nepheline syenite; fine-grained gray-brown rocks occurring as dikes without well defined edges in the nepheline syenite; and green-black dikes of diabase or diabase porphyrite, which are latest of all.

The gabbro is a speckled gray, coarse-textured rock showing plates of mica and often a few porphyritic plates of plagioclase megascopically. Thin sections are made up of half or less than half of a plagioclase having the extinction angle of andesine or sometimes labradorite; and of pale bluish-green augite, often idiomorphic, and brown biotite in about equal amounts, while brown hornblende and olivine are in smaller quantities. Magnetite and apatite in thick prisms are the chief accessories; and serpentine, chlorite and iron oxides occur as secondary products. In one section the biotite surrounding a weathered olivine crystal is modified so that the parts nearest the olivine are more strongly dichroic than the rest, bright green and orange brown in the two directions.

The fine-grained dikes of brownish plagioclase rock are not very sharply defined as a rule, perhaps because they were erupted before the mass as a whole had completely cooled down. In many cases these rocks are specked with white or pale flesh-colored spots, as if amygdaloidal, and they often contain what seem to be fragments of an older fine-grained reddish rock.

The general mass of these rocks consists of some greatly weathered, lath-shaped plagioclase, partly with a radiating arrangement, enclosing biotite, augite and magnetite in larger amounts. In this ground-mass are often well formed crystals of augite, sometimes in groups, pale green or brown, somewhat dichroic and with a zonal structure; and of dark brown hornblende. The lighter patches, suggesting amygdaloids, are composed chiefly of plagioclase, often with well shaped prisms projecting inwards, the centre being of some transparent mineral having low

[9] Ibid., p. 55.

double refraction, perhaps a zeolite. There are a few prisms with parallel extinction, probably nepheline, though so badly weathered as to leave their character uncertain. Without an analysis it would be difficult to place this rock with certainty, so for the present it will be left unnamed.

The dikes of dark gray or black diabase and diabase porphyrite have been little studied. The only one of which thin sections have been made is an olivine diabase with comparatively little augite, often in slender fibres or prisms having the usual extinction angle, but sometimes as broader portions between felspar laths. The magnetite, too, has elongated rod-like forms, and when the numerous needles of apatite are included, there is evident a tendency to elongation in almost all the constituents of the rock. The large, well-formed crystals of olivine, still fairly fresh, are however an exception to the rule just mentioned. These quite fresh rocks are probably of Keweenawan age like most of the diabase dikes on the north shore of Lake Superior, while the other eruptives described appear to be older, though not so old as the Huronian schists which they penetrate.

It is believed that with the possible exception of the gabbros, which may be older than the syenites, and the diabases, which are distinctly younger, all the rocks which have been referred to belong to the same magma and represent phases of magmatic differentiation. The dikes of heronite or analcite tinguaite, though found several miles to the east of the nearest syenite, are to be looked on no doubt as split off from the large mass described.

The older nepheline or elaeolite rocks and their associates can no longer be considered rare. In the Province of Ontario they are now known to occur very widely spread in Dungannon and adjoining townships, where they were first noticed by Dr. Adams, and where they have been followed up for many miles by Professor Miller because of their connection with the corundum bearing band of the Laurentian. The series of eruptives described in this paper form another large mass of nepheline syenites and related rocks, though of a very different type ; and the malignites described by Dr. Lawson from Pooh-bah Lake, west of Lake Superior, make a third, each with its own peculiarities differing markedly from the others. The nepheline rocks of Montreal make another Canadian locality, though on a smaller scale, and with their alnoite dikes, as described by Dr. Adams, present still another type ; the whole illustrating strikingly the great variability of this group of plutonic and dike rocks as contrasted with most others.

To refer to the areas described in the United States by Pirsson, Washington, Osann and others would lead too far ; and a mere list of the localities in Europe, India, South America, etc., would require considerable space.

In concluding this notice of the Port Coldwell and Peninsula syenitic rocks it should be mentioned that a number of them are handsome ornamental stones, as proved by polished specimens prepared by the Bureau of Mines for the Buffalo Exposition, where they attracted considerable attention. The dark gray augite syenite with its gleams of blue from the felspars is a particularly fine stone, resembling the famous Norwegian syenite, though on the whole finer in grain. As it can be obtained close to the Canadian Pacific railway and beside an excellent harbor on Lake Superior, in quarries affording blocks of almost any required dimensions, it should prove of importance in the future.

LAKE TEMISCAMING TO THE HEIGHT OF LAND.

BY WILLET G. MILLER.

At the request of the Director of the Bureau of Mines the writer spent a few weeks last summer in an examination of the territory lying north of the head of Lake Temiscaming and south of the water-shed which forms the divide between the waters flowing into James Bay and those flowing southward to the rivers Ottawa and St. Lawrence. This territory lies in the district of Nipissing immediately west of the Province of Quebec. Part of the district examined is unmapped and is in a virgin state; no lumbering, mining or agricultural operations having been carried on therein. No geological examination had previously been made of the greater part of it.

The object of our work was to get a general idea of the character of the rocks occurring in this unexplored territory. Moreover, the time at our disposal was limited and the territory examined was large. Hence no attempt could be made to do detailed work. This report merely gives an account of the observations which were made during a hurried canoe trip, and should therefore be considered preliminary in character.

Blanche River and Valley.

The Blanche river, so named on account of the white color of its waters at certain seasons when there is much clay sediment carried in supension, enters the north end of Lake Temiscaming by several mouths or channels. For the first thirty miles from its mouth, the river passing between clay banks, no rock is seen in place and but few boulders or fragments of the size of what is ordinarily called gravel.

About thirty miles from the lake the first rapid is encountered. This is caused by a low ridge of diorite, which is overlain by soil on either side of the channel, crossing the river.[1] About one half mile below this point rock of similar character, having a smoothly glaciated surface, is exposed on the shore. The rapid is on lot 3 in the fifth concession of the township of Evanturel. There is a short portage on either side.

One or two of the steamboats from Lake Temiscaming have navigated the river, during high water, nearly to this point.

Along the first stretch of the river the land has all been located by settlers within the last four or five years and clearings of considerable size have been made in various places.

As the mouth of the river is approached from Lake Temiscaming sandy shoals appear, and along the lower part of the river the banks are low, not exceeding 8 or 10 feet in height. Farther up they rise to greater heights. Along the lower stretches the clay forms a level surface back from the edge of the river. The upper part of the banks is in many places capped by a low, more or less hummocky, ridge of somewhat sandy material. This ridge is not wide, and beyond it the surface soil is clay. No boulders are found in the clay, which is distinctly bedded, along the river banks but in some places moraine-like deposits of large boulders cover the surface. A deposit of this kind is seen at the edge of Mr. Judge's clearing near the mouth of Wright's creek. At first glance this bedded clay with boulders overlying it would appear to be of preglacial age. It is likely however that it represents glacial material which has been worked over by water, the boulder deposits representing parts of the material which have not been disturbed and now project through the laminated clay. We did not make a careful study of these loose

[1] The rock here mentioned is really a diabase, but it was thought best to use a term with which prospectors are more familiar, and which will give them a good idea of the character of the rock. The same rule will be used in mentioning other rocks, common field terms being preferred to those less known to prospectors. At the end of the report the various rock types met with will be described more accurately.

deposits, being more concerned with the occurrence of rock in place, and are thus not in a position to state definitely whether certain clay deposits are of pre-glacial, inter-glacial or post glacial age.

On the upper stretches of the river some of the highest hills are composed of sand which at times is intermixed with more or less gravel.

Numerous land slides occur. Portions of the banks for 20 or 30 feet or more back from the river's edge have slid into the water carrying the trees with them. Some of these trees which have their tops broken off are stuck into the clay in an inverted position, and the stumps standing upright are buried to some depth in the soil.

Streamlets cutting through the clay banks enter the river at frequent intervals. The water in these when it does not issue from recent clearings is of good quality for drinking.

Larger streams also join the river at several points. Wright's creek, which comes in opposite Judge P.O , may be called the first branch. Then there is the Otter five miles farther up, which also enters the Blanche from the east. Above the first rapid a number of important tributaries or branches of the river are met with. These will be referred to again.

The Hudson Bay Company, it is said, at one time had a post surrounded by some 15 acres of clearing on Diable island at the junction of two branches of the river about a mile above where it enters the lake. The branch going off to the east is called the Devil's or Diable "sny," on account of the current at times being in one direction and at other times in the opposite. It connects the Blanche with the mouth of the Quinze river, and the direction of the current depends on whether or not the water in the former river is at a higher level than that in the latter.

We were told that there is a good sugar bush of soft maple on Diable island. Elms are quite numerous along the banks here ; and other trees are balm of gilead, white birch and poplar. Pine is, however, scarce along the lower part of the river, only an occasional tree of the original forest being seen. Most of the timber is second growth. The district has been burned over and the older trees are found chiefly near the edge of the water. Farther up the river near the junction of the Abitibi branch, it can be seen that pine at one time was quite abundant in the district, charred stubs standing here and there. The fire which destroyed the timber occurred probably 20 years or more ago, since when poplar and other trees have grown up. There is in places considerable second growth pine which is large enough for use in ordinary building operations. Spruce is quite abundant in some parts of the district.

This district having little pine has not attracted lumbermen. Had it contained valuable pineries there is little doubt it would have been thickly settled long before the present time. A large tillable area is now attracting numerous settlers, and within a few years, as the land is easily cleared, it will be an important agricultural district. Areas well suited for agriculture are found from the head of Lake Temiscaming to the height of land and beyond to the northward. The surface for some distance south of the height of land is more or less broken by rocky ridges and hills which protrude through the soil. In the vicinity of the height of land, to the westward of Beaver House lake and elsewhere, the surface where rocks are not exposed is covered by sand plains which have been burned over and now support a growth of small sparsely scattered trees. These plains are not suited for agriculture. Caribou trails run across them in all directions. As accounts of the district are to be found in other publications of the Department of Crown Lands it is not necessary to enter into further details here concerning the character of the country from an agricultural point of view.

This territory has been subjected to forest fires to a much greater extent than that in the vicinity of lake Temagami and other parts of the district farther south. Numerous fires have run over the country some years ago and others quite recently. As Indians have been left in undisputed possession of the northern part of the district until lately, they alone are responsible for the destruction of the timber.

The Abitibi Branch.

Less than two miles above the first rapid on the river a tributary, known as the Abitibi branch on account of its having been used to some extent as a part of the route to the lake of that name, comes in from the eastward. Proceeding up this branch shallow water with a swift current is encountered for the first three miles of the course when there is another rapid, necessitating a portage. The trail past this rapid is about 50 yards long and lies on the west bank. Up to the vicinity of this rapid the banks are composed of clay and landslides have occurred at various points. Rock in place occurs a short distance below the portage. It is graywacké, as is the rock at the rapid.

A hill which lies about one mile to the southwest of the rapid rises to a considerable height and is composed of diorite similar in character to that at the first rapid. The outcrops at the two points apparently belong to the same mass which is overlain for the greater part by clay and other loose sedimentary material.

A good view of the country can be obtained from this hill. Ranges of hills are seen some miles distant both to the eastward and to the westward with isolated hills intervening here and there.

About one mile above the last mentioned portage is another rapid. The portage here is something over 100 yards in length and runs along the west or lett-hand bank of the river. An island lies at the foot of the rapid and the canoe route to the foot of the portage passes around its western side. The rock here is graywacké, which has a few pebbles of red granite embedded in it.

Up stream a couple of hundred yards is another portage which runs along the right or east bank past some drift wood which has accumulated in the river. Its length is about 20 yards.

Going up stream less than a mile the next portage is met with. On the east bank just below the portage conglomerate is seen in place. Some of the boulders in the conglomerate are eight or ten inches in diameter and numerous pebbles are embedded in parts of the rock. The portage is said to be a mile in length from the river to the western extremity of First lake. It takes, however, about 30 minutes to walk over it and the distance would appear to be greater. The west end of the portage begins with a gradual ascent of a clay hill. From the top of this hill the trail runs across a sparsely wooded level plain, the surface of which is covered with sand and gravel till within a short distance of the east end where hummocky exposures of slate conglomerate are seen.

A short distance up stream from the west or lower end of the portage there is a high bank, probably 60 feet in height, capped with a bed ten to twelve feet thick of gravel and sand. Underlying this is blue clay in layers one or two inches thick. Most of the clay along the river shows distinct bedding. Up stream a little farther the river falls over a rocky ledge some 30 feet in height, the fall being almost perpendicular. The rock at this fall is slate conglomerate.

Before reaching First lake other falls are met with and the portages past them are little used, travel being by the one previously described. The glacial striæ along the river have a strike of N10° or 15°W.

First Lake.

The portage into First lake enters a bay which lies near the boundary of the surveyed territory, the western extremity of the lake running into the township of Marter. This bay runs

S 20° W and is about one-third of a mile in length. Another arm branches off N 45° W one-quarter of a mile and out of this the river flows. Slate is exposed on a little island which lies near the north shore at the junction of these two bays. Conglomerate forms the opposite or west shore. Slate is also seen at the outlet of the lake, passing into conglomerate a short distance down the river. The latter rock appears to overlie the former.

From near the point of junction of the two bays the lake stretches out for about a mile to the southeast and then strikes east for an eighth of a mile. A prominent point here is composed of slate which shows original bedding, being made up of different colored layers dipping at a low angle to the southward. A mile and a half from the west end of the lake syenite outcrops on the southern shore. Beyond this slate appears.

About three miles from the west end a narrows is passed through. From here the route runs approximately S 80° E to the portage, across an expanse of the lake which has a rather rounded outline and is about three-quarters of a mile in diameter. High hills lie a short distance from its southern shore. A rocky island used as an Indian camp ground is situated a quarter of a mile from the narrows or portage into the next lake. This island is composed of slate which holds a few pebbles and boulders of pink granite. The narrows just referred to is about 150 yards long and has considerable current near its foot, the water flowing over rounded boulders. We pulled our canoe up it although there is a portage trail running along its west side. The narrows runs in a northeast direction.

SECOND LAKE.

Second or Wendigo lake stretches out in a direction N 20° E for about one mile from the head of the narrows. We followed its western shore, on which slate and conglomerate are exposed. About one mile from the foot of the lake a dark rock, diorite comes in. Its presence is indicated just after leaving the narrows by the baking of the slate and by the occurrence in the latter of quartz stringers and pyrite.

From here the lake runs on in a direction N 40° E for about a mile and a quarter, three islands occurring along the shore. The river enters the upper end of the lake by rapids. The portage which is 100 yards in length lies to the west of the river.

THIRD LAKE.

Third lake stretches out from the head of the portage just mentioned in a direction N 35° E for about one mile. Then narrows are passed through which are about 100 yards in length. The lake then extends N 20° E for one mile. The river flows into this lake by rapids on the east shore one quarter mile from the north end.[2]

FOURTH LAKE.

A rough, rocky portage about 100 yards long leads from Third lake to Fourth lake. Along the shores the rock is slate, and high rocky hills lie about a quarter of a mile to the east The first stretch or expanse of the lake is about three quarters of a mile in length and lies in a direction N 30° E The river runs out of the lake 100 yards or so to the east of the portage. Three-quarters of a mile up from the foot the lake narrows and then expands again for a distance of 200 yards, when there is another narrows 20 yards in length which bears to the west. Above this narrows the lake again widens out for a distance of about one mile and lies in a direction N 30° E. A valley can be seen ahead for some distance following the same strike.

FIFTH LAKE.

A bay runs in from the northwest corner of Fourth lake, and a lift of a few feet over the rapids leads into Fifth lake, a small lake a couple of hundred yards long. Then a rapid comes

[2] The bearings given in this report refer to the magnetic north. As most of them were taken from the canoe with an ordinary compass they are only approximately correct.

in from the east which flows over boulders. The rock on the portage between Fourth and Fifth lakes is slate.

SIXTH LAKE TO TENTH LAKE.

The portage, 175 yards long, from Fifth to Sixth lake, runs out of a little bay to the northwest of the rapids. The first stretch of Sixth lake is about 600 yards in length and runs northeastward, and then the lake bends off to the west about 100 yards.

Seventh lake runs N 50° E for one-third of a mile. We pulled our canoes up a little rapid between Sixth and Seventh lakes, but there is a portage on the west side of the rapid. The canoes were also pulled up a rapid between Seventh and Eighth lakes. The river runs into the northeast corner of the former.

The portage from Eighth to Ninth lake is on the west side of the stream over bare rock, slate. The first stretch of Ninth lake is about one-third of a mile long and lies in a direction N 45° E The river runs from Ninth to Eighth lake by two streams, as it also does from Tenth to Ninth, the portage 50 yards in length being to the north of the streams. The trail is also over bare slate which carries a few pebbles. An island lies a few yards out from the end of the portage into Tenth lake and there is a narrow channel past it. The first expanse of this lake stretches out in a direction N 30° E for a third of a mile. Above this is a narrows followed by a second expanse one mile in length in a direction also N 30° E.

The portage about one-quarter of a mile in length goes out of Tenth lake at its extreme northern point. The creek is followed a short distance above its mouth and the portage leads off from the left or west side of the creek, and runs to the head of the rapids. A small pond lies a short distance to the west of the portage just before coming to the next lake.

ELEVENTH OR CROSS PORTAGE LAKE.

This lake is called Cross Portage lake by the Indians, owing to the fact that the route towards lake Present leads across its southern extremity, one portage being opposite the other across this end of the lake. The lake is also known as Raven Rock lake. The rock at the end of the portage entering the southern end of the lake is conglomerate Just at the head of the rapids a large boulder about ten feet long and four feet wide lies in the slate. It is light in color and stands weathering much better than the rock in which it is embedded, the matrix being worn off its upper surface and from its edge which faces up stream. At the time of our visit about eight inches of water was flowing rather rapidly over it and it was difficult to determine its true character. The rock exposed at this end of the portage is ash-like in appearance and weathers like graywacké. It contains fragments of all sizes. up to the boulder referred to, embedded in it. The boulder also has the appearance of being an ash rock or a lava.

Eleventh or Cross Portage lake is seven or eight miles long. The first stretch of the lake is narrow and runs N 45° E while the northern and northeastern part widens out. The boundary line between Quebec and Ontario runs across the end of its eastern extremity. The outlet of the river leading from lake Present enters the lake by a fall which can be seen and heard for some distance. This fall lies on the west shore of the lake not far from its southern end. The width of the first stretch of the lake is 300 or 400 yards.

At the end of this first stretch Mount Chanmanis, pronounced Shiminis, comes in view. This mountain lies immediately to the east of the inter-provincial boundary and is the most striking feature in the topography of the district. During our work last summer we saw it for a distance of some miles from the east, south and west. It lies at the height of land and has the appearance, from whatever direction it is viewed, of a gigantic hay stack, its well-rounded form standing up clear and distinct above the surrounding hills. The spelling of the name is taken from a map made for me by an intelligent Indian who hunts in the district. This region has never been mapped, and I have seen no reference to the mountain in any publication, so that it seems justifiable to accept the Indian's spelling. [3]

The lake bends off to the eastward half a mile above the narrows. On the east shore near this point the rock has a bedded appearance, the layers being ten or twelve inches thick, slate forming the lower layers with an impure quartzite above. Along this lake these rocks dip at a low angle, 15°, to the southwest. The quartzite, or graywacké carrying quartz grains, lies above the slate, and conglomerate appears to overlie the quartzite. If this is their order they have either been inverted or they possess a different relationship from that given for similar rocks by the Geological Survey in the report on the Lake Temiscaming map sheet. The question as to their relationship is of economic interest on account of the occurrence of iron ores. Samples of mineralized quartz were taken from a small island near the eastern end of the lake but were found to contain no gold.

The inter-provincial boundary line was traced for some distance both to the north and to the south of this end of the lake. On the south side the timber has not been burned since the line was run in 1874, but on the north fire has all but destroyed the line. We were able however to find blazes on some of the dead trees. No mile posts were found and consequently we could not locate ourselves very definitely, but this lake appears to be on the 35th mile. Outside of the boundary line no topographical work has been done here.

Cross Portage Lake to Lake Present.

The portage from Cross Portage lake leading towards lake Present runs as already stated from the west shore of the southern end of the former. The landing place lies a short distance north of the falls which has been referred to and leads at first up an incline of bare rock, the trail being indistinct. The rock here is a slate. The portage runs westward about one-third of a mile to the river. The river is followed for less than a mile in a direction north of west where another portage is met with which leads along the right or west side of a rapid. Up to this point the river is about 20 yards wide with low land on either side. The portage is about 225 yards long. From the upper end of this portage the river runs about N 80° W for a quarter of a mile, then turns N 30° E for a third of a mile and then bends to the westward. The river as it flows out of lake Present has low gravelly shores.

Lake Present.

We did not examine the more northern and the southern parts of this lake, which is of large size and can be said to resemble in some respects that beautiful and attractive lake which is now becoming so well known to tourists and sportsmen, lake Temagami. Our route across the lake lay in a direction N 25° W and it took two or three hours steady paddling to cross it.

On a sketch map recently published by the Geological Survey the body of water which is here called lake Present is named Larder lake. The writer however knows of no reason why the latter name should be applied to the lake as the former name is well established.

A few hundred yards around on the left hand side going into the lake, an outcrop on the shore of a dark diorite-like rock was examined. This rock is cut by two dikes, pink in color. One of these is three or four feet wide the other six or eight, and they run a parallel course a few feet apart.

There are numerous islands in the lake, some of which are of considerable size. A small one which lies about two miles from the outlet of the river in the direction of our route across

[3] Mr. Aubrey White, Assistant Commissioner of Crown Lands, who is familiar with the Chippewayan language, suggests that the true name of this elevation may be Kitchi-miniss, meaning "big island" from *kitchi*, great or big, and *miniss*, an island, the hill rising to the eye from all sides as an island does from a lake.

the lake and about 350 yards from the southern shore was found to be made up of three or four kinds of rock. At the camping place on the east side of this island the rock is conglomerate. On its west shore dikes of granite or quartz-porphyry cut through a dark rock which contains a high percentage of actinolite and black mica together with pyrite. On the large island which lies to the northward and is separated from the one referred to by a narrow channel there is a similar assemblage of rocks. A series of dark colored dikes cut the conglomerate.

Proceeding westward from the small island the outcrops at a point which juts into the lake just east of the narrows, which is about 2 miles westward of the little island, were found to exhibit dikes of quartz-porphyry cutting a chlorite schist which has a strike S 45° E and a vertical dip. The main body of the lake stretches out in a direction N 40° E from here. About 200 yards southeast of the narrows similar dikes are found cutting through slate, on the surface of which nodules or segregations of a different composition from the slate have weathered out. Some of the nodules are composed chiefly of magnetite. They also contain considerable biotite. On this southeastern side of the point a number of rusty boulders lie along the shore, some of which have a greenish color on the weathered surface and also on fresh surfaces. They are composed essentially of dolomite. We attached some importance to the occurrence of the boulders as dolomite of similar appearance is at times associated with iron ore deposits in the Huronian.

Up the shore of the lake north of the east end of the narrows is a cleared space which looks like a farm at a distance from the east. This lies about two miles westward of the small island to which reference has been made. The slate along the shore here has a dip of about 7° to the eastward or towards the island just mentioned. A hill up the shore to the northward was found to be composed of conglomerate containing fragments of slate, quartz, gray granite, and a porphyritic gray granite, together with a few red jasper pebbles associated with hematite. The conglomerate appears to overlie the slate and the whole dips towards the islands, which also contain conglomerate.

A short distance around the shore southwest of the narrows is a vein about three feet wide carrying light colored, fine-grained, massive iron pyrites. Across the channel, on the point to the north, rusty dolomite is found in place.

The canoe route from the narrows or the point just beyond it on the north shore runs almost due west to the bottom of a deep bay, the distance being between a mile and a half and two miles. Without a guide the portage would be hard to find.

Similar dolomite to that already mentioned outcrops on the last point passed going into the bay, and iron pyrites also occurs here. The high point on the north of the narrows where the dolomite occurs is composed of well laminated chlorite schist which dips at a high angle and strikes about N 45° W.

From this bay of lake Present a portage 300 or 400 yards long leads to a small round marshy lake or pond 150 yards across. The route across the pond runs about due north and the landing place is not distinct. Although the shores of this pond are low and marshy the water is remarkably clear and it resembles in this respect other small lakes in the district, around the shores of which the ground or low-bush cranberries are often found in great abundance.

The next portage is a little longer than the last mentioned one, and passes over the height of land formed by a hill which rises gradually from the shores of the pond, between the two branches of the Blanche. This portage comes out on another little pond with marshy shores which has a diameter of about 200 yards. The route runs across here in a direction N 30° W the landing place being near the foot of a slope which looks like a clearing. The next portage is about one mile in length and is poorly cut out, being very bushy. The ground, however, is not very rough.

Malone and Canoe Canal Lakes.

The next lake is about one-third of a mile long, its greatest extension being in a direction N 70° E. This lake has marshy shores and is known as Malone lake. During high water the lake has an outlet on the west to a branch of the Blanche river. At the time of our visit the water was low and the canoe had to be partly carried and partly pulled through this outlet. The distance, however, is only a few yards.

From the northeastern end of Malone lake a portage 150 yards in length leads over level ground to a lake which strikes in a direction N 75° E and is about one-third of a mile long. The portage from the north end of this lake is a rough one about 400 yards long. The lake to which it leads is known as Canoe Canal lake on account of the route out of it following a narrow shallow creek for some distance from its northeast corner.

A little island near the entrance to this creek contains exposures of jasper conglomerate. Similar rock is found on the west shore of the lake. The jasper which is not abundant occurs in the form of small bright red pebbles associated with larger pebbles of other materials. An outcrop of diorite was also observed about half way up the west shore of the lake. In the vicinity quartzite and graywacké occur and appear to overlie the jasper conglomerate. The matrix containing the jasper is graywacké, and the rock has a strike similar to that of the lake itself.

The lake is about half a mile long but from the end of one portage to the other, passing up the creek referred to, the distance is about one mile. The upper end of the lake shows exposures of graywacké which is much rusted and contains considerable pyrite.

We also discovered jasper conglomerate on the east side of Canoe Canal lake, first on a hill to the southeast of the little island already referred to. It forms a band which strikes northeastward. The jasper is not abundant and occurs in pieces four or five inches in diameter down to small fragments less than an inch across. There is a great variety of pebbles associated with it, white quartz, grey granite, black slate, etc. Most of the pebbles are well rounded, the jasper ones being among the most angular. To the south of the jasper conglomerate veinlets of specular hematite were found in graywacké.

Headquarters Lake.

On leaving Canoe Canal lake we followed the stream till we came to a small round marshy pond. The water being low we had difficulty in canoeing up the creek. The landing is on a marshy shore, and the portage which is about 500 yards long is brushy. The next lake is known as Headquarters lake. It extends for a distance of about a quarter of a mile in a direction N 65° E with a creek running into a beaver marsh from its southwest corner. A wide bay stretches out in a direction S 45° E At the landing on the northeast end of the lake the rock is graywacké slate with quartz stringers running in different directions through it. Similar rock is found for some distance both to the east and west. These stringers carry a little pyrite and chalcopyrite and some work has been done on them, but they are not promising. A small log camp has been erected near the landing.

It may be of interest to state that the fish we caught in this lake were pickerel and pike, the latter being a better food fish than the pike caught during the summer in the more southern part of the Province. On lake Present we caught perch as well. Unlike the lakes in the lake Temagami district these more northern waters contain few bass. The only fish of this kind we caught was taken at the foot of the first rapid above the junction of the Abitibi branch with the main stream.

Most of the country along the route described has been burned over some years ago. Farther to the northwest signs of more recent fires were apparent. The greater part of the timber is small. A bunch of trees representing the original forest is found here and there, generally near the shores of lakes and rivers where it has been protected from fires.

The country was examined for some distance to the southeast of Headquarters lake. Much of the surface is meadow-like and in places marshy. Conglomerate with small fragments of minerals forms some of the ridges. Masses of dolomite similar to that on the west side of lake Present together with considerable iron pyrites is also found in the rock.

Spectacle and Beaver House Lakes.

From Headquarters lake a rocky portage about 200 yards in length leads northward to another lake which we named Spectacle lake on account of its shape. The first expanse of this lake strikes N 60° E, the outlet being near the end of the portage. Then there is a narrows 15 or 20 yards long and 10 to 12 feet wide running N 10° E. The north half of the lake beyond this narrows strikes N 30° W. The rock at the end of the portage nearest Headquarters lake appears to be a brecciated graywacké.

The portage goes out of Spectacle lake from its north shore at a point where there are numerous reeds in the shallow water. It is about half a mile in length and runs north to another lake, which stretches north for a quarter of a mile. The portage enters it in marshy ground. About the middle of the west side of the lake a marshy creek-like narrows runs west for 200 yards and then enters Misemikowish or Beaver House lake, which is long and narrow and receives its name from the fact that a hill situated on its western shore some miles up from its foot bears a resemblance to a huge beaver house. This lake first stretches north from where we entered it, but has a bay which strikes westward to its foot or outlet. The lake is about 12 miles long and is river-like in character, bays stretching off on either side of the canoe route. The shores are rocky and picturesque, the rock belonging to the graywacké series.

Seven or eight miles up the lake a bay stretches out to the eastward just above the Beaver House rock, on the northern shore of which an Indian cabin has been erected. Two or three miles further up the canoe channel, which here strikes to the west, a second cabin is seen on an island in a narrow part of the lake. Immediately north of this cabin, which is surrounded by a garden spot, is an Indian burying ground. The end of the lake lies about two miles above, and another cabin has been erected on its western shore not far from the end. These cabins will serve as landmarks for anyone, unaccompanied by a guide, first visiting the lake. Northwest of the northern end of the lake high sand hills are seen, and a sand plain stretches for some miles west of this part of the lake, the plain being broken here and there by rocky ridges.

Quasis Lake.

A portage about three miles in length runs from the shore of the lake from nearly opposite the graveyard referred to in a westward direction across the sand plain. Most of this area has been burned over and little timber remains. The portage leads to a long narrow bay which extends S 15° W and opens out into a large somewhat circular lake, which we named Quasis lake. A narrow bay leads off from the east side of this larger bay a short distance north of its mouth. From the foot of the smaller bay a river runs out over a small rapid.

Quasis lake is over a mile across and the distance from the inlet, which lies a short distance northeast of the end of the three-mile portage, to the bottom of its south bay is about two miles and a half. The shores of the lake are sandy in many places with here and there outcrops of graywacké A creek runs into the northwest corner, up which we followed for a short distance, and then took a portage which leads southward to another lake also circular in form, lying west of and close to Quasis lake, with which it is connected by a narrow channel. Near the outlet of this channel on Quasis lake we came across an Indian's tent containing all his winter's outfit.

A sand plain, denuded of trees by successive fires, stretches some miles south of the southern extremity of Quasis lake. This plain lies at a considerably higher elevation than the surface of the lake. A trail was followed southward which became very indistinct about two miles from the lake on account of numerous caribou trails branching off from it. Some rock exposures were found which were chiefly schistose graywacké. One or two exposures of diorite were, however, met with and jasper conglomerate was found in place about two and one-half miles south of the lake.

Partridge Nest Portage.

At the foot of Beaver House lake is a small rapids. The portage, known as the Partridge Nest, leads past this on the east side. It is only a few yards in length. The rock at the rapids is a slaty graywacké more or less rusted with iron pyrites. About 50 yards east of the portage, on a continuation of the the ridge which runs across the rapids some blasting has been done, exposing dolomite with a little iron pyrites in slate. Similar outcrops of small extent carrying a little copper and iron pyrites occur on the shores of Beaver House lake. Some of these have been staked out as claims.

Below the Partridge Nest the canoe route runs across a small pond-like expansion of the river. From here a portage about 30 yards in length leads out of the western corner of the pond, 100 yards west of the channel of the river. This portage may be easily missed, as the route appears to be down the river. From the end of this portage the route runs 200 yards south, then it bears east of south. No rock is exposed for about a mile and a quarter, then a variety of graywacké is met with just below a little rapid down which we lowered our canoe. When the water is high this rapid can be run. The number of portages down the river varies according to the height of the water. Hence it will be understood that the portages mentioned in the following description will not all be met with at times of high water.

About a mile and a quarter farther down is a portage 100 yards in length which leaves the river on its east bank. Down to this point the banks are muddy, with points of rock here and there. We lowered our canoe over the rapids and did not take the portage. The strike of the rock here is about S 60° W and the dip 80° S. Two hundred yards below is another shallows, but the canoe was got through it without much difficulty. This is about a mile above the outlet of Malone lake, to which reference has already been made. A half mile farther down is a shallows 100 yards in length over rounded boulders. Within the next quarter mile or so there are two or three other shallows down which the canoe had to be pulled. A quarter mile farther on is an expansion of the river where the outlet of Malone lake comes in. There is a large bay running up to the outlet of Malone lake which is almost as large as the lake itself. High sand hills lie not far from the east bank of the river above the outlet of the lake.

A quarter mile below this outlet is a portage upwards of one-third of a mile in length. Along this part of its course the river runs southwest, which is its general trend so far. A rather steep hill has to be climbed at the north end of the portage and there is also a hill near its other end. Diorite is exposed at the south end of the portage, and it is likely that most of the trail is underlain by this rock.

The next portage, which is about 300 yards farther down, is 250 yards in length, and leads off from the east side of the river. Coming on down, the river begins to widen and hay marshes appear on either side of the channel. About one mile down an expansion known as Marshy lake is met with. This lake, as its name indicates, is very shallow, and in low water care has to be taken to follow the channel in order to get deep enough water for canoeing.

Near the foot of this lake a point of rock juts out from the east shore, being a variety of hornblende schist. Opposite this is an Indian cabin. Half a mile farther down a spring creek cuts its way through the clay banks on the west shore, the water of which is very clear and cool, unlike that of the river. A half mile below this a rock which appears to be biotite syenite was found in place on the west bank. About five or six miles farther down the next rock exposure was seen which is similar in appearance to that last referred to. It outcrops not far above low water level. A few hundred yards below this again the river breaks through a rocky ridge. The rock in this ridge is more or less laminated, the matrix being apparently hornblende schist or flaser gabbro. It holds angular inclusions of both light and dark colored material and is penetrated by quartz stringers. A little galena in association with quartz is found here on the west side of the river.

A quarter of a mile down stream a rock which has the appearance of fine-grained greenstone is exposed at the river's edge, and outcrops of similar material are found here and there for some distance below.

Jean Petit Rapids.

We visited a moose "lick," which lies about a mile and a half west of the next portage. Moose, and a few red deer, visit this spot in great numbers, judging from the paths worn in the soil which lead to it. The attraction seems to be saline water, which oozes out of low ground at certain seasons of the year. At the time of our visit the water had dried up. The "lick" lies at the edge of a rocky ridge west of a small, marshy lake. The portage referred to is known as the Jean Petit.

One quarter mile west of the portage is a mining claim of the same name. The deposit consists of four or five feet of calcite, with some quartz, carrying a small quantity of copper pyrites. In the vicinity of the deposit the rock is much shattered. It is worthy of note that there is much calcite, along with quartz, as vein matter in the whole of that part of the district we visited.

The Jean Petit rapids are small, and a portage runs along both banks. That on the west is the more level. It being low water when we came down the river, we portaged our outfit and took the canoe down stream to near the foot of the rapids, where we made a short lift over.

The portage past the next rapid is along the east bank, and is about forty yards in length, being a little shorter than the Jean Petit. Specimens of rock taken here may be either a variety of graywacké or crushed diorite, more likely the latter. The rock contains greenish yellow crystal-like forms.

It is three or four miles to the next portage or shallows, the trail being along the east bank. This portage is a long one, and is rough and brushy, being little better than a moose trail. We let our canoe down the rapids, which are shallow and flow over rounded boulders. The rock on both ends of the portage appears to be graywacké.

The next portage below during low water is within a mile of the one just described. It is about a mile and a quarter in length, and is rough and brushy. We floated the canoe down the rapids here and portaged our outfit. A little work was done some years ago on a mining claim which lies up the hill west of the lower end of the portage. The deposit consists of a quartz vein four or five feet wide, with stringers running off into the rock. The quartz is said to contain a small amount of gold. The rock on this side of the river near the shore is dioritic in character. Higher up the hill it is more schistose and graywacké-like in appearance. It may be added that this portage has different landing places on its southern end. During high water the distance that it is necessary to portage is less than at the time of our visit, when the water was low. It took us about fifty minutes to walk the whole length of the portage.

Sand Hill Portage.

It is about ten miles down stream from this portage to the Sand Hill portage, which is also sometimes called the Jean Petit. The Sand Hill is immediately above the junction of what is called the north branch of the Blanche and the branch we came down.

Between the portage last described and the Sand Hill we had to lift our canoe over a number of shallow places. Diorite and graywacké outcrops alternate along this part of the river. A rock forming a shoal runs out into the stream about two miles above the Sand Hill. It is a variety of graywacke. Then there is a similar shoal of smooth rock a mile farther down, which is dioritic in character. The rocks along this part of the stream are in many places covered with heavy layer of soil, like much of the country farther up. The Sand Hill portage is so named on account of the upper end of the portage formerly used running up a high, steep hill of sand, which lies a short distance in from the water's edge. A landing place has more recently been made a short distance farther up stream by which the ascent of the hill is more gradual. Sand hills thirty feet high or more line the river for half a mile or so above the portage. The sand rests on clay, which outcrops at the water's edge and for some distance above. The clay is distinctly bedded, the layers being from half an inch to one inch in hickness.

After ascending the hill at the upper end of the portage the trail runs across a level sand plain, which is sparsely wooded, and lies at a considerable height above most of the surrounding country. On a clear day a fine view can be had from the trail for a distance of some miles around. The portage is over half a mile in length, and at its lower end the trail descends steeply down a clay hill towards the river. At this point the water flows over a rocky ridge, forming a falls of considerable height. The rock at the falls and at the landing place is smooth and well polished, the glacial striæ having a direction N 10° or 15° E This rock when broken is seen to be considerably decomposed, and has the appearance of a diorite or gabbro.

The next portage is about one mile below the Sand Hill. Then there is another a couple of miles down, which is followed by a third about two hundred yards farther on. We did not take the usual portage, but pulled our canoe down, the water being low. On the first portage below the Sand Hill the rock is similar in character to that described at the latter. On the next two the rock resembles the more decomposed parts of the Sand Hill rock, but is fine-grained There are no more exposures of rock from this point down to the first rapid we encountered coming up stream, a short distance below where we turned up the Abitibi branch. Clay banks rise to a height of twenty feet or more along parts of the river's course, and land-slides are quite numerous. There is a good current all the way down this part of the river

A township map covers that part of the river on which the Sand Hill portage is situated, and for two or three miles above it. Up stream beyond this, however, there is no map of any kind of the river or surrounding country. The map shows the portage to be on lot 10 in the fourth concession of the township of Marter.

A settler's cabin has been erected at the point where the south branch joins the main stream, lot 8 in the first concession of Marter. A short distance farther down on the north bank is an Indian's hut.

South Branch of the Blanche.

A trip was made up the south branch of the Blanche to what is known as the Mountain portage. The water being low we had some difficulty in making our way up stream, but succeeded in poling the canoe up to within about a mile and a half of the portage. Here an exposure of Silurian limestone was met with which forms shallows in the river and made canoeing difficult. The rock may be either Clinton or Niagara. Fossils are not abundant, the most common being brachiopod shells. Below this the banks along the river are of clay and rise to some distance above the level of the water. Landslides are numerous. Just below the foot of the Mountain portage the banks are high, and the portage itself runs over an exceptionally high clay hill which lies to the west of the river. The rock at the upper end of the portage is chloritic and graywacké slate That part of the river avoided by the portage is rapid and has a considerable fall. This portion of the district has been visited by heavy fires years ago.

The Quinze River.

Although the Quinze river lies in the Province of Quebec it was decided to ascend it in order to examine the outcrops of iron ore which were known to occur there. It was thought that something might be learned from these which could be made use of in searching for ore just across the boundary in Ontario.

The Quinze enters the northeast corner of lake Temiscaming a short distance east of the mouth of the Blanche, the inter-provincial boundary lying between them. The village of North Temiscaming is situated at the mouth of the former river, and a road runs from it to Quinze lake, the river on account of the numerous rapids which occur on it being now little used except by river drivers.

The rock exposed at the mouth of the river is a quartzite which carries considerable mica. Near the foot of the first portage, and on its south side, conglomerate which appears to be the bottom layer of the fragmental series is exposed. The first two portages are short, being about 150 yards in length, the third is about half a mile long but is over a good road. The rock along this portage appears to be what has been mapped as Laurentian in other parts of the district. Many boulders of a pink syenite-like granite are strewn about. The rock in place resembles many of the friable micaceous gneisses of the Laurentian.

Between the third and fourth portages the current is swift. The latter portage is really made up of two portages during low water and starts in a bay below the point on which river drivers camp near the rapids. The first is 25 yards in length and leads to a small pond, then it is a few yards across this pond to the end of the portage proper, which is about two miles long. A shanty marks its upper end. In low water, however, the canoe can be put in the river a short distance below the shanty. The rock along the greater part of this portage to near its upper end is similar to that described as occurring along the third portage. Near the upper end chlorite schist, somewhat serpentinous in character, comes in and continues up the river to the bend above the fifth, sixth and seventh portages. At this point greenstone appears and is much narrower in width than the Geological Survey map shows it to be.

Outcroppings of Banded Iron Ore.

Counting the two parts of the fourth as two distinct portages, the iron ore band comes in on the eighth portage as described in the Geological Survey report for 1872-3, pages 131-2. We found the band as described on this portage and on the next one above which is separated from the former by a small narrow lake. Outcrops also occur on the "alligator" portage which runs just east of the first mentioned one and approximately parallel with it. A narrow band of magnetite-bearing rock runs from about the centre of the east side of the little lake and can be followed across to the near falls on the river, the direction being somewhat east of north. The river here makes a fine section through the band which is at this point about 30 feet wide and shows distinctly on both banks. It is composed of thin layers, magnetite and rock matter alternating, and has chlorite schist on both walls which are well defined. The chlorite on the east side comes in contact with diabase which is somewhat coarser in grain than the ordinary variety and has the spheroidal structure well developed by weathering, at one or two points on the bank near the high water level.

The band which crosses the portage on the west end of the little lake was followed to the southwest for half a mile. At this point it seems to have been disturbed by a syenite-like diorite. A trail was found here which runs from the east end of the little lake westward to the river. Walking up this we came to another outcrop which we followed northeast to the shore of the little lake. This band is a continuation of that which outcrops on the opposite shore of the lake, but is somewhat bent, probably owing to the lake lying in a line of fault.

There are thus seen to be two distinct bands of magnetic ore here, the one crossing the portage northwest of the end of the lake and the other crossing the lake near its centre. The former crosses the river below the falls, and as already stated, is cut through at this point, while the other runs out near the shore of the river at the falls. The distance between the two bands is less than a quarter of a mile.

The geological map shows the little lake to be wholly within a greenstone area, which is not correct. Greenstone or diabase outcrops near the falls and the river channel for a short distance below appears to owe its origin to the weathering out of a dike of this rock. The dike on the south shore of the river runs at an angle to the iron band but is not in place across it. The rock on either side of the band is graywacké-like in character with phases of amphibolite.

We followed the band to the northeast across the river for about a mile. It averages from 20 to 40 feet in width and can be easily traced, as it forms a slight depression between low ridges of the wall rock.

The banks on either side of the river where the band crosses are high, and the iron slate forms a striking talus on the north bank.

There are some large pot holes up the side of the cliff along the east side of the band on the southern shore of the river.

The magnetite on the portage leading out of the southern end of the little lake does not seem to be in place.

Porphyritic granite is exposed at different points up the river before Quinze lake is reached.

The portages along the river are well shown on the Geological Survey map.

Quinze Lake to Height of Land.

From the head of the river we proceeded up Quinze lake and followed the route towards lake Abitibi to within a short distance south of the height of land. Here we turned westward and travelled through a chain of small lakes to Cross Portage lake, whence we followed the route through to lake Present and down the branch of the Blanche river which has already been described.

The lake Abitibi route lies to the east of the inter-provincial boundary and from Quinze lake, which is connected with the head of lake Temiscaming by a wagon road, the route to Abitibi is an easy one. Long stretches of water are separated by a few portages which are well cut out. The route is much travelled, supplies for the Hudson Bay Company for their post on lake Abitibi and a large surrounding territory being taken in over it. The company use large freight canoes on the route, and the lumber companies have small steamboats on Quinze lake and Lonely river. Lumbering operations are being carried on within a short distance of the height of land. A lumber depot, surrounded by a farm of considerable size, is situated on the west side of Quinze lake at the end of the road leading to lake Temiscaming.

On Barrier lake we met To-ne-ne, a very intelligent Indian whose hunting ground lies west of Long lake and extends west to lake Present. He made a map for us of the canoe route through the unsurveyed area lying between these two lakes, which we found very useful. It enabled us to make our way from a bay on the west side of Long lake to Cross Portage lake without much difficulty. The bay referred to is the second and larger on the west side of Long lake south of its head.

On the east side of Long lake, north of the mouth of a bay which stretches to the eastward, chlorite schist is highly impregnated with pyrite Magnetite also occurs here in thin layers interbanded with rock matter, producing a structure much like that of the interbanded jasper and magnetite of lake Temagami and elsewhere and resembling the iron band on the Quinze river. The separation of the constituents into distinct layers however is not so perfect at the Long lake deposit as at that on the Quinze. Along the south shore of the northwest bay of Long lake pyrite occurs in considerable quantity at a couple of points.

The first two portages westward from Long lake by the route we followed are each half a mile or more in length. The third is a short lift along the bank of a creek. This is succeeded by one which took us seven minutes to walk over and which leads to White Birch lake. The rock on this lake and on the one immediately east is a white or light-colored flat-lying gneiss. The water of these lakes is very clear. The first lake east of White Birch empties into the latter and appears to have an outlet to the eastward as well, but we did not examine it carefully. At the end of an old timber road which comes out at the end of the portage leading into the former lake a stump has been upturned which exposes very red soil.

The gray granite or gneiss continues down White Birch lake and beyond to near the middle of the portage between its foot and the next lake. An island in the latter lake is composed of a typical slate which has an apparent dip at a low angle. The contact here is not far east of the inter-provincial boundary. There is a short portage connecting Big Chief lake, so called from the shape of a rock on its northern shore, with Cross Portage lake which has already been described.

Additional Notes on Rocks.

First rapids, Blanche river :—The rock is composed essentially of augite and plagioclase. It possesses a well defined ophitic structure and hence is a diabase. Some of the augite is more or less fibrous, resembling diallage. Small amounts of biotite and the secondary mineral chlorite are present. A patch of orthoclase and quartz forming a granophyric intergrowth was noticed in one thin section. Magnetite, pyrite and apatite occur as accessory constituents.

First portage on Abitibi branch :—Under the microscope this rock is seen to be of fragmental origin. The grains of which it is made up vary in outline from distinctly angular to rounded, and consist of quartz with smaller amounts of orthoclase and plagioclase. The grains differ in size, the larger being set in a ground-mass of the smaller ones. One or two of the largest are plagioclase. The material cementing the grains together is rather indefinite in character, but appears to be chlorite and sericite. A few grains of chlorite and biotite are also present. The rock may be put down as graywacké.

First lake :—The rock which occurs on the shore of First lake and which was called syenite on a preceding page is seen under the microscope to be composed essentially of plagioclase and hornblende, and should therefore be classed as a diorite. Quartz and orthoclase are present as are also chlorite, sphene and a few apatite needles.

Cross Portage lake :—The boulder which has been described as lying under the surface of the water near the head of the rapids at the foot of Cross Portage lake is seen to be of volcanic origin when thin sections of it are examined microscopically. The rock, which is more or less decomposed, is made up essentially of phenocrysts of plagioclase and orthoclase set in a very fine-grained ground-mass. The chief determinable constituents of the ground-mass are very fine needle-like crystals of plagioclase. The original dark colored constituents have been decomposed. A light-colored pyroxene seems to have been present as phenocrysts. Chlorite, serpentine and epidote are among the secondary minerals of the rock.

Cross Portage lake :—What has been referred to as a quartzite occurring on the eastern shore of this lake proves to be a rock of similar character to that from the first portage on the Abitibi branch. It is, however, coarser in grain than the latter.

Lake Present :—The quartz-porphyry which has been mentioned as occurring at two points on lake Present is composed of phenocrysts of quartz, orthoclase and plagioclase set in a very fine-grained ground-mass consisting of the former two minerals. Phenocrysts of hornblende occur sparingly, this mineral having been decomposed to a large extent into chlorite. In some facies of the rock, quartz is present in subordinate amount to felspar and is in smaller sized phenocrysts.

Canoe Canal lake :—The rock from the west shore of this lake which has been spoken of as diorite is more correctly named diabase, although it is not a typical representative of this class. I consists essentially of augite and plagioclase. Orthoclase and quartz are also present and form granophyric intergrowths, this structure being a somewhat striking feature of the rock. Chlorite and the usual accessory minerals of diabase were observed.

Quinze river :—The olivine diabase which is found near the edge of the magnetite belt on the Quinze river is similar in character to that which occurs in the vicinity of Sudbury. It is however coarser in grain and contains a higher percentage of olivine than the latter. In the sections examined the augite is subordinate in amount to the olivine, which occurs at times in large grains. The apatite present is represented by crystals which are of unusually large size for such an occurrence.

In the above descriptions the term plagioclase has been used for the lime-soda felspars only.

Summary.

It will be seen from what has been stated on preceding pages that the district examined contains as great a variety of rocks as probably any other part of the Province of equal area. We find here various kinds of igneous rocks, both plutonic and volcanic, such as granite, syenite, diorite, olivine diabase, quartz-porphyry and others of less importance. In addition to these most of the metamorphic fragmental rocks characteristic of the Huronian occur, among which may be mentioned quartzite, slate, graywacké and different varieties of the pyroclastic series, ash rocks and agglomerates.

Palæozoic formations represented by the limestone outlier on the south branch of the Blanche river are also present. Then among the more recent or post-Tertiary deposits are the interesting clays, which are of great importance agriculturally, together with the thick deposits of sand which cap some of the highest hills and overlie areas of considerable size in the more northern part of the district.

Although few discoveries of economic minerals have been made in this territory it may reasonably be expected, judging from the character and the variety of the rocks, that deposits of value will be found when the district is more carefully prospected, as it will be in a short time owing to the rapid settlement which is now taking place.

It has been pointed out that the olivine diabase of the Quinze river resembles that which occurs in the vicinity of Sudbury. Numerous outcrops of diabase have been examined in the district lying between these two points, but they contain little if any olivine. It would seem that at least some of the conditions of the Sudbury district are repeated in this more eastern field.

It may also be noted that the quartz-porphyries which are found in the gold bearing areas of Rainy River and in the western part of the Thunder Bay district are represented by rocks of similar character on the upper waters of the Blanche. In both districts these rocks are found in the vicinity of the height of land. The writer is not aware that rocks of this kind have been reported as occurring in the region which lies between the districts mentioned.

On the eastern shore of Lake Temiscaming in the Province of Quebec, argentiferous galena is being mined, the deposit appearing to be of considerable size. The galena occurs in a conglomerate or agglomerate of Huronian age. Similar rock is found at lake Present and other points up the Blanche. A small amount of galena has been discovered at one or two places, and the chances should be good for the finding of workable deposits occurring under similar conditions to that on Lake Temiscaming.

The localities where we examined iron ores which gave evidence of being of any economic interest are on the Quinze river and Long lake. Both of these localities are in the Province of Quebec a few miles east of the inter-provincial boundary. It will have been noticed however from the description which has been given that we discovered outcrops of the rock known as jasper conglomerate at three localities on the Ontario side of the boundary. These localities are lake Present, Canoe Canal lake and the area lying immediately to the south of Quasis lake.[4] The jasper pebbles in the conglomerate have undoubtedly been formed through the breaking down of bands or belts of rock composed of jasper and iron ore. Some of the pebbles show an association of jasper and hematite. Whether the rock from which the pebbles were derived is now exposed at the surface in any part of the district is impossible to determine before detailed prospecting has been done.

In conclusion, it may be stated that the popular belief that the height of land in this district represents the highest point of the surface from which sediment was derived for the formation of deposits of different ages which lie to the southward is scarcely based on fact. We found what appear to be thick deposits of Huronian conglomerate and other water-formed material resting on the surface close to the height of land. It is evident from this that the surface level must have changed considerably since Huronian times, and that what is now the height of land may have once been a comparatively low lying area.

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[4] It is interesting to know that outcrops of jasper conglomerate have been found some miles further west along the height of land. Mr. W. J. Wilson in the Summary Report of the Geological Survey for 1901, pp. 124-5, thus describes these outcrops:

"Five miles east of Kenogami lake [which lies on the northern boundary of the township of Eby—W.G.M.] in a straight line or seven and a half by the river at the first portage, there is an exposure of conglomerate containing jasper pebbles. There is also a band of dolomite 15 inches wide holding a considerable quantity of iron. Strike N 75° E, dip vertical. . .

"I returned to the northern part of Otto township and made a track-survey of a small winding river flowing into the Blanche seven miles north of Round lake. This stream drains a large number of lakes; the largest, called Anikojigami, is four miles from its mouth. The rocks up to this lake are greenstone and breccia conglomerate, holding jasper pebbles. The latter is well seen at the fourth and fifth portages, where the magma is of the ordinary dark-green colour and the pebbles are abundant and varied, being mostly well rounded. In fact some of the rock is composed chiefly of pebbles, with just enough of the matrix to hold them together. The pebbles consist of granite, quartzite, greenstone and jasper. On one small surface I counted seven jasper pebbles some two inches in diameter. The strike is N 20° E, dip vertical."

THE MINES OF ONTARIO.

BY W. B. H. CARTER.

The mining industry of Ontario continues steadily to grow. The expansion is more particularly noticeable in the nickel, copper and iron districts, where the continued value of the deposits after several years of increasing production is imparting confidence and financial strength to these branches of the business. In gold, another large producing mine and several smaller ones have been added, and the active development of a number of good prospects is going on in the various districts. In the silver region west of Port Arthur most of the old mines have been purchased by one company with the intention of working them on a larger scale than hitherto. Another zinc mine now under active development in Frontenac county bids fair, if the present rate of production is maintained, to equal the Zenith mine north of Lake Superior. The success which has followed the Canada Corundum Company in the initial operations at its mines and concentrating works during the past two years has led to plans for a new plant of a much greater capacity, and other concerns are preparing to engage in producing this superior abrasive. There has been much activity during the year in searching for graphite in the eastern counties. Several good deposits have been discovered and the diamond drill has been used in exploring known bodies, while at the Black Donald mine, the main producer, a modern graphite refinery has just been completed to treat the large deposits developed underground.

The skilled labor question is gradually adjusting itself to the requirements of the growing industry. Increased demand for experienced hands led to a general rise in wages, which was felt even in the most outlying camps, at one of which the wages paid to miners were found to be as high as in any other part of America. It is also noted that young engineers are now almost at a premium in the industry, instead of having to look elsewhere for employment, as used to be the case.

In the several mining districts and at both large and small mines blasting explosives were found too often to be handled with a deplorable lack of that care which comes of practical experience and an acquaintance with the qualities of the substances used. The dangerous practices sometimes employed argued ignorance and recklessness not only on the part of miners but of managers as well. In some cases the latter fail to make the thorough daily inspection of explosives and their condition required by the Mines Act. There are, of course, exceptions where every means is taken to prevent possible injury to the men and plant, not only in regard to explosives but in other particulars affecting health and safety. In fact, as to the latter, no such risk was found to prevail, the timbering, surface plant, etc., being usually well attended to. The large majority of accidents are due to dynamite unexpectedly exploding in one way or another.

GOLD AND SILVER MINES.

In eastern Ontario the larger properties have continued in active operation with the addition of another producer, and of the smaller mines several have shut down either partly or in whole for a period. At the gold-arsenic mines the situation has altered only in that the Atlas Arsenic Company has suspended work while negotiations for the amalgamation of the various arsenic interests in the district are under way. Along the southeastern shores of lake Wahnapitae, about 20 miles northeast of Sudbury, the finding of a number of auriferous quartz veins with the extensive developing of one of them is arousing interest in this new prospective gold district, of which, however, no account in this report is possible owing to its inaccessibility during the early spring months. In the Michipicoton Mining Division the Grace mine has become the chief representative of the gold industry by developing into what will, no doubt, shortly be a producing mine. Some of the old locations in the southern part of western Ontario now reached by the Ontario and Rainy River branch of the C.N.R. have taken on a new lease of life with a vim which ought to show their worth pretty thoroughly, and there are also the usual quota of prospects here as well as in the districts farther north which have had to shut down or remain idle. In the Sturgeon lake region all the properties appear to be showing up well under the steady development of the last two years or more, two of them producing bullion for a time at their small milling plants. Of the northwestern districts, the Manitou is much the more active for its extent, boasting one producing mine and a number of others rapidly advancing to that stage. The Lake of the Woods, however, brings forth several important new discoveries of auriferous deposits, some undergoing systematic development, together with the reinstatement of the Black Eagle or old Regina mine in the front rank of producers in the Province; but the two largest mines, the Sultana and Mikado, have been unable to maintain their accustomed output during the past year or more, although the prospects for continued life are still good.

The Victoria silver mine near Sault Ste. Marie while in operation for a few months last year increased the silver output slightly. The mines of the Port Arthur district however now form the only producers. By a recent amalgamation of the different interests operating in this field a comprehensive plan of joint development and treatment has begun.

Deloro Mine.

The extensive additions to the plant at this mine, which in the last report were noted as being under way, were completed in 1901, and have been in operation steadily since. The manager, Mr. P. Kirkegaard, amongst his many other improvements, designed a more complete system of concentration in the mill (noted below) whereby a further appreciable saving of the gold and concentrate values has been brought about. The improvements to the arsenic refining plant were also finished, and the results have proven very satisfactory not only in reduced cost, but in the production of a finer grade of arsenic. Other additions to the plant were being made at the date of inspection, December 1901. Uuderground development has been carried ahead only to a small extent, the work during the last year being confined to the extraction of the remaining ore exposed by the present development above the fourth or bottom level. The late foreman, Mr. Davis, has resigned, and T. Roberts now fills the position. The total number of employees is 150, of whom 75 are miners.

The Tuttle shaft and south workings have been abandoned, except for use as a pump way, and the skip-road timbers have been nearly all removed together with portions of the ladderway, but ingress and egress by the shaft is still had, and this outlet will be maintained in connection with a passage way to be timbered over in the first level from the Timber shaft north of the Gatling shaft through to the Tuttle shaft, thus providing the Gatling workings with these additional outlets. The old open stopes between the two shafts and from the surface down to the second level, and also above the first level north of the Gatling shaft, are now being filled with waste rock, and the second level is already blocked up. Into a sump at the bottom of the Tuttle shaft, all the mine water is drained, and here the two iron tanks forming the underground portion of the Harris Air Lift system of unwatering, are installed, the pipes running up the shaft and the old stopes to the surface, and thence to the stamp mill where the water is used. An auxiliary pump over a sump on the third level a few feet north of the Gatling shaft, is connected with a separate discharge pipe up the Gatling shaft to and along the second level north drift, and up the Timber shaft, and is maintained in case of accident to the air lift. The Gatling shaft has not been deepened, though it is intended to continue sinking in order to get ahead with the development of the mine. First level, north drift, 113 feet; at 28 feet north, a cross-cut driven east 40 feet; at 72 feet north the Timber shaft intersects. Second level, north drift, 142 feet; at 31 feet north, a cross-cut driven west 335 feet and at 140 feet west in this, drifting on the Gatling west cross-cut vein, north 90 feet and south 113 feet, and at 327 feet west, drifting on the Air vein, north 43 feet and south 34 feet, and at the face of this Air vein, north drift, a 20 foot upraise; in the south drift, 350 feet from the Gatling shaft, or 65 feet north of the Tuttle, a cross-cut runs west 95 feet, at 26 feet in which are drifts on the Tuttle west cross-cut vein, north 135 and south 60 feet, running diagonally back to and connecting with the main second level. Third level; the south drift has been completed through to the Tuttle shaft; at 241 feet south a winze connects with the stopes above the fourth level; at 390 feet south of the Gatling shaft, or 35 feet north of the Tuttle, there is an upraise connecting through the overhand stope with the second level, which will form another outlet from the lower workings up the Tuttle shaft. Fourth level; no further drifting, but at 200 feet south of the shaft a winze is being sunk on the vein, depth to date 55 feet, the hoisting being done by a small air hoist with kibble on skids. Stoping is progressing overhand, on the second level, north drift, and at the face of the west cross-cut from this level on the Air vein, and underhand, on the third level south drift, which stope is now down to within 25 feet of the fourth level. On the fourth level south a new overhand stope is being opened up from 150 feet in, and a second one near the south face of the drift.

The Timber shaft, 65 feet north of the Gatling, was sunk to the second or 100-foot level of the main workings.

The Red shaft, 280 feet west of the Tuttle shaft, reached a depth of 155 feet with one level, having drifts north 95 feet and south 72 feet, when mining was discontinued to install a proper skip road, which is now under way.

The underground ventilation is good; and since the installation of the Harris air lift no trouble has arisen from water, this system working very satisfactorily, requiring practically no attention.

A proper dynamite thawing house stands east of the compressor building, heated by exhaust steam coils, where no more than four boxes at a time are distributed on the racks for thawing, but some carelessness was noted in the handling and storing of dynamite underground.

Diamond drill exploration has been carried on during the past year with a Sullivan "E" machine, both from the surface and in the mine workings. From the latter holes were drilled, cross-cutting the formation in anticipation of finding other ore bodies. At present the drill is working about 900 feet south-west of the mine.

The stamp mill machinery, most of which was enumerated in the last Report, has been erected, and a 30 by 40 foot Strake table outside and below the mill has been added. The power is generated in a separate building thirty feet north of the mill by a plant consisting of two return tubular boilers fitted with automatic dampers, a high-speed engine running all the mill machinery, and a smaller high speed engine connected with the dynamo.

The Atlas Arsenic Company.

In the fall of 1901 the mine and stamp mill were shut down while negotiations were pending for a sale of the property and the amalgamation of the gold-arsenic mines in the vicinity. The mine workings were allowed to fill with water, so that no inspection could be made of them. However, other development work was found in progress at the Pearce mine, about 1,500 feet south of the main workings, where the shaft had (in December 1901), reached a depth of 165 feet, in size 7 by 14 feet, the incline changing from 25 degrees west at top to 41 degrees at bottom. First level, 65 feet; south drift, 35 feet, stoped 15 feet high for the full length of the drift, and three feet wide. Second level, depth 140 feet; south drift, 27 feet; west drift, ten feet. The operations were confined to sinking the shaft, using steam machine drills. A pump had been installed in the second level, north drift. As the skidway, ladders and other timbering in the shaft were more or less temporary in character and in an unsafe condition, with no partition between the compartments, instructions were left to put the shaft in proper shape to conform with the Mines Act. A new shaft house 15 feet high had been erected, and 30 feet back of this were the boiler and hoist house.

The development exposes a contact vein varying from one to ten feet wide down the shaft and the drifts, and four feet wide at the shaft bottom, with diorite on the hanging or west wall and syenite on the foot, and composed of quartz carrying pyrite and mispickel. As to the values contained, the manager, Mr. W. A. Hungerford, reports a return of $23 gold per ton from a mill run on 100 tons of ore from the first level, south stope. At the time of inspection there were eight men at work.

The Cook Property.

This property comprises lots 7, 8 and 9, in the ninth concession, and lots 10, 11 and 12, in the tenth concession of Marmora township, Hastings county, in all 1000 acres and an adjoining 4-acre mill site on the Moira river. The workings lie a quarter of a mile east of the Deloro mine. The Cook Land Company, Toronto, own the property, having had it under development since the fall of 1901 under the management of A. V. Morrison with a force of 30, of whom 20 are miners.

Mining work consists of the following : A shaft on lot 9 in the ninth concession, depth 35 feet, size 7 by 10 feet, and inclined at 25 degrees, sunk on a vein which runs from one foot in width at the top to two feet at the bottom and is composed of quartz with some pyrite, chalcopyrite and mispickel, the country rock being diorite. About a quarter mile south of the shaft a peculiar bedded deposit is being excavated. In one of the swampy depressions about 100 feet wide and 300 feet long, lying between the outcropping rocky hills, what is apparently a moraine has been discovered composed of large and small angular boulders, some half-a-ton in weight, of quartz carrying considerable pyrite, chalcopyrite and mispickel with a compact filling of sands of the same materials over four feet in depth. About 30 per cent. of the bed consists of the dioritic country rock of the district and the remainder is high grade milling ore. This morain lies under a 10-foot capping of clean stratified clay, the boulders of ore so far being raised from a 10 by 10-foot pit in the centre of the marsh through the frozen clay, short lateral excavations extending underneath. South of this pit for 100 feet a trench was sunk showing the bed of ore, and though no work has been done to the north it will probably run in that direction for another 150 feet, judging from the outline of the swamp. At the time of my visit the bed had been shown to be at least four feet deep, and, from the angle of dip of the surrounding rock formation the probability is that it will extend about a foot or so deeper.

The ore from both the shaft and this morainic deposit is being hauled south over a half-mile road and treated with very good results in an old stamp mill which was erected some thirty years ago, but has since been partially renovated for use in these limited test runs. One of the company's diamond drills now on the ground is to be employed in exploring the various veins and deposits on the property.

Belmont Mine.

Extensive improvements and enlargement of plant have been features of this mine during the past year-and-a-half. After the thorough preliminary development, followed by purchase of the property, plans for mining and treating on a large scale were set in motion with the result that a new 30-stamp mill has been erected and operated during the past year. Underground development work was not carried on so extensively during this period, but consisted mainly in the laying out of stoping ground in anticipation of the large demand of the near future. The motive power for all the workings is at present steam, generated by wood and coal fuel, but this will be replaced this season by hydraulically generated compressed air. The new power plant is situated at the outlet of Deer lake about two miles and a quarter from the mine, and is expected to be in operation about July 1st. Two dams are already built giving a head of 72.92 feet, and from these 1,500 feet of flume pipe will be laid to an adjoining power house in which the plant will be installed, consisting of two Leffel water turbines connected by rope drive to a specially designed air-compressor now under construction at the shops of Walker Bros. in Wigan, Eng'and. This will furnish 700-h.p. all the year round, or 5,000 cubic feet of air per minute, to be transmitted to the mine through 15,000 feet of 12-inch pipe.

Recent mining has been confined almost entirely to shafts Nos. 1, 2 and 3, which are the only ones now in operation. As most of the original development was carried on in these workings, they alone had attained sufficient depth and lateral extent for stoping. The present ore supply comes from Nos 1 and 2 only.

When the mine was inspected, 2nd December 1901, No. 1 shaft had reached a depth of 410 feet, being an increase of 100 feet. First and second levels, no new work. Third level, east drift, 131 feet; west drift, 105 feet. Fourth level (new), depth, 400 feet; east drift, 189 feet; west drift, 217 feet. The east drift is to connect with the third level west drift from No. 3 shaft, the two faces being now 550 feet apart. This connection will give another outlet and improve the ventilation of the two mines, which at present is not very good. New stopes have been opened up on an extensive scale from the third and fourth levels in both east and west drifts.

No. 2 shaft was sunk 20 feet farther to its present depth of 185 feet, where it connects with the second level from No. 3 shaft. This shaft is now merely an auxiliary to No. 3 shaft, and aids in maintaining better ventilation. The hoisting appliances, however, are sti l in place, and are occasionally used.

No. 3 shaft had been sunk to a depth of 295 feet, being an increase of 110 feet. First level, east drift, 178 feet. Second level, depth, 185 feet; east drift, 158 feet; at 85 feet east a branch drift, southeast 113 feet on another vein in which No. 4 shaft is sunk farther along; west drift, 484 feet; at 46 feet in, an up-raise recently started; at 124 feet in, the foot of No. 2 shaft intersects; at 338 feet in, a winze, depth 72 feet, being sunk to connect with the third level west drift; at 376 feet in, the drift branches northwest, 214 feet. Third level (new), depth, 285 feet; east drift, 194 feet; west drift, 277 feet. Stoping: above the first level and between shafts Nos. 2 and 3 the vein has been all stoped out. New stoping is being carried on along the west drifts of the first and second levels beyond No. 2 shaft.

No. 5 shaft was sunk to a depth of 103 feet, and a first level opened up at 68 feet depth, with an east drift 98 feet and a west drift 25 feet. These workings are now closed down.

Nos. 4, 6 and 7 shafts—no new work.

No. 10 shaft was sunk to a depth of 46 feet and then closed.

The shafts and hoisting apparatus were found to be lacking in some of the requirements, and directions were given to remedy these defects. The signal apparatus at the three shafts was in good condition, and signal codes and notices prohibiting riding in the buckets were posted at the hoists and shaft mouths.

The surface plant is well designed, the numerous shafts being connected by a surface tramroad, partly on trestles, over which all ore is hauled in large cars by horse-power to the crusher room at the top and rear of the stamp mill, where it is first weighed and then dumped on the crusher floor. The compressor house lies 200 feet east of the mill, containing a 16-drill Rand air-compressor and a separate power plant of two 80-h.p. return tubular boilers equipped with automatic dampers. The machine shop just north of the mill and east of No. 1 shaft house is fitted with drills, lathes and other small machinery, operated by a vertical engine in the same room, taking steam from the mill boilers.

The stamp mill building and plant is a model of modern design and practice. The building is entirely of wood, and the upper crusher rooms are ceiled off to retain the heat from the steam radiators. It forms one large, open room, with a series of floors, one below the other, the whole being open from end to end, affording a clear view of the interior from any inside point. The plant, supplied by the Wm. Hamilton Manufacturing Company, of Peterborough, Ont., consists of two Blake crushers, one 11 by 20 inches and one 9 by 11 inches, set up over the mill bins at the top and rear of the building; 30 stamps of 850 lbs. each in three 10-stamp batteries; Challenge ore feeders; from each battery a series of nine amalgamation plates, each four feet long, with one-inch drop between, except at the end of the upper three battery floor plates, where the drop is 18 inches to the lower series of six plates beyond and on the next floor, making in all 36 feet of plate surface for each battery; six Wilfley concentrators, into which the pulp is fed directly from the plates, and whence the tailings run to waste and the concentrates to the cyaniding plant; three cyanide tanks on the next floor below, in size 4 feet deep by 15 feet diameter, constructed of 3-16 inch sheet iron; on the same floor and to one side are two elevated solution tanks, and on the next floor below the settling tanks. The mill laboratory room forms the lower end of the building. The power plant, installed in adjoining rooms, consists of two 60-h.p. return tubular boilers, equipped with automatic dampers, a Corliss engine for the batteries and crushers, a high-speed engine operating the two dynamos lighting the camp and underground workings, and in the mill building on the vanner floor a vertical engine connected with the Wilfley tables.

Dynamite is now thawed in two houses, one at No. 1 shaft and the other at No. 3, and each about one hundred feet distant from the workings. The houses are of frame work heated by coils through which exhaust steam blows continuously, maintaining a temperature which in the cold weather thaws the dynamite in about ten hours. In each house about five boxes at a time are kept spread out on racks, this being sufficient for 48 hours' supply. One man has exclusive control of these thaw-houses, and another man does all the priming.

At the time of inspection the employees numbered 225, of whom 102 were miners. Manager, D. G. Kerr; foremen, T. W. Fisher and J. Stewart.

Boerth Mine.

Shortly after the last inspection of this mine in the fall of 1899 operations were suspended and not resumed until the fall of 1901 when, according to a communication recently received from the secretary of the company, about three months' work was accomplished, the stoppage being due to lack of money. It is hoped, however, by the company that the plan now under way to raise funds by bond issue will prove successful and allow of again opening up the mine at an early date. The late owners and operators, The Boerth Mining Company of Ontario, Limited, have been replaced by The Clarendon Mining Company of Ontario, Limited, secretary, Mr. Justin E. Smith, of Detroit, Mich. This gold property, as noted in the last Report, is in Frontenac county, 12 miles west of Clarendon station, on the Kingston and Pembroke Railway.

Sophia Mine.

Operations were suspended here in the spring of 1901, apparently on account of a difference between the owners and not from a lack of ore. The plant is being maintained in good repair in anticipation of the resumption of work.

Helena Mine.

This mine and works were shut down indefinitely in the spring of 1901, the reason given being trouble amongst the owners. No inspection of the property was made.

Grace Mine.

This mine is situated on location D J. 7 or claim No. 1052, Michipicoton Mining Division, five miles by road east of Michipicoton River P.O. The owners, the Algoma Commercial Company of Sault Ste. Marie, Ont., have also under control a large number of the adjoining locations, totalling 886 acres, across some of which the extension of the Grace vein is said to run. For the present, development is confined to the Grace, a force of 37, of whom 11 were mining under the superintendence of Mr. P. N. Nissen, being at work when the property was inspected, 1st March 1902. Measurements of underground work at that time were as follows :—

No. 1 shaft, depth 208 feet, size inside timbers, 4½ by 9 feet, divided into two compartments, hoistway and manway, the incline east gradually changing from 67 degrees at top to 80 degrees at bottom. First level, depth 100 feet ; south drift, 68 feet : north drift, 188 feet, connecting at 180 feet in with bottom of No. 2 shaft. Second level, depth 200 feet ; south drift, 116 feet ; north drift, 115 feet. No. 2 shaft, 167 feet north, 18° west of No. 1 shaft, depth, 105 feet, size, 6 by 10 feet, is used at present entirely for ventilation purposes, there being no timbers other than a 10-foot collar and gallows head frame. A ladderway is, however, to be built in to form a second outlet. In No. 1 shaft the collar extends down part way, followed by stulls supporting the ladders and skip road stringers, the latter carrying 20-lb. steel rails to the first level but not below.

The mine is unwatered by two pumps, one a Knowles sinking, 8 by 6⅝ by 6, installed over a sump back of the shaft at the second level, and the other a duplex Prescott, 4 by 5 by 4¼, over a similarly situated sump at the first level. A chamber is now being cut out on the second level wherein to install a small hoist to continue the shaft sinking, a rock pentice to be left at the present bottom of the skip road. A larger skip is on the way in to replace this one.

On the surface the small enclosed shaft house, 15 feet high, adjoins the power building 26 by 38 feet in plan and a few feet to the east, in which are installed two locomotive type boilers, one of 35-h.p., the other of 45-h.p., a three-drill Ingersoll air-compressor and receiver, and a duplex-cylinder single drum hoist-engine, cylinders 8½ by 14 inches, drum 36-inch face by 44 inches diameter, with band brake and friction clutch all in good order. The camp lies 700 feet to the southeast, consisting of sleeping and dining houses, office, warehouse and private dwellings all commendably presentable and clean, as in fact is the whole camp.

A large amount of road has been built about the property for hauling wood, together with a 3-mile section to complete the road in from Michipicoton Harbor. About 1600 cords of wood had been cut, 600 cords of which were piled at the mine.

The oil house, a log structure, is safely situated 200 feet southeast of the workings, but instructions were given to remove the dynamite magazine from its present position at 250 feet west to a safe location. The thawing is conducted in a small building close to the works heated by steam coils. Directions as to better methods of thawing were given with the recommendation that the house be removed to a sheltered spot at least 100 feet from the buildings.

A geological examination discloses a formation of porphyritic dark green diorite with the felspar in small white crystals, the rock having no marked schistosity and presenting a very blocky appearance due to several jointage planes. Across all these the quartz vein cuts as a true fissure, somewhat tortuous over short distances, but on the whole maintaining a uniform strike of north 15° west, with dip of about 70° east, and on the surface said to be traceable over several of the locations The vein as explored underground varies in folds from a few inches in width to five feet or more, but averaging probably two feet and a half, and is composed of a compact quartz white to gray in color, with little or no sulphides, and lying tight against walls devoid of selvage. The quartz frequently merges gradually into the trap walls showing hat more or less replacement of the latter by quartz has taken place in manner similar to that of the scattered seams and films of hornblendic schist enclosed in the body of the quartz. Stringers of calcite run along the walls as the result of secondary deposition, and at several points dikes of a black eruptive cut through the vein without, however, any apparent displacement of the latter. The average value of the vein in the shafts and levels is, according to the statement of the superintendent, about $12.00 across a probable average width of 2 feet.

Manxman Mine.

This comprises a group of 16 mining locations in the Michipicoton Mining Division situated four and a half miles east of Michipicoton River P. O. or eight miles south of Wawa by road, the different locations being either owned by or leased to the Manxman Gold Mining Company, whose head office is at Sault Ste. Marie, Ont., and manager, Angus Gibson, of the same place. Operations under this company began in July 1901, the average force since being about the same as at date of inspection, 3rd March 1902, namely, 17 in all, of whom ten are miners.

The main shaft on claim No. 1229 is 83 feet deep, eight by ten feet in size, inclined 75° west and timbered with a solid collar for 30 feet with square sets and lagging below. Pole skids and ladders are affixed down the foot wall but without platforms or compartment partition, which defects it was advised to remedy at once. At 48 feet depth a cross-cut is driven west 20 feet. The other mining work includes the re-opening of a 17-foot shaft on claim No. 709, one mile north of the main shaft and on another vein. On claim No. 641, one-half mile north of the main shaft there are two shafts, one 29 feet and the other 34 feet deep, and a tunnel 13 feet long. Surface stripping has been done on some of the other claims.

At the main shaft mining had been recently suspended in order that all hands might help in erecting the newly acquired mining machinery about half of which was in place, consisting of a 60-h.p. return tubular boiler, a pump and a 45-h.p. horizontal engine to be rigged into a hoist-engine with wooden drum. These will replace the swinging arm derrick, wooden horse whim and bucket formerly used. The camp is built on a small lake half a mile north of the workings near the centre of the group on claim No. 641.

Several cases of dynamite were found exposed in the open and close to the workings, with caps left on top, there being no magazine on the property. Under instructions the caps and dynamite were at once separated, and the latter removed to a safe distance for ten days until a magazine should be built. The practice of thawing the dynamite around the stove in the blacksmith shop was forbidden and proper methods suggested.

At the main shaft workings the formation is a green diorite through which an altered schistose zone about 15 feet wide strikes north and south with dip of 75 degrees west carrying the minerals which form the ore body. This schist has in large part been replaced by quartz lying in bands and pockets, throughout all of which over the width of 15 feet compact lenses and a thick dissemination of pyrrhotite and pyrite occur carrying, it is said, gold and silver values and in some of the assay samples traces of nickel, and from traces to over one per cent. of cobalt. The other workings are said to be on a different class of deposit, some of them quartz veins, but no surface examination could be made at that time of the year.

Lake Shebandowan Mine.

A visit was made to this property on 12th March 1902, although the last operations of over a year's duration had terminated about two weeks previously, more definite knowledge of its prospective value and the advisability of continuing its development being desired by the company.

The tunnel mentioned in the last Report as about to start has been driven 212 feet running east 30° south for the first 100 feet and for the remainder east, in size four by six feet and with a cross-cut from the face south 25 feet. This work was for the purpose of exploring along a fault plane in parts of which a quartz vein is found between walls of the grayish green, coarse and blocky diorite formation. The fissure strikes east and west with dip of 80° south, and is said to be easily traceable on the surface over a distance east of two miles. The first 100 feet of the tunnel is driven through the country rock to intersect the fault fissure, after which the latter is followed showing in the first 50 feet little more than a selvage seam with smooth walls of altered schists, but from here in to the face a quartz vein comes in, gradually widening to six feet between two defined walls. The vein is composed of a close interbanding of narrow seams of quartz with the diorite in all stages of alteration from the merely discolored granular original rock to a soft chloritic schist, throughout all of which minute grains of pyrites are sparsely disseminated. Assay samples of this last 60 feet of vein are said by one of the directors to have given unsatisfactory gold values, and if this is the case it evidently does not constitute a pay chute such as might be found in another part of the vein by a more careful examination of the surface outcrops.

In the engine-house, 500 feet west of the tunnel and below on the lake shore, a 25-h.p. return tubular boiler and a 2-drill air-compressor have been installed, supplying air to the two machine drills.

Instructions were given to erect another dynamite magazine situated at a safe distance to replace the present one lying 50 feet from the tunnel mouth and to keep separate the caps, fuse and tools, storing nothing but dynamite in the magazine.

A L 282 Mine.

At the time of inspection, 19th March 1902, this property had been under operation for about three months after a previous close-down of several years. The location, A L 282, is situated in the Island Falls district, Upper Seine river, and is 12 miles northeast of Hematite station on the recently completed Ontario and Rainy River branch of the Canadian Northern Railway, from which, however, no wagon road has as yet been built, recourse being had to the lake route both in summer and winter. Formerly the only access to the district was by way of a 50-mile wagon and canoe route from Bonheur on the C.P.R. to the north, but over this the difficulties of transportation were so many that numbers of other mines and prospects as well as this one were compelled to shut down.

Ths owners of the location have now let a working option to the New York and Ontario Gold Mining Company, Limited, with head office at Kingston, Ont., who under the management of their engineer, H. S. Emlaw, are undertaking further development, with the intention, should the results warrant, of ultimately purchasing it and erecting reduction works on the ground. The employees number 16, of whom half are mining. The work up to a recent date had been entirely of a preparatory nature, which in part accounted for certain unsafe conditions noted in the underground workings.

Mine development, practically all of which is old work, is as follows : Main or No. 1 shaft, depth 207 feet ; vertical for the first 75 feet and inclined 50 degrees northwest from there to the bottom, 132 feet ; size, 8 by 9½ feet. First level, depth 113 feet ; northeast drift, 177 feet ; southwest drift, 105 feet. A No. 7 Cameron sinking pump had been set up in the shaft bottom to remove the water, after which sinking was to be continued. Mining was confined to drifting northeast in the first level. The shaft is timbered with a 10-foot collar and below this square sets every 10 to 12 feet which support the ladders and platforms.

No. 2 shaft, lying 600 feet northeast of No. 1 shaft on the continuation of the vein, was sunk by the former operators to a depth of 20 feet, inclining 50 degrees northwest, 8 by 12 feet in size. Further development at this place has not yet begun. Beside the above there are several surface trenches sunk along the course of the vein between the two shafts.

The original power and hoist houses attached to the shaft house are still in use with the same machinery—a 40-h.p. return tubular boiler and a small duplex cylinder single drum hoist, using 1-inch steel rope; the small air compressor with receiver and the 15-h.p. vertical boiler since condemned) being still in place though disconnected. Additional machinery taken in about a year ago but not set up includes more pumps, an 85-h.p. locomotive type boiler, a large air-compressor of old design and a 10-stamp mill with accessory parts. The camp, located 200 feet east of the main shaft, has been found inadequate to accommodate the number of men employed and additional buildings are now under construction.

The dynamite magazine, a small log shanty minus roof, floor and doors, is situated safely (under present conditions) on top of a hill 600 feet north of the main shaft, but the construction of a better one in a more sheltered spot was advised, and much-needed instructions given for more careful handling of dynamite.

As has been stated in previous Reports of the Bureau of Mines, the country rock of the location is a grey biotite granite through which the vein occurs as a true fissure striking northeast and southwest with a dip of about 50 degrees northwest. The original faulting movement left well defined walls with selvage at an average and fairly uniform width apart of about 8 feet and altered most of the granite between to a chloritic schist, although in places a badly weathered crushed granite is the only result. Embedded throughout this schistose band and for the most part in or near the centre, lies the quartz vein which varies by lenticular expansion from less than a foot to 8 feet in width, but averaging underground in the northeast drift first level about three feet, and in the southwest drift an almost uniform width of two feet. In that part of the vein down which the shaft has been sunk the quartz band is considerably narrower than in any other exposure, averaging, above the level, about one foot and a half, and below, varying from one foot to two feet and a half to within 15 feet of the bottom, where it pinches to a few inches followed by a separation into several smaller stringers. Besides this main vein there are other quartz bands lying on either side and along one or other of the true walls of the fissure, but seldom over a foot or so in width and not at all continuous. The immediate walls of the main quartz lead are composed of a mixture about one foot wide of finely banded quartz and schist stringers and brown calcite, the quartz both here and in the main bodies being white and barren, except for occasional pockets or seams of brown calcite and red and green chlorite films. The lack of all sulphides beyond an occasional sprinkling of pyrites and galena is noticeable. It is probable that should this prospect develop into a mine, and the ore ultimately be stoped out, the whole or most of the true vein comprising the quartz bands and the schist will be mined and treated.

Elizabeth Mine.

This property consists of locations F M 171 and 172, of 373 acres, situated at the north end of Rice lake (about four miles west of Steep Rock lake) and two miles north of the Ontario and Rainy River branch of the Canadian Northern Railway from a point 5 miles west of Atikokan station. From here to the mine the route traverses several small lakes both summer and winter. The property was discovered during exploration of the territory under license of occupation to the Anglo Canadian Gold Estates, Limited, who, after acquiring the same, began development early in 1900. The above corporation is an English concern capitalized at £61,000 with head office in London, and represented in this country by their mine manager, Mr. Alan Sullivan, C.E.

Exploration and opening up of the mine has progressed steadily and rapidly since the first, varied by the adoption of the unusual method of examination with diamond drill, which in this case resulted quite satisfactorily, giving an early approximation of the characteristics of the quartz vein and pay chutes and allowing the formation of a more intelligent plan of future work. The diamond drilling began after the preliminary surface trenching, test-pitting and

Elizabeth gold mine; power and shaft houses.

Elizabeth gold mine; whip-sawing lumber.

shaft sinking, using a Bullock Beauty machine which put down 12 holes of a total length of 1880 feet. On the completion of this, regular mining was resumed, the measurements to date being as follows :

No. 1 shaft, on F M 171 (temporarily abandoned and full of water) ; depth 110 feet, vertical, and 5½ by 8 feet in size inside timbers. First level, depth 85 feet ; north drift, 50 feet ; south drift, 50 feet. An open head frame covers the shaft and the only other structure is the adjacent blacksmith shop. The shaft is safely boarded over.

No. 2 shaft, also on F M 171 but 400 feet north of No. 1 shaft ; depth 240 feet, size 7 by 10 feet and inclined 75 degrees east for 65 feet and below this vertical. First level, depth 65 feet ; north drift, 57 feet. Second level, depth 136 feet ; north drift, 126 feet, including two sharp turns to the west, one of 6 feet at 17 feet in, and the other of 12 feet at 60 feet in. Third level, depth 236 feet ; north drift, 50 feet, including a turn to west of 6 feet at 15 feet in ; south drift, 10 feet. At 100 feet depth, and in the foot or west wall of the shaft a cross-cut was run in to the vein. Unwatering is affected by a No. 7 Cameron sinking pump in the shaft bottom and a 2½ by 2¾ by 4 duplex Northey on the second level 20 feet north, both using steam and exhausting on the surface. The shaft timbering consists of a solid 20-foot collar with dividers below, to which the pole skids and the ladder and platforms are affixed, and as far down as the second level the partition between the two compartments. For the completion of the remainder of this partition and the erection of a guard rail about the shaft entrance at the second level instructions were left.

No. 2 shaft house is a solid wooden structure 20 feet high and enclosed, and 30 feet west of this connected thereto by a closed passageway is the power building, divided into hoist, compressor and boiler rooms with an attached dry room. The plant comprises two locomotive type boilers of 35 and 25-h.p. respectively, the high pressure half of a 6-drill Rand air compressor, and a duplex-cylinder, single-drum hoist, cylinders 6½ by 8½ inches, drum 24 inches diameter by 24 inch face, using ⅝-inch steel rope. The machine drills in use are Nos. 2 and 3 Rand. A blacksmith shop adjoins.

It is announced to be the company's intention to erect, probably in the spring of 1903, a 20-stamp mill, for which the site has been chosen at the foot of a rock bluff 300 feet east of No. 2 shaft. About half the rock excavation for the foundation has been completed, and 175,000 feet of lumber brought in for the building. To obtain an adequate water supply for this plant a log dam 60 feet wide and 16 feet high has been constructed across a creek valley backing up the waters and forming a swampy lake of considerable extent.

The camp lies on the shore of Rice lake about three quarters of a mile from the mine workings, comprising boarding and bunk houses, office, assay office, store houses, stables and three private dwellings.

For the main dynamite magazine the old blacksmith shop at No. 1 shaft is used. Instructions were given to remove from the magazine all material but dynamite. The other log magazine lies about 350 feet northeast of the camp buildings, which is too close considering the lack of any intervening rise of ground.

The vein under development by the No. 2 workings lies along a contact between a grayish green more or less schistose diorite on the east side and a pink to gray protogine on the west, the contact striking roughly north and south with a wavy dip averaging about vertical as far as explored. The quartz vein either traverses the true contact or more frequently lies wholly in trap or in protogine, removed a few feet from the contact and in nearly every case with smooth walls without selvage, its characteristics being those of a bedded vein of a width varying from one to 14 feet by gradual lenticular enlargement. In the places where the size has decreased other parallel quartz bands appear, thus maintaining a good width of quartz throughout the mine. It is stated by the management that the ore occurs in a pay chute which has already been roughly defined, giving a length of about 250 feet along the course of the vein.

Jack Lake Mine.

Mining was suspended on 1st April 1901, and all hands but a man to keep the workings pumped out were sent to Sturgeon lake north of Ignace on the C.P.R. to develop a more promising prospect owned by the same corporation, the Jack Lake Gold Mining Company, Limited. This has apparently turned out satisfactorily, as the Jack Lake mine at the time of inspection, 10th March 1902, was found entirely closed, and it was the intention to remove the pumps, hoist and machine drills at once to the new locations. However, Mr. J. S. Steele, the manager, states that the older mine was looking as well as ever, but that wishing to curtail development expenses, the company deemed it advisable to concentrate all efforts on the better property.

Log Cabin Location.

On the south shore of Wild Potato lake about 12 miles east of Mine Centre, two mining locations, G 532 and 533, have been acquired by the Log Cabin Gold Mining Company, whose manager is Mr. F. C. Fisk. A large force of miners are engaged developing the auriferous quartz deposit, the intention being to sink the two shafts, now down to a depth of about 50 and 60 feet respectively, to 100 feet and at this level explore further. Hoist engine and machine drills were in operation working with steam power.

No inspection of the property was possible when in this vicinity owing to the unsafe condition of the ice on the rivers along the route.

Clear Lake Mine.

This mine was abandoned in July 1901, since which time everything of value has been removed.

Sapawe Lake Mine.

Mining development progressed here for several months after the last inspection, the shaft being sunk to a depth of 50 feet. The gold values, it is reported, were satisfactory ; but owing to difficulties arising between the owners operations had to be suspended and have continued so to the date of inspection, a year later.

Golden Star Mine.

During the past year this property has undergone a systematic though somewhat limited course of development for the purpose of locating the continuation of the ore bodies in the main or any other adjoining or parallel veins, if such should exist, for which the directors raised a sum approaching $30,000. This is now all expended but, in the estimation of the shareholders, without obtaining sufficient ore or prospects of getting the same to warrant their furnishing further funds, and so the mine was closed down. The opinion of Mr. H. H. Wood, manager of late operations, is that continued development of the mine is better justified now than at any previous time during the year, this opinion being based on indications that the pay chute has begun to expand on the sixth level north with good values and that it will prove continuous.

Before the recent mining began a good deal of preparatory underground work was necessary to get the working roads and levels into a safe condition. The shaft had to be almost entirely re-timbered, and over the fifth and six levels the stulls and lagging strengthened in places to guard against the periodical breaking away of the 6-inch false wall in the big open stope above. The work done measures up as follows : Main shaft, depth unchanged, but the rock pentice below the sixth level was removed preparatory to further sinking. Fifth level north, 153 feet (41 feet increase) ; at 112 feet in, the old stope up to the fourth level was carried south

20 feet further, 4½ feet wide. Sixth level north, 432 feet (270 feet increase): at 185 feet in, an overhand stope 15 feet high for 81 feet along the level, then enlarging to 65 feet high by 40 feet length at bottom and 20 feet at top, and average width 5 feet; at 277 feet in, a branch drift northwest 83 feet; at 386 feet in, an overhand stope 8 feet high and 20 feet long. Sixth level south, from the old face at 40 feet south, which was all in country rock, cross-cuts were driven east 38 feet and west 40 feet; at 12 feet in the east one a vein was struck and drifted on south 106 feet and overhand stoped for a length south of 50 feet, the stope rising up at an incline of 60° north, gradually narrowing to 20 feet length at 70 feet above, where it connects with the shaft, its width being from 2½ to 4 feet; the west cross-cut struck another vein at the face on which a 22-foot drift was run south. In the shaft at 40 feet above the sixth level a drift runs north 25 feet by 20 feet high, in ore.

The west shaft was re-opened and a drift run north 103 feet from the bottom, at 87 feet; but encountering only stringers the whole was abandoned.

The other work consisted in sinking a 5 by 10 foot pit 10 feet deep on location A L 114 on an undefined outcrop of pyrrhotite, pyrite and chalcopyrite said to be nickeliferous; and a 5-foot pit on a magnetite exposure 300 feet south of the other.

The Government "S" diamond drill which was obtained by the company for three months during the summer, explored the deposits from both surface and underground, drilling eight holes with a total length of 1,001 feet. The above magnetite and copper-nickel bodies were tested but with no very valuable findings. The examination for the main gold vein showed amongst other things that it widens out again to the north beyond the pinch in the north levels underground, the drill finding 4 feet 3 inches of quartz vein at 519 feet north of the shaft carrying gold and silver, and that no parallel vein exists for at least 176 feet east, as proven by the barren core from the boring east from the face of the east cross-cut from the sixth level south.

The surface plant has undergone a few alterations along the line of repairs, a new mortar block being put in for B battery and new foundations for the compressor, dynamo and mine hoist with a general overhauling and aligning of all parts of the machinery. The mill ran fairly continuously from July 1901 to March 1902, on day shift only most of the time, crushing 2093 tons from which a small return accrued. The whole plant has again been gone over and very carefully prepared for a period of idleness.

Foley Mine.

A visit was made to this mine on 15th March 1902, although no work had been done since the last inspection of a year previous. It was then believed that a sheriff's sale of the property would take place, and from later information this has occurred, a syndicate of capitalists from Hancock and Houghton, Mich., bidding it in. Preparations are going on for the resumption of work under the superintendence of Mr. J. C. Foley, the original manager of the mine. The stock pile contains some 600 tons of ore on which the mill can run while stopes on the several veins cross-cut by the second level from No. 5 shaft and elsewhere on the property are laid out for continued production. The syndicate who bought the mine have organized under the name of Protogene Gold Mines Company with a capital stock of $1,500,000 divided into 1,500,000 shares of $1 each. The head office of the company is at Windsor, Ont., and the officers, president, Fred J. Bawden, Houghton, Mich., vice-president and general manager, J. C. Foley, Detroit, Mich., and secretary-treasurer, A. St. George Ellis, Windsor, Ont.

Eagle Lake Region.

There is not as much activity here as might have been expected from the showings of the previous or first year's work. The explanation probably lies in the fact that the operators were in all cases either the original prospectors and their partners or others of limited means who had only enough money for a small amount of development work, and since the completion of this during the past year the owners have had to wait for outside capital to carry on the work. This has now apparently been interested in the district, as working options are let on the Baden-Powell and Golden Eagle mines. From the latter, owned by the Golden Eagle Mining Company of Rat Portage, a lot of 19 tons of ore was in July, 1901, treated in the small stamp mill at the adjoining Eldorado mine.

Work has progressed only intermittently at the Viking location.

No inspection of the mines of this district could be made on account of the breaking up of the ice on the lake in the month of April 1902.

Gold Moose Mine.

This mine lies about one mile west of the Hermann and Larson property and 6 miles south of Dryden, C. P. R on lot 8, in the first concession of Van Horne township, Rainy River district, and consists of the west half of the south 140 acres of the lot. The owners are R. D. and H. G. Hutchison, J. G. Hammond, of Dryden, Ont., and C. J. Seih, of New Sharon, Iowa.

Development work began in October 1901 and continued intermittently up to 4th April, 1902, when the inspection was made, with the following results : Shaft, depth 64 feet, size 6 by 8 feet, vertical for 20 feet with timbered collar, and inclined 72° north from there to the bottom with wall plates, skid poles and ladders without platforms or partition between the two compartments. First level, depth 62 feet ; east drift 20 feet ; west drift, 11 feet. Further sinking of the shaft had just been resumed with a small total force of four. Hoisting and unwatering was done by hand windlass, bucket and hemp rope, for as yet no mining machinery had been installed. Blacksmith shop, stable and bunk house make up the camp, but it is stated that a suitable hoisting and air compressor plant with power and shaft house will be erected this season.

The geological formation is the same as on the Hermann-Larson property described below, being a grayish green trap schist striking east and west with a nearly vertical dip. The quartz is embedded in the trap in conformity with its strike and dip and with distinct south or foot wall along which an inch or so of selvage runs. One well defined quartz band from 8 to 18 inches wide, on the average 12 inches, lies against the foot wall ; to the north of this, the remainder of the vein matter, 4 to 5 feet wide, consists of shattered and altered green schist carrying a few scattered quartz stringers. Some of this schist has been partially replaced by quartz in solution, leaving a flinty quartzose mass, throughout which pyrites occurs. In February of this year a mill test of 67 tons of the ore made at the Keewatin Reduction Works is said by Hutchison Bros. to have given satisfactory returns.

Hermann and Larson Mine.

The property consists of the southwest 40 acres of lot 6 in the first concession of Van Horne township, Rainy River district, and is situated at the west end of Wabigoon lake, five miles south of Dryden station on the C.P.R. The holders of the mining lease (No. 2346) are A. B. Hermann, 860 Monadnock Block, Chicago, and G. Larson, Dryden, Ont., who have recently let a working option to the Redeemer Gold Mining and Milling Company of Windsor, Ont., which is now under Mr. Larson's management carrying on development.

At the date of inspection, 4th April 1902, it was found that mining had been suspended for lack of pumps to handle the water and of an air-compressor to work the machine drills, the workings having now reached too great a depth to allow of steam continuing to be used. The one shaft is 66 feet deep, size 6 by 9 feet and vertical, with a 6-foot collar, but without ladder-way or other timbering. First level, depth 60 feet ; east drift, 20 feet. Besides the shaft there are several surface test pits and considerable stripping.

The shaft head frame is solidly constructed, 20 feet high and open. Hoisting is done by steel bucket, ½-inch steel rope and a small duplex-cylinder hoist-engine, all in good shape. The force of four men was employed installing a 3-drill Rand air-compressor and receiver in the power house near by, which with the 30-h.p locomotive type boiler, hoist, pump and two No. 3 Rand drills constitute the mining plant. The camp, boarding house and bunk house only, is situated 600 feet east of the mine.

The country rock of the location and neighboring region is a fine-grained trap schist, grayish green in color, showing in its many large exposures distinct bands of a composition varying considerably from the ordinary trap, and originating no doubt with the eruption. The strike is east to west and the dip vertical. Embedded in the folds of the trap and with identical strike and dip lies the vein, composed of an intimate mixture of white quartz and the grayish green trap, not at all or but slightly altered with scattered patches of iron pyrites The surface outcrops show one more or less defined and continuous quartz band varying in width from a few inches to 8 feet, outside of which and forming the rest of the vein are other small and irregular stringers interbanded with the schist. Down the shaft the vein widens from 8 feet at the surface to 10½ feet at the bottom.

Big Master Mine.

This mine has been kept in active operation not only in erecting the remainder of the surface plant, but also underground, where development has been confined to the two main veins. In order to bring the mine quickly into shape for supplying the mill, the unusual method has been adopted of paying high western wages and working eight hour shifts. By this means the main shaft was sunk rapidly, and considerable ore was blocked out along and above the first level on the two veins, one to the east and the other to the west of the shaft. The original plan, by which ore was to be hauled in wagons from the mine to the mill, a distance of about a quarter mile, was abandoned at the last moment, and instead a Hallidie aerial tram will be installed. The mill station is 25 feet higher than the loading station at the mine, which necessitates operating the tram by power. This machinery, it is expected, will be in place and ready for work by July 1st, when crushing in the mill will begin.

There has been a change in the management of the mine, Mr. W. H. Pickering now filling the position. The foreman is W. Shovells, and the total force numbers 25, of whom 14 are miners. An addition to the group of claims has been made by the purchase of the remaining three-quarters of S 25, an adjoining location of 100 acres.

Mining development is as follows : Main shaft, depth 170 feet, continued down vertically, in size 5 by 9 feet inside timbers. First level, depth 75 feet ; east cross-cut 210 feet ; at 142 feet in, a drift north 25 feet ; at 177 feet in, drifting north 223 feet and south 54 feet along the east vein. At 101 feet in this north drift a 37-foot up-raise was made connecting with the bottom of the old No. 2 shaft, the total depth of which is now 99 feet ; from 100 feet to 170 feet in, the drift was widened to 12 feet ; at 175 feet in, cross-cutting east 12 feet and west 19 feet. West cross-cut, 75 feet ; at 34 feet in, drifting north 207 feet and south 270 feet along the west vein. In this north drift from 123 feet to 170 feet north the drift widens to 12 feet, and at the end of this is an upraise to the surface, height 52 feet, size 5 by 6 feet, called the air shaft. In the south drift, at 132 feet, cross-cutting west 26 feet, and at 21 feet west in this a 25-foot upraise. Practically no stoping has been done as yet beyond beginning the first overhand levels at the upraises, and the placing of the first line of timbers below in preparation for a quick start.

The Helena shaft is situated on HP 368, half a mile north-east of the main shaft, and on the west vein. This old test pit was continued down vertically to a depth of 52 feet, in size 5 by 8 feet, in order to ascertain whether the ore at this end of the property was of the same character and of as good value as in the main workings. It is reported that this was found to be the case, and that the vein averages two feet and a half of pay ore. These workings are now abandoned.

The main shaft below the collar is timbered with square sets at 4 feet 8 inch centres down to the bottom, lagged, and divided into two compartments, one for the cage and the other the man and pump way. The timber is substantial, and the ladder-way in good condition. The drifts are timbered over solidly below the three upraises, and the Air and No. 2 shafts on the west and east veins respectively have platforms and ladder-ways at frequent intervals up to the surface, thus forming two other outlets and providing good ventilation. One pump, a Snow duplex, $5\frac{1}{4}$ by $3\frac{1}{2}$ by 5, raises from the first level to tanks in the shaft house above, this water forming the boiler supply. In the bottom of the shaft the Cameron sinking pump is still in commission. The cage is used for hoisting from the bottom of the shaft while sinking is under way, and in order to do this the cage guides were lengthened out for another ten feet, and the safety dogs detached, and still the hoisting and lowering of men continued. Instructions were left to immediately put this safety device in working order and maintain it so at all times. The hoist and rope and signal apparatus are all in good condition.

The work now in progress consists of continuing the shaft down 5 feet farther to the second level at 175 feet depth, and there cross-cutting to the west vein on which drifts will be run to the north and south to open up more stoping ground. As the east vein appears to be dipping towards the shaft, a cross-cut will not be made to reach it until a further depth of at least one hundred feet is attained, at which point it is possible the shaft and vein may intersect.

The powder magazine is the same building as formerly, in which 38 boxes of dynamite were stored at the time of inspection. All is kept in good order. Thawing is done in a 10 by 12-foot log shanty 80 feet southwest of the shaft house, heated by coils using live steam under pressure, the supply of powder not exceeding a box and a half at any one time. Several barrels of oil are also stored in this house. Instructions were given to remove this oil to a proper oil shed, and a recommendation made that exhaust steam be blown through the coils to replace the system of heating by live steam under pressure.

The shaft house and adjoining buildings, as noted in the last Report, have been completed, and a second 80-h.p. return tubular boiler installed alongside of the first. In the rear of the shaft house an 8 by 13 inch horizontal engine is set up and connected with the machine shop. West of the shaft house and connected therewith by a 40-foot trestle tramway, an ore bin has been erected, in plan 12 by 40 feet and 20 feet high in which some 250 tons of ore are stored preparatory to its being transferred to the mill on the aerial tram for which the loading station will be built in front of and below this bin. The stamp mill was completed in November 1901, the machinery as installed consisting of a 7 by 11-inch Blake crusher, feeding to a set of 10 by 24-inch rolls, which will crush to half-inch size, preparatory to feeding into the batteries ; Challenge ore feeders ; 10 stamps of 1000 pounds each ; amalgamation plates ; a four-compartment hydraulic classifier ; 4 Frue vanners, one with egg-shell surface belt ; a 12 by 36 foot Strake table in the lower end of the mill ; and a clean-up pan. The power is furnished by a 60-h.p. return tubular boiler and a 40-h p. horizontal engine. The pumping station has yet to be erected on the lake shore below.

A saw-mill with a capacity of 10,000 feet per day was erected on the lake shore in front of the stamp mill, and has cut the lumber used at the mine and for the camp which has recently been increased by two private dwellings.

Underground development now gives a better idea of the character of the veins than was obtainable from the surface examination noted in the last Report. They lie in altered zones in and along the strike and dip of the formation, the zone of the west vein being one hundred feet in width, of which however only 10 or 12 feet can be considered as actually belonging to the vein, while at the east vein, 200 feet to the east, the metamorphic action though leaving a well-defined plane of movement has altered the rock for but 5 to 6 feet on either side of the fissure. The two veins appear to be converging with small dip, and it is hoped they may connect lower down ; but from their bedded character this is not certain. The vein in the west zone consists primarily of a wavy quartz band in width from a few inches to two feet and is imbedded between bands about 10 inches wide of a light highly quartzose schist—the altered trap—outside of which again lies fine chloritic schist interbanded for a foot or so with thin stringers of quartz, all carrying a fairly high average proportion of pyrites. The main quartz band or pay streak is not continuous throughout, but occasionally breaks up into a number of small stringers, the continuation of the solid band to be found farther on and generally shifted a few feet to one side. The east vein is of much the same character, but with this difference that the intermixed altered trap is less abundant, the values being confined more closely to the clean quartz. In the two veins the values are in gold which occurs both free and in the pyrites, and in view of this feature it will probably pay to stope a considerable width of the highly mineralized schist on the walls, thus obtaining stopes from three to five feet in width.

Locations HW 74 and 75.

This mining property is situated near the end of Mosher bay, off the east side of Upper Manitou lake, and about five miles south of Gold Rock. It is held under option by Paul Paulson, who is in charge of its present development.

The country rock is a compact, light green chloritic schist, striking about northeast and southwest, with a dip of 65 degrees northwest. Lying in the folds of this and near the brow of the hill a quartz vein outcrops, and is traceable along the strike of the formation for several hundred feet, running into both locations, and averaging about six feet in width. It is composed of large and small quartz lenses and chloritic schist, holding a fair percentage of pyrites and chalcopyrite. Both walls are well defined. Several pits and trenches have been sunk on the surface exposures over a distance of about 300 feet, and one shaft is down 25 feet following the vein, which maintains its width of from six to eight feet. From the foot of the hill, 50 feet below, and directed towards this shaft, a cross-cut tunnel is now being driven, having length to date 73 feet, of which the first 40 feet is open cut. The intention is to cross-cut the formation and the vein at this depth and then explore the latter before closing the option.

Much carelessness was displayed in the storing and handling of dynamite. There was no magazine, and powder was left lying without shelter outside of the blacksmith shop ; thawing operations, also, were conducted by placing the dynamite around the stove in the blacksmith shop. Suitable instructions were left to remedy this state of affairs.

The employees numbered five, of whom three were miners, the other two being engaged in building a small camp.

Royal Sovereign Mine.

This property, formerly known as the Lower Neepawa mine, consists of locations H W 54, 87, 253 and 253A, the last being mining rights under the bay. The situation is on the northwest side of Lower Manitou lake, opposite Beaver Head island. The owners are the Neepawa Gold Mining Company of Ontario, Limited, but this company has let a working option on the property to a St Paul syndicate, who are the present operators. The mine had been closed down for several years until February 1902, when it was unwatered and some 23 tons of ore stoped from the various parts of the workings and taken to the Glass Reef stamp mill on the opposite side of the lake for treatment. The results of the mill run were sufficiently satisfactory to warrant immediately setting a force of men at work constructing camps and mine buildings, of which about half were completed at the date of inspection, preparatory to extensive underground development this season. The manager, Mr. H. D. Alston, has at present a force of nine men, but this will be increased to about twenty-five later on.

The underground development, most of which was done by the former operators, is as follows: Shaft, located on H W 54, depth 105 feet, size 6 by 8 feet, inclined 60 degrees south. First level, depth 65 feet; southwest drift, 10 feet. Second level, depth 100 feet; southwest drift, 30 feet; northeast drift, 26 feet. The future operations will begin about June, as soon as the mining machinery, consisting of a 16-h.p. hoist, 20-h.p. boiler and pump is installed, the intention being to sink to 250 feet and drive another level at 200 feet to thoroughly explore the vein along this as well as the upper level. Another shaft will probably be sunk on the vein 150 feet southwest of the present shaft to the 100-foot level.

The country rock is a green to gray schist, hornblendic to chloritic in character, in places slate-like and columnar, but merging again into ordinary trap. The strike is northeast to southwest, and the dip 60 degrees southeast. Across a width of at least 300 feet this formation carries several lenticular quartz veins parallel in their general course and lying in the folds of the formation, some of them outcropping for a hundred feet or more, and from a few inches to ten feet or more in width. Judging from surface exposures a uniform width is not maintained in the veins for any great distance some of the outcroppings showing them to pinch out at one or both ends or to break up into a series of small quartz stringers. They then appear to be replaced by parallel lenses a short distance to one side; or, as in one instance where the strike was followed, several small outcrops may be found in the same line over a distance of several hundred feet, possibly indicating that although the quartz lenses narrow in places to stringers, a certain continuity along their line of strike may be looked for.

The vein under development is exposed on the surface northeast of the shaft for 150 feet to the lake shore; and at a point 1000 feet farther on the other side of the bay, and along the same northeast strike, more quartz was found. Southwest of the shaft the quartz body is traceable for 200 feet or so. The shaft follows the vein down from top to bottom, with fairly well defined walls, exposing a width of from 8 to over 12 feet of a white to smoky quartz intermixed with small pockets of dark hornblendic to chloritic quartzose schist, the whole carrying a large proportion of pyrites and chalcopyrite. The drifts, which are short, were all run on the vein showing it to maintain its well defined character.

Glass Reef Mine.

This mine is still closed down, but the directors of the company are placing another block of shares on the market from which they hope to secure sufficient capital to this season carry on further development, not only in the present workings, but in opening up what is said to be an extension of the vein on the adjoining location. The expectation of finding ore in the present workings seems hardly warranted considering that the original thorough exploration development of a year ago failed in the attempt. (See 10th Report Bureau of Mines.) Last summer a little mining was done consisting of the stoping out of a block of rock above the first level between the shaft and the upraise, 20 feet east, but this rock has not been hoisted out.

During February 1902, 23 tons of ore from the Royal Sovereign mine on the opposite side of the lake were treated in the stamp mill.

The sawmill has been in intermittent operation since September 1901, supplying lumber to adjoining mines. The surface plant is unchanged and being kept in good condition in anticipation of future resumption of operations. Geo. W. Glass is in charge.

Twentieth Century Mine.

This property comprises locations H W 44, 47, 244 and H P 398 containing in all 269 acres, situated on Upper Manitou lake nine miles southwest of Gold Rock P.O. or 28 miles southwest of Dinorwic station on the C. P. R. Surface development, such as stripping of veins and a little sinking has been done at different periods during the past two or three years by the former owners, but about the beginning of 1901 operations were begun by the new proprietors, the Twentieth Century Mining Company. Limited, president, Anthony Blum, secretary John Mollath, with offices at Toronto and Boston, and mine manager, Dryden Smith. An average force of about 24 men has been employed continuously, most of them on surface construction, while the mine has been allowed but a small number, at present eight, the result being that comparatively little underground work has been done. The company has however brought in a 20-stamp mill with other accessory machinery and a sawmill in expectation of starting milling in August 1902. There are several large surface exposures of quartz lenses or veins from which it is intended to mine ore for the mill ; but the existence of this temporary supply does not alter the fact that the property is not as yet in shape for continuous production.

Mining development is as follows : Main shaft, on H P 398, depth 175 feet ; size 7 by 11 feet or 5½ by 9 feet inside cribbing ; inclined 83 degrees south. First level, depth 80 feet ; east drift, 32 feet with sump at face ; west drift, 24 feet with cross-cuts from face north 37 feet and south 40 feet. Second level, depth 160 feet ; drifting and cutting of station chamber about to start.

The pumps are located, one, a No. 5 Cameron, in the shaft bottom and the other, a No. 9 Cameron, over the sump in the first level east. The shaft timbering consists of a solid 24-foot collar with dividers below this to the bottom at about 16 foot centres supporting pole skids for bucket and ladders, the latter reaching only to the first level and the bucket being used to descend lower. Instructions were given to complete the ladder-way and the partition between the two compartments.

The shaft house and the compressor, boiler and hoist house adjoin. They are constructed of logs and contain a 60-h.p. return tubular boiler, a 3-drill Rand air compressor, a duplex-cylinder single-drum hoist, cylinders 6 by 8 inches and drum 19-inch face by 12-inch diameter, using ⅝-inch steel rope, with, on the same foundation as this hoist, a 15-h.p. vertical boiler now out of use.

About two years ago a vertical shaft was sunk 40 feet at 50 feet east of the new main shaft, in size 6 by 10 feet and now abandoned and covered over. The remaining development consisted of stripping several of the quartz out-croppings in the vicinity of the present workings.

The camp is a collection of log and frame buildings including office and assay office, boarding and bunk house, warehouse, stable and blacksmith shop with another bunk house and an ice house now under construction. At the lake shore one mile distant is the dock and warehouse. Most of the machinery and plant for the 20-stamp mill mentioned above is now on hand on the side and top of the hill 400 feet north of the mine where it is proposed to erect the structure. There were many large piles of logs in front of the camp containing, it is said, over 100,000 feet board measure, for sawing which, however, the mill has not yet arrived.

The dynamite magazine, an 8 by 10 foot log building, is situated behind a hill in a safe place at 1000 feet north of the workings. Isolation of the dynamite and better thawing arrangements were required, and instructions were left covering these points.

The country rock of the property, and in fact of the district, consists of altered trap and hornblende and micaceous schists of the Keewatin period which weather for the most part to a light green, though the natural color inclines to gray. The strike is not constant, varying from east and west to northeast and southwest, with dip roughly vertical. In the vicinity of the mine, however, the former strike prevails.

By the surface outcroppings and stripping at points near to and distant from the workings there are exposed a large number of parallel quartz veins and stringers, some of them as much as 25 feet wide, lying embedded between the folds of the formation with the same east and west strike and traceable in several instances over a considerable distance by disconnected outcrops. Others again begin abruptly not only at the surface, but underground where the workings have found them as lenticular bodies without any indications that they extend back, beyond the pinched down end in sight. This leads to the conclusion that the zone of trap, several hundred feet wide as far as cleared and running through the locations, carries a large number of roughly parallel lenses and stringers of quartz, some of which may prove to be continuous while others will pinch out, and that the width of these bodies is not likely to be uniform on account of their wavy character. In the mine the main shaft strikes a vein coming in from the north or foot wall 50 feet below the surface and follows it down to 110 feet depth, the south wall keeping about the centre of the shaft to this point where all disappears again. On the first level in the north cross cut from the west drift this vein is 25 feet in width, which is the same as that of its surface exposure. At about 140 feet depth in the shaft another quartz vein enters on the south side with same strike and dip extending to the bottom, 35 feet farther, in waves from a few inches to 3 feet wide ; and in the south cross-cut from the first level west drift what is probably the same vein is cut, being here 10 feet wide.

The veins are made up of white quartz fairly clean in the central portions but towards the walls carrying contorted bands and pockets of a mica-hornblende schist, which in some places forms the much larger portion. A small scattering of pyrites, chalcopyrite and occasionally zinc-blende occurs throughout the whole mass, the pyrites extending back into the wall rock of trap

Independence Mine.

Since July 1901 a force of about five men has been engaged in putting up more buildings apparently in anticipation of further mining, and 100,000 feet of lumber has been cut at the Glass Reef mine sawmill on the other side of Manitou lake for the erection of the stamp mill brought in here about two years ago. The intentions of the company as to future work do not, however, appear to be very settled. Mr. A. E. Botterell is in charge.

Moose Lake Mine.

After working a period of five months in mining and completing the surface plant noted in the last report the mine was again shut down in February 1901, the cause, according to the late manager, being lack of money. This difficulty, it is expected, will shortly be overcome and operations resumed.

Sairey Gamp Mine.

Last May a lien was placed on this property which resulted in its immediately closing down. So far no alteration of this state of affairs has occurred.

Gold Standard Mine.

Development continued here until December 1901, by which time the shaft had been sunk to a depth of 150 feet with 20 feet of drifting when, owing to the inadequate hand appliances, it was deemed advisable to suspend operations until suitable machinery could be obtained.

Sultana Mine.

During the past year the scale of operations has gradually decreased until at the date of inspection, 2nd April 1902, but half the normal force was employed, namely 31, of whom 16 are miners. The stamp mill had run on the day shift pretty steadily except during October 1901, when it stood idle as the ore in the one stope had all to be broken down before any could be removed. After taking what ore was to be found in the lower levels of the Crown Reef vein at the west end of the mine, a general cleaning out of all the stopes in the old workings was begun producing quartz which, though not of high grade, was rich enough to pay for treatment. It was stated by the manager, Mr. W. H. Strong, that by the middle of April this source of supply would be exhausted, after which it is the intention to shut down the mill for a year at least and to confine all operations to underground development, until such time as the recently discovered quartz body is in shape for stoping. The use of the vanners in the mill was discontinued some months ago, the percentage of concentrates in the ore being insignificant. The surface plant, both mining and milling machinery, is unchanged and maintained in good shape. Two wood barges, each of 40 cords capacity, have been built for the use of the mine.

The new mining work is as follows ; Main shaft, fourth level south driven to 754 feet, connecting at 726 feet in with the winze from the second level on the Crown Reef vein, which winze was continued down to this level. A little stoping was done on either side of the winze along the line of the Crown Reef vein. At 30 feet south of the shaft on the fourth level about 1,500 tons of ore were broken down underhand into the old open stope below. The seventh level had been driven northeast 577 feet to date, with 30 feet still to go before striking the new quartz body. From May to August 1901 a diamond drill was employed underground to test the continuation of the Crown Reef vein and to explore for the lower faulted portion of the main vein. One of the former group of bore holes from the face of the fourth level south struck some quartz at 36 feet in, which runs 2 to 4 feet wide with small gold values and as it is in the natural position of the lower extension of the Crown Reef vein preparations are now under way to drift in to it. Regarding the fault which cut off the main vein it will be remembered, as stated in the earlier reports, that this was struck in the roof of the seventh level at the shaft, cutting off the quartz entirely, the fault plane striking about northwest and southeast with dip underground of 66° southwest and that on the surface at 800 feet northeast of the shaft what is apparently the outcrop of the plane forms the side of a ravine with same dip and strike. In prospecting for the continuation of the vein the seventh level had been intermittently driven northeast until last May, when, at 357 feet in with still no quartz, a diamond drill was set up at the face boring 3 holes further northeast a total length of 771 feet, in which at an average of 256 feet vein matter—quartz intermixed with altered schists—was struck running from 8 to 13 feet in width with gold values. It is of this vein that the seventh level is now within 30 feet. Considerable doubt prevails, however, about this being the same vein that traverses the old workings, for here gneiss forms the south wall with trap on the northeast side only, whereas in these bore holes and the drift nothing but green trap has been found on both sides of the quartz.

The Inspector's Book could not be found at the time of my visit, nor had it turned up at a later date, 13th May. The loss of this book is much to be regretted for with it is lost a detailed record of the mine such as can never in its entirety be replaced.

Keewatin Reduction Works.

During the past year this mill handled all the ore from the Sakoose mine, and in February an additional lot of 67 tons from the Gold Moose mine near Dryden. On account of the recent suspension of production at the Sakoose, which belongs to the Ottawa Milling and Mining Company, who also own the reduction works, the latter will be closed unless a paying consignment of ore from outside be received. Mr. W. J. Craig, the manager, has maintained the plant in good condition.

Golden Horn Mine.

On the south side of Rush bay west of Ptarmigan bay, Lake of the Woods, and 24 miles west of Rat Portage by water, lies mining location D 267 containing 70 acres, known as the Golden Horn property. It is owned by the Rush Bay Golden Horn Mining Company, Limited, of St. John, N.B. ; president, C. H. Hutchins ; vice-president, Dr. C. W. Clarke, Winnipeg ; secretary-treasurer, J. H. Cassidey, St. John ; and mine manager, H. Ridout, Rat Portage. Operations began in June 1901, with a large force, reduced to nine at the date of inspection, 31st March 1902, work consisting of sinking a new shaft, the old shafts and pits of the former owners having been abandoned, and erecting the necessary camp buildings.

Mining work measures up as follows: Main shaft, depth 111 feet, size 7 by 10 feet and inclined 80° north. First level, depth 100 feet ; west drift 25 feet. The shaft collar of squared timbers extends down 25 feet with square sets below supporting the pole skids and a good ladder-way, the partition between the two compartments yet to go in. A small pump unwaters from the foot of the shaft. For hoisting a wooden bucket with ⅝-inch steel rope is used.

The shaft house is an enclosed structure with the engine house adjoining containing a 12-h.p. vertical boiler on the same foundation with a small duplex-cylinder hoist. A 40-h.p. return tubular boiler and a 3 drill air-compressor were purchased this winter but are not yet set up.

The geological examination of the property shows that the true country rock is an altered trap, probably diorite, striking east and west with a slight dip north, and that over a width of from 300 to 500 feet north and south across the location the trap has undergone metamorphism, gradually changing towards the centre from a dark hornblende schist to a yellowish green chlorite schist. Over the surface are found innumerable small stringers and irregular splashes of quartz, together with a number of well defined veins embedded in the formation with the same strike and dip and a width of 5 feet more or less, all being about parallel. A gradual change is noted in the veins outwards from the centre of the schistose zone, from a dark smoky quartz carrying galena, blende, chalcopyrite and pyrite, to a clean white quartz with but little mineral, and that iron pyrites only. The gold values in the former are said to exceed appreciably those in the latter.

The shaft has been sunk in the chlorite schist on a quartz stringer one foot wide at top, 2½ feet at 30 feet depth, and pinching out at 45 feet. On both sides are other irregular, small quartz bands. Below the 45-foot level no quartz is to be seen, although in the foot wall another band occurs which is followed on the level at the bottom, where its width is from 1 to 1½ feet. It is stated, however, by the manager that the schist itself carries pay values.

Mikado Mine.

Operations at this property are somewhat curtailed as compared with those of the past year, No. 2 mine being now shut down and all efforts concentrated in the lower levels of the main or No. 1 vein, the only present source of ore supply. The character of the ore below the seventh level has changed, and instead of clean, white quartz with a fairly even dissemination of gold as formerly, the vein is made up of interbanded seams of altered green schists and a darker quartz, the gold occurring almost entirely in or associated with the schist instead of in the quartz. Another vein, called No. 3, situated about 1,500 feet south of the main shaft on No. 1 vein, striking east and west at right angles to No. 1 vein, with 80° dip north through a formation of trap schists, from 6 to 12 feet wide, and assaying about $5 from wall to wall has been known to exist, but no attempt was made to test it until this summer, when it was tapped by diamond drill at a depth of 135 feet. About six feet of quartz and 14 feet of vein matter carrying low values in gold was found, on the whole sufficiently promising to warrant a thorough examination. Mainly for this purpose, though also to explore the present No. 2 vein at a vertical depth of 600 feet, the ninth level is being driven south from the incline shaft to cover the 775 feet to No. 3 vein, of which distance 425 feet has been traversed. On the surface No 2 vein is traceable to No. 3 lode, which seems to absorb it and, judging from the relative sizes of the two, is the main vein from which No. 2 is merely an offshoot or branch. The following resumé at date of 1st April 1902, covers the past year's mining:

No. 1, or vertical shaft, depth 259 feet (19 feet increase); now abandoned.

Incline shaft, depth on incline 1,170 feet (365 feet increase), or vertical 660 feet, with slightly increased dip, the last 400 feet being at 33°. Sixth level north, 50 feet. Seventh level north, 206 feet (196 feet increase); south, 121 feet (111 feet increase). Eighth level (new); depth, 920 feet on incline, or 500 feet vertical (from here the elevation of the surface gradually increases to the south, thus accounting for the proportionate increase in depth of the levels); north drift 24 feet; south drift 256 feet; at 150 feet south, a winze connecting with the ninth level. Ninth level, depth, 1,044 feet on incline, or 600 feet vertical; south drift 425 feet; at 200 feet south, a winze connecting with the tenth level. Tenth level, depth 1,170 feet on incline, or 660 feet vertical; south drift 94 feet.

Stoping: A general cleaning up of all the old stopes has been carried out so thoroughly that now no ore remains above the seventh level. The following quantities extracted are given in cubic feet: Third level south, 1,740; fourth level north, 2,100; fifth level south, 6,381; sixth level south, 13,881, and 210 near the face; north, 300; seventh level south, 400; north, 8,415; eighth level south, 29,524; ninth level south, 13,178 in one stope, 3,095 in another further south and 11,785 in an underhand stope.

At No. 2 shaft mining continued all season until November last, during which period considerable development was done with unsatisfactory results, the stopes giving only occasional rich pockets both too small and too far apart to pay for the development necessary to find them, and the workings have been abandoned. The shaft is now 250 feet deep, an increase of 70 feet. From the second level at 145 feet south, the winze was sunk 25 feet further to a depth of 70 feet, connecting with the third level. Third level (new), depth 250 feet; south drift 197 feet. Stoping on the second level south of the winze produced 4,220 cubic feet of ore and on the third level south between the shaft and winze, 106,566 cubic feet, these stopes averaging 5 feet width of which 2½ feet was quartz.

Two pumps, one on the eighth level, and another on the fourth level at No. 1 shaft, effect the unwatering, and ventilation is good.

A few changes are noted in the surface plant, the installation of the new 6-drill air-compressor, and the drills, lathes, etc. in the machine shop (the ground floor of the shaft or crusher house) having been completed. The mine water now pumped up to a 10 by 10-foot tank built in the top of the crusher house is used for flushing out the tailings from the cyanide tanks, thus replacing the former system of tramming. In another tank back of the mill the boiler feed water is heated by the exhaust steam from the engines. The stamp mill has run continuously, except during the months of June and July owing to a shortage of ore, and the cyaniding of the remainder of the old tailings dump in the bay is now completed.

More careful handling and storage of dynamite was found to be necessary, and instructions covering these and a few other points were entered in the Inspector's Book.

The mine staff is unchanged, except that with the present reduced force of 49 but one foreman is employed.

Mikado Reef Location.

Mining Locations D 484 to 489 with a total area of 123 acres cover a group of small islands lying to the west of Stevens Island, Shoal lake, Lake of the Woods, and are known as the Mikado Reef property. Last year the quartz vein underwent extensive surface examination and some 20 tons were shipped to the Crown Point 5-stamp mill near the Mikado mine for treatment, giving such satisfactory returns that a sale was soon after made to a syndicate from Traverse City, Mich., who purpose opening up the mine this season.

Black Eagle Mine.

Last spring this mine, formerly known as the Regina, changed hands, the owners, the Regina (Canada) Gold Mine, Limited, selling out to the Black Eagle Gold Mining Company, Limited, with head office at College Hill Chambers, London, E.C , England. The directors of the new company are S. R. Bastard, General Sir H. C. Wilkinson, N. S. McMillan and Frank Peterson, the last being managing director as well as mine manager. The new corporation is capitalized at £100,000 in £1 shares, and by means of public subscription for part of the treasury stock sufficient money was raised to reopen the mine about a year ago on a more comprehensive scale and to instal an efficient plant to replace the old mining machinery and steam stamp batteries which proved such a discouraging failure. At the date of inspection, 28th March 1902, the mine workings have been very appreciably extended both laterally and in depth, showing the well defined vein to maintain with but few breaks a good width throughout and it is said good values. The following summarizes the present state of the mine :

Main shaft, depth 535 feet (60 feet increase). First and second levels unchanged. Third level, south, stoping only ; north, unchanged. Fourth level, south, 382 feet (127 feet increase); north, unchanged. Fifth level, unchanged. Sixth level, south, 309 feet (93 feet increase); north, stoping only. Seventh level, south, stoping only ; north, unchanged. Eighth level, south, 112 feet (103 feet increase); north, 135 feet (126 feet increase). Ninth level (new), depth 531 feet (60 feet increase). East cross-cut, 16 feet, from the face of which are the level drifts, south 70 feet, and north 30 feet. In order to obtain a working shaft of uniform incline to replace the present one which dips west for the upper half and then east to the bottom, another was started down 44 feet west of the mouth of the old one dipping 83° east to connect and coincide with the east incline of the latter below the bend, but after reaching a depth of 64 feet the work was abandoned, for the present at least, because the thin dividing wall between the two was being too greatly shaken, and operations endangered on the working side.

Stoping : In the third level south the floor over the old stope below was broken down. Fourth level at 100 feet south, the old stope carried 20 feet further south, 12 feet high by 4½ feet wide, present length 50 feet ; at 200 feet south, another old one 100 feet long by 45 feet high by 4½ feet wide was enlarged a little to the south. Sixth level south, a little overhand stoping at a few points ; north, at 20 feet in, an overhand stope just started, 30 feet long by 10 feet high and 6 feet wide ; at 250 feet in, another new overhand stope 50 feet long by 50 feet high by 6 feet wide. Seventh level south, at 15 feet from the shaft a new overhand stope 60 feet long by 45 feet high by 5 feet wide, now working. Eighth level, from the face of the 10-foot cross-cut east, a stope working north and south 270 feet long on the north and 100 feet on the south side, by 25 feet high and 6 feet wide. An unsafe scale of false wall one to three feet thick overhangs on the east wall, but is now being timbered up. A large amount of ore is already blocked out throughout the mine, principally below the sixth level, though in practically all of the upper levels and stopes bodies still remain, and in most of the drift faces the width of quartz from 3 to 7 feet indicates the continuation of the vein. Judging from these appearances, the workings are in shape to supply the mill for a long time to come.

Some deficiencies were noted in shaft timbering, skidway and provision for ventilation, and instructions were left to have the necessary improvements made.

By the erection of the new reduction works the appearance of the property has been greatly changed, the old buildings now forming a minor part both in size and use, having been subdivided into engine and other rooms for the new plant. The only portions of the old mill which remain intact are the cyanide room, the seven abandoned Tremaine 2-stamp batteries and the Gates crusher at the top by the shaft mouth. The following enumeration of the parts of the new milling plant furnished by the Jenckes Machine Company and erected 100 feet east of the old building shows that on this occasion nothing but machinery of proved and reliable type has been installed ; 30 gravity stamps of 1,050 lbs. each, set up in three 10-stamp batteries ; Challenge ore feeders ; inside and outside battery amalgamation plates with four other auxiliary 4 by 6 foot plates strung up over the four Wilfley tables on the floor below ; and a large steel water tank at the top of the building. The mine buckets dump directly on to a grizzly feeding the Gates crusher, from which by a system of travelling belts the ore is conveyed a distance of 100 feet to and distributed throughout the mill bins. On the ground floor the concentrates are accumulating in bins to be trucked over to the cyanide vats later on when these have been renovated.

The old power plant consisting of a 6-drill compound steam and air-compressor, receiver, condensor, pumps, 100-light dynamo and 3 return tubular boilers has been again made use of, though some of the foundations had to be altered or rebuilt, and a new 12 by 30-inch Corliss engine purchased which operates the entire mill machinery except the crusher, for which a separate horizontal engine has been set up. In the machine shop the lathes, drills, etc., are run by another engine ; and at the shaft head a new duplex-cylinder single-drum hoist, cylinders 10 by 15 inches and drum 54 inches diameter by 38-inch face, using 1-inch steel rope with a capacity of 3 tons per load has replaced the old hoist engine and is equipped with a satisfactory indicator, signal apparatus and signal code.

Additions to the camp include a new school house and a few private dwellings.

The 45-foot propellor tug belonging to the company has undergone complete refitting and will be again in commission this summer, mainly for the purpose of towing on barges from various parts of the lake the 3,000 cords of wood cut last winter.

The dynamite magazine contains 200 carefully kept boxes and is situated about 300 feet up and over the hill south of the workings in a safe place ; but underground the methods of handling the explosive were far from what they should be. Instructions covering this point were given in the Inspector's Book.

The employees number 71, of whom 42 are miners, with J. M. Jones foreman.

Flint Lake Property.

The Flint Lake Gold Mining Company, president N. C. Westerfield and secretary C. L. Baker of Philadelphia, and manager Theodore Breidenbach of Rat Portage, has acquired mining locations McA 285 and 286 containing 82 acres on Flint lake, southeast of Lake of the Woods. It is learned from the manager that, although nothing but surface trenching has been done on the quartz vein, a reduction plant with a capacity of 60 tons daily is to be installed as soon as possible this spring, most of the machinery being already at Rat Portage. There are no buildings as yet.

Sakoose Mine.

No visit was paid to the property this year as about two weeks ago, on 15th March 1902, operations were suspended, but it was learned from the manager, Mr. W. J. Craig, who assumed charge after the resignation of Mr. H. A. Guess last fall, that production of ore and its shipment to the company's reduction mill at Keewatin continued steadily to the above date, when a stoppage was necessary owing to the fact that the levels had been systematically cleaned of ore with no further development of the vein since last September and that now practically the only quartz in sight lies in the floor of the bottom level. It is expected, however, that a settlement of the differences between the chief shareholders which caused the above state of affairs will shortly be made, followed by the resumption of development and at a later date of ore production, the pay chute in the mine, according to the manager, being now better defined than formerly and quite as rich. There have been mined and milled altogether 7,735 tons of ore from these stopes.

Long Lake Mine.

Near Long Lake river in the New Klondike district and 13 miles south of Dyment, C. P. R., the above property is situated, covering locations S V 353, 354, 355 and H W 575, an area of 130 acres owned by the Long Lake Gold Mining Company, Manchester, Eng., the mine superintendent being John D. Aaron, Wabigoon. From the latter it is learned that the present force of three is engaged erecting buildings in anticipation of the arrival of more men and of a mining plant comprising boiler, engine and small stamp mill for test purposes, without as yet ny attempt at continuing the underground development consisting of two shafts, one 20 feet and the other 28 feet deep.

Sturgeon Lake Region.

This section of western Ontario is maintaining its original promising outlook, the mining companies who went in to test the quartz veins being satisfied with the prospects, and now there are several fairly well developed mines and two stamp mills with a number of complete mining plants in the district.

The United States Gold Mining Company, E. G. Filer, president, Filer City, Mich., A. V. McAlvay, secretary, Manistee, Mich., and E. Arthur Shores, manager, Ignace, Ont., was the first to penetrate to this out-of-the-way spot in 1899. Development of the property has progressed with few breaks, the work to date as described by the manager being as follows: No. 1 shaft, depth 70 feet, with a drift from bottom 102 feet east and a cross-cut 55 feet south. No. 2 shaft, depth 65 feet. No. 3 shaft, depth 35 feet. A tunnel has been driven about 200 feet northwest into the side hill bearing for No. 3 shaft. The mining machinery consists of two 35 h p. boilers, two hoist engines, three pumps and three machine drills. A 2-stamp Tremaine mill now on the ground has not yet been set up. A large number of buildings are erected and the force averages about twenty-five.

The Sturgeon Lake Mining Company completed the erection of the 10-stamp mill, which in last year's Report was noted as being on the road in, and during the summer of 1901 produced bullion to the value of some $8,000. In the fall, however, work was suspended and not until this spring have preparations for the resumption of mining begun. In February, it was reported, men and supplies went in to the mine.

The Jack Lake Gold Mining Company, Limited, of Saginaw, Mich., president, Ezra Rust, secretary, M. Pursell and manager J. S. Steele, which during the winter of 1900-1901 was developing the Jack Lake mine in the Seine river region, has since widened its scope of operations by taking up several gold propositions on Sturgeon lake. From the manager it is learned that a large force of men have been engaged opening up the property since the spring of 1901 and with such favorable results that a comprehensive plant is now en route to the mine.

The Anglo-Canadian Gold Estates Limited, of London, England, Mr. Alan Sullivan manager, has also acquired lands in this district, and during last summer's season did a sufficient amount of stripping and other surface work to trace a quartz vein a long distance over which it maintains, the manager reports, satisfactory width and values.

Besides the operations of the above concerns others are interesting themselves in the district, and it is probable that prospecting will this season go on actively.

Consolidated Mines Company of Lake Superior.

Within the past year changes have taken place in the silver situation at the mines west of Port Arthur, from which it would appear that the scope of operations is likely to be greatly enlarged. Two groups of properties, one containing the Porcupine, Badger and Keystone all adjoining, and the other 7 miles west, the East and West End Silver Mountain mines also adjoin-

Twentieth Century gold mine, showing shaft and power houses.

Big Master gold mine; stamp mill.

Stobie copper mine, showing shaft and power houses.

Rock Lake copper mine, showing boarding camp, office, power and shaft houses.

ing each other, covering in all 1,884½ acres and situated about 30 miles southwest of Port Arthur, have been acquired by the above company whose capital stock is $1,000,000, and head office in Port Arthur, Ont. The directors are C. W. Stone, Warren, Pa., president; Herbert Shear, Port Arthur, vice-president and general manager; M. A. Myers, Warren, Pa., secretary; A. M. Wiley, Port Arthur, treasurer; and F. N. Gibbs, Port Arthur. The intention of the company is said to be to undertake a large and comprehensive system of development of the East and West End mines first of all, to do which an adequate mining and milling plant will have to be erected. If these mines later on show that the work has been warranted by producing paying quantities of ore, then a similar course will be followed at the other group of mines.

WEST END SILVER MINE.

Although operations have progressed steadily here since the last inspection, except for the usual spring close down in the mill due to lack of water, it is intended shortly to improve and increase the capacity of the existing plant by the addition of 10-stamps with Frue vanners to the present 10-stamp mill, a 6-drill air-compressor and machine drills, a new hoist and a cage for the main or No. 2 shaft, an ore sorting plant, and a gravity water supply system with 8,000 feet of pipe line leading around the hill from Lizard lake, by which it is hoped all further inconveniences due to lack of water will be overcome.

Mine measurements at date of inspection, 7th April 1901, are as follows:—No. 1 shaft, abandoned, and all machinery at the head removed. No. 2 shaft, depth unchanged. First level, east, a small amount of ore removed, cleaning out the old stopes down to the second level, leaving narrow shattered pillars and insecure timbers, which are liable to collapse at any moment. It was instructed to board up and abandon this drift, and at the same time to see that the stulls and lagging over the working second level below are maintained in a secure condition. Second level, east drift continued in to 318 feet; at 84 feet in, an underhand stope 61 feet long by 20 feet deep and 5 feet wide, from the centre of which a winze connects with the third level below, both stope and winze now used for storing the ore; at 252 feet in an overhand stope now working, 25 feet long by 12 feet high and 6 feet wide; at 263 feet in, a winze connecting with the third level below for an air passage. Third level, east drift continued in to 477 feet; at 115 feet in, the winze connects from the second level; at 167 feet in, a cross-cut south 11 feet; at 200 feet in, a cross-cut north 8 feet; at 234 feet in, an overhand stope 61 feet long by 5½ feet wide connecting at its peak with the air winze from second level; at 335 feet in, an overhand working stope 50 feet long by 15 feet high and 8 feet wide; at 420 feet in, a cross-cut south 32 feet, being driven to strike the "big" or south vein, from which the vein now being developed branched off at the shaft. Fourth level, no further drifting; a little stoping done east of the shaft. Mining in these workings has been limited to the drifts east of No. 2 shaft. The tunnel noted in the last Report as about to be commenced at a point at the bottom of the valley about 1700 feet west of No. 2 shaft has been driven east 317 feet toward the old workings with which it was to connect, but is now discontinued. It is timbered over for 150 feet where the overlying slate is unsafe. Another shaft was sunk vertically 90 feet on the vein at about half-way between No. 2 shaft and the tunnel mouth. The same system of temporary underground storage of the milling ore in the old stopes west of No. 2 shaft is in practice, a large supply having already accumulated.

A few changes are noted in the surface plant. The boiler from No. 1 shaft has been removed and installed in the No. 2 shaft house, replacing the boiler formerly in use. A 50-foot dam was built in the next valley south from a storage basin to catch the overflow from Lizard lake, but it leaked so badly on account of the porous nature of the subsoil as to necessitate abandonment. In the stamp mill the engine has been shifted up to a new cement foundation on the upper floor of the engine room. The mill ran almost continuously from 1st April 1901 to

1st March 1902, full time half of that period, and on one shift only during the other half. Operations are to be resumed in about a week.

The dynamite, 13 boxes in all, is stored in an old tunnel 500 feet east of No. 2 shaft. The prevailing dampness is such that it will be necessary to erect a wooden structure out in the open to obtain better ventilation. More than the usual degree of carelessness was found to prevail among the miners in the handling of dynamite, it being customary with some to prepare the frozen sticks for the evening b'ast by putting them into their boot tops and leaving them there all day. Instruc'ions were left in the Inspector's Book to correct there dangerous practices, but fool-hardiness is not easily overcome.

The employees number 39, of whom 25 are miners. Mr. Herbert Shear is manager.

PORCUPINE SILVER MINE.

After being closed down more than ten years this mine was again opened in June 1901 for the purpose of examination in anticipation of its sale, which took place later, to the above company. A force of from 4 to 12 had been employed continuously under the supervision of Mr. Frank N. Gibbs of Port Arthur up to the time of visit, 8th April 1902, since when operations have again been suspended. The main shaft workings were unwatered down to the second level, mining being confined to the first and second level southwest drifts. In the first level the old overhand stope was enlarged a little. The second level southwest drift has been increased in length and the old low stope just beyond the shaft carried 8 feet higher by 5 feet wide over its length of 100 feet. The levels are solidly timbered over below these stopes. The bucket travels along a skid floor at the 80-degree incline of the shaft ; the ladders extend in an unbroken string to the second level, but without platforms and with no partition between the two compartments. As the mine is not a wet one, a small pump on the second level suffices to keep the water down. Of the ore stoped most had been shipped, though a foot or so of the lower grade still covers the timbers. The old tunnel run in northeast to the shaft workings from the southwest side of the hill had caved in in the first portion and has had to be abandoned, but another outlet was started in diagonally to reach the solid part of the tunnel and was within a few feet of breaking through when work in the mine was suspended.

The shaft house was refitted and the machinery put in shape, the latter including a 40 h.p. return tubular boiler, a large cumbersome hoist of old design and a small compound engine connected to the 50-light dynamo which lights the underground workings and surface plant at the mine.

No proper magazine was in use, the dynamite being stored in an open shed at the mouth of the tunnel beside the workings.

The veins of this mine are similar to those at the West End Silver Mountain, composed of white calcspar, amethystine quartz, a little green fluorite, zincblende and pyrite with argentite and native silver. They traverse the same slates at about vertical dip and vary considerably in width. Underground in the last worked stopes the vein runs from two to four feet wide either as one compact body or broken up into several smaller bands, all of about the same richness.

VICTORIA SILVER MINE.

No visit was made to this mine situated north of Garden River station, C. P. R., as it had closed down again in November 1901 after eight months' working. No definite plans for future work are as yet known to have been drawn up by the owners, Ross & Company of Quebec, Que.

IRON MINES.

In the eastern townships there are likely to be important developments as to the continuity with depth of the size and quality of some of the magnetite deposits as a result of the work now being done upon them. The Michipicoton field continues to hold first place in the iron districts of the Province on account of the continued prosperity of the Helen mine under greatly increased development and output, and by reason of the finds made by diamond drilling on several other portions of the same range. Further west in the region between Sturgeon and Long lakes east of lake Nipigon, and along the Atikokan river and Steep Rock lake, exploration is going on with considerable activity for ore on the strength of the favorable indications in both fields.

Radnor Mine.

Magnetic iron deposits have been located on the above property covering 50 acres in lot 16 in the ninth and 50 acres on lot 17 in the tenth concession of the township of Grattan, Renfrew county, situated 4½ miles by road from the railway at Caldwell station. Under the owners, the Canada Iron Furnace Company, Montreal, development has proceeded for over a year both in actual mining and in diamond drill exploration, the latter by the employment of one of the Government's drills. About 3,000 tons of ore had been extracted at the time the property was visited in June 1902, of which 1,100 tons were shipped to the company's blast furnace at Radnor Forges, Quebec. On lot 17 in the tenth concession, diamond drilling and a limited amount of surface mining resulted in an ore pile of 180 tons, but as work discontinued there some time ago no examination of the deposit was made.

The main or No. 2 open pit on the ore body situated on lot 16, to which development is now confined, measures 35 feet in depth with surface dimensions of 100 feet by 35 to 40 feet, the length along the strike of the deposit, and with sloping walls except on the southwest side, which rises vertically. From the floor a 7-foot adit cross-cuts the ore by an opening 16 feet wide by 18 feet high. Northwest of the pit for a distance of 150 feet the deposit has been stripped and at a point southeast 100 feet another pit has been sunk 4 or 5 feet deep by 40 feet long and 45 feet wide, all of the above showing the deposit of magnetite to strike northwest and southeast with dip southwest varying from a maximum of 40° to a considerably flatter angle, and to lie in a formation of micaceous (biotite) gneiss, which is cut by dykes of pegmatite that sometimes even traverse the magnetite body.

The hoisting apparatus in present use consists of horse derrick, which will be shortly replaced by a 25-h.p. steam hoist already set up but not yet completely connected. The camp, a boarding house and stable, lie 500 feet distant, with office and blacksmith shop at the mine, where another office is now under construction.

The supply of dynamite is stored on lot 17, from where one box at a time is brought to the preparation house 250 feet northwest of the mine. The use of an electric battery and connections for blasting was recommended. The employees number 35 under the superintendence of D. J. McCuan.

The above particulars are taken from the notes of Mr. W. G. Miller, Provincial Geologist and Inspector of Mines, who visited and inspected the mine 8th June 1902.

Wilbur Mine.

Mining was suspended at the end of May 1901, since which time a force of 3 has been employed to keep the underground workings pumped out. At the time of my visit, 20th December 1901, an extra gang of 9 men was engaged in cutting cordwood. The mine had been under development for two years continuously, and from the workings have been taken the large stock-piles of magnetite on hand, none of which has yet been shipped.

Measurements of the new underground work were not obtainable at the time, but note is made of a new shaft, called No. 4, sunk along the vein at a point 250 feet south of No. 3 shaft. A skip road has been installed in this, the skip being operated by a separate hoist in the engine house back of the shaft mouth, taking steam from the power house at No. 3 shaft. Four pumps are kept in intermittent operation, two in No. 3 shaft, one in No. 4 and one in No. 1. Other than the addition of the No. 4 shaft hoist the surface plant is unchanged.

Wm. Caldwell of Toronto is still owner and operator, with S. Jackson as foreman.

Mineral Range Iron Mining Company.

The properties belonging to this Company are situated in Mayo township, Hastings county, and are reached by a good wagon road from L'Amable station on the Central Ontario railway, one mine being four miles east on lot 2 in the sixth concession, called No. 2 mine, another, No. 3 mine, on lot 3 at a short distance from No. 2 mine, and a third, the Childs mine, 7 miles east on lots 11 and 12, in the ninth concession. The company's claim to a fourth property on lots 4 and 5 in the sixth concession is still in dispute, so that the only development here has been surface exploratory work. The lands, which were originally taken up in the name of H. C. Farnum, who acted as a trustee for a Detroit syndicate, have been turned over to the corporation formed of the members of this syndicate, called the Mineral Range Iron Mining Company, capitalized at $500,000, and with head office at Windsor, Ont. Mr. H. C. Farnum, L'Amable station, is mine manager. The employees number 32, of whom 20 are miners.

During the year 1901 development of the bodies of magnetic iron ore went on, chiefly at the Childs mine, where extensive stock piles of ore have accumulated and as soon as snow and weather permit, this and as much more ore as can be mined this winter will be drawn to the railway for shipment, for which purpose an unloading dock at the siding at L'Amable station is now under construction, 250 feet long. Mr. Farnum informs me that plans are being made for the construction of a standard gauge railroad from the C. O. Ry. tracks in to the mine, the idea being to generate electricity by water power on the York river, and to use an electric locomotive able to haul about a two-car load over the rather steep grades on the proposed line.

No. 2 mine is an open cut, in plan 20 by 32 feet and 20 feet deep, with surface stripping and trenching of outcroppings on adjacent parts of the location. Most of the ore from here together with a lot from the Childs mine, was shipped last year.

The Childs mine consists of two open cuts 50 feet apart, the westerly one 20 by 30 feet surface area and 12 feet deep, and the easterly, 72 feet long by 10 to 18 feet wide and 15 feet deep, out of which about 800 tons of ore have been taken and sorted ready for shipment. Here, also, the iron bodies have been explored back and away from the workings by considerable surface trenching. Hoisting at both mines is done by substantial derricks and horse whims.

An examination of the geological features of the deposits was not possible during winter, and observations were limited to the working places. The pit at No. 2 mine is surrounded by magnetite which is for the most part of unusually coarse grain and entirely free from visible sulphides, though containing an intermixture of tremolite with mica and chloritic schists in pockets and seams The ore has the unusual property of electrical conductivity of very weak currents. Judging from surface exposures and reports of surveys by dip needle, the magnetic body lies east and west under an area 600 feet long by 100 feet wide on lot 2 in the sixth concession and is then replaced at a short distance to one side by the No. 3 mine body on lot 3 of the same concession, which extends 1000 feet farther at twice the width to and under a marsh. The Childs mine ore differs somewhat in character, though in freedom from the deleterious impurities, sulphur and phosphorous, it is the equal of the other deposits. Mostly fine-grained with a slightly higher percentage of intermixed black hornblende and calcite and over 15 per cent. silica, it forms an excellent flux, on account of which its value to the smelters is as great as that of the richer ore from Nos. 2 and 3 mines. The open pits are almost entirely in ore on what appears to be two parallel bodies of magnetite, separated by a 4-foot band of chloritic schist, though probably they both form part of the main body. This has been exposed by a trench for 150 feet south of the pits to its southern boundary and north Mr. Farnum states it is easily traceable for 1000 feet by magnetic needle under the wide swamp and into the hills on the farther side, where the outcroppings give evidence of the same character of ore. The scattered exposures and broken magnetic attraction which are reported to exist beyond this point indicate the cessation here of the large deposit, which so far shows definite magnetic boundaries and positive and negative poles at the two ends, its area being estimated at about 1200 by 1200 feet. The swamp under which the main portion of the magnetite body lies is nearly surrounded by a range of hills, but by the deepening of the channel at one end it will be possible to drain it and allow of the lower central portion of the ore being mined

The following assays are furnished by Mr. Farnum as being close averages of numerous samples of the respective ores of the three mines :

	Iron per cent.	Sulphur per cent.	Phosphorus per cent.
No. 1, or Childs mine	51-52	.01-traces	trace
No. 2 mine......................	56	.01	trace
No. 3 mine.....	62-68	.02-traces	trace

Camp buildings have been completed at the Childs mine, and also a dynamite magazine, the latter lying within 100 feet of the open workings and in full view. Instructions were given to remove the magazine to a distant and sheltered place before mining is resumed, and to employ proper thawing apparatus.

On 8th May 1902 it was learned from the manager that for various reasons operations at the mine last winter were considerably hampered so that his estimated output was not reached. At No. 2 mine work was not resumed. No. 3 mine on the ore body on lot 3 in the sixth concession has been opened up at a point about 800 feet distant from No. 2 mine and 1,000 tons of ore extracted, 560 of which have been shipped to the smelters. Complete new camp buildings have also been erected here. At the Childs further mining resulted in producing 1,000 tons additional, and out of this and the old stock 400 tons were shipped.

St. Charles Mine.

The owners of the mine are the Anglo-American Iron Company, who gave a working lease on a royalty per ton of the output to Stephen Wellington, and the latter with a force of 10 men, has been mining and shipping ore since the fall of 1901.

The original 300-foot open cut is abandoned for the present, but at 25 feet beyond its west end another pit 8 by 10 feet in surface area and 10 feet deep is being sunk in the narrowing continuation of the vein in the big cut and entirely in the magnetic ore. At 25 feet west of the centre of this main pit another parallel body is opening up, the size of which at the time of my visit, 7th December 1901, was 40 feet long by 10 feet wide and 10 feet deep between walls of diorite, both ends and the floor showing clean, compact ore. Near the side limits, however, considerable granular calcite is intermixed and overcaps a portion of the magnetite body. West of this about 50 feet a fourth pit had been stoped out by the former operators 15 feet deep and 25 by 25 feet in plan, but mining on it had not been resumed. At a point 100 feet north of the open cuts an outcropping of ore on another one of the series of parallel lenses was stripped preparatory to development in the near future. The system of raising the ore from the pits is by derrick and horse whim, dumping on to platforms to be drawn over a mile road to the railroad. The force work on day shifts only, and drilling is entirely by hand.

Instructions were given to construct a proper dynamite magazine, and to use safer methods of thawing the explosive when frozen.

Coe Mine.

This old hematite property situated one-half mile west of Eldorado in Madoc township, Hastings county, is now owned by A. W. Coe of Madoc, Ont., who re-opened it early in 1901, since when it has been in continuous operation. All the ore is going to stock piles instead of being shipped.

The present workings include a series of three open cuts with a continuation to the west on the Empey property (just over the boundary line which cuts across the deposit). The east pit is 60 by 50 feet in plan and 45 feet deep ; the central one, to which work is now confined, 46 by 20 feet in plan and 45 feet deep ; and the west, 20 by 15 feet and 10 feet deep, narrow strips of ground separating the three. The Empey pit to the west, beyond another dividing strip of ground is 60 feet long, 8 feet wide and 45 feet deep, this work having been done in the winter season of 1900-01 under a short lease by H. C. Farnum who mined and shipped 1600 tons.

The deposit is a bedded vein of red hematite lying in the folds of a green trap with walls of soft chloritic schist a few inches thick, striking east and west with dip of 55 degrees south.

Hoisting is done by derrick and horse whim. The force numbers 8, all of them miners.

Coe Hill Mine.

About 10,000 tons of magnetite ore from the stock piles are reported by S. Wellington, Madoc, to have been shipped during last year, without, however, any resumption of mining.

Brennan Mine.

This hematite property located on lot 7 in the sixth concession Madoc township, Hastings county, and owned by Mr. D. E. K. Stewart of Madoc, has been in operation since the summer up to about 10th December 1901, during which period 250 tons of ore were mined, and shipped to the blast furnaces at Radnor Forges, Que. The work was confined to the surface and consisted merely of stripping and trenching without, Mr. Stewart states, as yet exposing a large body of hematite. It is however his intention to resume development on a larger scale in the spring of 1902. No mining machinery has as yet been erected.

Magnetawan Mine.

This magnetic iron property covers lots 16 and 17, in the third concession, 200 acres, and the mining rights only of lots 125, 126 and 127, concession A, 300 acres, in the township of Lount, Parry Sound district, and is reached by a 14-mile road northwesterly from Sundridge, G. T. R., the owners being the Cramp Steel Company of Toronto. Mining began 8th May 1901, and continued until the end of the year, with an average force of ten, the results being as follows : An open cross-cut 25 feet long by 12 feet wide and 15 feet deep at the face has been driven west into the hillside towards the magnetite body, which is, however, still 10 feet beyond the cut. At 10 feet northwest of this cut an open trench along the ore body was then started and opened to 50 feet in length by 10 feet average width and 12 to 22 feet deep. A large amount of surface exploratory work was done over the different lots on which are said to outcrop a number of other bodies of magnetite, all covered with snow at the time of my visit, 28th January 1902. As a result of the work in the trench an ore pile of about 500 tons has accumulated.

The formation is a dark green to black garnetiferous diorite in which occur the bodies of magnetite the strike, dip and other characteristics of which are, however, not determinable on account of the small amount of work yet done. The developed body is apparently a lens trending north and south, about 10 feet wide, consisting in places of practically clean ore both fine-grained and coarsely crystalline, and in places intermixed with the dark green fibrous hornblende which also lines the walls. No sulphides are visible except along the walls in small irregular patches.

It is reported that operations ceased for the winter with the intention of exploring the deposits in the spring with a diamond drill. Work has been by hand so far. A small camp has been erected near the mine.

Breitung Iron Company.

An area of mining lands situated in Deroche and Jarvis townships, Algoma district, a mile and three-quarters east of Wilde station, Algoma Central Railway, or one mile from the end of a siding run in toward the mine has been acquired by the above company, whose offices are at Marquette, Mich. The following are directors: president, Geo. Wagner; vice-president, John F. Carey; secretary-treasurer, E. N. Breitung. Mine superintendent, John Foley, was employing a force of fifteen at the date of inspection, 15th February 1902.

Operations began in the fall of last year with a general examination of the surface exposures of the ore, a specular hematite, which with the advent of the snow gave place to underground work. A tunnel has been driven west into the hill cross-cutting the formation to the ore bodies at about 130 feet above the small lake, its length to date 167 feet and size 6 by 6 feet. The other work, all in the near vicinity, consisted of several deep open-cuts and pits and a number of trenches.

The camp of three buildings is located a short distance to the south and the power house is on the lake shore directly below enclosing a 30-h p. locomotive type boiler, an auxiliary 15-h.p. vertical boiler, a one drill air compressor and a small pump. Both coal and wood are used as fuel. The compressed air is conveyed to the machine drill in the tunnel through 500 feet of 2-inch piping.

A dynamite magazine has been constructed in the abandoned open-cut up the hill by boarding over the top and sides maintaining a cool, dry atmosphere. There are 31 boxes of the explosive on hand. Thawing is done in a small building near the mouth of the tunnel.

A geological examination discloses a country rock of slaty trap dark green in color, striking northwest-southeast with a dip of 60 degrees southwest, in which the ore body lies embedded. The work of stripping off the heavy surface growth has not sufficiently advanced to clearly disclose its mode of occurrence or to make it appear whether there is one or several parallel deposits, for ore has been found over a width southwest-northeast of about 400 feet. In the tunnel for 60 feet from the face the hematite contents of the trap gradually increase from a minute proportion to a body in quantity at the face and the presence of this specular hematite is evidenced entirely by the red streak obtained in scratching the rock. The lenses or bands of ore are composed of interlaminated thin fluidal seams of iron-black specular hematite and green schist, the former in some of the workings greatly predominating, and with occasionally quartz and calcite stringers or pockets. Magnetic attraction is entirely absent. The ore is said to be of high bessemer quality and if so will obtain a ready market at the new steel plant at Sault Ste. Marie, Ont.

Helen Mine.

During the past year very radical changes have been inaugurated in the methods of mining and ore raising. The use of the steam shovel on the upper benches for loading the blasted ore has been abandoned, as has also the cable derrick spanning the pits, being found unsuited to requirements and too expensive. With the sudden destruction of the locomotive crane at the pit's edge when hit by a rock from a blast, only the skip road was left running from the top of the crusher house to the mouth of the pit Since then this road has been continued down to the floor of the pit, ending in a sump, into which the skips disappear for loading, and in addition a second double-track trestle road, constructed from the same upper point radially to another part of the working, to be operated by the Lidgerwood hoist formerly in use on the cableway. There are now, therefore, four well-equipped lines, giving a very large hoisting capacity. Open mining will continue until the new shaft just commenced at 60 feet south of the pit reaches a depth of 50 feet below the floor, and from there is connected by drifts and mill holes from the surface with all parts of the ore body, when the ore will be milled down to tram roads below and hoisted out on the new double track skip road. By this method the undue amount of handling necessary in the present system of tramming from all parts of the pit floor will be avoided.

Work in the upper original benches and in the tunnels has been suspended, all mining being now confined to the more recent pit, originally a small pond at the upper or west end of Boyer lake, but since drained by the unwatering of the main body. The pit has been worked to a depth of 50 feet below the old level of the lake and of the railway tracks. It is 285 feet long east and west by 100 feet wide, with nearly vertical walls, to which in many places loosely attached rocks cling, requiring thorough, careful scaling every day, particularly after blasting.

Through the narrow neck of land dividing the bed of Boyer lake from the present workings a small tunnel is being driven for a drainage and waste passage from the pit floor level, until the completion of which the unwatering will still be effected by the small pump drawing from the skip sumps.

From the top of the skip roads the ore dumps into a large chute feeding direct to the No. 8 Gates crusher, and thence, in five to six inch sizes, drops to bins and the railroad cars beneath to be transported to the winter season's stock piles two miles away along the line of the Algoma Central and Hudson Bay Railway from where, when navigation re-opens, the steam shovel will reload the cars for shipment to Michipicoton Harbor.

Additions to the surface plant include two more boilers of about 80-h.p., each, opposite the original pair, one of them for use when the new skip road begins operations and the other as an auxiliary; a six drill straight-line air-compressor in a small room on the ground floor of the crusher house. Another ten-drill compressor is to be set up shortly.

The level of Boyer lake had been lowered 65 feet at the date of inspection, 28th February 1902. The greater portion of the water has now been removed, although there still remains a depth of 50 feet at the central point, where the shelving shores converge. The pumping plant, installed on a barge floating near the west shore, consists of a centrifugal pump with horizontal engine, two large duplex pumps and a 40-h.p. locomotive boiler. Only the two duplex pumps are in present use, but they will be assisted shortly by a 60-h.p. locomotive boiler and two No. 10 Cameron pumps, now in course of installation as a separate plant on the adjacent shore.

The sanitary condition of the camp and vicinity required attention, particularly in the matter of destroying the winter's accumulation of rubbish.

The dynamite magazine lies at a safe distance from the workings, sheltered therefrom behind the lower or western banks of Boyer lake. On the far or north side of Boyer lake stand the black powder magazine and, a little beyond, the storehouse for supplies of caps, fuse, etc. Both magazines evince care in their maintenance. A steam-heated building is under construction with proper appliances for thawing frozen dynamite. Fuse and battery are both employed in blasting, the latter in the heavy series charges when breaking out ore, using electric current from the dynamo, and the former for block-hole work in reducing the size of the deposed masses. Considerable danger, not always avoidable, attends the latter operation, for whenever a hole is allowed a lifting position pieces of rock are thrown over all parts of the mine and camp buildings, frequently doing damage.

No new disclosures of moment are revealed in the workings. The pit is expanding in ore of a good quality except for occasionally occurring pockets of granular pyrites, defined and relatively small as exhibited in several places about the walls of the mine. These do not, however, greatly disconcert operations, merely requiring more care in their separate extraction and disposal to avoid contaminating the clean ore. The output at the time of inspection was limited, on account of making alterations in the plant, to 1,100 tons daily, but this would be increased as soon as the new skip road could be put in operation.

The Lake Superior Power Company has done away with the former contract system of mining, and now carries on the operations under the management of its own mine staff composed of Mr. E. F. Bradt, general manager, and Mr. A. E. Buzzo, superintendent. The total force numbers 293, of whom 163 are miners and muckers under foreman John Crellin.

Nipigon and Long Lake Iron Ranges.

The country surrounding lake Nipigon and for from 30 to 70 miles away has during the past two summer seasons been explored by numerous parties working along the main tributary rivers and lakes, near many of which iron ranges were discovered of more or less importance. The best showings are probably between Nipigon and Long lakes, where a large area of land has been taken up by different operators and already partly explored by the diamond drill as well as by surface work. The iron occurs both as hematite and magnetite finely interbanded with chert, jasper or other less compact siliceous rock. So far as found the outcroppings are too lean to be mined as ore, but in respect of sulphur, phosphorus and other impurities the quality of the ore is good. Much the same surface conditions exist in this region as at Steep Rock lake, the banded hematite in the softer rocks having been denuded or gouged out and later filled with a depth of surface clay requiring the use of drills to explore the underlying rock.

Last season the Algoma Commercial Company, with branch office at Port Arthur, had in its employ 50 men under the management of Mr. G. H. Brotherton engaged chiefly in exploratory survey work, mapping out the country, without much actual development of the iron outcrops found. This year it is intended to examine the locations further with the diamond drill and at the same time to extend the survey work.

Mr. R. H. Flaherty who also had a diamond drill exploring just east of Nipigon lake on adjoining ranges will do more work this year, the results so far obtained not indicating the presence of as large ore bodies as are thought to exist.

Atikokan and Steep Rock Iron Ranges.

A wide and very active interest is manifested in this field, not limited as at this time last year (March 1901) to the magnetite deposits on the Atikokan to the east, but expanding over the whole stretch of country on which iron or indications of iron have been found, namely, from Whiskey Jack lake past Sapawe lake and along the Atikokan river to the west end of Steep Rock lake, a distance of 25 miles, and southwest from Steep Rock lake for about an equal distance, several miles in width. Nothing but magnetic iron has been found from the eastern extremity of the ranges west to below the east arm of Steep Rock lake, but from this point for about six miles in width west the drift carries pebbles of a fine grade of hematite, and is itself very strongly colored red and yellow constituting, with the favorable rock formations of alternating compact and soft, largely chloritic schists and a series of cherts, conglomerates and quartzites (more prevalent in the immediate vicinity of Steep Rock lake), indications of the presence of soft iron ore (hematite) on which the different operators base their hopes. There are only a very few outcrops of hematite *in situ* and these have not yet proved to be important. The present exploratory work for hematite consists in boring with the diamond drill chiefly in the deep clay deposits filling depressions in the trap rocks at the bottom of which the soft schists occur carrying, it is believed, the iron ore. The bodies of magnetite which outcrop at various points throughout the whole district are also receiving attention, but not to the same extent latterly as the hematite, probably for the reasons that most of them contain a considerable percentage of sulphur, and having a banded character are small in comparison with the immense soft ore deposits that occur in similar rocks in the Minnesota iron ranges further south of which it is expected duplicates will be found here.

The operators in the district include R. H. Flaherty, Wiley & Company, Mackenzie, Mann & Company, all of Port Arthur, and T. H. Hogan of Atikokan, with the last of whom several capitalists and others interested in iron mining are associated. All of the above are concentrating their efforts on the locations of the district immediately on and southwest of Steep Rock lake, while in the older magnetite area to the east R. M. Hunter of Duluth, Mackenzie, Mann & Company and Grahame & Horne of Port Arthur are largely interested, the locations E 9, 10, 11, on which the tunnel was driven and other prospecting work done (noted in the last Report) having been sold outright to R. M. Hunter, who, it is stated, will extract 1000 tons or so of magnetite from the deposits thereon for a test blast. During several months last fall Mackenzie, Mann & Company explored several of a very extensive group of claims along the course of the Atikokan river with two diamond drills, one the Government's "C" drill, making several interesting and probably valuable finds of magnetite, and propose to continue the work this season on as large a scale or larger.

Mr. H. E. Knobel, superintendent of the explorations for R. H. Flaherty, with headquarters at Atikokan, has completed a road from this station north to Steep Rock lake, about 6 miles distant, the first mile or so of which T. H. Hogan had previously constructed, to transport the drill machinery to the northern locations and intends to put in another diamond drill in addition to that belonging to the Government now in his employ, as well as two standpipe drills to explore the underlying rock of the clay lands.

T. H. Hogan and his associates have located an extensive series of points for bore holes mostly over the clay areas filling the hollows between the outcropping ridges of tougher rocks and at eight of these, all just south of the Canadian Northern railway track and a mile or so west of Atikokan station, preparatory pits have been sunk from 12 to 25 feet deep (to water level), in which wells two churn drills are to bore. These drills have not yet arrived.

The Algoma Commercial Company's western explorations under the superintendence of G. H. Brotherton of Port Arthur, though not yet extended actively to this field, probably will be this season.

Mosher and Horne Iron Locations.

Along Seine bay, Rainy Lake, lots 11 and 12 in the third concession of the township of Watten have been acquired by Messrs. Dan Mosher of Fort Frances and J. T. Horne of Fort William, Ont., as iron locations, which Mr. Horne states they intend to thoroughly test by diamond drill. Considerable surface stripping has already been done, the magnetite deposit being now traceable for several hundred feet with a width of about 30 feet, surface samples assaying metallic iron, 49.10 per cent., sulphur, 0.14 and phosphorus 0 019.

COPPER MINES.

The copper situation remains quiet in the eastern districts there being but one mine near Parry Sound and a few outlying prospects in the course of development. To the west, however, along the north shore of lake Huron and near Sault Ste. Marie an activity equalling that of the pioneer days of this section is being awakened. Numbers of locations are being acquired or developed extending over many miles east and west and a width of 20 to 30 miles, all fairly accessible to lines of transportation, especially since the Bruce Mines and Algoma Central Railway has just been completed through the centre of the district; and no doubt the success with which mines such as the Rock Lake have met has also materially aided in the re-establishment of the industry. In western Ontario the old Tip-Top copper mine has resumed development under new hands with the promise of a thorough exploration.

McGown Mine.

A special inspection of this mine was made on 29th August 1901. It was found that on 5th August work had been resumed after the stoppage in 1900 and under the same ownership, that of the Parry Sound Copper Mining Company. Operations were confined to No. 3 shaft, which was 47½ feet deep, 9 by 9 feet in size and vertical, timbered with a solid collar 32 feet deep and one square set, but with no division partition between the two compartments, and no ladders, the men entering and leaving the mine by the bucket. This last is a very unsafe method and is forbidden by the Mines Act. The hoisting was done by a substantial horse whim with brake, ⅝-inch steel rope, swinging arm derrick and bucket, and the signalling by shouting up the shaft. Instructions were left with the foreman, Carl Anderson, to place ladders, partition and signal apparatus in the shaft, and to prohibit men riding in the bucket. The miners employed numbered six.

On 25th January 1902 a second visit was made, at which time work was still confined to No. 3 shaft, having progressed steadily with six men since the previous inspection. The shaft was 87 feet deep with a level at 77 feet and south drift therefrom, 22 feet. The instructions given in August had been complied with, the shaft casing having been extended down to 60 feet with a good ladderway and partition between the two compartments. The dynamite magazine was found to be damp, and it was recommended that the boxes containing the explosives should be periodically turned over and slats placed between the tiers to allow of a better ventilation. The practice of thawing the dynamite by placing it on the floor around a stove in the blacksmith shop was prohibited, and instructions given as to the proper methods of handling.

It will be remembered from former reports that the gneissoid country rock of the location strikes east and west with dip of about 45 degrees south and that the copper-bearing zones or lenses are embedded therein with the same strike and dip. One of these ore bodies along the outcropping of which the tunnel, main shaft and No. 3 shaft were started, has dipped away to the south from these workings, and it is with the expectation of striking it again, as well as some of the other bodies exposed on the surface that the south cross-cut is now being driven from the 77-foot level. No ore body has yet been met in the shaft or cross-cut.

Massey Station Mine.

The owners of this property were recently incorporated into the Massey Station Mining Company, Limited, with head office at Copper Cliff, Ont.; president, J. J. Thompson, and directors, R. M. Thompson and Major R. G. Leckie Under the continued management of Mr. Joseph Errington development has been greatly extended underground, measuring on 10th February 1902 as follows:—

Main shaft, depth 233 feet. First level, depth 74 feet; west drift, 25 feet long by 18 feet wide; east drift, 100 feet. These drifts connect north of the shaft leaving a pillar 6 feet wide and then run as one, north 46 feet, to another parallel set of drifts extending west 65 feet and east 25 feet. Second level, depth 150 feet; west drift, 120 feet; at 100 feet in, cross-cuts driven north 20 feet and south 15 feet; east drift, 89 feet; a clear passage-way is provided around the shaft. Third level, depth 230 feet; west drift, 10 feet; east drift, 14 feet.

Near the west boundary of section 16 and about a mile west of the main workings on section 14 a tunnel has been driven east into the face of a bluff along the ore body, in length 120 feet, and 6 by 7 feet in size, to determine whether the vein would at this point warrant development. This work was discontinued with what were considered sufficiently satisfactory showings to justify the installation of an adequate mining plant without any further efforts at hand work. The character of the vein or mineralized shear zone has here changed, the gangue being composed of trap entirely lacking in the secondary filling of quartz found as the main matrix of the ore body in the shaft workings.

Solidly constructed timbering exists down the shaft all maintained in good condition, but safer hoisting appliances were advised to replace the present inadequate method of using bucket on skid poles. The shaft and power houses adjoin each other, the former 24 by 36 feet in plan and enclosed, and the latter of about the same size. The mining plant comprises a 60-h.p. locomotive type boiler, a 3-drill Ingersoll air compressor with 3 machine drills, pumps and a duplex-cylinder, single 3-foot drum hoist using ½-inch steel rope. The company propose to instal a more adequate working plant, but it appears that no concentrator will be necessary, the hand-sorted product containing 5 per cent. copper in a highly quartzose gangue being much more desirable for smelting purposes than the clean sulphides. The recent shipments to the Ontario Smelting Works at Copper Cliff have amounted to about 25 tons daily of average grade material as taken from all the levels, no regular stoping having yet begun.

The 3-mile railroad siding to the mine from Massey station is already graded for the first mile, and the remainder is to be completed this spring.

A well-ventilated magazine has been built in a side hill a quarter-mile distant from the workings in a convenient situation and kept in good condition; but instructions were given to discontinue the method of thawing dynamite by storing two boxes or so at a time on the rafters in the engine room, and to follow a proper and safer system.

The force numbers 25, of whom 19 are miners under foreman J. O. Summers.

Stobie Mine.

The above property covers block N and the south half of block O, having a total area of 375 acres in Johnson township one mile north of Stobie station, or 2½ miles northeast of Desbarats, C. P. R. After a year's work in which a good deal was accomplished both in mining and in the erection of a complete mining plant, operations were suspended in December last, a small force being retained to keep the workings pumped out. The owners are the Stobie Mining Company, manager, A. B. Upton, Sault Ste. Marie, Ont.

Underground development measures as follows: Main shaft, depth 160 feet, size 8 by 12 feet, vertical for 35 feet and for the rest inclined 77° south. First level, depth 100 feet; east drift, 90 feet; at 35 feet in, a cross-cut north 9 feet and drift from face east 10 feet; west drift, 173 feet. The shaft is timbered solidly part of the way down, with dividers below this for the skid road and ladder-way, all of which are in good condition.

The surface plant comprises a shaft house 20 by 38 feet in plan and 40 feet high to the sheave, with boiler room adjoining containing two boilers, a 60-h.p. return tubular and an auxiliary 20-h.p. vertical, and a No. 6 Cameron pump for purposes of fire protection. From the top of the building the bucket empties into cars running out on trestles to ore and waste dumps. The dangerous practice of removing the steam gauge from the boiler for the night was forbidden. In the engine house 15 feet to the north are installed a 5-drill Rand air-compressor with high and low pressure air and steam cylinders and a duplex-cylinder single-drum hoist, cylinders 4½ by 7 inches, drum 24 inches face by 13 inches diameter, using ⅝-inch steel rope with the steel bucket.

The dynamite magazine is a log building lying about 250 feet east of the workings with an insufficient rise of ground between, and besides the 34 cases of dynamite on hand caps, fuse, oils and other supplies are kept therein. It was advised that another magazine properly situated according to the requirement of the Mines Act for storing nothing but dynamite be erected when operations are resumed. The caps were removed at once.

The formation in which the work is done is a light pink to yellow quartzite approaching an arkose, fractured along several lines but with two main and nearly vertical fault planes, at right angles at the intersection of which the shaft has been sunk. The north and south fault, defined only by an inch or so of gouge and smooth walls, forms the east side of the shaft and as the movement has been entirely vertical the quartz vein in the east and west fault is not laterally displaced. The vein is "frozen" to the sharply defined walls of quartzite. Its width down the shaft to and along the first level drifts varies from 1 to 3 feet and below the level is not over a foot, but here a second and parallel vein appears in the foot or north wall running to the bottom four feet from the first vein with a width of from 2 to 3 feet. A small amount of gypsum is intimately intermixed throughout the quartz with occasionally some angular fragments or stringers of quartzite partially altered by solution to a nearly clear quartz, the copper minerals chalcopyrite, bornite and a little red oxide being found in the clear quartz portions of the vein only, in heavy pockets and seams or again in a disseminated state, and throughout in fairly large quantities.

A dump of several hundred tons of fairly rich ore has already accumulated and further production may start at an early date.

Bruce Mines.

In the spring of 1901 the new surface plant was completed, by which time also the mine development had advanced far enough to allow of a test mill-run of six weeks' duration. About the middle of June all operations were suddenly put an end to by the almost complete demolition by fire of the main or No. 4 shaft buildings. Since then the structures have been rebuilt and all damaged machinery repaired or replaced, but no further attempt has been made to resume work. The owners remain unchanged, but since the resignation of Mr. Wm. Braden, Mr. Louis J. Abrahams has occupied the position of manager and at this date, 11th February 1902, employs a force of 20 keeping the surface plant in shape and No. 2 and No. 4 workings unwatered.

The new head frame at No. 4 or main shaft, 48 feet high to the sheaves, will include in its structure large ore bins emptying by chute into cars beneath whence the ore is transported to the mill. The power plant and other buildings embrace engine and boiler houses, machine and blacksmith shops, dry room and large boarding and warehouses. The machinery installed consists of a 350-h.p. Heine water tube boiler; a 40-h.p. locomotive type boiler; a duplex 8 by 4 by 12 feed pump; a duplex-cylinder double-drum hoist engine, cylinders 12 by 18 inches and drums 60 inches in diameter by 36 inches face, using 1-inch steel rope; a 14-drill Rand air compressor, compound air and steam, with receiver; and a 500-light or 30-kilowatt dynamo with a 1,500-watt exciter operated by a 50-h.p. high speed engine. The machine shop equipment includes drills, lathes, etc., with a separate 40-h.p. horizontal engine. At No. 2 shaft the boiler, hoist and shaft houses enclose a 70-h.p. return tubular boiler and a 60-h.p. quadruple friction hoist.

From the main workings to the concentrator, which is situated 1½ miles to the east on the lake shore, a standard gauge railroad has been built ending in a 700-foot trestle of 5 per cent. grade at the top and rear of the mill building over the ore bins and crushers. The main structure covers a ground area of 176 feet length by 66 feet width with a height of 90 feet from the root to the lowest floor. Adjoining, to the north, stands the engine house, 30 by 32 feet in plan, the boiler house 44 by 48 feet, and the concentrate bin rooms, 40 by 77 feet, with the new crusher house to the south-west upper corner, 35 by 77 feet. The concentrating plant in detail consists of two gyrating crushers, a No. 5 Austin and a No. 3 Gates; 7 trommels; several belt conveyors and elevators; 24 three-compartment Hartz jigs; a Bryan (Griffin) 3-roll mill; 6 sets of rolls, all of 10-inch face by 30-inch diameter; three double-deck convex slime tables 17 feet in diameter; and 18 Frue vanners with 6-foot smooth belts, all of the above operated by a

150-h.p. Brown engine and a 350-h.p. Heine water tube boiler. The pump in the station on the lake shore has a capacity of 1½ million gallons per 24 hours. At a point 1,800 feet southeast of the mill a coal dock with storage bins for 1,000 tons has been built 450 feet out into the lake.

The new rolling stock of 10 side-dump ore cars of 5 ton capacity and a 20-ton Baldwin locomotive was in operation with the rest of the plant last season.

The old tailings dumps deposited at various points on the property by the various mills since the first operations of this mine over 50 years ago are estimated to contain about 100,000 tons assaying roughly 95 per cent. silica and 1 per cent. copper, forming a valuable flux for the copper-nickel ores of the Sudbury region. for which purpose regular shipments are now being made to Copper Cliff.

Rock Lake Mine.

The extensive additions to the surface plant noted in the last Report as under way progressed rapidly to completion, the mine closing down for the time being several months previously, and on the first of this year both mine and works starting up in conjunction. Since then a moderate scale of operations consistent with the experimental stage has been maintained awaiting complete adjustment of the concentrator to allow treating the maximum capacity of the plant, 120 tons of ore daily. From the mine to the mill over the mile and a half of railroad the ore is transported in five-ton side-dump cars by a Baldwin locomotive to large bins, the cordwood being also brought here, but shot down forty feet from the trestle to the boiler room below. On the Bruce Mines and Algoma Railway the steel extends to within one mile of the concentrator on the shore of Rock lake, and when completed shipments of the concentrates will begin.

On re-opening the mine stoping commenced at once in pursuance of the previous plan of development, and this with all other new work done up to the date of inspection, 12th February 1902, measures as follows:

Main shaft, depth unchanged. First level, northwest drift, 169 feet (55 feet increase); at 57 feet in, an overhand stope 43 feet long by 25 feet wide by 25 feet high, with a spiral upraise 60 feet high from the south corner, the stope further along the level ending in a lower overhand one 45 feet long by 5 feet high by 10 feet wide; southeast drift, 140 feet (13 feet increase); at 60 feet in, a cross-cut southwest 15 feet; at 72 feet in, an overhand stope 30 feet in length along the drift by 20 feet wide by 50 feet high running up at 37° incline to the southeast; at 90 feet in, another cross-cut southwest 17 feet. Second level, northwest drift, 128 feet (35 feet increase); at 40 feet in, an upraise in progress, height to date 54 feet, size 6 by 8 feet, from which point an incline upraise is being run northwest to connect with the first level for ventilation, and stope levels started, both over and underhand, using the upraise for a chute; at 46 feet in, a cross-cut southwest 21 feet; southeast drift, 92 feet (16 feet increase); at 42 feet in, a cross-cut southwest 29 feet. Below the second level no further mining had been done since last inspection, the shaft being penticed over at this depth and the water allowed to rise part way up.

The mining plant in the power house near the shaft remains unchanged and in good condition, except that the cage hoist lacked an indicator device, which it was advised to attach at once.

On the trestlework forming the approach of the railroad to the top of the mill a water tank was erected, in size 24 feet diameter by 25 feet high, to supply the engine and concentrator plant, being in turn replenished from the pumping station, 170 feet below on the lake shore. A number of assembled structures make up the imposing mill building, which from peak to the concentrate bin floor above the railway track gives a height of 104 feet, the vanner room or lower portion being 67 feet wide by 47 feet long, the upper portion 36 feet wide by 91 feet long, and the engine room on the east side 25 feet wide by 38 feet long, with a 38 by 39-foot boiler-room still further east. The assay office, camp and other accessory buildings lie scattered along the shore in the near vicinity. The following constitute the milling plant—a 10 by 20-inch Blake crusher; 4 horizontal trommels; 5 double-compartment Hartz jigs; numerous belt elevators; 3 sets of rolls, one of 6-inch face by 48-inch diameter and the other two each of 16-inch face by 30-inch diameter; a Chilian mill; 2 vertical screen sizers; 2 hydraulic sizers; and 6 Wilfley tables; a power plant consisting of three return tubular 80-h.p. boilers; a 250-h.p. Corliss engine operating the entire plant; a 500-light dynamo with exciter; and 200 feet distant, near the lake shore, a duplex 10 by 14-inch cylinder, geared pump operated off the main shafting by a five-ply rope drive, taking 2,000 feet of 1 inch manilla rope.

The dynamite magazine lies about 1,000 feet east of the mine workings and the thawing house close by, the latter heated by steam coils or when the temperature is too low suitable hot water tins are used. More care was advised in the handling and storing of explosives underground.

A better conception of the vein now obtains since the large stopes have been opened up. The walls appear to vary in dip southwest from 45° to 55° owing to their undefined character throughout, but maintain a fairly uniform strike of about north 15° west—south 15° east in apparent conformity with the trap country rock. The vein is composed on the whole of nearly equal quantities of quartz in bands and pockets with somewhat brecciated contours and of seams of altered chloritic schist and slaty brown to red trap, the one or the other locally predominating, and is bounded by false walls of soft slab-like discolored trap a foot or more thick merging gradually into the original green trap country rock. Throughout the ore, indifferently in either the quartz or the brown interbedded trap, chalcopyrite and a little scattered bornite are disseminated in both large and small crystals and grains, with a tendency to local concentration. The results of considerable metamorphic action both chemical and physical appear, the former exhibited by the oxidation of the copper sulphides largely or entirely in portions of the stopes to the red oxide, and the latter by a series of faults at acute angles across the strike of the vein and by the general disturbed character of the entire deposit. Displacement of the vein due to faulting seemed to be mainly horizontal, the movements being from two to ten feet where determinable. Where opened up the stopes are maintaining a width of 20 feet or so, all of the ore being milled, though some portions of it are much richer in copper than others.

Fraser Property.

This copper location situated on the south half of lot 3 in the second concession of Aberdeen township and about one mile north of Rock lake is owned by Wm. Fraser of Bruce Mines, P.O. It is now under option to Noah W. Grey, Marquette, Mich., who represents the Pioneer Iron Company of that place, by whom some development work was done last fall. This consists of two shafts, one 33 feet and the other 8 feet deep, together with surface trenching, exposing a vein of intermixed trap and quartz carrying chalcopyrite as the chief sulphide and traversing a formation of green trap. It is stated by the owner that more extensive operations will be undertaken in the spring of 1902.

Indian Lake Mine.

On the small body of water known as Indian lake, an arm of Rock lake, and one mile northwest of the Rock Lake mine, is situated the south half of lot 6 in the second concession of Aberdeen township, Algoma district, owned by a syndicate the chief member of which is Mr. W. W. McMillan, of Duluth. J. P. McNolty, contractor for the mining work in progress at the time of inspection, has, with a force of seven men, sunk a vertical shaft 30 feet deep, in size

6 by 8 feet. The work has opened up a deposit of interbanded brown discolored trap and quartz in stringers and pockets. The trap is replaced in part by quartz, forming a quartzose matrix, throughout all of which and increasing towards the bottom a small proportion of chalcopyrite is disseminated.

The mining machinery includes a 12-h.p. vertical boiler, a small duplex hoist engine and a swinging arm derrick, the former two situated 50 feet from the shaft while the sleep camp and boarding house is below on the lake shore.

Dynamite was being carelessly dealt with, the daily supply of one box brought over from the Rock Lake mill being left exposed to flying rocks from the mine, and for thawing it was piled in a box close to the boiler stack and near the blacksmith forge. Instructions were left as to a proper method of handling.

Sault Prospecting and Development Company.

The above Company with offices in Sault Ste. Marie, Mich., and president, Daniel Brown, secretary, R. N. Adams, own, according to information received from the secretary, 957 acres of mining lands in concessions four and five, Morin township, Algoma district, 25 miles north by road from Bruce Mines station, C.P.R. The development of a quartz vein carrying chalcopyrite began 1st February 1902, the shaft being now 20 feet deep which with the former surface trenching and the erection of camps comprises all the work done.

Taylor Mine.

This copper property comprises the north half of lots 2, 3 and 4 in the fifth concession, and the south halves of lots 3 and 4 in the sixth concession of Anderson township, Algoma district, and is reached by an 18-mile road north from Garden River, C.P.R. It is also a mile west of the new A.C. and H.B. Ry., running north from Sault Ste. Marie, to which a road may later be built. The mine was opened up about a year ago by the owners, the Taylor Copper Mining Company, Limited, of Sault Ste. Marie, Ont., president, R. H. Taylor, secretary, H. P. Taylor, and mine captain, J. Taylor, operations being fairly continuous until an accident happened recently to the machinery. On 22nd February 1902 the force numbered 9, of whom two were miners.

No. 1 shaft on lot 2 in the fifth concession is abandoned, and is said to be 30 feet deep. No. 2 or main shaft on the same lot, but 400 feet west of No. 1 shaft, 50 feet deep, size inside timbers 5 by 10 feet and vertical, is now temporarily closed. It is timbered with square sets at 6 feet centres, lagged and divided into two compartments, hoistway and manway, in which latter the ladders hang vertically instead of being inclined between the platforms, as is required. Guides extend down the hoistway for the bucket crosshead. The head frame is an open structure 12 feet high. At 200 feet southeast of No. 2 shaft a tunnel is being driven along the vein in the bottom of a narrow gully and is at present 25 feet long and timbered over, with 25 feet of open cut work at the mouth, and 60 feet of the creek bottom (the vein) cleared beyond this. Some rich ore piles have accumulated along the sides of this working. Between this tunnel and No. 2 shaft an open trench 15 feet long by 6 feet deep has been sunk on the vein exposing 4 feet of mineralized quartz vein. No. 3 shaft is sunk on lot 3 in the fifth concession at a quarter mile northwest of No. 2 shaft, in depth 35 feet, size 6 by 8 feet, vertical, and timbered for 24 feet down. This is reported to be on the vein, but being temporarily closed could not be examined. No. 4 shaft on lot 3 in the sixth concession lies one-third of a mile north-northwest of No. 3 shaft, in depth 19 feet and vertical. This and No. 1 shaft were sunk by the original operators and are now abandoned.

The mining plant collected in a 30 by 50-foot building situated 12 feet south of No. 2 shaft, consists of a 60-h p. locomotive type boiler, a 3-drill Ingersoll air compressor and receiver,

Rock Lake copper mine; concentrating plant.

A. L. 282 gold mine.

Royal Sovereign gold mine.

Black Eagle gold mine, showing old and new stamp mills.

Mond Nickel Company; bins of roasted ore.

Ontario Smelting Works, Copper Cliff.

Canadian Copper Company, Creighton mine.

Canadian Copper Company; No. 3 mine.

Canadian Copper Company; main pit, No. 3 mine.

machine drills, a duplex-cylinder single-drum hoist engine, cylinders 5 by 8-inch, drum 26-inch face by 26-inch diameter, using $\frac{5}{8}$-inch steel rope, a duplex $4\frac{1}{2}$ by 3 by 4 feed pump and a No. 6 Cameron sinking pump. The camp lies half a mile northwest of the mine with boarding and bunk houses, office, warehouse and stables.

The dynamite magazine has been built 500 feet north of the main workings in a safe position but lacked a door which it was advised should be put on at once. There were 18 boxes on hand. Thawing operations were carefully conducted in a proper tin at a safe distance from the mine.

The country rock of the locality is a pink hornblende granite approaching a syenite. Through this runs a narrow intrusive dike of trap in which, either entirely embedded therein or with one of its walls against the granite as a contact, occurs the quartz vein, which shows defined selvage walls, and varies in width from 4 to 6 feet and upwards. The strike is north 20 degrees west, and dip a few degrees to the northeast. The vein runs along the top of the hill through No. 3 shaft, southeasterly past No. 2 shaft and into the deep, narrow gully below, which has been formed by the weathering away of the trap and subsequent breaking up of the quartz vein between the precipitous granite walls. The vein follows this down the hill 600 feet or as far as it has been traced, outcropping in the bottom or along the sides of the ravine. Clean white quartz forms the main portion of the ore body with near the walls an interbanding of altered schists, throughout the whole or portions of which occur the valuable sulphides chalcopyrite, bornite, pyrite and the carbonates malachite and azurite, the first probably predominating with decreasing quantities of the rest as named. Appreciable values in gold are also said to have been obtained. The plan of development as begun favors sinking the main or No. 2 shaft vertically through the country rock to cut the vein at about 75 feet down this being 25 feet farther than the present depth of the shaft, and below this to tap the ore therefrom by cross-cuts.

Ranson Location.

In December, 1901 work was begun on this property, which lies one mile and a half west of the Taylor mine in Anderson township, Algoma district, and had progressed steadily up to 22nd February 1902, the date of inspection, with a force of eight men under the supervision of D. J. Ranson of Sault Ste. Marie, Mich., J. C. Burns being foreman. The camp at the bottom of a valley, is composed of several log buildings with two now under construction, and dynamite was stored in a tent in the midst of them in entire disregard of danger. Instructions were given to remove the dynamite at once to a safe distance and to erect a proper magazine, as well as to substitute a safe method of thawing the explosive for the practice in use of exposing it to the heat of a box stove within 50 feet of the mine.

The mine workings, 1,000 feet northwest and up the hillside from the camp, consist of an open cut 20 feet wide by 15 feet deep by 12 feet high at the face, in the floor of which a shaft is being sunk 6 by 9 feet in size with a depth of 12 feet to date. The work lies against a contact between green trap and a felspathic rock, the latter considerably altered by replacement with quartz. A few clean and indefinite quartz bands traverse the main body with no visible sulphides. There are said to be low gold values present.

Sault Gray Copper Company.

An area of 67 acres of mining lands on lot 5 in the first concession, and options on 300 acres adjoining in McMahon township, Algoma district, on the shores of Patton lake, eight miles by road north of the Rock Lake mine, have been acquired by the above company whose headquarters are at Sault Ste. Marie, Ont., and president, J. J. Kehoe. Last summer some mining work was done followed by a suspension from October to February 1902, at which time a small gang was being employed building camps and preparing for more extensive development. A shaft has been sunk 25 feet south of the lake shore, in depth 50 feet, size 6 by 8 feet and vertical, covered with rough platform and hand windlass, but with no timbering. At 50 feet east of the shaft a shallow pit is sunk on the same vein, and at 50 feet south a parallel vein trenched along for 100 feet.

The two parallel veins lie embedded in fine-grained schistose trap and have the same east and west strike and vertical dip as the formation. They are fairly well defined between walls of selvage and vary from 2 feet to 6 feet in width composed of quartz interbanded with narrower seams of altered trap and a little calcite, throughout which the valuable minerals tetrahedrite (gray copper), chalcopyrite and malachite are scattered and, it is said, small though appreciable values in gold and silver.

Superior Copper Mine.

The property consists of mining locations WD 220, 221, 222 of 160 acres each and WD 223 to 227 of 40 acres each, in all 680 acres staked out over two miles of country in a northwest and southeast direction lying partly in Gaudette township, Algoma district, and 4½ miles east by road from Birch Camp station, A. C. & H. B. R. In the spring of 1901 the lands were acquired by the Superior Copper Company, Limited, whose capital is in 150,000 shares of $10 each; offices in Sault Ste. Marie, Ontario and Michigan; president, Frank Perry; secretary, Thomas R. Harvey; mining engineers, DeMorest and Sylvester, Sudbury. The employees at date of inspection, 18th February 1902, numbered 18, with foreman P. A. Derry.

Mining work measured as follows: No. 1 shaft, on WD 220, depth 69 feet, size 6 by 9 feet, vertical for 40 feet and for the rest inclined 65 degrees southwest. At 40 feet depth the shaft is penticed over for the driving of a cross-cut, having a length at date of 5 feet. The shaft collar extends down 12 feet with hand windlass on top and vertical string of ladders suspended therefrom to the bottom. The upper ladder being weak, instructions were given to reverse them top for bottom at once, and to begin timbering in platforms and put in a partition between the compartments. No. 2 shaft, 4,000 feet southeast of No. 1 shaft, on WD 221 and at the end of a small lake, is 17 feet deep, 6 by 8 feet in size, inclined 60 degrees northwest and timbered with a short collar and log covering supporting the hand windlass. Sinking was in progress. No. 3 shaft, 300 feet southeast of No. 2 shaft and also on WD 221 is 32 feet deep, 6 by 8 feet in size, inclined 60 degrees northeast and covered with logs and a hand windlass. No. 4 shaft, on the boundary line between WD 220 and WD 221 and 1,880 feet southeast of No. 1 shaft, is temporarily shut down and full of water. Its depth is said to be 27 feet. Besides the above a large number of surface trenches and test pits exist along the same line as the result of the original work. Hand labor which has been employed entirely up to the present will, it is stated, be replaced by machines this spring with the installation on the shores of the small lake of a mining plant consisting of a 60-h.p. boiler, 6-drill air compressor with machine drills, hoist engine and pumps to be furnished by the James Cooper Manufacturing Company of Montreal. There is on hand though not yet in use a horse whim with steel rope and buckets. The camp buildings situated by the road between the workings include office, boarding house and stable.

The dynamite, of which 20 cases are on hand, lies in a tent in the midst of the camp along with the other tins and boxes, while thawing operations are conducted by using at Nos. 1 and 2 shafts warm water tins that are too rusty to be kept clean and also too small, and at No. 3 shaft by ranging the sticks about an open fire burning at the top of and beside the shaft mouth. These forbidden practices were condemned, with instructions for the proper care of the dynamite.

The ore body, a mixture of white clean quartz with a darker variety containing altered schists and pockets of black hornblende, both carrying massive and disseminated chalcopyrite, pyrite and a little galena, varies in width from a few feet to 45 feet at No. 2 shaft composed of about one-third ore and the rest barren vein matter, the ore carrying a high percentage of copper. From numerous assay reports it also appears that appreciable gold and silver values will be obtained. The vein maintains an almost uniform strike of northwest-southeast along which lie the different workings all on vein—it is thought the same vein though on account of the great depth of surface soil covering and the long stretches between some of the shafts this is not actually determined—and apparently forms a contact deposit between a pink hornblende granite on the northeast and a gray diorite on the southwest, lying either right in the contact or removed a few feet therefrom and entirely in the diorite.

Locations on Black Bay.

This district was not again inspected owing to the unsafe state of the ice road over the bay in April 1902, when I was in the district, but from the owners in Port Arthur it was learned that development work on the Trombly location, E S 111, was discontinued shortly after my last visit for lack of money and also pending a sale of the property, which however did not take place. Grahame & Company, who, together with Trombly and Pritchard, all of Port Arthur, own the adjoining locations E S 107, 108, 109 to the southwest on the shore of the peninsula, give it as their intention to explore the amygdaloidal trap rocks this season by a diamond drill. This work will be of great value as giving much desired data as to the characteristics and value of these copper-bearing formations. The Black Bay Mining Company of recent incorporation have acquired a 75-acre location near the southwest end of Black Bay peninsula and on the same formation. For a short time development has progressed, with a force numbering seven.

Tip-Top Mine.

This old copper property was taken up a number of years ago, but owing to its inaccessibility at that time but little development was accomplished, the last being done in 1899. Now, however, the recently completed Ontario and Rainy River branch of the Canadian Northern railway passes within about five miles of the mine, though the waggon road in use from Kashabowie station is nine miles long. The mine locations K 62, 63, 64, 65 containing 336 acres, are situated on the east shore of Round lake, which is four miles west of Shebandowan lake, and are held under bond by the present operators, the New York Canadian Copper Syndicate with head office at the mine ; president, W. G. Pollock, Cleveland, Ohio ; vice-president, P. L. Kimberley, Sharon, Pa. ; secretary-treasurer, Henry Folger ; general manager, B. W. Folger, the two last of Kingston, Ont., and mine superintendent, T. R. Jones. At present the employees number 14, of whom 6 are miners with R. Sandoe, foreman.

Operations under the new management began 7th December 1901, and at 11th March 1902, the date of my visit, a new camp had been built half a mile from the mine on Round lake consisting of office, bunk and boarding houses ; six miles of a winter road cut through the swamps, connecting with the lakes and 1½ miles of old government road to make the 9 mile route from Kashabowie station; and mining machinery and supplies brought in for the season's work. It is the intention to build a shorter road over the high lands which afford a good route.

Mining work, practically all of which is old, is confined to location K 65 and as follows : No. 1 shaft, depth 56 feet, size 6 by 8 feet and vertical. First level, depth 50 feet ; east drift, 35 feet ; west drift, 5 feet ; north cross-cut, 102 feet ; south cross-cut, 28 feet. At the bottom of the shaft the foot wall of the vein appears dipping 75° north and in the additional sinking this will be followed. The shaft is timbered with a 10 foot collar supporting the landing platforms over which the head frame of squared timbers 20 feet high stands, and below the collar, square sets, with ladder-way and hoist compartment, the latter lined from top to bottom with planking. Hoisting is with bucket and ⅝ inch steel rope, the signal device being in good shape with the code posted at both shaft mouth and engine house. A No. 6 Northey pump located in the east drift at the level effects the unwatering

No. 2 shaft, 500 feet east of No. 1 shaft, is full of water, not having been re-opened. The depth is said to be 52 feet.

The new power house stands 100 feet east of No. 1 shaft, in size 25 by 45 feet, with a wing for the dry room. Installed here are a 60-h.p. marine water tube boiler and a single-drum 5½ by 10-inch cylinder hoist engine.

The dynamite, of which there were 25 boxes on hand, is stored along with caps, fuse, tools and other supplies in an old unlocked shed 200 feet southwest of the workings in an unsafe place, but is thawed in proper warm water tins in another old shed east of the mine. Here also caps, fuse and mining machinery are kept. Instructions were given to erect a proper magazine and to store therein as well as in the thawing house nothing but the explosive, and to separate the caps from the dynamite.

The country rock of the property is a gray to green diorite, both finely granular and schistose, striking about east and west with dip of a few degrees north. There are two veins in the workings quite different in composition, but both apparently embedded in the trap with the same strike and dip and parallel to each other. The south vein lies along the foot wall of the trap, and at the level underground is 20 feet wide and is composed of altered schists near the walls, merging into the main central portion of dark, fine-grained quartz interbanded with seams of schist, the whole vein with a fair percentage of chalcopyrite and pyrite in about equal quantities. Occasional bands two to three inches wide of chalcopyrite and large pockets or seams of pyrite traverse the body, the mineral always finely granular instead of crystalline. The north wall of this vein as seen in the north cross-cut is formed by a 3-foot dyke of pink and gray felsite with, beyond, 35 feet of the diorite carrying considerable scattered pyrite in grains and seams, but with very little chalcopyrite. From this point the cross-cut passes through the north vein 50 feet in width composed of a blue vitreous quartz very hard and compact, seamed with irregular films of hornblende or chlorite and all highly impregnated with fine grains of iron pyrites, but with a much less though, it is stated by the manager, a paying quantity of chalcopyrite.

COPPER-NICKEL MINES.

The results of another year's work in the big open mines of the Canadian Copper Company show not only as good a grade of ore in the bottom as formerly, but also in several cases a widening out of the bodies. In one mine at the 1000-foot level another large deposit of equal grade to the original body has been struck which was not known to exist until found by the diamond drill from this depth. At outlying points from 20 to 50 miles from Copper Cliff exploration on several other locations has given either good promise on account of extensive surface outcrops, or large ore bodies continuous both in size and value with depth ; all of which though covering but a small portion of the known nickel ranges supports the view that permanency will mark these deposits. Besides the Victoria Mines smelter, another new one is under erection at the mines of the Algoma Commercial Company, while the plant at Copper Cliff has more than doubled its capacity and must continue to increase in order to keep pace with the growing output of the mines.

Canadian Copper Company's Mines and Works.

The usual activity continued to be displayed in the company's operations up to and for a month or so after the visit of inspection beginning 29th January, 1902. The employees then numbered 1265, distributed as follows : in working mines 565, in the smelters 250, in the roast yards 145, and on the surface 305. A few notable increases and changes since last year deserve mention, such as the growth of the output by the addition of the Creighton mine, the finding by the diamond drill of another apparently extensive ore body from the thirteenth or 972-foot or bottom level in the Copper Cliff mine, the generally satisfactory development of the ore bodies in the other mines, and the laying out of another roast yard above the new smelter, which already largely replaces the old one, it being the intention to ultimately abandon these old yards and smelter, because inconveniently situated and inadequate to present requirements.

In April, however, the negotiations covering a period of several months for the sale of the entire property reached a climax, followed by the decision to curtail operations all around until the final details of the transfer could be settled and work resumed under the new owners. The force has therefore decreased to a minimum sufficient for little more than the proper maintenance of the plant, except in the case of the Creighton, which continues to work full force, supplying roast heaps for future smelting. In this transition period nothing definite regarding future operations is obtainable, but it is expected that no great period will elapse before work in all departments is again under way.

Changes in the staff comprise the appointment of John Campbell as master mechanic and Tom Kilpatrick as smelter superintendent.

COPPER CLIFF MINE.

No further sinking of the shaft is in view for the present, new development being confined to the thirteenth or 972-foot level, where the west drift continued in to 140 feet turning then north for 30 feet through the main ore body which last from the tenth level down has all been extracted and the entrance filled with waste. At 102 feet in the level from the shaft branch drifts run northwest 33 feet and southwest 42 feet, the latter then branching south 12 feet with an 18 foot winze therein, and northwest 40 feet. From 70 feet in the level a diamond drill hole was bored northwest 193 feet, the last 90 feet through ore both clean and mixed, and from the southwest branch drifts two others in a southerly direction, which however as well as the drifts themselves exposed no valuable ore or indications thereof, since when the only work has been the continuation of the northwest branch drift towards the new ore for its subsequent development. In the third and fourth levels over and underhand stoping progresses on remaining walls of ore, the muck being trammed out the lower level to the old shaft down which the skip road has been reconstructed. The arrangement of the pumps exists as noted at the last inspection. Several recommendations touching the safety and sanitation of the workings were deemed necessary.

Alterations on the surface embrace the installation of a complete new battery of three return tubular boilers fitted with automatic stokers, and the removal of the original inadequate plant ; the erection of another more powerful electric generating station in a 20 by 40 foot building adjoining the engine house equipped with two dynamos and engines ; and a new 20 by 40 foot coal shed.

NOS. 1 AND 2 MINES.

No. 1 Mine extension : The sinking of a new open pit was recently commenced on the extension of the McArthur No. 1 ore body on the west face of the hill from the site of the old workings, as a result largely of the diamond drill exploration there of an earlier date.

No. 2 Mine : This mine, originally known as the McArthur No. 2, has been abbreviated in name to the above. The continued sinking of the open pit gives a present depth of 217 feet, the chimney-like ore body gradually widening out with a consequent increase in the contour of the working toward the bottom to an approximate average diameter of 120 feet with slightly overhanging walls. The latter of necessity require constant scaling, and at the time of the second visit in April all work below was suspended for the examination of the entire wall and the removal of loose or dangerous looking rock. On account of this ever present risk to the men a new plan of operation is approaching completion by which future stoping will be done under an arched roof formed of the present pit floor, the workings to be reached by a new shaft sunk vertically from the first level in the present incline at 80 feet south of the pit wall and through barren rock. This shaft is now 15 feet below the pit floor level, and when deep enough will connect by drifts with the ore body under the working. The diamond drill recently located from a chamber off the pit floor and at 160 feet southwest therefrom the continuation in depth of another ore deposit outcropping about vertically above. This find will be investigated at a later date.

The boiler capacity for mine and crusher house has been increased to a total of 3 locomotive type and 5 return tubular boilers.

No. 2 Mine extensions: At 150 feet and 700 feet respectively north of No. 2 mine two more vertical pits have been opened on other chimneys of ore, which are probably the extensions of the ore body in No. 2. During the year first one and then the other was mined at intermittent periods, the former attaining a depth of 110 feet with a circular cross section of 20 by 30 feet and the latter a depth of 40 feet and cross section of 15 by 20 feet. Both contained a considerable quantity of ice and water at the time of my inspection which was gradually being hoisted out in anticipation of sinking 8 by 10-foot shafts from the bottom of each from which to carry on further development and production of the ore in sight on walls and floor. At the first or south working the surface plant consists of an air hoist, winding steel rope and bucket from a swinging arm derrick.

NO. 3 MINE.

The original and main pit now measures a depth of 40 feet, being an increase of 10 feet, and has an area 300 feet long by 50 to 125 feet wide, its general course being southeast-northwest. Near the southeast end a heavy arch and pillar supports a roof of barren rock. The necessity for careful scaling of all the walls here, as in the other mines, is apparent and forms part of the routine work. From the face of the adit on the southwest side of the pit into which the ore is trammed for hoisting, the shaft has been continued down 60 feet below and dips 62 degrees northeast under the floor of the pit, and from the bottom a drift has been run northeast 100 feet, with a cross-cut at 15 feet from the shaft northwest 20 feet making for the ore body in the new west pit.

The timbering of this extension of the incline into three hoist compartments one for waste and two for ore and a manway is now well under way. Last summer active development was commenced on another outrop of mineral 50 feet west of the main opening which has resulted in a pit 45 feet deep, 100 feet long and 60 feet wide with very clean ore on the walls and the floor. The hoisting equipment consists of swinging arm derrick, steel rope and bucket and a hoist in the rock house, this temporary arrangement to be abandoned when underground connection between the two workings allows of raising everything up the one main shaft.

The addition of a fourth return tubular boiler and the equipment of all with automatic stokers gives now a sufficient steaming capacity for the rest of the plant. The storage and preparation of the dynamite is properly attended to.

NO. 4 MINE.

This with the No. 5 mine noted below comprise what were originally known as the Clara Bell group. By the rapid development of the mineral body since last inspection an open working has been stoped out running roughly northeast and southwest with the southwest corner 80 feet east of the rock house, and measuring about 300 feet in length by 50 feet in width by a depth of 40 feet over the southwest 90 feet and of 60 feet over the remaining 210 feet, in which latter portion two arches of barren ground 30 feet wide span the trench from side to side. A shaft descends from the floor in the extreme southwest corner to a depth of 60 feet below the lower pit level from the bottom of which a drift runs north-northwest, that when far enough in will connect by upraise with the pit for the handling of the ore down here, replacing the present system which makes use of an auxiliary engine to hoist the 20 feet from the lower to the upper pit floor that the ore may be loaded into the skip at that point. The culls from the sorting tables composing about one-third of the rock raised are shipped to the smelters for use as flux.

NO. 5 MINE.

This working also consists of a pit and is situated 800 feet southeast of No. 4 mine, its surface opening 20 by 25 feet in area and depth 20 feet, sunk on a mineralized body similar to that at No. 4, though of somewhat lower grade on account of the greater quantity of intermixed diorite, the ore, however, entirely surrounding the pit. The surface equipment embraces swinging arm derrick and bucket at the mine with hoist engine and boiler in the power house 300 feet southeast and running south from the pit a counterbalanced gravity tram road 250 feet in length down to the railway tracks, where a crusher and small ore bin handle the output.

STOBIE MINE.

Mining was suspended here about November, 1901, the character of the ore developed in the other new and richer deposits overcoming the need at present for this highly ferruginous deposit to form suitable fluxing mixtures with the ore from the other mines. Pumping has, however, continued, to facilitate a speedy resumption at any time.

CREIGHTON MINE.

This latest development of the Canadian Copper Company's mining lands is situated near the boundary line between the townships of Snider and Creighton in the first concession, 12 miles by the recently completed branch of the Manitoulin and North Shore railway from Sudbury. The work of stripping began in July 1900, and in July 1901 the first ore was shipped, but the erection of the remaining portions of the surface plant has continued to the present time, allowing a production now of from 500 to 600 tons daily for shipment to the roast yards at Copper Cliff.

The ore deposit as determined by test pits, trenches and other surface work covers an area 1,100 feet long by 400 feet wide with occasional traversing dikes of trap. Mining is as yet wholly in one main open cast 135 feet long east and west by 80 feet wide and 62 feet deep with nearly vertical sides, on all of which and in the floor practically nothing is to be seen but clean ore of pyrrhotite with chalcopyrite, the approximate average assay value of same said to be less than 2 per cent. copper and over 7 per cent. nickel. The granite contact with the trap on the south lies within 30 feet of the pit in reality a contact with the ore body at this point, but on the north side it is removed from the mineralized zone beyond several ranges of hills. At 60 feet south of the wall a working shaft descends through the granite dipping 80° north to the pit floor level and appearing again in the rear of a 30 foot adit chamber in which the tramcar loads are transferred to the skips.

The double track skip road rises to the top of the rock house which is 30 feet south of the shaft and from here the ore is dumped over grizzlies passing through crushers, trommels and sorting tables to the ore bins below, which aggregate a capacity of 1,000 tons. This structure strongly built with iron angle bracing throughout measures 42 by 45 feet in plan and 62 feet in height to the peak, with three railroad tracks passing beneath. The equipment consists of two Blake crushers of about 600 tons combined daily capacity, a smaller one for the grizzly fines and the usual sizing and picking machines, with the engine located in the basement taking steam from the adjacent power house. The power plant comprises three 100-h. p. return tubular boilers, a double 6-foot drum duplex-cylinder hoist engine winding one-inch steel cables from the two independent skips and two air compressors, a compound 5 drill and a straight line 8-drill. Scattered about the property are the remaining buildings, including a comfortably fitted dry room, offices, warehouse and blacksmith shop. In the distance is a hamlet of private dwellings and boarding houses for the 134 employees and their families.

The dynamite magazine is a log and earth structure 600 feet west of the workings and 100 feet from the railroad tracks, kept in a satisfactory condition.

SMELTING PLANT.

The old or east smelter suspended operations about the first of the year and it is now a question whether or not the furnaces will again be blown in at their present location, the company intending as soon as sufficient slag ground can be made at the new or west smelter to gradually remove thither the whole of this old plant. During the last weeks of operation these 5 furnaces ran on raw ore from the richer mines, such as the Creighton, producing a low grade (17 per cent.) matte which was spilled, roasted on the heaps and resmelted, in the last process using the gangue culls from the No. 4 mine for a good flux. After the destruction by fire last year of the assay office back of the old smelter a new one was built at the west smelter, and at Copper Cliff a new office begun, now about completed. Another blower plant of the Connersville type has been added.

The new or west smelter has grown extensively, the furnaces now numbering eight, connected in pairs to the four dust chambers and stacks ; along the rear of the whole building new coke bins surmounted by railroad trestle work now approach completion ; at the foot of the yard at a point to which slag tunnels from all the furnaces are being constructed a slag elevator has been built to run by rope drive off an engine in a separate shed 100 feet distant, and when in operation it will be possible to reach all parts of the extensive dumping flats below the smelter. The Connersville blower plant has been enlarged by the addition of two more machines complete with direct connected engines, making five in all, and a new power house is being erected east of the other buildings with an equipment of three 100-h.p. return tubular boilers with automatic stokers, and adjoining this a new coal shed.

ROAST YARDS.

Nos. 1 and 2 yards at the old site contain a total of 63 heaps operated as usual under contract by Dan McKinnon, who employs a force of 100 men. Much carelessness was observable in the use and handling of the explosives both at the magazine and thawing houses and in blasting at the heaps, necessitating giving strict instructions for the immediate employment of safe methods.

The No. 3 or new yard stretches out in a straight line over the flat valley west of the new smelter, and since the formation of the first heap in November last 27 have accumulated, none quite roasted yet so that but 45 men are employed by the contractor, Thos. Smiles Safer methods in the handling of the explosives were also necessary here, for which instructions were given.

ONTARIO SMELTING WORKS.

These works, three-quarters of a mile southwest of the town of Copper Cliff, noted in the last Report as under erection by the Orford Copper Company, have been completed and in operation for the past year or so refining the 30 per cent. nickel-copper matte from the adjacent Canadian Copper Company's smelters with copper ore from the Massey mine for a good flux, to a matte containing from 68 per cent. to 75 per cent. of nickel and copper. The plant equipment differs from that formerly described only in that two Brown calciners instead of one were installed, and gives a daily capacity of 100 tons of matte and ore, or an average monthly run of 2,400 tons.

Operations are under the management of Mr. T. W. Stiles with a force of 150 employees.

Gertrude Mine.

Since the completion of the Manitoulin and North Shore Railway to this property last year operations have been actively resumed resulting in the erection of a combined rock and shaft house at No. 4 shaft, in plan 34 by 47 feet and 63 feet high, with a power plant of one 60-h.p. boiler, a duplex-cylinder single 5½-foot drum hoist, one horizontal engine for the stationary plant, a 50-light dynamo, a double Buchanan (Blake) crusher, jaws 12 by 15 inches, grizzlies, trommels and picking tables. The skip runs up to the top with either No. 4 ore or that from the Elsie mine, the latter being loaded into the skip from bins in the shaft mouth below the railway tracks into which cars dump. From here the crushed and sorted ore is shunted in 5-ton side-dump cars over a narrow-gauge road to the roast yard one-quarter mile distant, the present output of Gertrude and Elsie ore thus handled amounting to 250 to 300 tons daily.

The compressor plant located at 1000 feet west of No. 4 and midway between the various shafts contains two locomotive type boilers of 60-h.p. each and a 10-drill Ingersoll air compressor, the air transmitted to the workings through 5-inch piping. A lathe and drill machine shop 25 feet east of the rock house operates by a separate engine using steam from the adjacent plant. The remaining new surface work includes excellent boarding houses, oil and other warehouses, the inauguration of the roast yard, the construction of a narrow gauge railroad and the preparation of the smelter site and railroad trestle.

In the roast yards six heaps of ore 40 by 80 foot plan and 14 feet high have been built of which three were burning at the date of inspection. The smelter will be located 1900 feet southeast of No. 4 shaft and 900 feet south-southwest of the roast yards on the side of a low hill overlooking a swamp, and dumping ground inconveniently flat but probably quite adequate, the plant equipment to consist of one Herreschof water-jacketted furnance of 100 tons daily capacity and accessories, which is expected to be in operation before the end of the year.

But little attempt at development underground has been made since last inspection, No. 3 shaft and tunnel being temporarily abandoned and only No. 4, the new shaft, being open in preparation for extended production. From No. 4 shaft No. 1 shaft lies 750 feet east, No. 2, 2800 feet west, and No. 3, 3400 feet west. No 4 shaft is 60 feet deep, inclining 60° north, with a level at 46 feet depth just commenced, down to which the workings are in ore.

The results obtained in a large number of diamond drill holes bored at various points over the property chiefly in the swampy areas where surface prospecting was impossible and also from points underground are governing the present development, and it would appear that no radical difference exists between this deposit and the older ones of the district in the method of occurrence, the diorite formation being the same in all. The nickel content is, however, in great excess of the copper.

The dynamite magazine was found to be damp; and thawing operations were conducted in a house heated by steam situated much too close to the workings, touching which and other minor deficiencies advice was given in the Inspector's Book.

The employees number 85, of whom 8 were miners The superintendant is T. Travers and engineer E. H. Dodd.

Elsie Mine.

The Algoma Commercial Company of Sault Ste. Marie, Ont., with local office in Sudbury, acquired last spring lot 12 in the fifth concession of McKim, about 4 miles northwest of Sudbury and adjoining the old Murray mine. During the year and under the superintendence of C. M. Boss very active development has progressed resulting in the erection of a model surface plant which allows a daily output of from 200 to 250 tons of nickel-copper ore. This is loaded direct into 50-ton steel cars for shipment over the one-mile siding recently run in here and thence on the main line of the Manitoulin and North Shore Railway to the roast yards at the company's other mine, the Gertrude, for subsequent reduction in the smelter now in course of erection there.

The main workings at the date of my visit, 5th February 1902, consisted of an open pit 25 feet deep, in area 150 feet long by 100 feet wide at the surface and 100 feet by 20 feet respectively at the bottom, from which practically all the ore shipped to date has been mined. The walls themselves are fairly solid, but a loose capping overhangs which will need attention when spring opens. The muck is hoisted by skip up the face of the pit and over trestle work to the top of the shaft headframe, and there dumped into a 50-ton ore bin to be loaded by chutes into the railway cars beneath. At 68 feet north of the north pit wall a vertical shaft has been sunk a depth of 80 feet through the barren wall rock to connect by levels and upraises with the floor of the open workings so that all hoisting may be done through one shaft. Its cross section measures 8 by 14 feet, but inside the timbering consisting of a 6-foot collar with square sets and planking below, the construction of which has just began, 6 by 12 feet in size, to be divided into two hoist compartments and a manway. The first level at 70 feet depth extends south 35 feet with a 40° upraise south from the face 15 feet long intended to pierce the floor of the pit ; at 25 feet in drifts recently commenced run east 5 feet and west 5 feet. At present steel bucket and rope are employed, with an open shaft superstructure carrying the ore bin in its rear and serving the purpose of both shaft and pit hoist systems.

The various buildings, power, boiler and dry houses, blacksmith shop, warehouse, office, stable and camp, have been advantageously located about the property. Most of them are covered with corrugated iron sheeting. The machine equipment embraces two locomotive type boilers of 60 and 65-h.p respectively, feed pumps, a 6-drill Rand straight-line air-compressor, a 150-light dynamo run by a small horizontal engine, a duplex-cylinder single 2-foot drum hoist winding ⅝-inch steel cable and the skip from the pit. In a temporary shed close to the shaft is another duplex-cylinder hoist of single 3-foot drum, winding ⅝-inch cable and the bucket. Both hoists are in good condition. From a small lake in a swamp 3300 feet southwest of the mine the water supply is pumped to the mine by means of a separate plant at the lake consisting of a 15-h.p. vertical boiler, a 7 by 5 by 12 Northey pump and 4-inch pipe line.

Along the railroad siding 1700 feet west of the workings and on the far side of a high hill the dynamite magazine, a frame structure 10 by 20 feet in plan, has been built with ample means for thorough ventilation of the dynamite, at present amounting to 21 boxes. Thawing is done at a safe distance from the workings in another small frame house heated by exhaust steam coils. The force numbers 90, of whom 67 are miners under foreman R. McBride.

The ore body of nickeliferous pyrrhotite and chalcopyrite occurs apparently as a lens without defined walls in a mineralized zone of diorite striking east and west with a dip north roughly of 35°. The ore body is 35 feet wide in the open pit and is traceable east and west on the surface for a short distance only, but there is ore in the pit floor and the bottom 25 feet of the shaft, which presumably marks the continuation in depth of the deposit. Although a large number of exploratory holes have been bored by the diamond drill in the vicinity of the mine, in some of which small bodies were struck, insufficient data still exist on which to base an estimate of the extent of the deposit. The ore occurs in both clean and mixed masses of about equal average nickel and copper content. The granite bounding the diorite dike is said to lie a considerable distance away on both sides of the property.

Great Lakes Copper Company.

The underground workings of the company's nickel-copper mine on lots 5 and 6 in the second concession of Blezard township have been but slightly increased since last inspection, all mining operations terminating in May of last year for a while. A force of two is, however, still engaged in keeping the mine unwatered in order to allow of a speedy resumption in the near future.

VICTORIA MINES.

Within the past year or so this property has grown from a prospect into a producing mine. The extensive surface plant at mine, roast yard and smelter noted in last report as in course of erection, allows the treatment of from 125 to 150 tons of ore daily and the production of an 80 per cent. nickel-copper matte for regular shipment to the Mond Nickel Refinery at Clydach, Wales.

Underground development was at the date of my visit, 7th February, 1902, confined to the one or main shaft and the levels therefrom, the two adjoining open pits to the east and west (enlargements of two of the other main shafts) being closed for the winter months on account of the dangerous accumulations of snow and ice. The measurements of the workings were as follows :

Main shaft, depth 372 feet (280 feet increase) maintained vertical, size inside timbers 4 by 12 feet and divided into two cage compartments and a ladderway. First level, depth 52 feet, with landing station on north side ; west drift, 170 feet ; at 80 feet in, a cross-cut south 13 feet ; at 112 feet in, the west open-cast or pit with its floor at this level, in size 50 feet long by 30 feet wide and at the surface 45 feet above, 85 feet long by 40 feet wide ; east drift, 232 feet ; at 110 feet in, the east open-cast 80 feet long by 25 feet wide, extending down to second level. Second level, depth 124 feet, with landing station on south side ; west drift, 103 feet ; at 48 feet in, a wide stope 55 feet long to end of drift by 100 feet high up a 60-degree rise north, a supporting pillar remaining on the west side, and out of the upper northwest corner a 30-foot upraise and a west drift 45 feet long connecting with the floor of the west open-cast on the first level ; east drift, 244 feet ; at 124 feet in, the floor of the east open-cast, in size 120 feet long by 27 feet wide, the same as at the surface, 118 feet above, the walls being vertical. Third level, depth 203 feet, with landing station on north side ; west drift, 40 feet ; at 10 feet in, a stope 30 feet long to end of drift by 60 feet high up a 65-degree rise north ; east drift, 202 feet ; at 37 feet in, a crosscut south 26 feet ; at 175 feet in, a stope 25 feet long on the level by 50 feet high up a 45-degree rise south, the last 15 feet being a 10 by 10 foot drive ; at 10 feet above the floor a branch stope runs west, 25 feet long by 85 feet high on a 55-degree rise west, the width of the whole stope averaging 25 feet, and approximating that of the other stopes in the mine. Fourth level, depth 277 feet with station on north side ; west drift, 50 feet ; at 10 feet in, a stope 40 feet long to end of drift by 25 feet wide and 55 feet high on a rise of 55 degrees north ; east drift, 191 feet. Fifth level, depth 356 feet, with station on north side just completed and a 15-foot sump below ; west drift, 5 feet ; east drift 20 feet.

Unwatering is effected by a sinking pump in the shaft sump and a 12 by 12 by 5 Northey on the fourth level station. In several of the stopes the wall rock requires constant attention to keep the loose pieces scaled off. The shaft timbering is solidly constructed and extends down only to the fourth level, below which as soon as the levels are far enough advanced it will be continued. An auxiliary hoist engine on the fourth level station operates a bucket from here to the fifth. A suitable signal code is posted in the hoist room with a gong for each cage. The hoist now winds a one-inch rope in place of the $\frac{7}{8}$-inch cable originally used ; the recent addition of a 10-drill Rand straight-line air-compressor to the former 5-drill machine affords an air capacity for 15 drills ; and these with the 6 by 6-inch horizontal engine operating the 50-light dynamo and another 10 by 12-inch horizontal engine for the crusher, comprise the rest of the power plant, all installed in one 30 by 30 foot engine room, with boiler plant adjacent recently increased by the addition of a fourth locomotive type boiler of 90-h.p. The rock house on the east side measures 27 by 32 feet in plan and 30 feet high, and the shaft house adjoining to the north is 38 feet high. By damming a swamp 200 feet to the northwest and conserving the water an adequate supply is obtained for boiler and fire-hydrant, being drawn up by a No. 13 Cameron pump in a separate building close to the workings. Besides the above buildings there remain the office, dry and oil houses, blacksmith shop and numerous private and boarding houses scattered about the property.

An aerial tram of the Bleichert patent connects the mine with the roast heaps and the smelter. The total distance from the upper mine station in the crusher house to the lower station at the rear and top of the smelter building where the driving power is applied is 11,000 feet, the incline of the system being insufficient for self operation. When loaded with ore the buckets in passing are dumped on to the roast heaps, continuing thence to the central station, a roasted-ore bin house, to be there detached, refilled and then allowed to finish the trip to the smelter bins or, if containing low grade rock for flux, to run uninterruptedly right through.

The roast heaps at present number 14, of which 9 are burning and 5 being broken down, in plan measuring 30 feet width by from 80 to 100 feet length and in depth 10 feet. These dimensions appear to be suitable, as no interior fusion results and little dynamite is required in breaking up the heaps, thus permitting cheap handling of the roasted ore. Samuel Muirhead conducts the work under contract employing a force of 17.

After destruction by fire last year of the cable derrick system in the original roast yard back of the smelter, it was deemed advisable to abandon this site for the more convenient one above described which is located half-way between the mine and smelter as at this point the sulphurous fumes are not so obnoxious, and to employ a different method of handling the ore to and from the heaps. The improved method consists of a central aerial tram loading station or ore bin house erected at the south end of the yard, the cables passing through the end of the station up to which the tram cars loaded from the heaps are hauled by a 30-h.p. gasoline hoist and then dumped.

The smelter plant comprises a furnace building, several large storage bin rooms, and engine and boiler room, the main structures being of steel with sheet iron covering, in which are installed two water-jacketed blast furnaces and forehearths two bessemer converters taking molten matte direct from the furnaces, crushers and pulverizers, travelling cranes and other accessory machinery. In the power rooms are five 100-h.p. return tubular boilers, feed pumps, a Reidler air compressor, two Connersville blowers with engines direct connected, a 125 kilowatt dynamo directly connected with a compound tandem high-speed engine, several pumps, and in the machine shop, lathes and drills run by a separate engine. Branch railroad sidings connect the adjacent C.P.R. tracks with different parts of the works, the upper storage bins being reached by graded trestle work, and the shunting accomplished by a small locomotive.

The methods of storing and handling explosives both above and below ground were not entirely satisfactory, and instructions to improve the same in certain particulars were left.

The mine workings have opened up two fairly well defined bodies of nickeliferous pyrrhotite and chalcopyrite about 200 feet apart lying in conformity with the east and west strike and south dip of the finely schistose diorite formation and connected by narrow veins and stringers of ore all in the same plane. Subsequent movements have disturbed the formation about the more solid ore bodies and produced slickensided surfaces and contorted folds, allowing a foot or more of white quartz to be deposited in the walls of the deposit with occasional seams of calcite traversing the ore. The central portions of the ore are clean, towards the walls becoming intermixed with bands of schist, but in both the clean and mixed ore the nickel and copper contents are said to remain about the same.

Blue Lake Nickel Properties.

The above form the south-eastern portion of a nickel range running through the townships of Maclennan, Capreol, and Norman in a northwesterly direction along the shores of Moose, Blue, Speckled Trout, Waddell, and Selwyn lakes, and following the contact between greenstones and Laurentian rocks, which is marked out by the course of this succession of lakes The only important development of the mineral belt is in the Blue lake section from the shores of that lake southeast over locations W D 1, 3, 4, 5, 6, 7, 8, aggregating 420 acres, and owned by the Algoma Commercial Company, and on F 5, 6, 7, 8, in Maclennan township, 16 miles north-east of Sudbury, owned by Messrs. Cochrane & McVittie of Sudbury. On the east shore of the lower or south end of Moose lake on Cochrane & McVittie's property several shallow pits show small outcroppings of intermixed pyrrhotite and greenstone. A quarter mile north on the same shore, and for about 1000 feet further over a width of 150 feet the rock has been stripped in various places from 100 to 200 feet long by 15 to 50 feet wide. Test pits, short cross-cuts and trenches show a more or less pronounced covering of the yellow gossan peculiar to the nickel ranges through which the white-tinged weathered ore bodies or unaltered deposits outcrop. There appears a fairly continuous mineralized zone containing lenticular bodies of pyrrhotite and chalcopyrite, for the most part intermixed with a considerable proportion of greenstone, and from a few feet to 35 feet wide, separated by areas of lean apparently unworkable material, and on either side of this other similar but smaller and disconnected deposits, all generally parallel in their northwest-southeast course in conformity with that of the formation. Though occasionally and only for a short distance a wall may be traceable, the barren rock capping found overlying the mineralized portions in many of the workings and the general surface weathering preclude any exact physical definition of the ore bodies.

From the upper end of Moose lake, for a quarter of a mile or so to location F 5, the northern boundary of this group of claims, the results of the work done are seen in occasional strippings, the first one 30 by 40 feet in area, exposing a width of 30 feet of clean and mixed ore, and another 500 feet farther north, 25 by 70 feet, with ore over half its area. Beyond this, in the same northerly direction, a series of eight pits 10 to 20 feet deep show a mixed grade of ore, which in several is overcapped by barren rock.

Across an intervening swamp to the northwest, and on the farther side of the next hill on location W D 1, the explorations of the Algoma Commercial Company are under way with a diamond drill, the existing surface pits being the work of the former owners The main outcropping of ore after being stripped measured 75 feet in length by 25 feet maximum width, and by sinking seven diamond drill holes from a central point from the surface, it was found to maintain this cross section to a depth of 140 feet at least; the walls dipping a few degrees to the southwest in conformity with the enclosing rock. An eighth hole was in progress, from a point a little to one side inclined to cut the deposit at greater depth. The ore occurs both clean and mixed, composed of nickeliferous pyrrhotite with chalcopyrite and trap, the clean and mixed ore said to assay equally well in nickel and copper. On different sides of this, but within a radius of 200 feet, a number of other small mineralized ore bodies have been partially exposed by the surface pits and trenches. At a point 500 feet southwest, 15 feet of ore trend southeast towards location F 5, and at 350 feet west, two pits show 5 feet of clean ore and 10 feet of mixed with the same strike.

The ore bearing formation consists of a hornblendic medium fine-grained and grayish green to pink rock, probably a diorite, the Laurentian contact being at least several hundred feet from the mineralized area. In occurrence no important difference was noticed between these and the well-known Sudbury nickel-copper ores, the greenstone formations being the same at both except for the variation from white to pink felspar in the rock of the former. Similar features were the Laurentian contact in proximity, the deposits in the form of lenses and chimneys usually disconnected though occasionally with a continuation from the one to the other marked by lean zones or streaks along the mineralized belt, and with the nickel-copper content ranging from about 3 to 8 per cent. The present surface exposures indicate fair-sized workable deposits which may with the prosecution of diamond drill explorations be reasonably expected to expand to larger dimensions.

Nickel Cliff Mine.

On 27th January 1902 a visit was made to lot 17 in the eighth concession of Armour township, Parry Sound district, 3½ miles east of Burk's Falls, where it was reported a nickeliferous ore body was being developed. It was found that after a year's work the mine had been closed in March 1901, the results of operations being a shaft 32 feet deep with drift north 20 feet and from the face of this another 5 foot sink, in size 7 by 9 feet. As the timbering had been removed an inspection of the shaft was impracticable, but judging from the dump and a few exposures not covered by snow the country rock is a micaceous gneiss and the ore, an intermixture of pyrrhotite, chalcopyrite and pyrite therewith, occurring in a mineralized zone of the rock. Similar bodies are said by the locator to outcrop at various points for several miles northeast of this property, giving surface assays as high as 1.79 per cent. of nickel with fair percentages of copper. From the shaft workings a stock pile of some 10 tons of the sulphides has accumulated.

The recent operators, the Magnetawan Mining Company of Connellsville, Pa., secretary, R. S. Hews, hold an option on the land from the joint owners, S. T. Evans and F. McLaughlin of Burk's Falls, and the latter report that mining was discontinued until adequate machinery and a diamond drill for exploratory work could be acquired which may be this spring.

The dynamite magazine is a root house in an exposed position too close to the camp, and instructions were given to erect a new one to comply with the Mines Act requirements before resuming work.

MICA MINES.

The mica industry has recently fallen into the hands of two or three large operators. who represent some of the heaviest consumers, by reason of their possessing the most productive mines, and as these furnish more than an ample supply many of the smaller producers have had to temporarily drop out. There are, however, a number of mica dealers with trimming shops in the district centres who buy up small lots wherever obtainable, thus furnishing a sufficient market for all the mines were it not that producers think the prices now obtainable too small. In comparison with those of the boom period two years ago they appear so, but the latter were abnormal and should not enter into calculations of profits at the present time. The abundance of the mineral on hand has also not only affected the price but prevented in selling at all in many cases. At the close of last year, however, a change was perceptible in an increased demand which if continued will probably lead to a rise in prices, and from the nature of these mica deposits it is unlikely that the larger ones referred to will be able to maintain their large output for any indefinite period.

Pike Lake Mine.

A visit was made to this old mine on 18th December 1901, although it had been closed since the previous summer, the last development not having opened up any extensive chutes of the larger crystals of muscovite—over 2 by 3 inches in size—which now form practically the only valuable product of the mine, this being of first quality for stove mica or other purposes where transparency, toughness and freedom from blemishes are prime requisites. The smaller crystals (under 2 by 3 inches) are sufficiently abundant; but this size mica is used mainly for insulation purposes in electric apparatus, and for such the Pike Lake muscovite is too "hard." If prices for small material increase again, the mine will, it is expected, resume production.

There is no apparent reason why further work will not disclose just as good mica as that which formerly made this mine noted. The property is still owned by W. A. Allen of Ottawa, though the last operations were conducted under lease by J. J. Noble of Perth.

McLaren's Mine.

This property, located on lot 4 in the 8th concession North Burgess township, Lanark county, and six miles south of Perth by road, adjoins the old Capt. Adams mines which were worked on a large scale for many years until recently for apatite and amber mica. It is for these two minerals that the McLaren deposits are now under development. The owner is Hon. Peter McLaren of Perth, and the manager, Mr. W. McLaren ; the force of miners numbering four. Mining is confined to one trench 80 feet long by 3 to 8 feet wide and 8 feet deep, along the course of the vein, on which underhand stoping is being done. The vein matrix is pyroxene carrying variable though paying quantities of good quality amber mica, granular light green apatite in bands and pockets, and a little intermixed calcite. There are about two tons of mica on hand, and a smaller amount of apatite.

Lacey Mine.

The lease under which this mine was worked by Mr J. W. Trousdale of Sydenham expired about the beginning of 1901, and the property reverted to the owners, the General Electric Company of Schenectady, N.Y., who have since continued mining without break. The mine is said to yield a daily output of 3½ to 5 tons, of which part is shipped to the company's trimming shop in Sydenham, 8 miles distant by summer road, and the remainder stored away at the mine where at the time of inspection, 13th December 1901, a large quantity had accumulated. The stock is roughly sorted before storing into sizes from 1 by 3 inches up to crystals 3 feet in diameter, pieces of the latter dimensions being of course comparatively rare.

The mine is operated from one shaft though latterly the underground workings have been extended. The main shaft has reached a depth of 110 feet and at the bottom is 12 by 20 feet in size. An air shaft has been sunk 45 feet northwest of the main shaft connecting with the first level therefrom at 45 feet depth the level extending 20 feet farther northwest, or in all 65 feet northwest of main shaft, and southeast 25 feet. The shaft is timbered with a vertical 6 by 6-foot collar 25 feet deep, and with lagging over the remainder of the opening. Entrance to the workings is had through the air shaft, where a suitable ladderway is maintained. A horse whim, using steel rope and bucket on skids, dumps by means of a swinging arm derrick on to a platform where the mica is cleaned, sorted and barrelled for shipment or storage. A hoist house has been built 10 feet west of the shaft, in which a portable boiler and single drum hoist are being installed to replace the present hoisting system as soon as a new solid head frame can be erected.

The employees number 25 ; foreman, R. H. Smith, and manager, G. W. McNaughton

The General Electric Company have been acquiring other mica properties in the district, one of which, situated on the shores of Gould lake in Loughboro township, Frontenac county, they are now developing with a force of 6 men. This is an old property on which considerable work had already been done by shafts and pits, none of which however are being re-opened, the present work consisting of a new open trench 12 feet long by 8 feet wide driven into the side of the hill 50 feet above the lake, where some valuable crystals of mica have been struck. The country rock is red granite, and in a dyke of trap in this is the vein of dark mica schist about 8 feet wide carrying large crystals of amber mica.

A temporary dynamite magazine is in use at a safe distance from the workings.

McClatchey Mine.

Situated on lot 8 in the tenth concession, Loughboro township, on the shore of Gould lake, and adjoining the property now being worked by the General Electric Company, is another old mine, recently re-opened under the ownership of Messrs. McClatchey & Hayden, of Belleville, with the former in charge and a force of six men.

The work is confined to one vertical shaft, depth 30 feet, size 8 by 15 feet, timbered with a 10-foot collar and ladderway. Hoisting is done by hand windlass. The mica, of which several tons were on hand, is roughly cleaned and thumb-trimmed at the mine before shipment.

The country rock ot this region surrounding Gould, Blue and Cronch lakes, all visible from the top of this property, is a red granite outcropping in immense rounded hills. The granite is cut up with a net work of trap dykes having no uniform strike, but generally of nearly vertical dip. The trap is dark green in color and contains as a minor constituent light green pyroxene and biotite. In these dykes, parallel to the course of the trap and of the same vertical dip, occur veins or lenses of mica schist ranging from biotite to muscovite and occasionally altered to green chlorite. The other chief constituent is either light green massive pyroxene or coarsely crystalline calc spar in masses and seams. Frequently both are present and, as an accessory, apatite. In this vein matter the valuable crystals of amber mica (phlogopite) are found, not in regular or constant bodies, but after the manner of a pay chute, the mica bearing portion in general beginning abruptly and terminating in the same way, though, with certain visible and definite indications, such as the appearance of the seam of calcite bounding the pay chute, or some other local peculiarity.

Judging from the developement of deposits in this region, it would appear that in adjoining or even in the same vein the characteristics change with the predominant vein filling for where this is pyroxene the mica bearing chutes are more continuous and furnish larger and more nearly perfect crystals, whereas where much calcite is present the mica tends to locate in pockets. A fine quality of mica is, however, obtained from both classes of deposits.

Bear Lake Mine.

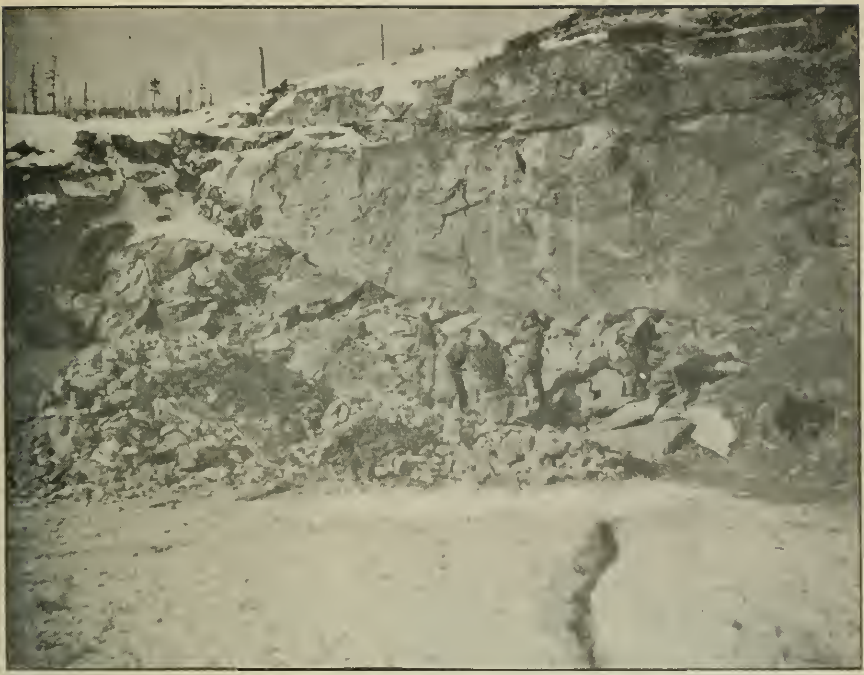
This old property, located on the southwest shore of Bear lake, in Loughborough township, comprising some 200 acres, is reached by a three-mile road northwest of the village of Perth Road. The owner is J. H. Roberts of that place, who is also in charge of the present operations and of the force of four miners. The deposits have been worked at intervals for the past three years, the last resumption being a week previous to the date of inspection, 14th December 1901. As a result of the old work an area of about five acres is covered with a great number of pits, trenches and shafts, both shallow and deep, most of them caved in and unworkable. The mineral sought by the first owners was apatite, the amber mica being then for the most part cast aside; but by the change in value of the two, apatite deposits being now unprofitable except where occurring in very large dimensions, this mineral has become merely a by-product in the extraction of the mica

Mining is confined to one shaft, the depth of which is 95 feet. It inclines 42 degrees, and is in size 6 to 12 feet wide by 15 feet high. Sinking for the present is discontinued in order to follow by drifting the several exposures of mica bodies. Hoisting is done by bucket on skids, hemp rope, swinging arm derrick and a horse. The dynamite, brought in from town in small quantities at a time, is stored in the trimming shop. and in thawing it the foolhardy method of laying it on a screen above the stove is in use. Instructions were left to remove immediately all dynamite and store it in a proper magazine; also, to procure a standard thawing tin.

The land to which the mining work has been confined covers an area of about five acres, under which extends a large eruptive dike of trap, chiefly pyroxene, lying in a granite

Canada Corundum Company ; Craig mine, Raglan township, county of Renfrew.

Canada Corundum Company ; concentrating plant.
Photo by Dr. A. E. Barlow, Ottawa.



Craig corundum mine; main open cut.

Canada Corundum Company; upper west open cut, Craig mine.

Atlas Arsenic Company ; stamp mill.

Wilbur iron mine.

Black Donald graphite mine and refining plant.

formation. Throughout this trap occur seams of clean, green pyroxene, varying widely in both strike and dip, in which the amber mica crystals are found as chutes or in pockets, defined by the surrounding wall of pink calc spar a few inches in thickness. The occasional associated seams or lenticular masses of mica schist are nearly always an indication of large mica not far off, while the richest chutes occur where the pyroxene predominates in the vein filling with extinction of most of the calcite.

Hanlan Mine.

Operations were suspended at this mine on 1st June 1901, with the intention of starting up again in the spring of the coming year, by which time the large stock of mica on hand (transferred to the company's mica trimming works in Ottawa) will be somewhat reduced, and, it is hoped, better prices for the mineral will prevail.

The underground workings were full of water when visited in December 1901. The surface plant and machinery are being looked after by a caretaker. Dynamite is still stored in a large box 250 feet from the workings in an exposed situation, and instructions were given for the removal of the same to a more distant locality, or preferably to a magazine built in accordance with the requirements of the Mines Act. The owners are F. W. Webster & Co. of Ottawa, Ont.

Stoness Mine.

Mining has progressed steadily since the last inspection to date, 15th December 1901, with a fairly uniform and large production. The mica, after being first rough-cleaned in the mine shop, is barrelled and drawn 30 miles over waggon road to Kingston to the company's trimming works in that place. The ownership of the mine remains the same, with Mr. J. M. Stoness as manager, and H. McCadden foreman over the force of thirty. Additional irregular development has been prosecuted on several of the adjoining locations, noted in the last report, but so far insufficiently to allow of steady production, practically all the mica coming from the main shaft workings. This shaft has reached a depth of 354 feet (in the last report by mistake stated to be 440 feet) on an incline which flattens out from 42 degrees at the surface to 26 degrees at bottom, the average being about 30 degrees north and the size of shaft or stope from 10 to 25 feet wide by 30 to 45 feet high. At 201 feet depth in the shaft the workings are in a pocket or seam of mica-bearing calcite.

Ventilation is provided by horizontal or gently sloping air-tight pentices 20 feet in length in steps down the middle of the shaft from top to near the bottom, and along the top of this the man-way is placed with the skip road in the lower compartment. Defects in the skip road and other parts of the workings due to faulty construction and otherwise were noted, and instructions left to provide necessary safeguards against accident. The customary practice of riding in the skip was prohibited, and improvements were suggested in the apparatus used for thawing dynamite.

Bawden Property.

This mica prospect having recently suspended work was not visited, but under date of 26th December 1901 the owner, Mr. J. Bawden of Kingston, informs me that the locations cover lots 4 and 5, an area of 140 acres in the eleventh concession of Miller township, Frontenac county ; that for the past year two or three men have been intermittently employed stripping the mica-bearing formation to determine its extent rather than in actual production, although a considerable stock pile of mica has resulted from the work ; and that the mica is muscovite.

Munslow's Mine.

This mine is located on the west half of lot 13, in the sixth concession North Burgess township, adjoining the Martha mine, the working pits of the latter forming the continuation of those of the former and on the same mica vein. Mr. T. J. Smith, who is in charge of operations, holds a working lease of the property and with three men has been stoping a little amber mica out of the 2-foot vein in this pit, which is 15 feet long by 5 feet wide and 10 feet deep, chiefly to find whether or not this narrowing extension of the big Martha deposit will open out again to a workable size.

Dynamite was used with a degree of carelessness excusable only on the ground of ignorance of its dangerous properties. The small store is kept in the mica house, and that to be thawed is laid under the stove in the same place. Instructions were left with Mr. Smith for the safe storing and handling of the dynamite.

Bliss Mine.

This mine, which was first opened up some thirty years ago and has been operated at different times since, lies in South Burgess township twelve miles southeast of Perth by road. From Mr. L. J. Gemmell of Perth it is learned that he re-opened the mine for a period of three months last summer, 1901, taking out considerable mica and still leaving a good show in the mine when operations had to be again suspended on account of inadequate means of unwatering the workings.

Byrne's Mine.

This property, 8 miles south of Perth, has during the past year been worked only intermittently and at no considerable depth from the surface. A few tons of good quality amber mica were taken out during each of the periods of operations. Patrick Byrnes is still owner and operator.

Blair Mine.

The Blair mine is located on lot 3 in the ninth concession of Bathurst township at the head of Bennett's lake, 13 miles southwest of Perth by road, and is owned by R. Blair, J. Morrow and L. J. Gemmell of Perth.

From Mr. Gemmell the information is received that during the month of December 1901 two prospect pits were sunk 20 feet deep, from which a high grade, light-colored amber mica was taken, and that it is proposed to undertake more extensive mining in the spring.

Martha Mine.

At the time of my visit, 18th December 1901, the mine had been closed a week after working intermittently with a force of three miners since the summer test pitting and partially opening up other surface exposures. The intention is to resume sinking in January in the old workings in one of the deep shafts or pits, which will first have to be pumped out. The surface plant including boilers, pumps and hoist engine is ready to start up at any time. A force of ten or twelve men is to be employed, and with the good show of amber mica in the bottom of the pit it is expected the mine will shortly be shipping again.

The owners are the Mica Manufacturing Company of Ottawa, Ont., and T. J. Smith, superintendent of late operations, is expected again to take charge.

Gibson's Mine.

This mica deposit, located on a 40-acre claim on lot 25 in the ninth concession of Elmsley township, Lanark county, and two miles southeast of Perth, underlies the farm house and surrounding garden lawn of E. N. Hayes. From the rock exposures in the limited development work it appears that a dyke probably of pyroxene extends under the lot on which the farm buildings stand and in this amber mica is found associated with a little calcite. A pit 10 by 10 feet in plan and 4 feet deep has been sunk in the lawn 10 feet in front of the house, in the bottom of which is a good show of mica, as also in a trench 20 feet to one side in which the drain was laid. The rock floor of the cellar under the house is also studded with mica crystals

Practically nothing has yet been done in the way of development, mining having begun but a week or so previous to my visit on 18th December 1901. The operators, A. Gibson and E. N. Hayes of Perth, are mining under lease from J. Jackland, the owner, and expect shortly to open up the property on a more extensive scale.

Kent Bros' Mica Trimming Works.

These are located in Kingston and are owned by Kent Bros. of that city, the mica treated coming chiefly from their mines in Bedford township, 30 miles north of Kingston, though also from other properties in the district. In the original shop employing 17 men the mica is subjected to a series of three operations consisting of splitting the crystals into sections of an average thickness of about $\frac{1}{8}$-inch, thumb trimming (breaking off the rough edges) and rough knife trimming. The last process for occasional orders is replaced by cutting to dimension. Most of the mica is then in marketable shape, but recently in order to supply the demand for a product in very thin laminae a second shop was added to the works, in which 20 girls are employed splitting the knife-trimmed mica down to the necessary fineness—that of the thinnest of films.

General Electric Company's Trimming Works.

This establishment at Sydenham which originally belonged to the firm of Webster & Co., mica miners and dealers, has been sold to the General Electric Company of Schenectady, N.Y., who here thumb-trim and split the mica from their own and a few other mines in the district down to $\frac{1}{8}$ or $\frac{1}{16}$ inch thickness and into sizes ranging from 1 by 3 inches to 5 by 8 inches. The employees number 40, of whom 27 are girls, most of the latter having been brought from Ottawa on account of their expertness. A daily output of three thousand pounds (3,000 lbs.) is said by the manager, Mr. G. W. McNaughton, to be maintained.

Trousdale Mica Trimming Works.

These shops in Sydenham are owned by J. W. Trousdale of that place, and are kept in operation off and on the year round, but with only a small force of men. The process consists simply of thumb-trimming, splitting and sorting the mica into a saleable article. The material is purchased in the rough from the mines in the district.

Adams Mica Trimming Works.

These shops in Perth are owned by John H. Adams, who buys, trims and sells mica from the mines of the district, carrying on the business on a small scale only with an average force of about three men. The principal work is in rough thumb-trimming and splitting for the small mine owners, who have not the facilities for doing this themselves at the mine.

Apatite also is dealt in whenever lots are to be obtained.

Mica Trimming Works in Ottawa.

Webster & Company now confine their trimming operations to the main shop in Ottawa at 274 Stewart street, the Sydenham branch having been disposed of. From 3 to 6 are employed in thumb-trimming only, under the management of J. E. Chown.

Eugene Munsell & Company, with office and works at 332 Wellington street, buy up mica from the mines of Ontario and Quebec. They thumb-trim, split and cut it to dimension for shipment to the United States market or to their factory at Schenectady, N.Y. where, under the name of the Mica Insulating Company, the same concern manufactures micanite board and cloth and other electric goods, for which purpose Canadian mica is preferred to that from India and elsewhere. Mr. S. O. Filion, the manager, employs a force of 20 and handles yearly a large tonnage of mica.

The Canadian Mica Company of 476 Sussex street, has during the past year intermittently employed a force of about five under the management of Mr. E. R. Wilkinson, for the purpose of trimming and disposing of the entire stock on hand.

The Mica Manufacturing Company, Limited, whose office and works are at 213 217 Dalhousie St., is under the management of Mr. F. Fuller. Five hands were at work at the time of my visit, though occasionally during the past year as many as fifty were employed. The chief market is outside of Canada for which thumb-trimmed and split mica is in greatest demand, knife-trimmed and dimension goods being more for the local trade and therefore of limited output. The company gets most of the mica from its own mines in Ontario and Quebec of which there are a number now in operation

The Sills-Eddy Mica Company of 396-398 Wellington St. employs in its shops an average force of 60 under the management of Charles Guerton, and for the last year and a half has bought and treated nothing but Ontario mica in these works. The plant includes 22 machine-run knives, each run by a female operative, which remove from the mica the jagged edges as it comes from the thumb-trimming department. A projecting parallel rod of iron in front of the knives protects the fingers of the employees, the mica being pushed under the rod. The product is shipped to markets in the United States and England and to the company's other factory at Waverly, N. Y., where it is manufactured into micabeston (similar to micanite) and other goods for electrical purposes. The company's head office is at 30 Broad St., New York.

Mica Grinding Works.

A new industry has been begun at Gananoque in the erection of a modest plant for the grinding and pulverizing of scrap mica. Ground mica has many useful applications and is in considerable demand as a lubricant, for wall-paper, roofing, annealing and other purposes, the principal markets being in Canada and England. The United States does not afford an outlet as a prohibitive import duty of 25 per cent is imposed by that country. The owners are the international Mica Company of Gananoque, Ont., and manager, J. W. Logan. A force of 15 men is employed in the works.

The plant had been in operation one month when it was visited in December 1901, turning out an average of a ton a day in as many as eight grades or sizes. The mica is first roughly screened and then trimmed (cleaned) before entering the grinder, which is a sheet-iron cylinder, 9 feet long by 30 inches in diameter, punched in rows to $\frac{3}{16}$-inch holes and set at an incline of $1\frac{1}{2}$-inches in its length. As the machine slowly revolves loose pieces of steel enclosed in the cylinder break up and pulverize the mica until fine enough to drop through the $\frac{3}{16}$-inch holes. It is then sized or graded in trommels from flakes down to the finest powder, the finer screens being of silk. The plant is operated by water power on the Gananoque river beside which the works are located.

The manager gives it as a probability that the company will also erect a talc grinding works beside the present plant using talc from Ontario mines as soon as a continuous supply of the crude material can be depended on.

Black Donald Graphite Mine.

This mine, of which a partial description was given in the last Report, is located on lot 11 in the third concession of Brougham township, Renfrew county, and by the present road is 22 miles from Calabogie on the Kingston and Pembroke Railway, although this distance will be shortened by the new 14-mile road of which four miles have been completed. The owners are the Ontario Graphite Company with offices in Ottawa, and manager, J. McRae.

Extensive surface construction has characterized this year's work and in order to rush its completion the mine was closed in October, about two months previous to the date of inspection, 21st December 1901, and allowed to fill with water. The old system of operating with steam will now be replaced by an electric plant, the electricity to be generated at Mountain chute on the Madawaska river about $2\frac{1}{4}$ miles southeast of the mine, which will also light and heat the camp and furnish power to the new graphite refinery nearly completed on the lake shore close to the mine. The plant will allow of a considerably greater output even with the same amount of mining as formerly, for both the high and low grade ore can be handled, and the product being of fine quality, transportation costs will be considerably reduced. The refinery building, 46 by 87 feet in plan and 40 feet high with three floors full length, is of wood, with galvanized sheet iron covering and foundation of stone, while at the south end an addition has yet to be built for the Blake crusher and 10-stamp battery. The other machinery is in duplicate, the two plants to be maintained and operated separately, each occupying half of the building down its length from top to bottom, and consisting of two buddles 16 feet in diameter by $2\frac{1}{2}$ feet deep from which the concentrated graphite is conveyed to a dryer and thence by elevator to bins above the top floor, being afterwards sized in a long series of trommels. The different grades of the flake graphite are then subjected to grinding by ordinary mill-stones which polish the flakes, producing a material valuable for lubricants and foundry mould facing. This plant, it is expected, will be ready by 1st March 1902 to turn out about 15 tons per 10 hours.

The mining machinery recently in use includes two boilers, one of 45-h.p. and one, an auxiliary, of 25 h.p., a duplex-cylinder single drum hoist engine hoisting with $\frac{5}{8}$-inch steel rope and bucket from the adjoining main shaft, and half of a 6-drill Rand air compressor. This plant is to be maintained in its entirety as a reserve when the other 6-drill compressor and electric hoist to be purchased for future operations have been installed.

In the development of the water power on the Madawaska river a lumber company's dam and log chute have been made use of, the flume being built in the rocky side of the river in length 90 feet by 20 feet wide and 12 feet high. The outside cribbing extends out into the middle of the chute with a penstock at the end, giving 22 feet head of water. The adjoining power house will contain four 30-inch water wheels of 600-h.p. total capacity on the one horizontal shaft direct connected to a 350-kilowatt electric generator. This plant is expected to be completed before the end of February. The transmission line already erected is strung with three copper wires of a total length of 36,000 feet for the 3-phase alternating current.

A new office, boarding house, warehouse and several private dwellings have been added to the camp. The old dynamite magazine, a root house 100 feet south of the refinery, has been replaced by a galvanized iron building 300 feet east, but within 100 feet of the workings. It was advised to remove the explosives to a new building situated and constructed according to the Mines Act requirements for safety.

Mining development measures up as follows : Main shaft, depth 80 feet, size 10 by 12 feet and vertical. The one level at the bottom runs northeast 200 feet out under Whitefish lake and southwest 24 feet, the former stoped out 50 feet high for 120 feet in, and 30 feet high for the remaining 80 feet, and the latter stoped 16 feet high for its full length, both stopes being from 8 to 22 feet wide or averaging about 13 feet. A 20-foot collar extends down the shaft, with a 50-foot open head frame. Running along the outcropping of the vein southwest from the shaft for 135 feet is an old trench 12 feet wide and 39 feet deep. At 54 feet south of this is another open cut 10 feet wide by 50 feet long ; and 50 feet beyond this a temporarily abandoned vertical shaft 49 feet deep. From here on for several hundred feet surface cross cuts have uncovered the vein. The output of the mine in 1901 was 2,200 tons shipping ore, of which 250 are still on hand together with about 100 tons of low grade. Last spring (1901) three diamond drill holes were sunk by the company's machine from the 80-foot level in the shaft, finding graphite to a depth of 122 feet below the surface, where a hard flinty rock precluded further drilling for the time.

An examination of the surface exposures shows the country rock to be a white limestone through which a vertical vein of graphite strikes northeast-southwest, varying in width from 7 to 22 feet, and averaging about 14 feet of "clean" ore, that is, graphite with 15 to 20 per cent. of invisible rock matter. For from two to three feet back the walls are schistose limestone carrying thickly disseminated flake graphite ; beyond they are less altered, containing however sufficient graphite to make milling ore over a width of 40 feet where worked. In the central body the graphite occurs both in the flake and crystalline forms.

Canada Corundum Company.

Mining and milling has progressed steadily since the last inspection, operations being confined to the Craig mine on lots 3 and 4 in the eighteenth concession of Raglan township, county of Renfrew, with the exception of a little prospecting during the past summer on the company's other lands. The force at this date, 23rd January 1902, numbers 60 of whom 14 are mining and 16 working in the mill under superintendent G. F. Bartlett.

Mine development has consisted of quarrying or opening up large surface cuts as benches in the hillside. The main working is in three steps, the lower 80 by 80 feet in plan and 30 feet high at face to the middle floor, which is 60 by 130 feet in plan and 30 feet high at face to the upper floor, the latter being 60 by 60 feet in plan and 12 feet deep at its face. Ten miners were working on the bottom step at the time of inspection. The east cut lies 600 feet along the hillside east of the main working on about the same level and is 15 by 20 feet surface area by 15 feet deep. It is not at present being worked. The west cut is 600 feet west of and 100 feet higher up the hill than the main working, and is of 25 by 35 feet plan by 10 feet deep at face, four miners being employed here.

These several workings are maintained with the view of gaining an insight into the characteristics of the corundum bearing veins or zones rather than for the purpose of obtaining an adequate supply of corundum. Any one of the openings, but especially the larger, exposes enough corundum bearing rock to supply the demand for a long time to come.. The corundum occurs apparently in mineralized seams or zones, the crystals and magma differing only in size and degree of fineness respectively. The latter consists of felspar varying in color from pink and brown to green, biotite and hornblende, magnetite disseminated in large and small crystals, pyrites in lesser quantity and more rarely garnets. The average diameter of the corundum crystals ranges in the different openings from $\frac{1}{8}$-inch to $\frac{3}{4}$-inch.

It has been demonstrated by the reduction plant in the two years of its operation, (1) that to obtain a market for the corundum the product must be practically clean and the various grades sized with complete accuracy ; (2) that this result can be arrived at only by an elaborate system of grading and by treating in the concentrators only one of these closely sized grades at a time. The plant has been gradually altered and remodelled until now a very close approximation to the desired article is obtained. The building, however, which was originally a sawmill, is in no way suited for so elaborate a process, where great cleanliness by easy and close adjustment is a prime necessity. It has, therefore, seemed advisable that a new mill with both building and machinery designed for the purpose should be erected in the near future and for this most of the plans are already prepared and the mill site chosen. The new mill will give an increased output over the present plant, which now produces on the average $2\frac{1}{2}$ tons of corundum a day.

Carelessness was noted in the thawing and handling of dynamite after its removal from the magazine for use, and safe methods were pointed out with instructions that they be followed in future.

Richardson Felspar Mine.

During the summer seasons this property is closed down for the reason that by mining on a large scale during the winter alone, when the cost of working is less, it has hitherto been possible to take out enough to supply the demand. At the date of my visit, however, (11th December 1901) preparations were being made to quarry 10,000 long tons by the middle of March 1902. A force of 30 miners was required together with some 50 teams to haul the spar to the railroad. For haulage purposes the route to Glendower on the Kingston & Pembroke Railway has been shortened to two miles by building a pontoon over a dividing body of water, and the road will be available in summer as well as winter.

Mr. H. Richardson of Kingston, one of the owners, states that during the previous winter 4,500 long tons were mined and shipped to pottery works in the United States, which at present provides the only market. A sample lot of 100 tons had been sent to England for distribution among manufacturers there, in the attempt to awaken interest in this new sourse of felspar. As soon as English consumers can be made to feel assured of a continued supply, it is believed there will be no lack of demand from them. Uncertainty on this score has led to inferior substances replacing felspar in the pottery trade during recent years.

On account of a prohibitive import duty on crushed felspar or felspar treated in any way, all shipments to the United States have had to be made in the rough, but if the English market which is free to Canada can be opened up Mr. Richardson proposes to erect a crushing plant at Kingston and ship the fine felspar in bags, thus reducing the loss of material en route, avoiding contamination, and obtaining a better price.

No inspection was made of the mine, as operations had not yet been actually resumed.

Jarman Pyrites Mine.

This property is located in Madoc township, Hastings county, one-quarter mile from the Central Ontario Railway siding and one mile south-east of Bannockburn station on the same line. The owners are the Rio Myra Company of Madoc, in which the General Chemical Company of Buffalo and the Nicholls Chemical Company of New York are interested. Mr. Z. H. Jarman is manager though at the time of my inspection, 7th December 1901, T. E. Burnside was in charge. The force employed numbered 30 of whom 20 were engaged in mining.

Development had been in continuous progress for over a year and a half on the deposits of iron pyrites, from which monthly shipments averaging 600 tons had been and were being made to chemical works in New York and Buffalo for use in the manufacture of sulphuric acid. Returns from the consignments showed that a content of from 46 to 48 per cent sulphur had been maintained. The waste dumps of only a few tons were evidence that the ore is practically clean and all pay.

Results of mining development are as follows: Main open-pit, width 32 feet, depth 84 feet and length at top 85 feet narrowing to 50 feet at bottom, dipping 55 degrees north, with smooth, clean foot wall, but a dangerous hanging wall of soft chloritic schist badly fissured and loosened into immense slabs. Dangerous masses of ice had accumulated on the upper portions of the pit. To the face of the foot wall an insecure and uneven pole skid way clung and up this a battered kibble was hoisted by hemp rope, single pulley block and a team of horses. The incomplete ladderway formed an unsafe travelling road. In fact these workings were so unsafe that it was deemed advisable to give instructions either to shut them down at once or to begin the work of scaling the walls, installing a proper ladderway and skid road and a hoist engine with brake and steel rope, and otherwise improve the condition of the pit; it was also recommended that future mining be conducted entirely from underground and the open pit abandoned, where the soft wall rock will continue to weather and become unsafe as long as any is left overhanging.

Another part of the property was under development by a shaft at a point 600 feet south of the open pit. The depth of this was 98 feet and size 7 by 12 feet; and the inclination was east 85 degrees at top, flattening to 76 degrees at bottom. First level, depth 64 feet; north drift, 5 feet, and south drift, 5 feet. The shaft was timbered with a short collar and below this occasional stulls, some of which were held up by the pole skids instead of vice versa. The ladders hung in a continuous insecure string to the bottom, with no partition between the hoist and ladder compartments. The hoist engine was a wooden horse whim with 7-foot drum and no brakes, the bucket being attached by hemp rope. Instructions were left to timber the shaft in accordance with the Mines Act requirements for safety, and to put a brake on the whim drum and use steel rope.

At both mines machine drills were in use run by steam from a portable 17-h.p. boiler at the big pit, and from two similar boilers of a combined 24-h.p capacity at the shaft workings.

A thorough examination of the geological features was not possible at the time of my visit, but from cursory observations the bodies of pyrites occur both as bedded lenses or chimneys and in veins in a formation of light-colored chloritic schist. The vein of pyrites which the shaft is developing runs north and south at right angles to the east and west strike of the lens in the open pit and is from 10 to 20 feet wide as exposed in the underground workings and some surface cross-cuts to the south. The ore in both workings is a granular pyrites, throughout which quartz in grains and fine stringers is disseminated with considerable uniformity, but in small enough quantity (as shown above) to permit of the ore running 46 to 48 per cent. sulphur.

Nickel Lake Iron Pyrites Property.

This is located on P 577 and 580 with water lots corresponding on Nickel lake north of Swell bay, Rainy lake, in Watten township, the Canadian Northern railway cutting across the property. An option is held by Mr. W. Prescott of Cleveland, Ohio, from the owner, Mr. W. A. Preston of Winnipeg, the present development being under the management of Mr. Lucius P. Brown with a force of six. Work of an exploratory nature began 1st March 1902, preparatory to the installation of the diamond drill which is now testing the extent of the deposits of iron pyrites. No inspection was made, the above information being obtained from the manager on 5th April 1902.

Ottawa Carbide Works.

It was found on visiting this plant on 21st January 1902 that operations had been suspended for several weeks in order that extensive alterations and repairs chiefly in the milling department might be made. Mr. Frank Bronson, the manager, informed me that production was kept in full swing at the rate of 4,000 tons yearly during the past season, employing a force of 40 men with the full number of 20 furnaces, so that there was then calcium carbide enough on hand to tide over the few months during which the manufactory would be idle for repairs.

Willson Carbide Works.

The Willson Carbide Works Company, of St. Catharines, Limited, whose factory is situated on the Welland canal, Merritton, continued in operation during the year. This is the pioneer establishment of the industry in Ontario.

Gananoque Granite Quarries.

The oldest and most extensively worked granite quarries on the St. Lawrence river are situated within two miles of Gananoque on Forsythe, Jumper, Leek and Grindstone islands, comprising the group known as Forsythe's Quarries. These furnish granite of slightly differing physical characteristics, ranging in texture from coarse to fine and of varying shades of red. The product is used largely for building and paving, for which latter purpose Grindstone island has furnished in the last few years very large quantities.

The reason the largest quarries are located on the islands instead of on the mainland deposits is chiefly the advantageous shipping facilities of the former, and not because of any lack of equally good areas of stone farther inland, for of these many are known and several have been worked.

Another important quarry is that of Messrs. Black and Burgess of Gananoque, at Willetsholm, six miles west of Gananoque, the stone being a blue granite, obtaining its unusual color from the dark blue felspar crystals, which also give it a lustrous shimmer when polished, and make it particularly valuable for ornamental work.

In the granite wherever worked throughout this section the rift runs water level (horizontal) and the run or grain lies exactly east and west and is square with the heads, which permit rectangular blocks to be taken out anywhere. The quarries have been in the last few years worked intermittently as orders are received, but at all of them the surface plants are maintained in readiness for immediate operations at any time of the year.

Henderson Talc Mine.

At the time of my visit the mine was still shut down, practically nothing having been done in the way of development since last inspection. In February 1902, however, word was received from Mr. J. E. Harrison of Madoc, one of the owners, that the mine was to be immediately re-opened on an active scale.

Jackson's Serpentine Mine.

This property is owned by Mr. Geo. Jackson of Gananoque, Ont., and is situated two miles and a quarter west of that town in Leeds township, Leeds county. For many years the main portion of the land has been and still is used for farming purposes, there being a heavy covering of surface soil and but few rock exposures. The latter show a general formation of highly quartzose fine-grained gneiss, and enclosed in this is a dike of serpentine of which the strike, dip and other physical features as a body could not be determined for lack of sufficient outcroppings and development. The dike, however, apparently extends over the property for a distance of at least one-third of a mile between the two exposures, and in width, judging merely from the uncovered portions in the workings, it is from 20 to 50 feet. Mining is entirely by open pits, the one at the northeast end being 20 feet long, 10 feet wide and 15 feet deep; while at the southwest end there are several cuts, one 100 by 15 feet in plan and 8 feet deep, the others southeast of this being only shallow strippings. At both exposures the surpentine is of compact structure and shows signs of fluidity due to original eruption, is soft, being easily cut with a knife, and has a distinct oily feeling and resinous lustre. Stringers of chrysotile run through the mass in various directions, and also a few gritty seams which, however, are easily sorted out. The color in the weathered surface portions varies from grayish white to light and dark green yellows and browns, with indications that the predominent color with depth will be a greenish tint.

The mine has been operated during the summer seasons of the past five years, producing in all 1800 tons, which has been shipped to the pulverizing mill at Montreal. The resultant fine white powder is made use of for various purposes, such as lubricants, paper filler, &c., &c. Though not so pure or soft as the fine grades of talc, it yet replaces the latter largely where chemical purity is not a prime necessity. Mr. Jackson intends resuming production this spring the same as usual, and may also erect his own crushing and pulverizing plant near the mine which will allow of considerable increase in his sales, whereas these are now confined to the one market, that of the crushing plant at Montreal.

Zenith Zinc Mine.

Mining has progressed steadily on a small scale during the past year with the result that about 800 tons of ore, averaging 45 per cent. zinc, were mined, cobbed, sacked and taken over the 13-mile road to the shore of lake Superior; hauling having just been completed at the time I visited the property, 5th March 1902 A rough dock was being built into the lake to allow of loading the ore into the vessels in which it will be shipped to refineries either to Belgium, as formerly, or to the United States. The foreman is now Mr. Sage, and the force numbers 14 of whom 6 are miners, while during the past month 13 others were temporarily employed in sacking the ore.

The owners, the Grand Calumet Mining Company of Ottawa, Ont., have not undertaken any systematic plan of development the stoping out of the above ore from the biggest showings in the various old workings leaving the property in practically the same state as before. No. 1 shaft at its depth of 30 feet was enlarged to 20 by 20 feet, in the west side a 10-foot winze sunk, in size 6 by 12 feet, and at the surface some underhand stoping done, producing in all 80 tons of ore. Small stringers and pockets of zincblende show on all the shaft faces, and on the west side the continuation of the ore body in the winze extends up to the surface one or two feet wide in irregular outline but probably large enough to pay to follow. The tunnel was driven a few feet further, total length now 80 feet, and discontinued as no more ore struck, but from the whole working, including the open cut at its mouth, 40 tons were extracted. Between No. 1 shaft and the tunnel an outcropping of blende gave 20 tons from an underhand open stope. From the two old open cuts on the brow of the hill 160 tons further were mined by stoping 6 feet deeper still leaving a fair showing of ore in the bottom. No. 2 shaft at the west side of the hill is now down 50 feet, an increase of 15 feet, the last 8 forming a sump below the level floor into which the bucket drops for loading. The first level was abandoned and closed up, no ore being found therein. In the second level at 42 feet depth the east drift 42 feet in length was originally run at 38 feet depth followed by the removal of a 4-foot underhand level now 25 feet in, and along which a lens of ore lies from 2 to 8 feet wide, its upper edge pinching out in the roof. The first level 6 feet above shows no ore at all, but in the floor ore fills the drift from wall to wall and strikes about northeast-southwest with dip of 60° north. Considerable ore has also been mined from around the mouth of the shaft which with that from underground totals some 500 tons. This No. 2 shaft, now the only working place on the property, has been re-timbered with an 8 by 10-foot collar 20 feet deep down which the pole skids and ladders extend.

The mining plant consists of a 20-h.p. vertical boiler, a duplex $6\frac{1}{4}$ by 8 inch cylinder single 2 by 2-foot drum hoist-engine using $\frac{1}{2}$-inch steel rope and a pump set up in a new building at the mouth of No. 2 shaft, with a swinging arm derrick for the steel bucket. The two machine drills are using steam power. Instructions were left to build a suitable dynamite magazine, and to take greater precautions in using the explosive.

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